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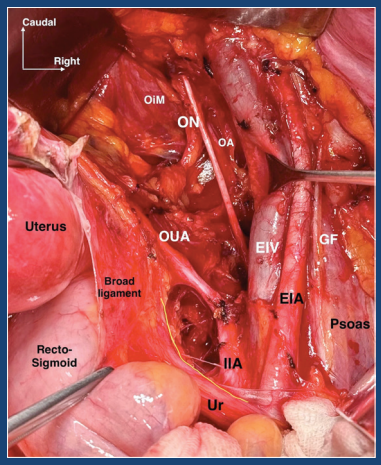

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Cover Picture: İlker Selçuk et al. Pelvic avascular spaces

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Aims and Scope

Journal of the Turkish-German Gynecological Association is the official, open access publication of the Turkish-German Gynecological Education and Research Foundation and Turkish-German Gynecological Association and is published quarterly on March, June, September and December. The publication language of the journal is English. Manuscripts are reviewed in accordance with "double-blind peer review" process for both reviewers and authors.

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The ''Journal of the Turkish-German Gynecological Association'' (EISSN 1309-0380; Abbreviated as "J Turk Ger Gynecol Assoc") is the official, open access publication of the Turkish-German Gynecological Education and Research Foundation and the Turkish-German Gynecological Association. Formerly named "ARTEMIS", the journal is published quarterly (March, June, September, December) in English and publishes original peer-reviewed articles, reviews, and commentaries in the fields of Gynecology, Gynecologic Oncology, Endocrinology & Reproductive Medicine and Obstetrics. Case reports are not accepted for publication. Reviews will be considered for publication only if they are prepared by authors who have at least three published manuscripts in international peer reviewed journals and these studies should be cited in the review. Otherwise only invited reviews will be considered for peer review from qualified experts in the area.

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PRISMA for preferred reporting items for systematic reviews and meta-analyses (Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 2009; 6(7): e1000097.) (http://www.prisma-statement.org/),

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MOOSE guidelines for meta-analysis and systemic reviews of observational studies (Stroup DF, Berlin JA, Morton SC, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting Meta-analysis of observational Studies in Epidemiology (MOOSE) group. JAMA 2000; 283: 2008-12).

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degree(s) of the author(s) and source(s) of the work or study, a short title (running head) of no more than 50 characters. The name, address, telephone (including the mobile phone number) and fax numbers and e-mail address of the corresponding author should be listed on the title page.

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All manuscripts should be accompanied by an abstract. A structured abstract is required with original articles and it should include the following subheadings: Objective, Material and Methods, Results and Conclusion. A structured abstract is not required with review articles. The abstract should be limited to 250 words for original articles and review articles.

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Describe the plan, the patients, experimental animals, material and controls, the methods and procedures utilized, and the statistical method(s) employed. In addition to the normal peer review procedure, all randomized controlled trials (RCTs) submitted to the journal are sent to members of a team of professional medical statisticians for reviewing.

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Present the detailed findings supported with statistical methods. Figures and tables should supplement, not duplicate the text; presentation of data in either one or the other will suffice. Emphasize only your important observations; do not compare your observations with those of others. Such comparisons and comments are reserved for the discussion section.

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Book;

Kohler G; Egelkraut H. In Kohler G and Egelkraut H (edts).Munchener Funktionelle Entwicklungsdiagnostik im zweitem und drittem Lebensjahr. Handanweisung. Munchen: Uni Munchen, Institut fur Soziale Paediatrie und Jugendmedizin; 1984.

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Editorial

Dear Colleagues,

It is my great pleasure to introduce the second issue of the "Journal of the Turkish-German Gynecological Association (J Turk Ger Gynecol Assoc)" in the publishing year of 2026. This issue is consisted of seven articles, and one review that we hope you will read with interest. Also you may have the oppurtunity to read the quiz. Here we share some of our favorite articles that were published in this issue of the journal.

Gestational diabetes mellitus (GDM) is linked to adverse obstetrical outcomes, especially fetal macrosomia. Recent findings suggest that even women with mildly elevated glucose levels during antepartum GDM screening remain at risk for fetal macrosomia. A study comparing perinatal, neonatal, and early childhood outcomes among three groups of pregnant women based on glucose tolerance status: those diagnosed with gestational diabetes, those with normal glucose tolerance, and those with only one abnormal value on the oral glucose tolerance test will be available for you to read.

The most prevalent HPV-related illness is unquestionably cervical cancer. Persistent genital high-risk HPV infection accounts for about 99.7% of cervical cancer cases. The link between HPV and squamous cell carcinoma of the cervix is stronger than the link between smoking and lung cancer. Globally, cervical cancer ranks among the most common cancers in women. There is limited understanding of how HPV-31 is associated with cervical intraepithelial lesions. You will also have the opportunity to read a meta-analysis assessing the final histopathological outcomes in patients who tested positive for HPV-31.

Dear Participants,

I would also like to remind you about the seventh Social Responsibility Project organized by the Turkish German Gynecological Education and Research Foundation, scheduled for June 5-6, 2026, in Van-Türkiye. This initiative, taking place in this beautiful city, is traditionally structured into four steps: a public awareness meeting involving local community members, a scientific conference attended by health professionals, the execution of advanced surgeries and medical examinations/screenings for local women, and ultimately, a donation of medical equipment to a local hospital. We believe that our project will be deemed successful if we can prevent even a single maternal death. It is these small efforts that may ultimately pave the way for a significant change. We would be delighted to have our colleagues participate in this intensive scientific endeavor.

Please also save the dates **"28 April-2 May 2027"** in your calendars for the 16th Turkish German Gynecology Congress which will be held in Antalya.

Dear Esteemed Readers, Authors and Reviewers,

Our goal is to shorten turnaround times inside the editorial system with an emphasis on offering thorough explanations for adverse judgments (especially those made without external review) for help with correction and resubmission elsewhere. J Turk Ger Gynecol Assoc also supports Open Access. By allowing researchers to freely share their work, we may accelerate scientific advancements and promote interdisciplinary collaboration. Visit us online at www.jtgga.org, and follow us on Twitter at @JtggaOfficial to stay in contact.

We are looking forward to receiving your valuable submissions, thank you in advance for your contributions.

Sincerely,

Prof. Cihat Ünlü, M.D.
Editor in Chief of *J Turk Ger Gynecol Assoc*
President of TGGF

Large population-based assessment of SARS-CoV-2 teratogenicity by profiling congenital anomalies during COVID-19 pandemic

Susan Jehangir[1,2], Preethi R. Navaneethan[3], Reka Karuppasami[4], Manisha Madhai Beck[3], Benjamin J. Ross[5], Manish Kumar[5], Sridhar Santhanam[5], Sundeep Kisku[1], John Fletcher[6]

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Abstract

Objective: This study examined population-level trends in congenital anomalies before and during the coronavirus disease-19 (COVID-19) pandemic in India, which experienced one of the most severe COVID-19 outbreaks with multiple devastating waves.

Material and Methods: We conducted a retrospective analysis of prospectively collected data from the Antenatal Detection of Congenital Anomalies registry between pre-pandemic (January 2018-May 2020) and pandemic (June 2020-December 2022). Time series analysis examined temporal trends and seasonal patterns.

Results: Among 175,749 prenatal scans, 2.895 congenital anomalies were detected (overall rate 16.5 per 1,000 scans). Detection rates were similar pre-pandemic (14.8 per 1,000 scans, n=1.370) and during the pandemic (18.3 per 1.000 scans, n=1.525; p=0.096). The distribution of anomalies by organ system remained consistent, with head/neck and genitourinary anomalies predominating (19-23% and 14-22% annually, respectively). A persistent seasonal pattern was observed, with peaks in the fourth quarter annually (mean November: 62.7 cases) and troughs at the beginning of each year (mean January: 36.8 cases). The Seasonal Autoregressive Integrated Moving Average model accurately predicted 2023 trends confirming the stability of the epidemiologic process.

Conclusion: Our large-scale study provides compelling evidence that the COVID-19 pandemic was not associated with a change in the rate or pattern of congenital anomalies at the population level. The discovery of a robust seasonal variation in anomaly detection represents a significant finding that demands detailed delineation to inform preventive strategies. [J Turk Ger Gynecol Assoc. 2026; 27(2): 76-83]

Keywords: COVID-19, SARS-CoV-2, congenital anomaly, birth defect, teratogenicity

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Introduction

Congenital anomalies affect approximately 3-6% of births globally and remain a leading cause of infant mortality (1,2). Structural malformations are caused by disruptions during organogenesis in the first trimester of pregnancy (weeks 1-13 of gestation) (3). Understanding the factors that influence these disruptions is important to inform preventive strategies and prenatal counselling.

On March 11, 2020, the World Health Organization declared the coronavirus disease-19 (COVID-19) pandemic a public health emergency. It severely disrupted healthcare systems worldwide. Concerns were raised regarding the potential teratogenic effects of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (4,5). Evidence emerged that linked maternal SARS-CoV-2 infection to adverse pregnancy outcomes associated with placental dysfunction, fetal distress, preterm birth, low birth weight, and increased neonatal intensive care unit admissions (6). Multiple mechanisms were proposed for potential teratogenic effects, including direct viral infection by vertical transmission, use of antivirals and corticosteroids or alternate medicine in the mother, vaccination, and indirect factors, such as disrupted prenatal care for chronic conditions (diabetes, hypertension), maternal stress, and nutritional changes during the pandemic period (7-9).

Since 2020, studies examining the association between COVID-19 and congenital anomalies have yielded inconsistent results.

India experienced one of the world's largest COVID-19 outbreaks, accounting for approximately one-fifth of global cases during the pandemic period (10). The large population, substantial disease burden during multiple pandemic waves, and genetic diversity provide a unique opportunity to examine population-level trends in congenital anomalies. Furthermore, the endogamous structure of many Indian populations may amplify detection of recessive genetic conditions, potentially making this population particularly informative for studying any systematic changes in anomaly patterns.

The aim of the present study was to investigate whether the COVID-19 pandemic period was associated with changes in the rates, patterns, or temporal trends of structural congenital anomalies detected during routine prenatal screening in Tamil Nadu, South India. We employed time series analysis to characterize baseline patterns and pandemic-era trends, providing population-level evidence in real-world settings to guide clinical practice.

Material and Methods

Study design and setting

This retrospective cohort study analyzed prospectively collected data from a large tertiary care maternity center in Tamil Nadu, South India. This study was approved by the Ethics Committee of Christian Medical College (approval number: ECR/326/INST/TN/2013/RR-2019, date: 19.05.2023), and the requirement for individual informed consent was waived given the use of de-identified registry data.

Data source

Data were obtained from the Antenatal Detection of Congenital Anomalies (ADAC) registry, a prospectively maintained institutional database. The registry systematically records all structural anomalies detected during routine prenatal ultrasound examinations. All pregnant women receiving prenatal care at our institution undergo standardized ultrasound screening, including a first trimester scan (11-14 weeks gestation) and a second trimester anomaly scan (18-24 weeks gestation; comprehensive fetal anatomical survey following International Society of Ultrasound in Obstetrics and Gynecology guidelines) (11,12). All scans were performed by certified sonographers, using standardized protocols and equipment. Detected anomalies were reviewed and confirmed by maternal-fetal medicine specialists. Anomalies were classified according to the International Classification of Diseases, 10th revision coding system and categorized by primary organ system affected.

Study periods and exposure definition

The study period spanned 60 months from January 2018 through December 2022. Based on the WHO pandemic declaration (March 11, 2020) and the emergence of the first confirmed COVID-19 case in Tamil Nadu on March 7, 2020, we defined study periods as follows: pre-pandemic period: January 2018 through May 2020 (29 months) and pandemic period: June 2020 through December 2022 (31 months). The June 2020 start date for the pandemic period accounts for the approximate 3-month lag between potential first-trimester SARS-CoV-2 exposure (following pandemic onset in March 2020) and detection at the routine 18-24 week anomaly scan.

Statistical analysis

Categorical variables are presented as frequencies and percentages, continuous variables as means with standard deviations (SDs) or medians with interquartile ranges, as appropriate. The chi-square test was used to compare anomaly detection rates between periods. Two-sided p-values <0.05 were considered statistically significant.

Time series analysis

Time series decomposition was performed to examine trend, seasonal, and irregular components. The augmented Dickey-Fuller test assessed data stationarity (test statistic -4.86, $p<0.001$, indicating stationarity). Given the pronounced seasonal

pattern in the data, we employed Seasonal Autoregressive Integrated Moving Average (SARIMA) modeling. The general $SARIMA_{(p,d,q)}(P,D,Q)_s$ model structure includes p: order of non-seasonal autoregressive component, d: order of non-seasonal differencing, q: order of non-seasonal moving average component, P: order of seasonal autoregressive component, D: order of seasonal differencing, Q: order of seasonal moving average component, s: seasonal period (12 months). Model selection was based on minimization of the Akaike Information Criterion and Bayesian Information Criterion, along with examination of residual autocorrelation function and partial autocorrelation function plots. The optimal model, $SARIMA(0,0,0)(0,1,1)_{12}$, was validated using the Ljung-Box test for residual autocorrelation. All statistical analyses were performed using R version 4.3.2 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Study population and scan volume

During the 60-month study period, 175,749 prenatal ultrasound scans were performed and recorded in the ADAC registry. The pre-pandemic period (January 2018-May 2020) included 92,364 scans, while the pandemic period (June 2020-December 2022) included 83,385 scans.

Anomaly detection rates

A total of 2,895 structural congenital anomalies were identified during the study period, yielding an overall detection rate of 16.5 per 1,000 scans [95% confidence interval (CI): 15.9-17.1]. In the pre-pandemic period, 1,370 anomalies were detected among 92,364 scans [rate: 14.8 per 1,000 scans (95% CI: 14.1-15.6)]. In the pandemic period 1,525 anomalies were detected among 83,385 scans [rate: 18.3 per 1,000 scans (95% CI: 17.4-19.2)]. The difference in detection rates between periods was not statistically significant ($p=0.096$).

Distribution by organ system

The distribution of congenital anomalies by primary organ system affected remained remarkably consistent across both periods (Figure 1). The most frequently detected categories were head and neck anomalies (19-23% annually; including neural tube defects, craniofacial malformations, and brain anomalies) and genitourinary anomalies (14-22% annually including renal agenesis, hydronephrosis, and urinary tract malformations). Multiple system anomalies were 15-20% annually. No significant shift in the proportional distribution of anomaly types was observed between pre-pandemic and pandemic periods ($p=0.342$).

Temporal trends and seasonality

Time series decomposition revealed a striking and consistent seasonal pattern throughout the entire study period, persisting across both pre-pandemic and pandemic periods (Figure 2). Monthly anomaly detection showed peak detection in the fourth quarter (October-December) every year (October: mean 56.1 cases (SD: 7.8, range 45-69); November: mean 62.7 cases (SD: 8.9, range 48-78); December: mean 58.4 cases (SD: 9.2, range 42-case). A trough in detection was seen in the first quarter (January-March) of every year [January: mean 36.8 cases (SD: 5.6, range 28-47]; February: mean 38.2 cases (SD: 4.9, range 31-48); March: mean 41.5 cases [SD: 6.2, range 33-52)]. Intermediate rates occurred in the remaining months, April-September (mean range: 45.3-52.8 cases). July showed the highest variability (SD: 12.8). The coefficient of seasonal variation was 28.4%, indicating substantial periodic fluctuation.

SARIMA model and forecasting

The Augmented Dickey-Fuller test was performed to assess data stationarity with a test statistic of -4.86 ($p<0.001$). The optimal SARIMA model was used to predict anomalies for each month in the post-pandemic period, including 2023. The forecast demonstrated a continuation of the existing trend with seasonal patterns, accompanied by expanding CIs, reflecting appropriate increased uncertainty in long-term predictions (Figure 3). The actual and predicted values for the year 2023 are listed in Table 1. The actual values were within the upper and lower proximity limits for each month, respectively. In general, the predicted values were comparable to the actual values, indicating that the model could capture the underlying patterns in the data.

Discussion

The Indian population is highly endogamous in nature, characterized by sympatric isolation patterns which provides a unique and powerful “real-world” setting to investigate teratogenicity. This genetic structure can amplify the detection of subtle shifts in anomaly rates or the emergence of specific malformation patterns, making this population particularly sensitive for identifying new environmental insults, such as a potential viral teratogen.

This large registry-based study of 175,749 prenatal scans over five years found no significant change in the rate or pattern of structural congenital anomalies detected during the COVID-19 pandemic period compared to the pre-pandemic baseline. Although India faced one of the most severe COVID-19 outbreaks, marked by multiple waves impacting millions, the anomaly detection rate remained consistently stable at approximately 15-18 per 1,000 scans throughout the study period. Further, the distribution of anomalies by organ system remained

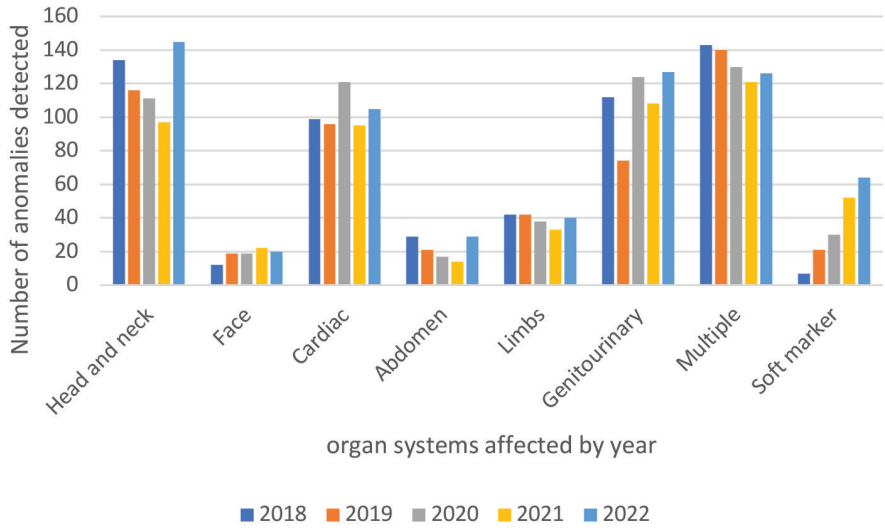

Figure 1. Distribution of detected anomalies by organ system from 2018 to 2022. The bar chart shows the number of anomalies detected across different organ systems. Each color represents a different year (2018–2022), allowing comparison of temporal trends in anomaly detection across organ systems

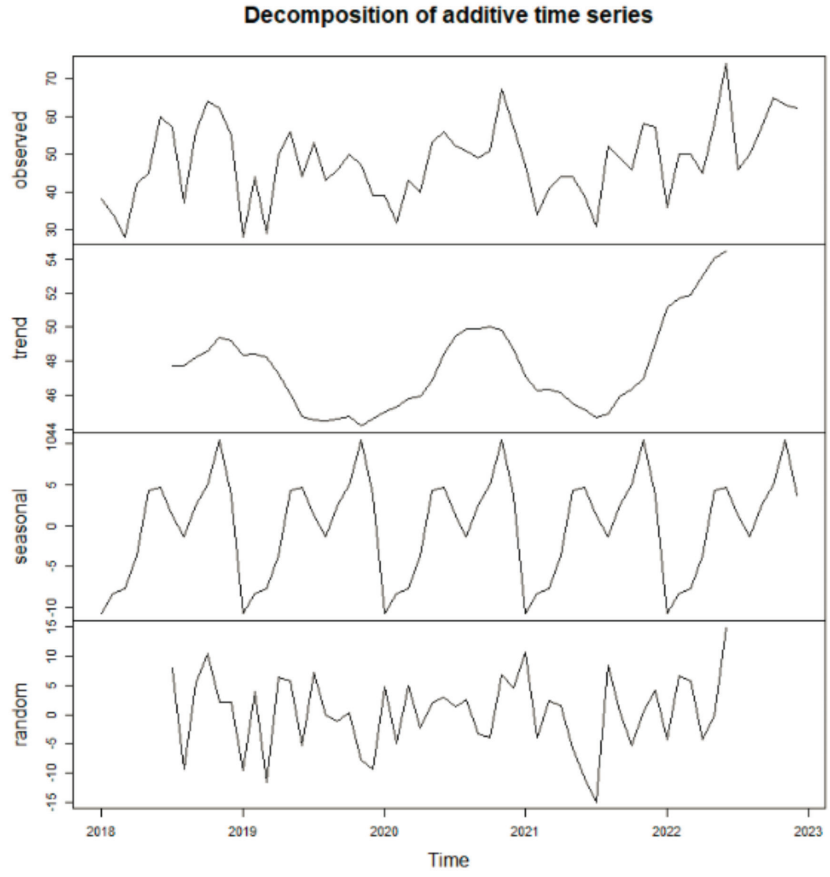

Figure 2. Additive time series decomposition of total anomalies from 2018–2022. The top panel shows the observed time series of total anomalies. The second panel represents the trend component, indicating the long-term progression of anomalies after removing seasonal effects. The third panel displays the seasonal component, reflecting repeating periodic patterns within each year. The bottom panel shows the random component, which represents irregular fluctuations remaining after removing both trend and seasonal effects

consistent, with head/neck and genitourinary malformations predominating. A marked and persistent seasonal pattern in anomaly detection with consistent fourth-quarter peaks and first-quarter troughs was noted, that was unaffected by the pandemic. Time series modelling accurately predicted future trends, suggesting stable underlying epidemiological patterns.

Our findings contribute to a growing but inconsistent body of literature examining the relationship between COVID-19 and congenital anomalies. An Iranian national birth registry analysis compared births during COVID-19 (Nov 2020-Feb 2021) with pre-pandemic births (Nov 2019-Feb 2020). Although the study period was only three months they found significantly increased incidence of congenital birth anomalies during the pandemic ($p<0.00001$), with particular increases in central nervous system ($p=0.04$) and genitourinary anomalies ($p=0.03$) (13). Auger et al. (14) performed an interrupted time series analysis of pre- and post-pandemic period and confirmed that the frequency of microcephaly increased during the late pandemic period. A study from China reported increased incidence of congenital heart disease during the pandemic, with incidence rates rising from 1.12% in 2020 to 5.46% in 2023 ($p<0.001$) (15). Among mothers with COVID-19 infection, 11 of 12 cardiac abnormalities occurred when infection happened before 8 weeks gestation. Studies from Iraq and Pakistan reported upward trends in neural tube defects during the pandemic (16,17). Another study reported association between SARS-CoV-2 infection during early weeks of gestation with situs inversus (18). Notably absent is the consistent pattern of specific anomalies that characterizes known teratogenic viral infections such as rubella, CMV, and Zika (19-22).

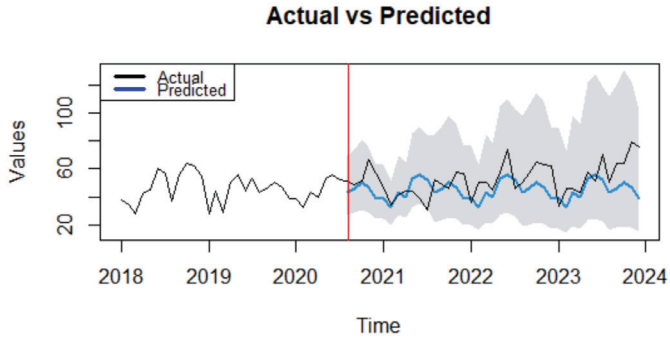

Figure 3. Observed and Seasonal Autoregressive Integrated Moving Average (SARIMA) predicted values of total anomalies. The black line represents the observed values from 2018 to 2023. The red vertical line indicates the start of the forecasting period (June 2020). The blue line shows the SARIMA model predictions for the post-training period. The grey shaded region represents the 95% prediction interval, illustrating the uncertainty associated with the forecast estimates. The widening of the interval over time reflects increasing uncertainty in longer term predictions

These findings must be considered alongside substantial evidence showing no meaningful associations. A prospective Nordic registry-based study included 343,066 liveborn singleton infants with pregnancies starting between March 2020 and February 2022 (23). Among 17,704 (5.2%) infants with major congenital anomalies, adjusted odds ratios for COVID-19 infection during the first trimester ranged from 0.84 (95% CI 0.51-1.40) for eye anomalies to 1.12 (0.68-1.84) for oro-facial clefts. The study concluded that COVID-19 infection and vaccination during the first trimester were not associated with risk of congenital anomalies. International Registry of Coronavirus Exposure in Pregnancy cohort study found that

Table 1. Actual and predicted values for 2023

Months	Actual value	Forecast value	Uncertainty limits	
			95 LCL	95 UCL
January 23	33	41	27.75	59.93
February 23	46	42	28.70	61.99
March 23	46	42	28.34	61.20
April 23	43	48	32.78	70.80
May 23	58	56	37.99	82.05
June 23	51	59	39.93	86.24
July 23	70	50	34.32	74.12
August 23	50	51	34.74	75.02
September 23	64	56	38.23	82.56
October 23	64	60	40.76	88.02
November 23	79	65	44.05	95.14
December 23	76	59	40.12	86.64

LCL: Lower confidence limit, UCL: Upper confidence limit

in pregnancies exposed to SARS-CoV-2 in the first trimester, the risk of any major congenital malformation did not differ significantly from an internal reference group with negative SARS-CoV-2 tests (24).

Several contextual factors warrant consideration in attributing to this disparity. Changes in healthcare access and prenatal screening practices during the pandemic may have influenced both detection and reporting of anomalies. The positive studies face challenges including healthcare disruption affecting case ascertainment, potential confounding from disease severity and treatment approaches, and in some cases, reliance on population-level rather than individual exposure data. The pandemic period saw increases in maternal stress, depression, metabolic dysregulation, delayed management of chronic conditions (diabetes, hypertension), and use of alternative medications (7-9,25). Changes in ultrasound protocols, operator experience (reassignment of personnel), or threshold for anomaly reporting may have occurred. Furthermore, women pregnant during the pandemic were reportedly older, more likely nulliparous, had higher BMI, and had higher rates of diabetes and hypertension which are all risk factors for congenital anomalies (7-9).

The consistent fourth-quarter peaks and first-quarter troughs in congenital anomaly detection in Tamil Nadu highlight a robust seasonal pattern that persisted across pre- and post-COVID-19 periods, suggesting structural, biological, or behavioral drivers, rather than SARS-CoV-2. In tropical regions such as Tamil Nadu, influenza and respiratory syncytial virus peak during July-August, coinciding with the monsoon season (26). Maternal infections during the periconceptional period may influence fetal development through direct teratogenic effects, immune-mediated mechanisms, or fever-related hyperthermia, all linked to anomalies such as neural tube and cardiac defects (27,28). The timing is compelling: infections in July-August affect conceptions in June-August, with anomaly scans at 18-22 weeks falling in October-December, matching observed peaks.

Nutritional seasonality also plays a role. Reduced availability of leafy greens during monsoon may lower folate intake, a critical factor in preventing neural tube defects (29). Cloud cover and reduced outdoor activity may impair vitamin D synthesis, while pre-harvest “hungry seasons” can exacerbate maternal undernutrition, affecting organogenesis (30). Environmental exposures during monsoon further compound risks. Increased gastrointestinal infections, pesticide exposure during agricultural cycles, and indoor air pollution from biomass fuels all pose potential teratogenic threats. Monsoon-related transport challenges can delay access to healthcare, while agricultural demands may postpone prenatal visits. Hospital workflow variations could theoretically affect detection rates, but the persistence of seasonal peaks despite pandemic disruptions argues against purely operational causes.

Prospective, multidisciplinary studies that integrate epidemiological surveillance with biological and environmental monitoring are required to test these hypotheses. Longitudinal cohort studies following women from the periconceptional period through pregnancy could capture viral exposure, nutritional status, and environmental factors in real time, while linking them to anomaly outcomes. Pre- and post-conceptual testing for folate, vitamin D, and markers of immune activation during febrile illness, would help clarify mechanistic pathways. Geospatial mapping of agricultural cycles, pesticide use, and healthcare access during monsoon seasons could provide contextual correlations, while qualitative studies on maternal health-seeking behavior would add sociocultural dimensions. Importantly, harmonizing anomaly detection protocols across centers and ensuring standardized timing of scans would minimize operational bias. Together, these approaches would unravel the biological, nutritional, environmental, and behavioral contributions to the observed seasonality, thereby strengthening causal inference and informing targeted public health interventions.

Study limitations

This study has several acknowledged limitations. We used population-level timing rather than individual-level SARS-CoV-2 infection or vaccination data, precluding assessment of infection timing relative to organogenesis, disease severity, or immunological responses, thus potentially masking individual-level associations. Registry-based ultrasound detection cannot capture subtle anomalies, postnatal diagnoses, early pregnancy losses, or pregnancy outcomes (terminations, stillbirths), and detection sensitivity may vary by operator experience or anomaly type. While adequately powered for overall rates, the study had limited ability to detect changes in specific rare anomalies or definitively distinguish biological from operational causes of seasonal variation. The available data did not permit sensitivity analyses. The 2.5-year pandemic follow-up may be insufficient to capture subtle or delayed effects. The single-center design limits generalizability to populations with different genetic backgrounds, healthcare systems, or pandemic experiences.

Further, the 10% decrease in scan volume during initial lockdowns (April-June 2020) suggests potential selection bias if healthcare access disruption differentially affected specific risk groups. We could not adjust for important confounders including maternal age, parity, BMI, chronic conditions (diabetes, hypertension), medications, socioeconomic factors, stress, or nutrition. Despite these limitations, strengths include the large sample size (175,749 scans),

a prospectively maintained pre-pandemic registry, standardized protocols, robust statistical methods including time series analysis, validation through accurate 2023 forecasting, and representation of a high COVID-19 burden setting maximizing potential to detect population-level effects

As COVID-19 transitions from pandemic to endemic status globally, these findings support continued reassurance during prenatal counselling. Furthermore, they highlight the critical importance of maintaining robust prenatal screening programs and registry systems during public health emergencies.

Conclusion

Over the five-year study period, prenatal ultrasound anomaly detection rates showed a modest increase during the pandemic compared to the pre-pandemic phase, though this difference was not statistically significant. The types of anomalies detected remained consistent, with head/neck and genitourinary anomalies being the most common, and no notable shifts in organ system distribution were observed. A clear seasonal pattern persisted throughout, with higher detection rates in the final quarter of each year and lower rates in the first quarter. Forecasting using a SARIMA model successfully captured these temporal trends, indicating stable anomaly surveillance and predictable seasonal variation despite external disruptions.

Ethics

Ethics Committee Approval: *This study was approved by the Ethics Committee of Christian Medical College (approval number: ECR/326/INST/TN/2013/RR-2019, date: 19.05.2023).*

Informed Consent: *The requirement for individual informed consent was waived given the use of de-identified registry data.*

Footnotes

Author Contributions: *Surgical and Medical Practices: S.J., M.M.B., P.R.N., M.K., S.S., B.J.R., J.F., Concept: S.J., J.F., Design: S.J, J.F., R.K., M.M.B., S.S., Data Collection or Processing: P.R.N., B.J.R., R.K., Analysis or Interpretation: S.J., J.F., M.M.B., Literature Search: S.J., M.M.B., P.R.N., Writing: S.J., J.F., R.K.*

Conflict of Interest: *No conflict of interest is declared by the authors.*

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Belief in sexual myths and sociocultural factors associated with vaginismus: a case-control study in Turkish women

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Abstract

Objective: To investigate the relationship between belief in sexual myths and the presence of vaginismus, and to evaluate the influence of sociodemographic and cultural factors on sexual myth endorsement among Turkish women.

Material and Methods: This case-control study included women diagnosed with vaginismus and an equal number of age-matched women without sexual dysfunction. Participants completed a sociodemographic questionnaire and the sexual myths scale (SMS). Comparative analyses were conducted to assess differences in total and subscale scores between groups, and multiple regression analysis was performed to evaluate the predictive role of sociodemographic variables on belief in sexual myths.

Results: Women with vaginismus (n=40) had significantly higher total scores on the SMS compared to the control group (n=40; $p<0.001$). Subscale analyses revealed that myths related to sexuality, gender roles, and sexual morality were more strongly endorsed by women with vaginismus. Multiple regression analysis showed that lower education level, conservative family background, and rural upbringing were significant predictors of stronger belief in sexual myths ($p<0.05$).

Conclusion: The findings suggest that belief in sexual myths is more prevalent among women with vaginismus and is influenced by key sociodemographic and cultural factors. Addressing these beliefs through culturally sensitive education and psychosexual interventions may enhance the effectiveness of vaginismus treatment. [J Turk Ger Gynecol Assoc. 2026; 27(2): 84-92]

Keywords: Vaginismus, sexual myths, sociocultural factors, sexual dysfunction, psychosexual beliefs

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Introduction

Vaginismus [*Diagnostic and Statistical Manual of Mental Disorders* (DSM)-5: genito-pelvic pain/penetration disorder] is a painful condition in which sexual intercourse becomes impossible due to involuntary contractions of the outer third of the vaginal muscles, resulting in pain and/or fear during attempted penetration (1,2). It is not only a physical condition, but also a psychosomatic crisis where both mental and physical symptoms coexist (1,3). Vaginismus is considered a multifactorial disorder and is increasingly recognized as one of the most common sexual problems among women today. In addition, sexual myths are known to contribute to sexual dysfunctions but are often overlooked or poorly addressed.

From a theoretical perspective, sexual myths can be understood within the framework of sexual script theory and sociocultural

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learning paradigms (4,5). According to sexual script theory, individuals internalize culturally transmitted "scripts" that dictate acceptable sexual behaviors and reinforce gendered expectations (6). These culturally learned narratives are further maintained through socialization within family, media, and religious settings (7). Sexual myths are unscientific beliefs and stereotypes about sexuality that are widely accepted within society and often passed down through generations without question (8-11). These myths tend to flourish in traditional cultures where sexuality is viewed as taboo, shameful, or inappropriate to discuss openly (10-12). As a result, these myths may contribute to distorted perceptions of sexuality, unrealistic expectations, and increased anxiety surrounding sexual experiences, particularly among women. Studies have shown that inadequate sexual education, lack of accurate information, and limited communication on sexual matters further reinforce these misconceptions (13). In such contexts, women often have insufficient knowledge about both their own and their partner's sexual functioning, which may lead to low self-esteem, relational problems, and ultimately sexual dysfunctions, including vaginismus (9,14,15).

Despite the growing recognition of vaginismus as a complex and multifactorial condition, the role of sexual myths surrounding its development and persistence remains underexplored. Cross-cultural research demonstrates considerable variation in the reported prevalence and clinical presentation of vaginismus. Population-based studies in Western countries have found prevalence rates between 0.8% and 7%, whereas rates in clinical and community samples from Asia and the Middle East are often substantially higher (16,17). These regional differences are thought to reflect diverse sociocultural norms, levels of sexual education, and openness in discussing sexual issues (7,18). Studies from Arab and Muslim-majority settings further indicate that limited premarital sexual communication, modesty norms, and gendered expectations shape both symptom expression and help-seeking behavior (19). Understanding these cultural nuances is essential for contextualizing the current findings within the global literature.

Therefore, this study was conducted to investigate the relationship between belief in sexual myths and vaginismus by comparing women diagnosed with the condition to a control group without sexual dysfunction. The goal was to explore whether a higher endorsement of sexual myths was associated with the presence of vaginismus. Furthermore, the study aimed to explore how sociodemographic characteristics influence belief in sexual myths within both groups.

Material and Methods

This study was approved by the Ankara Medipol University Non-Interventional Clinical Research Ethics Committee (approval number: 128, date: 18.10.2023) and institutional permission. The participants were recruited through convenience sampling among women who consecutively attended the outpatient gynecology clinic during the study period and met the inclusion criteria.

The participants were divided into two groups: women diagnosed with vaginismus and women without any sexual dysfunction. The diagnosis of vaginismus was made by a gynecologist based on clinical examination and according to the DSM-5 criteria for genito-pelvic pain/penetration disorder. The diagnosis was supported by the presence of recurrent involuntary contraction of the pelvic floor muscles, marked fear or anxiety about vaginal penetration, and consistent avoidance behavior observed during gynecological evaluation. Participants with known psychiatric or neurological disorders, a history of sexual trauma, or any comorbid sexual dysfunctions other than vaginismus (such as dyspareunia, hypoactive sexual desire disorder, or anorgasmia) were excluded. Women currently receiving psychiatric treatment or using psychotropic medication were also not eligible. No additional structured psychometric or self-report instruments were administered.

The control group consisted of women who attended the outpatient clinic for reasons unrelated to sexual dysfunction and were evaluated as not having vaginismus or any sexual intercourse problems based on their clinical history and gynecological examination. These participants reported a history of regular vaginal intercourse without pain, fear, or avoidance behavior, and had no current or past diagnosis of any sexual dysfunction.

Data collection tools

After obtaining informed consent from each participant, data were collected through face-to-face interviews using the introductory information form and the sexual myths scale (SMS). The SMS was developed by Gölbaşı et al. (20) and its validity and reliability were confirmed in Turkish populations. The scale consists of 28 items rated on a 5-point Likert scale ranging from 1 (completely disagree) to 5 (completely agree). Higher scores indicate a greater belief in sexual myths.

The scale includes eight sub-dimensions:

1. **Sexual orientation (items 1–5):** e.g., "Homosexuality is a disease."
2. **Gender roles (items 6–11):** e.g., "Housework is a woman's duty."
3. **Age and sexuality (items 12–15):** e.g., "Sexual life ends with aging."
4. **Sexual behavior (items 16–18):** e.g., "Every stage of sexual intercourse must be under the man's control."
5. **Masturbation (items 19–20):** e.g., "Masturbation causes physical illness."

6. Sexual violence (items 21–24): e.g., "Non-consensual sexual intercourse between spouses cannot be considered rape."

7. Sexual intercourse (items 25–26): e.g., "Sexuality means sexual intercourse."

8. Sexual satisfaction (items 27–28): e.g., "Women can only reach orgasm through intercourse."

The total score of the SMS is calculated by summing the responses to all 28 items, while subscale scores are obtained by summing the relevant items within each sub-dimension. The scale does not include a cut-off point; higher scores indicate a stronger belief in sexual myths (20). The original Cronbach's alpha coefficient for the scale was reported as 0.91 (20). In the present study, internal consistency was found to be excellent, with Cronbach's alpha values of 0.941 in the control group and 0.961 in the vaginismus group.

Due to the sensitive nature of the subject, particular attention was paid to minimizing emotional discomfort and ensuring participant confidentiality and anonymity during data collection. All interviews were conducted in a private counseling room by a female researcher experienced in sexual health communication. Participants were informed that they could refuse to answer any question or withdraw from the study at any time without providing justification. To reduce potential response bias and social desirability effects, neutral, non-judgmental language was used, and participants were assured that there were no "right" or "wrong" answers. No identifying information was recorded on the questionnaires, and data were coded numerically to preserve anonymity. In case of emotional distress during or after the interview, participants were offered immediate psychological support through referral to the hospital's counseling service.

Statistical analysis

The beliefs in sexual myths and related factors were analyzed for both groups. Descriptive statistics are presented as mean, standard deviation, median, and interquartile range (25^{th}–75^{th} percentiles) for continuous variables, and as frequency and percentage for categorical variables. The normality of data distribution was assessed using the Kolmogorov–Smirnov test, histogram plots, skewness–kurtosis coefficients, and Q–Q plots.

Comparisons between the vaginismus and control groups were performed using the chi-square test or Fisher's exact test for categorical variables. For continuous variables, the independent samples t-test was used when normal distribution was present, and the Mann-Whitney U test was used for abnormal distribution. The total SMS score was normally distributed; thus, comparisons across more than two groups were conducted using the analysis of variance (ANOVA). The homogeneity of variances was evaluated using Levene's test. The one-way ANOVA test was applied when variances were homogeneous, and Welch's ANOVA was used when they were heterogeneous. Post-hoc analyses were performed using Tukey's test following the one-way ANOVA or Tamhane's T2 test following Welch's ANOVA, depending on the assumption of equal variances. Moreover, to control for potential confounding variables, a multiple linear regression analysis was conducted including education level, age, place of residence (urban/rural), and occupational status as covariates to evaluate their independent effects on the total SMS scores.

Results

Sociodemographic characteristics

A total of 80 women were included in the study, with 40 participants in the vaginismus group and 40 in the control group. The mean age was 25.3±2.8 years in the vaginismus group and 26.8±3.8 years in the control group ($p=0.070$). Similarly, there were no differences in terms of age categories (≤25 vs. >25 years), educational level of participants and their husbands, or marital duration ($p>0.05$ for all) between the two groups.

Although not significant, a higher proportion of women in the vaginismus group were housewives or workers, while civil servants were more frequent in the control group ($p=0.171$). The type of family (nuclear vs. extended), place of residence (urban vs. rural), and income level did not differ significantly between the groups, although a higher proportion of women in the vaginismus group resided in rural areas ($p=0.201$) and had medium or good income levels ($p=0.061$).

Overall, no significant differences were found between the groups in terms of sociodemographic characteristics (Table 1).

Beliefs in sexual myths and subscale comparisons

The total SMS score was significantly higher among women with vaginismus (95.3±15.2) compared to those without the condition (73.2±15.6; $p<0.001$). Similarly, all subscale scores of the SMS were significantly higher in the vaginismus group.

In the sexual orientation subscale, the mean score was 19.1±3.9 in the vaginismus group and 17.5±2.5 in the control group ($p=0.030$). The gender subscale showed a substantial difference between groups (15.1±5.3 vs. 10.0±4.0; $p<0.001$), as did the age and sexuality subscale (15.1±3.0 vs. 11.3±3.2; $p<0.001$).

Women with vaginismus also had significantly higher scores in the sexual behavior (11.3±2.3 vs. 7.6±2.6), masturbation (7.4±1.5 vs. 5.3±1.4), sexual violence (9.1±1.0 vs. 7.2±2.3), sexual intercourse (9.1±1.0 vs. 7.2±2.3), and sexual satisfaction (9.2±1.0 vs. 7.2±2.4) subscales ($p<0.001$ for all).

These findings suggest that women with vaginismus endorse sexual myths more strongly across all dimensions of the SMS (Table 2).

Table 1. Comparison of sociodemographic and related factors of participants vaginismus and control group

		Control group (n=40)*	Vaginismus group (n=40)*	p
Average age (SD)		26.8 (3.8)	25.3 (2.8)	0.070[a]
Age n (%)	≤25	15 (39.5)	23 (60.5)	0.073[b]
	>25	25 (59.5)	17 (40.5)	
Education level n (%)	Middle school	4 (50.0)	4 (50.0)	0.804[b]
	High school	14 (46.7)	16 (53.3)	
	Associate degree	6 (42.9)	8 (57.1)	
	Undergraduate	16 (57.1)	12 (42.9)	
Profession n (%)	Housewife	20 (50.0)	20 (50.0)	0.171[b]
	Civil servant	15 (65.2)	8 (34.8)	
	Worker	3 (30.0)	7 (70.0)	
	Other	2 (28.6)	5 (71.4)	
Education level (husband) n (%)	Middle school	2 (50.0)	2 (50.0)	0.915[b]
	High school	9 (52.9)	8 (47.1)	
	Associate degree	12 (44.4)	15 (55.6)	
	Undergraduate	17 (53.1)	15 (46.9)	
Profession (husband) n (%)	Civil servant	16 (64.0)	9 (36.0)	0.115[b]
	Worker	21 (47.7)	23 (52.3)	
	Other	3 (27.3)	8 (72.7)	
Marriage duration- years average (SD)		2.7 (2.5)	2 (2.1)	0.093[a]
Marriage duration	≤1 year	19 (41.3)	27 (58.7)	0.070[b]
	>1 year	21 (61.8)	13 (38.2)	
Family type	Core	36 (53.7)	31 (46.3)	0.130[b]
	Wide	4 (30.8)	9 (69.2)	
Place of residence	City center	39 (52.7)	35 (47.3)	0.201[c]
	District	1 (16.7)	5 (83.3)	
Income situation	Low	18 (64.3)	10 (35.7)	0.061[b]
	Medium/good	22 (42.3)	30 (57.7)	

*Row percentage is used
[a]Mann-Whitney U test, [b]chi-square test, [c]Fisher's exact test
SD: Standard deviation

Associations between sociodemographic characteristics and sexual myth beliefs

Among women without vaginismus, the total SMS scores varied significantly according to several sociodemographic variables. Participants with lower levels of education had significantly higher SMS scores ($p<0.001$), with the highest scores observed among those with only middle school education (87.4±1.5) and the lowest among university graduates (58.1±10.6). Profession was also associated with SMS scores, with housewives scoring significantly higher (83.3±9.6) than civil servants (58.9±12.7; $p<0.001$). Women with low income had higher SMS scores than those with medium or high income ($p<0.001$). Moreover, participants whose husbands were less educated or worked in manual labor had significantly higher SMS scores ($p<0.001$ for both). Other variables, such as age, marriage duration, family type, and place of residence, did not show significant associations with SMS scores in this group.

In the vaginismus group, similar patterns were observed. The total SMS scores were significantly higher among participants with lower education levels ($p=0.010$), housewives ($p=0.001$), and those whose husbands had lower education levels ($p=0.028$) or were employed as laborers rather than civil servants ($p=0.005$). Moreover, women living in rural areas had significantly higher SMS scores than those residing in city centers (110.8±5.8 vs. 93.1±14.8; $p=0.013$). However, variables such as age group, income level, marriage duration, and family type were not significantly associated with SMS scores within the vaginismus group.

Table 2. Comparison of the scores of those vaginismus and control group participants on SMS and its subscales

SMS and its subscales	Control group		Vaginismus group		p
	Mean (SD)[a]	Median (Q1-Q3)[b]	Mean (SD)[a]	Median (Q1-Q3)[b]	
Sexual orientation	17.5 (2.5)	17.0 (16.0-20.0)	19.1 (3.9)	19.5 (17.0-20.5)	**0.030**[c]
Gender	10.0 (4.0)	8.5 (6.5-12.5)	15.1 (5.3)	15.0 (12.0-18.0)	**<0.001**[d]
Age and sexuality	11.3 (3.2)	11.5 (9.0-13.0)	15.1 (3.0)	16.0 (14.5-16.0)	**<0.001**[d]
Sexual behavior	7.6 (2.6)	8.0 (6.0-9.0)	11.3 (2.3)	12.0 (9.5-12.0)	**<0.001**[d]
Masturbation	5.3 (1.4)	6.0 (5.0-6.0)	7.4 (1.5)	8.0 (6.0-8.0)	**<0.001**[d]
Sexual violence	7.2 (2.3)	8.0 (5.5-8.5)	9.1 (1.0)	10.0 (8.0-10.0)	**<0.001**[d]
Sexual intercourse	7.2 (2.3)	8.0 (5.5-8.5)	9.1 (1.0)	10.0 (8.0-10.0)	**<0.001**[d]
Sexual satisfaction	7.2 (2.4)	8.0 (6.0-8.5)	9.2 (1.0)	10.0 (8.0-10.0)	**<0.001**[d]
Total scale score	73.2 (15.6)	76.5 (64.5-85.0)	95.3 (15.2)	94.0 (87.5-106.0)	**<0.001**[c]

[a]Standard deviation, [b]25-75% first and third quartile values, [c]Independent two-sample t-test, [d]Mann-Whitney U test
SD: Standard deviation, SMS: Sexual myths scale

These findings suggest that lower education and occupational status, both for women and their partners, as well as place of residence, are associated with stronger belief in sexual myths and this trend appears to be stronger in women with vaginismus (Table 3).

Discussion

Sexual function and quality of life (QoL) are key dimensions affected across a broad spectrum of gynecologic and psychosexual disorders. Recent evidence demonstrates that genital pain, even outside the context of vaginismus, is associated with substantial reductions in sexual satisfaction, emotional wellbeing, and mental health (21). In a large population-based study, women reporting genital pain exhibited significantly lower scores on the female sexual function index and on all QoL domains compared with pain-free women, alongside higher levels of anxiety, depression, and sexual distress. Similarly, in women treated for cervical cancer, persistent pain, body image concerns, and hormonal changes have been shown to compromise both sexual functioning and QoL (22). These findings highlight that sexual health is a multidimensional construct influenced by physical, psychological, and cultural determinants. Within this broader context, vaginismus represents a functional condition that, although distinct from oncologic or chronic pain disorders, produces comparable impairments in intimacy, self-esteem, and overall wellbeing. Recognizing such parallels highlights the need for integrated, biopsychosocial models of assessment and treatment that address both the physical and emotional aspects of female sexual dysfunction.

Vaginismus is not merely a physiological condition but a complex phenomenon shaped by sociocultural norms, gender roles, and widely accepted yet inaccurate beliefs about sexuality. Among these, sexual myths, defined as exaggerated and scientifically unfounded beliefs, are frequently cited as contributing factors in the development of sexual dysfunctions, particularly in traditional societies where sexuality is often considered taboo and rarely discussed openly (17,23). In Türkiye, vaginismus is reported as the most common sexual health complaint among women seeking clinical support (23,24). One of the primary predisposing elements underlying this high prevalence appears to be the persistence of sexual myths. Doğan and Saraçoğlu (25) reported that women with vaginismus often lack adequate sexual knowledge and enter arranged marriages, which increases their vulnerability to such myths. Evidence also suggests that women who lack formal sexual knowledge, obtain information primarily from social media, or perceive sexuality negatively due to religious reasons are at higher risk of vaginismus. Thus, sociocultural factors and women's low sexual self-consciousness should be considered holistically in treatment approaches (26).

Psychological factors also play a significant role. Previous studies have identified elevated levels of anxiety, depression, and social phobia among women diagnosed with vaginismus (27-29). Furthermore, stronger belief in sexual myths has been associated with greater emotional distress, lower sexual satisfaction, and resistance to treatment (30-32). There is also evidence that women who fear pain, injury, bleeding, or losing control during penetration are more likely to develop vaginismus (33). Interviews with women who have successfully overcome vaginismus reveal that their experiences are not solely medical or individual in nature but deeply rooted in broader cultural narratives shaped by misinformation and silence surrounding sexuality (34,35). Understanding the role of cultural and religious influences on female sexual pain is particularly important for providing culturally competent care to

Table 3. Comparison of total SMS score of participants vaginismus and control group sociodemographic and related factors

		Control group (n=40)		Vaginismus group (n=40)	
		SMS total score mean (SD)	p	SMS total score mean (SD)	p
Age n (%)	≤25	77.7 (13.6)	0.159*	99.1 (13.0)	0.064*
	>25	70.5 (16.3)		90.2 (16.7)	
Education level n (%)	Middle school	87.4 (1.5)[a]	**<0.001****	104 (8.8)[a]	**0.010*****
	High school	84.5 (10.2)[a,b]		101.3 (13.6)[a]	
	Associate degree	77.3 (4.1)[b]		95.4 (13.5)[a,b]	
	Undergraduate	58.1 (10.6)[c]		84.2 (14.7)[b]	
Profession n (%)	Housewife	83.3 (9.6)[a]	**<0.001*****	104 (10.6)[a]	**<0.001*****
	Civil servant	58.9 (12.7)[b]		81.5 (16.0)[b,c]	
	Worker	79.7 (8.6)[a]		94.9 (13.8)[a,b]	
	Other	70.5 (7.8)[a,b]		83.6 (7.2)[b]	
Education level (husband) n (%)	Middle school	70.5 (26.2)[a-c]	**<0.001*****	103 (15.6)[a,b]	**0.028*****
	High school	86.7 (10.3)[a,b]		100.5 (9.6)[a,b]	
	Associate degree	80.7 (7.3)[b]		100.6 (15.2)[a]	
	Undergraduate	61.2 (12.7)[c]		86.3 (14.3)[b]	
Profession (husband) n (%)	Civil servant	59.3 (12.3)[a]	**<0.001*****	83.6 (16.2)[a]	**0.005*****
	Worker	84.2 (8.6)[b]		101.3 (12.9)[b]	
	Other	71 (5.6)[a,b]		91.3 (11.7)[a,b]	
Marriage duration- years average (SD) marriage duration	≤1 year	74.6 (14.7)	0.608*	93 (16.8)	0.165*
	>1 year	72 (16.6)		100.2 (9.9)	
Family type	Core	72.2 (15.8)	0.214*	93.5 (15.1)	0.164*
	Wide	82.5 (10.4)		101.6 (14.6)	
Place of residence	City center	72.9 (15.6)	0.414*	93.1 (14.8)	**0.013***
	District	86 (0)		110.8 (5.8)	
Income situation	Low	84.3 (9.6)	**<0.001***	97.5 (20.8)	0.607*
	Medium/good	64.2 (13.6)		94.6 (13.1)	

*Independent two-sample t-test. **One-way analysis of variance (post-hoc Tamhane). ***One-way analysis of variance (post-hoc Tukey)
[a-c]: There is no difference between groups with the same letter for each variable
SD: Standard deviation, SMS: Sexual myths scale

Muslim women and for reducing implicit biases in healthcare. Interventions such as psychotherapy, physiotherapy, and sexual education have been found beneficial, but broader cultural change that embraces women's sexual agency is also needed. The cross-cultural literature supports the notion that sociocultural learning and sexual myths are deeply intertwined in shaping women's sexual health across societies. Studies have shown that beliefs concerning female purity, pain, and sexual passivity are sustained through collective cultural narratives rather than individual psychopathology (7). In Muslim-majority and other traditional contexts, limited sexual education, gendered expectations, and modesty norms further reinforce avoidance behaviors and anxiety during sexual activity (7,36). Such myths and sociocultural and religious values are often transmitted intergenerationally, forming part of broader "sexual scripts" that dictate appropriate sexual conduct within a given culture. Recognizing this dynamic is important, as effective treatment requires distinguishing between misinformation that undermines sexual function and satisfaction and moral or religious values that guide cultural identity. Intervention programs incorporating culturally attuned psychoeducation have been shown to improve acceptance and outcomes in the management of vaginismus and related conditions (18,36).

The relationship between sexual myths and sociodemographic variables also influences individuals' access to accurate sexual information and their overall attitudes toward

sexuality (37). Earlier studies have demonstrated that variables, such as education level, marital status, income, and region of residence, are associated with belief in sexual myths. For instance, Yılmaz (32) reported that levels of anxiety and belief in sexual myths varied significantly according to age, education, and income status, while Dalan (30) found higher levels of belief in sexual myths among high school graduates compared to those with other educational backgrounds. Similarly, Doğan and Saraçoğlu (25) found a significant relationship between lower education levels and stronger beliefs in sexual myths. These findings support the hypothesis that the lack of formal sexual education together with exposure to traditional belief systems increases the susceptibility of misinformation. This is also consistent with national data from the CETAD survey (2006), which reported higher rates of fear, avoidance, or pain-related barriers to sexual intercourse among women living in rural areas (38). Since biopsychosocial factors strongly influence sexual myths, acknowledging these mediators in sexual education for both women and men is essential (39). The higher prevalence of vaginismus and belief in sexual myths in such regions is often attributed to stronger traditional norms, limited access to sexual health education, and a lower awareness of sexual rights (40). In addition, it is important to distinguish between culturally or religiously grounded sexual values and sexual myths. While values reflect moral or spiritual principles that guide behavior within specific cultural or religious contexts, sexual myths refer to scientifically inaccurate or distorted beliefs about sexuality that can restrict sexual function and satisfaction or perpetuate gender inequality. The present study does not aim to challenge cultural or sociocultural and religious values, but rather to identify misinformed beliefs that may hinder healthy sexual functioning or contribute to conditions such as vaginismus. In this regard, the SMS (20) was specifically designed to assess misconceptions and false beliefs about sexuality, rather than normative or faith-based sexual values, providing a culturally appropriate framework for distinguishing myths from values.

In the present study, women diagnosed with vaginismus exhibited significantly higher beliefs in sexual myths compared to women without sexual dysfunction. This difference was consistent across all subdimensions of the SMS, particularly those related to gender roles, sexual behavior, masturbation, and sexual satisfaction. These results align with previous research showing that distorted beliefs and stereotypical sexual scripts are more prevalent among women with sexual pain disorders (5,6). Such myths, which often emphasize female passivity, male dominance, and the moralization of sexuality, can create cognitive and emotional barriers to sexual expression, thereby reinforcing avoidance and anxiety during sexual activity.

In our sample, patterns mirror findings from other studies conducted in traditional or religious societies, where restricted sexual education and rigid gender expectations perpetuate misinformation and guilt surrounding sexuality (7,36,40). Together, these findings illustrate the multifactorial nature of vaginismus, reflecting an interplay between individual vulnerability, relational dynamics, and sociocultural conditioning.

Our results suggest that addressing these myths will be important for effective prevention and treatment. Culturally sensitive psychoeducation that respects religious and sociocultural and religious values while challenging inaccurate beliefs may help reduce shame, fear, and avoidance behaviors associated with sexual activity. Training healthcare professionals to discuss sexuality in a non-judgmental, culturally aware manner can also improve patient engagement and treatment adherence. Ultimately, these findings emphasize that vaginismus is not merely a psychosexual disorder but a socioculturally mediated condition, requiring interventions that integrate education, empathy, and empowerment (5-7,36,40).

This study has several limitations that should be considered when interpreting the findings. First, the study sample was drawn exclusively from a single private hospital, which may have introduced selection bias. Women seeking care in private settings often represent a more socioeconomically homogeneous group with higher education and income levels than the general population. Therefore, the findings may not fully reflect the attitudes and sexual belief patterns of women from different regions or socioeconomic backgrounds. Moreover, the study sample was obtained from women attending a gynecology outpatient clinic, which may not fully represent the general female population. This clinical recruitment approach, based on convenience sampling, could have introduced selection bias by including individuals who were more likely to seek medical help or to discuss sexual concerns. Consequently, women with milder symptoms or those reluctant to seek care might be underrepresented. Second, the statistical power of the study was restricted due to the relatively small sample size, which prevented the study from potentially detecting more nuanced differences and possible interactions among variables. Although regression analysis was conducted to control for key sociodemographic covariates such as education level, age, and place of residence, unmeasured factors, such as religiosity or exposure to sexual education, may still have influenced the results. Third, the diagnosis of vaginismus was based on clinical evaluation without the use of standardized diagnostic interviews or structured psychometric assessments, which may have introduced variability in diagnostic classification. Furthermore, the cross-sectional design of the study prevented any inference of causality between belief in sexual myths and

the presence of vaginismus. Finally, because the data relied on self-report measures, the possibility of social desirability bias, particularly in reporting sexual beliefs and behaviors, cannot be excluded. The reliance on self-reported data introduces an inherent limitation, particularly in studies addressing sexuality within conservative sociocultural environments, such as is found in Türkiye. Participants may under-report or modify their responses due to feelings of shame, social desirability, or fear of judgment, even when anonymity is guaranteed. This tendency can lead to underestimation of sensitive attitudes or experiences, including belief in sexual myths or fear related to intercourse. Although privacy and neutral questioning techniques were applied to reduce this bias, it cannot be entirely eliminated in sexuality research conducted in traditional societies.

Study limitations

Future research should aim to include more diverse and representative samples by involving participants from multiple regions, healthcare settings, and cultural backgrounds. Larger-scale studies with probabilistic sampling methods could enhance the generalizability of findings and allow for subgroup analyses across different sociodemographic strata. Longitudinal designs are also recommended to better understand the temporal and potentially causal relationship between belief in sexual myths and the development or persistence of vaginismus. In addition, future studies may benefit from incorporating structured diagnostic tools and in-depth qualitative interviews to explore the psychological and relational dimensions of sexual dysfunction in more depth. Moreover, intervention-based studies that integrate sexual education with culturally sensitive approaches, while considering women's sociocultural backgrounds and religious values, could significantly contribute to prevention and treatment efforts.

Conclusion

The findings of this study highlight the importance of addressing sexual myths as a contributing factor in the development and persistence of vaginismus. Healthcare professionals working with women diagnosed with vaginismus should assess not only physiological symptoms but also cultural beliefs and misinformation related to sexuality. Educational interventions that target inaccurate sexual beliefs, particularly among women with limited formal education or those residing in more traditional settings, may be an essential component of comprehensive care. Clinicians are encouraged to incorporate culturally sensitive sexual health education into treatment plans, involve partners when appropriate, and collaborate with mental health professionals to address associated anxiety or phobias. By understanding the sociocultural factors foundation vaginismus, professionals may offer more personalized, effective, and sustainable interventions for affected individuals.

Ethics

Ethics Committee Approval: *This study was approved by the Ankara Medipol University Non-Interventional Clinical Research Ethics Committee (approval number: 128, date: 18.10.2023).*

Informed Consent: *After obtaining informed consent from each participant, data were collected through face-to-face interviews using the introductory information form and the sexual myths scale.*

Footnotes

Author Contributions: *Concept: Y.K, C.K., Design: Y.K., Data Collection or Processing: Y.A., Analysis or Interpretation: Y.K., T.T., Literature Search: Y.K., T.T., Writing: Y.K., T.T., Y.A., C.K.*

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Serum osteopontin as a diagnostic marker for missed abortion: evidence from a prospective study

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Abstract

Objective: Osteopontin (OPN) is a multifunctional molecule involved in embryo implantation and blastocyst adhesion. Given its role at the maternal–fetal interface, OPN has been proposed as a potential biomarker for early pregnancy outcomes. The aim of this study was to evaluate the association between serum OPN levels and missed abortion in women presenting with early pregnancy bleeding.

Material and Methods: In this prospective study, primigravid women between 6 and 11 weeks of gestation with confirmed fetal cardiac activity were enrolled. Participants were classified into three groups according to clinical presentation: normal pregnancy, threatened abortion, and missed abortion. Blood samples were obtained at admission, and serum OPN levels were measured using an enzyme-linked immunosorbent assay. Inflammatory markers including white blood cell count, neutrophil-to-lymphocyte ratio, C-reactive protein levels, and body mass index were also recorded.

Results: The study cohort numbered 198 women, aged 18-42 years, with 38, 80 and 80 women in the normal pregnancy, threatened and missed abortion groups, respectively. OPN levels showed a significant and progressive increase with the lowest levels observed in normal pregnancies, higher levels in threatened abortion, and the highest levels in missed abortion ($p<0.001$). Receiver operating characteristic curve analysis demonstrated strong discriminative capacity of OPN for pregnancy loss (area under the curve =0.846, $p<0.001$). A cut-off value of 1.15 ng/mL was associated with 100% sensitivity, whereas a cut-off value of 2.15 ng/mL was associated with 100% specificity.

Conclusion: Elevated serum OPN levels are associated with early pregnancy loss and may serve as a potential biomarker in missed abortion. However, these findings should be interpreted with caution given the exploratory nature of the analysis. [J Turk Ger Gynecol Assoc. 2026; 27(2): 93-8]

Keywords: Diagnostic marker, early pregnancy bleeding, inflammatory biomarkers, missed abortion, osteopontin

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Introduction

Osteopontin (OPN) is an extracellular matrix glycoprotein involved in a wide range of physiological and pathological processes, including inflammation, immune regulation, cell adhesion, migration, and tissue remodeling (1). In the context of reproductive biology, OPN is expressed in the endometrium and plays a pivotal role in decidualization and embryo implantation (1,2). The expression of OPN increases during the early- and mid-secretory phases of the menstrual cycle, supporting blastocyst adhesion and trophoblast invasion

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through interactions with integrin subunits and fibronectin (3,4). Experimental studies in animal models have demonstrated that OPN deficiency leads to reduced implantation and increased embryonic resorption, suggesting a potential major role in mammalian early pregnancy maintenance (5-7).

OPN also contributes to angiogenesis in the endometrium and placenta, helping to maintain a synchronized maternal–embryonic interface and supporting blastocyst viability (8,9). OPN expression is hormonally regulated, particularly by estrogen, which stimulates OPN secretion from endometrial glands. Estrogen-induced OPN promotes blastocyst adhesion competence by enhancing integrin complex formation on the trophectoderm (8,9).

Threatened abortion, clinically defined as vaginal bleeding in early pregnancy in the presence of fetal cardiac activity, is associated with an increased risk of miscarriage, preterm birth, and fetal growth restriction (10,11). Recent evidence suggests that this condition is linked to altered inflammatory pathways, including disturbances in fibrinogen metabolism and systemic inflammatory responses, which may contribute to adverse outcomes (12). Embryo implantation is a complex process dependent on tightly regulated immune activity within the maternal uterine environment. While a balanced immune milieu is essential for successful implantation and early gestation, dysregulated or excessive inflammation may lead to implantation failure or early pregnancy loss. Uterine "CD56 bright" natural killer cells, which produce cytokines such as interferon gamma, play a pivotal role in modulating trophoblast invasion and maintaining immune tolerance at the maternal–fetal interface (13).

Although the precise mechanisms remain unclear, several studies have suggested a link between altered inflammatory responses and early pregnancy complications. These include elevated oxidative stress, dysregulated fibrinogen metabolism, and imbalances in proinflammatory cytokine production (2,14,15). Notably, patients with recurrent pregnancy loss have demonstrated increased secretion of tumor necrosis factor alpha and interleukin-12 from peripheral blood mononuclear cells, suggesting a systemic proinflammatory state (14,16). Given this inflammatory background, OPN has emerged as a promising biomarker due to its dual role in immune modulation and trophoblast interaction during early pregnancy.

Given its established roles in implantation, decidualization, immune regulation, and inflammation, OPN is a strong candidate biomarker for early pregnancy complications, such as abortus imminens and missed abortion. We hypothesized that elevated serum OPN levels may reflect underlying immunological dysregulation and could serve as a diagnostic and prognostic marker in early pregnancy loss. Therefore, the study objective was to investigate serum OPN levels in women presenting with bleeding in early pregnancy and to evaluate the association between serum OPN levels and missed abortion in these women.

Material and Methods

Study design and participants

This prospective study included pregnant women aged between 18 and 42 years, all of whom were followed at a tertiary referral hospital over the defined study period. Participants were categorized into three groups based on clinical presentation: (1) the normal pregnancy group included women without any history of vaginal bleeding; (2) the threatened abortion group included women who experienced vaginal bleeding but continued to have viable pregnancies within four weeks of admission; and (3) the missed abortion group comprised women whose pregnancies ended in miscarriage or missed abortion within the same follow-up period. All women in the missed abortion group had confirmed fetal cardiac activity at admission, and pregnancy loss was diagnosed during the four-week follow-up period.

Inclusion criteria were: a healthy eating index (HEI) score >80 which was chosen to minimize the potential confounding effects of dietary quality on systemic inflammatory markers. Since nutritional status has been shown to influence inflammatory pathways and immune mediators, this criterion allowed selection of a more homogeneous cohort for evaluation of the association between serum OPN levels and early pregnancy loss.

In addition, restricting hospital admission to within three hours of the onset of vaginal bleeding aimed to reduce temporal variability in inflammatory marker levels. This approach ensured that OPN measurements reflected the early biological response to pregnancy disturbance rather than secondary systemic inflammatory changes. Only primigravid women with no history of miscarriage, no medication use other than multivitamins, and normal gynecological and ultrasound findings were included. In addition, all participants had conceived within one year of attempting pregnancy. For the threatened abortion and missed abortion groups, only women who presented to the hospital within three hours of the onset of vaginal bleeding were eligible. The presence of any active infectious disease constituted an exclusion criterion.

Ethical considerations

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Ethical approval was granted by the Institutional Ethics Committee of Batman Research and Training Hospital (approval number: 2020-8, date: 02.12.2020). Written informed consent was obtained from all participants prior to inclusion in the study.

Data collection and laboratory analysis

Demographic data including age, gestational week, and body mass index (BMI) were recorded at baseline. Blood samples were collected from each participant upon admission. Serum OPN levels were measured using an enzyme-linked immunosorbent assay kit (BT LAB, Bioassay Technology Laboratory, China), according to the manufacturer's protocol. Additionally, hematologic and biochemical markers including white blood cell count (WBC), C-reactive protein (CRP) level and neutrophil-to-lymphocyte ratio (NLR) were measured as part of routine laboratory evaluation.

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed using the Shapiro–Wilk test. Variables with a normal distribution are expressed as mean ± standard deviation, while non-normally distributed variables are presented as median and interquartile range. Comparisons between three or more groups were performed using one-way analysis of variance for normally distributed data and the Kruskal–Wallis test for non-normally distributed data. Post-hoc analyses were conducted using Tukey's HSD or the Dunn–Bonferroni test, as appropriate. Differences between categorical variables were assessed using the chi-square test or Fisher's exact test.

Receiver operating characteristic (ROC) curve analysis was performed to assess the discriminative performance of serum OPN levels for missed abortion. The area under the curve (AUC), 95% confidence intervals, and optimal cut-off values were calculated. A p-value of <0.05 was considered statistically significant.

Results

A total of 198 pregnant women were included in the study. The participants' ages ranged from 18 to 42 years, with a mean age of 29.07±5.29 years. The mean gestational age was 7.82±1.14 weeks, and the mean BMI was 21.04±1.16 kg/m^2.

In terms of hematological and biochemical parameters, the mean WBC was 10.10±2.09 $\times 10^3/\mu$L, the mean CRP level was 7.20±1.43 mg/L, the mean serum OPN level was 2.56±0.99 ng/mL, and the NLR was 2.92±0.83. Descriptive statistics of the entire study population are presented in Table 1.

Participants were divided into three groups according to clinical presentation: normal pregnancy (n=38); threatened abortion (n=80); and missed abortion (n=80). Group-specific comparisons of clinical and inflammatory parameters are presented in Table 2.

When the three groups were compared, no statistically significant difference was found in terms of age (p=0.506). However, WBC, CRP, serum OPN, NLR, and BMI levels showed significant differences between the groups (p<0.001). Post-hoc analysis demonstrated that the missed abortion group had

Table 1. Descriptive statistics of the entire study population

Parameter	n	Minimum	Maximum	Mean ± SD
Age	198	18.0	42.0	29.07±5.29
Gestational week	198	6.0	11.0	7.82±1.14
WBC (x10$^3/\mu$L)	198	5.0	14.0	10.10±2.09
CRP (mg/L)	198	5.0	11.0	7.20±1.43
BMI (kg/m^2)	198	19.0	24.0	21.04±1.16
Osteopontin (ng/mL)	198	1.1	4.89	2.56±1.00
SD: Standard deviation, BMI: Body mass index, WBC: White blood cell, CRP: C-reactive protein				

Table 2. Comparison of clinical and inflammatory parameters between groups

Parameter	Normal pregnancy (n=38)	Threatened abortion (n = 80)	Missed abortion (n=80)	p-value
Age	29.74±4.90	29.15±5.60	28.68±5.18	0.506
Gestational week	8.05±1.56	7.83±1.05	7.70±0.99	NS
WBC (x10$^3/\mu$L)	6.42±1.15	10.73±0.93	11.23±1.11	<0.001
CRP (mg/L)	6.21±1.07	7.10±1.12	7.78±1.58	<0.001
BMI (kg/m^2)	21.79±1.02	20.95±1.05	20.78±1.18	<0.001
Osteopontin (ng/mL)	1.51±0.30	1.98±0.34	3.65±0.49	<0.001
NLR	1.54±0.31	2.81±0.21	3.69±0.31	<0.001
Values are presented as mean ± standard deviation. NS: Non-significant, BMI: Body mass index, WBC: White blood cell, CRP: C-reactive protein, NLR: Neutrophil-to-lymphocyte ratio				

significantly higher serum OPN levels compared to both the normal pregnancy and threatened abortion groups ($p<0.001$). Moreover, the threatened abortion group had significantly higher OPN levels than the normal pregnancy group ($p<0.01$). Similarly, the NLR was significantly elevated in the missed abortion group compared to both the normal pregnancy and threatened abortion groups ($p<0.001$), and the threatened abortion group also showed significantly higher NLR values compared to the normal pregnancy group ($p<0.001$).

ROC curve analysis revealed a strong discriminative association between elevated serum OPN levels and missed abortion, with an AUC of 0.846 ($p<0.001$). The 95 percent confidence interval ranged from 0.774 to 0.918, supporting the reliability of OPNs clinical discriminative capacity. A cut-off value of 1.15 ng/mL yielded 100% sensitivity, while a cut-off value of 2.15 ng/mL provided 100% specificity. Although some overlap was observed between certain cases, this did not meaningfully affect the overall discriminative performance. The ROC curves are shown in Figure 1. Figure 1a shows the ROC curve for distinguishing healthy pregnancies from abortus imminens, indicating moderate discriminative capacity. Figure 1b shows the ROC curve for differentiating healthy pregnancies from missed abortion, demonstrating strong discriminative performance.

Upon examining the ROC curve coordinates, varying sensitivity and specificity combinations were observed for different cut-off values. At an OPN threshold of 1.15 ng/mL, sensitivity reached 100 percent, while specificity remained very low at only 5.3 percent. While cases below this threshold had an extremely low likelihood of pregnancy loss, the majority of those above it were false positives. Therefore, although this threshold may be suitable for screening purposes where high sensitivity is essential, it should not be interpreted as providing definitive diagnostic certainty. In contrast, when a cut-off of 2.15 ng/mL was applied, specificity reached 100 percent, eliminating the risk of false positives. OPN levels above this threshold encompassed the majority of pregnancy loss cases, highlighting its potential value as a highly specific marker for clinical scenarios where stronger rule in discrimination is desired. In summary, OPN levels below 1.15 ng/mL were rarely observed among pregnancy loss cases, whereas levels above 2.15 ng/mL were strongly associated with adverse pregnancy outcomes.

Discussion

This study demonstrated a significant increase in serum OPN levels in women with threatened abortion and missed abortion compared to those with normal pregnancies. The progressive rise in OPN across the clinical spectrum suggests that OPN elevation reflects the severity of early pregnancy disturbance. These findings support the hypothesis that elevated OPN levels may be associated with early pregnancy loss, particularly in the presence of vaginal bleeding.

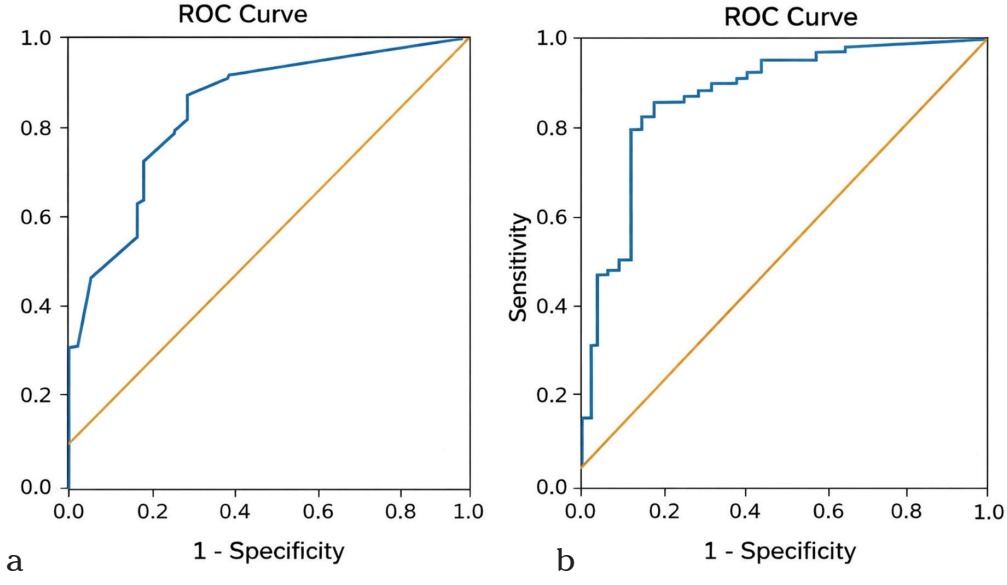

Figure 1. (a) Receiver operating characteristic (ROC) curve illustrating the association between serum osteopontin levels and threatened abortion compared with healthy pregnancies. The area under the curve (AUC) was 0.846. A cut-off value of 1.15 ng/mL provided high sensitivity, indicating potential utility for risk stratification rather than definitive diagnosis. (b) ROC curve illustrating the association between serum osteopontin levels and missed abortion compared with healthy pregnancies. The AUC was 0.846. A cut-off value of 2.15 ng/mL demonstrated high specificity, suggesting potential value in confirming adverse pregnancy outcomes in selected clinical settings

The current results are consistent with previous reports indicating that dysregulated immune responses contribute to early pregnancy complications. In line with the literature, elevated OPN levels were accompanied by increases in conventional inflammatory markers such as NLR, supporting the assumption that OPN mirrors systemic immune activation during early pregnancy (13,16). Earlier studies have shown that OPN is involved in implantation, decidualization, angiogenesis, and immune regulation at the maternal–fetal interface, and these biological functions may explain its rise during pathological implantation processes (1,5,6). Hormonal regulation by estrogen and its role in promoting blastocyst adhesion competence further reinforce the central position of OPN in early pregnancy physiology (8,9). Taken together, our findings extend previous mechanistic studies by demonstrating a clinical association between elevated OPN levels and early pregnancy loss.

The ROC curve analysis in our study revealed high diagnostic performance, with cut-off values indicating potential roles for both screening and diagnostic confirmation. A threshold of 1.15 ng/mL, showing 100 percent sensitivity, may be helpful in early identification of pregnancies at risk, whereas a level above 2.15 ng/mL, with 100% specificity, may help confirm adverse outcomes in selected clinical situations. These findings suggest that OPN could aid risk stratification and clinical decision-making, particularly in emergency settings or outpatient triage, where rapid assessment is crucial.

Another strength of this study was the inclusion of a well-defined and homogeneous population, as well as the parallel evaluation of several inflammatory parameters. Robust statistical analyses, including post-hoc and ROC methods, further enhance the reliability of the results. The availability of clinically meaningful cut-off values also increased the translational relevance of our findings and may guide future clinical protocols.

Study limitations

The study population was intentionally selected using strict inclusion criteria, including primigravid status, a narrow BMI range, a high HEI score, and the absence of overt inflammatory or infectious conditions. While this approach enhanced internal validity by minimizing potential confounding factors, it resulted in a highly homogeneous cohort and therefore limits the external generalizability of the findings. Therefore, the results should be interpreted as a proof-of-concept demonstrating an association between serum OPN levels and early pregnancy loss rather than as a broadly generalizable screening or diagnostic model.

In addition, serum OPN levels were only measured at a single time point, which limits assessment of temporal changes and precludes conclusions regarding its longitudinal or prognostic behavior during early pregnancy**.**

Other limitations should also be considered. The observational design prevents establishing a causal relationship between OPN elevation and pregnancy loss. Finally, factors such as genetic predisposition or subclinical infections were beyond the scope of this study and may have influenced inflammatory status.

Despite these limitations, this study contributes to growing evidence that inflammatory mediators may play a key role in early pregnancy failure. Longitudinal monitoring of OPN levels, as well as isoform-specific and molecular studies, may provide deeper insights into its pathophysiological role. Future research should also evaluate the clinical utility of OPN in combination with other inflammatory or hormonal markers to improve predictive accuracy in early pregnancy loss. Therefore, the present findings should not be interpreted as establishing OPN as an independent predictor of pregnancy loss.

Conclusion

Elevated serum OPN levels were associated with early pregnancy loss. Furthermore, the progressive increase from normal pregnancy to threatened abortion and missed abortion highlighted the potential clinical value of measuring OPN. ROC analysis confirmed a strong diagnostic performance, suggesting applicability in both screening and confirmation settings using different cut-off values. OPN may serve as a useful biomarker for early risk stratification in pregnant women presenting with vaginal bleeding, helping to identify cases that require closer monitoring or intervention. Larger prospective and longitudinal studies are warranted to validate these findings and to clarify the mechanistic role of OPN in early pregnancy outcomes.

Ethics

Ethics Committee Approval: *This study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Ethical approval was granted by the Institutional Ethics Committee of Batman Research and Training Hospital (approval number: 2020-8, date: 02.12.2020).*

Informed Consent: *Written informed consent was obtained from all participants prior to inclusion in the study.*

Footnotes

Author Contributions: *Concept: D.B., C.A., Design: Y.B., C.A., Data Collection or Processing: E.O., E.G., Z.B., Analysis or Interpretation: Y.B., C.A., Literature Search: E.G., Z.B., Writing: C.A.*

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Perinatal outcomes in pregnancies with one abnormal oral glucose tolerance test value: a retrospective cohort study

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Abstract

Objective: To compare perinatal, neonatal, and early childhood outcomes among pregnant women classified into three groups based on oral glucose tolerance test (OGTT) results: gestational diabetes mellitus (GDM), normal glucose tolerance, and one abnormal OGTT value.

Material and Methods: This single-center retrospective cohort study included singleton pregnancies screened between 24 and 28 weeks of gestation and delivered at the same institution. Participants were categorized into GDM, normal glucose tolerance, or one abnormal OGTT value. Maternal demographic data, obstetric outcomes, neonatal outcomes [birth weight, Apgar scores, neonatal intensive care unit (NICU) admission], and early childhood developmental data were collected retrospectively from hospital records. Statistical analyses were performed using the Kruskal-Wallis and chi-square tests.

Results: The study included 292 pregnancies categorized into GDM (n=28), normal glucose tolerance (n=224), or one abnormal OGTT value (n=40). Women in the GDM group were significantly older and had higher gravidity and parity than those in the normal glucose tolerance group (p=0.01 and p=0.003, respectively). No significant differences were observed between the groups in terms of birth weight (p=0.651) or NICU admission rates (p=0.29). Although NICU admission rates were higher in the GDM group (12.5%) and in the group with one abnormal OGTT value (10.0%) than in the normal glucose tolerance group (5.8%), these differences did not reach statistical significance. No clinically meaningful differences were identified during early childhood follow-up.

Conclusion: Pregnant women with one abnormal OGTT value did not differ significantly from those with GDM or normal glucose tolerance in terms of adverse perinatal outcomes. Larger prospective studies are required to guide clinical management. [J Turk Ger Gynecol Assoc. 2026; 27(2): 99-106]

Keywords: Gestational diabetes mellitus, oral glucose tolerance test, one abnormal OGTT value, perinatal outcomes

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Introduction

Gestational diabetes mellitus (GDM) is defined as glucose intolerance that is detected for the first time during pregnancy. It is currently considered one of the most significant metabolic issues in obstetric care (1,2). The global prevalence of hyperglycemia during pregnancy is high, and GDM affects a significant proportion of pregnancies, posing both short- and long-term risks to the mother and fetus (3).

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From a maternal perspective, GDM is associated with preeclampsia, cesarean delivery, and the development of type 2 diabetes in later years (4-6). For fetuses and newborns, exposure to an intrauterine hyperglycemic environment increases the risk of short-term complications, such as macrosomia, birth trauma, neonatal hypoglycemia, and respiratory distress syndrome (7-10). These findings indicate that glucose metabolism during pregnancy directly affects the pregnancy and perinatal outcomes.

However, it is increasingly understood that the effects of hyperglycemia during pregnancy are not limited to the perinatal period. It has been reported that children of mothers with a history of GDM have an increased risk of obesity and metabolic disorders, and that there may be long-term effects on neurocognitive and neuropsychiatric development (11-13). These data further highlight the clinical significance of the degree of glucose tolerance during pregnancy.

Different test approaches and diagnostic thresholds are used for GDM screening and diagnosis, and in clinical practice, single-step and two-step oral glucose tolerance test (OGTT) methods are widely used. In the single-stage approach, exceeding the fasting and postprandial glucose thresholds determined by a 75 g OGTT is considered sufficient for diagnosis. In the two-stage method, a 50 g screening test is first administered, and if the threshold value is exceeded, a 100 g OGTT is performed for diagnostic evaluation (14-17). These different screening and diagnostic strategies have led to the emergence of pregnancies that do not fully meet the GDM diagnostic criteria but show limited glucose elevation in the OGTT, leading to the formation of a clinically heterogeneous patient group.

The aim of the present study was to compare the perinatal, neonatal and early childhood outcomes of three groups of women classified according to their glucose tolerance status during pregnancy; women diagnosed with gestational diabetes, women with normal glucose tolerance and women with only one abnormal value detected in the OGTT. We hypothesized that, as the degree of maternal glucose intolerance increased, so will the frequency of adverse perinatal and neonatal outcomes; pregnancies with a single abnormal OGTT value will show an intermediate risk profile between normal glucose tolerance and GDM.

Material and Methods

Ethical approval

This study was approved by the Clinical Research Ethics Committee of University of Health Sciences Türkiye, İstanbul Training and Research Hospital (approval number: 310, date: 24.11.2023). This study was conducted using a retrospective cohort design. As our center is a teaching and research hospital, routine informed consent was obtained from all patients who applied, stating that their medical data may be used for scientific research. Throughout the research process, all data were anonymized and evaluated in accordance with the Declaration of Helsinki principles.

Study design and setting

This single-center retrospective cohort study included pregnant women who gave birth at a tertiary referral center between January 1 and December 31, 2021. At our center, gestational diabetes screening, diagnosis, and follow-up processes are performed in a standardized manner in accordance with national and international guidelines.

Study population

During the specified study period, a total of 3,947 births occurred at our center. Of these, 292 were included in the study: they had singleton pregnancies; underwent glucose screening and/or diagnostic OGTTs at our institution between the 24th and 28th weeks of pregnancy; and had complete basic clinical data for the delivery and newborn periods. The process of selecting the study population is illustrated in Figure 1.

Exclusion criteria

Pregnancies with the following characteristics were excluded from the study: (1) multiple pregnancies; (2) type 1 or type 2 diabetes diagnosed before pregnancy; (3) OGTT or delivery performed at another healthcare facility; (4) incomplete basic obstetric or neonatal data for the mother or newborn; and (5) newborns with major congenital anomalies.

Glucose screening and diagnostic criteria

At our center, GDM screening is routinely performed between weeks 24 and 28 of pregnancy. In clinical practice, single-step or two-step screening and diagnostic strategies have been employed. In the single-stage approach, a 75 g OGTT is performed and a diagnosis of GDM is made if the fasting plasma glucose level is ≥92 mg/dL, the 1-hour glucose level is ≥180 mg/dL or the 2-hour glucose level is ≥153 mg/dL.

In the two-step approach, a 50 g glucose challenge test is first performed, and if the one-hour plasma glucose value is ≥140 mg/dL, a 100 g OGTT is administered. At least two of the following measurements exceeding the diagnostic thresholds (fasting ≥95 mg/dL, 1-hour ≥180 mg/dL, 2-hour ≥155 mg/dL, and 3-hour ≥140 mg/dL) were considered sufficient for a diagnosis of GDM in the 100 g OGTT. These diagnostic thresholds are consistent with the recommendations of the IADPSG, ADA and World Health Organization.

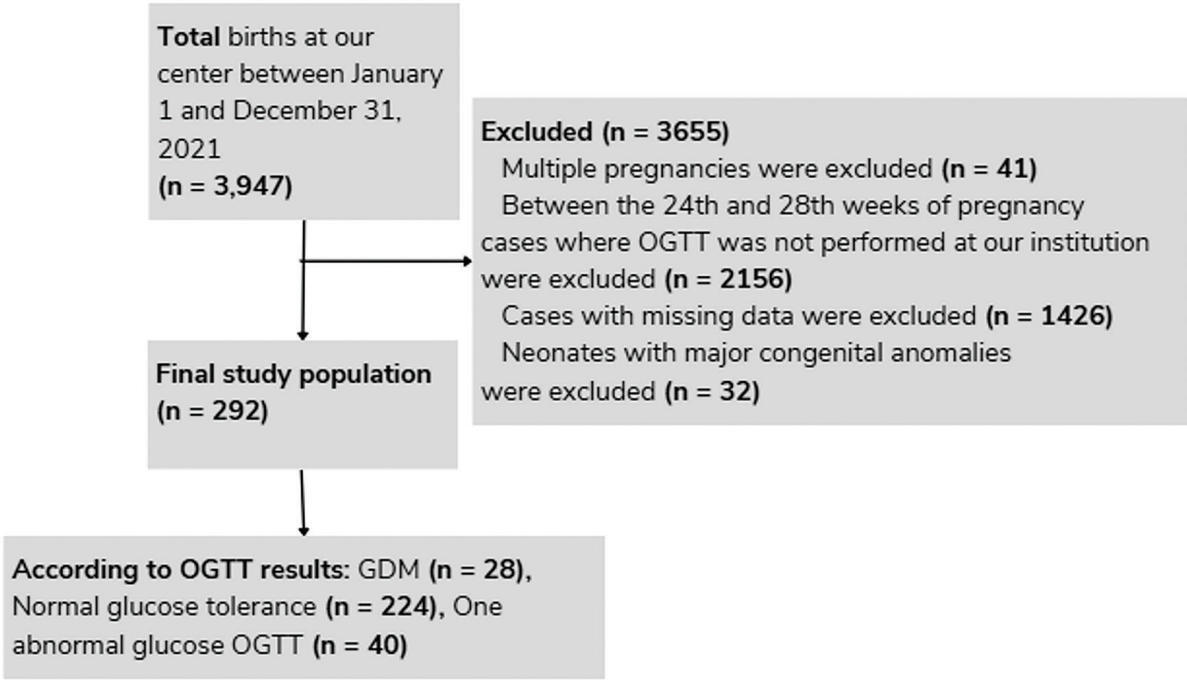

Figure 1. Patient selection flowchart showing the inclusion and exclusion process of the study population
OGTT: Oral glucose tolerance test, GDM: Gestational diabetes mellitus

Classification of OGTT groups

The cases included in the study were divided into three clinical groups based on OGTT results: cases diagnosed with gestational diabetes (Group A); cases with all OGTT measurements within normal limits (Group B); and cases with only one OGTT measurement exceeding the diagnostic thresholds (Group C). Cases with a single abnormal OGTT value were evaluated as a separate category, as this group is frequently encountered in clinical practice but there is no clear consensus in the literature regarding its diagnostic and prognostic significance.

Data collection

All clinical data were retrospectively obtained from the hospital's electronic medical records system. Maternal variables included age, gravida, parity and body mass index (BMI). Obstetric data were limited to gestational age at delivery and mode of delivery. Data on the newborns included birth weight, Apgar scores at one and five minutes, and admission to the neonatal intensive care unit (NICU) or not. The reasons for admission to the NICU were classified through a detailed review of clinical records.

Early childhood follow-up

Data on early childhood were obtained from routine pediatric outpatient follow-up records. Clinical notes on achieving the milestones of sitting and walking unaided, as well as general health status, were evaluated in the records for the sixth, twelfth, and twenty-fourth months. These evaluations were not based on a standard developmental screening scale, but rather on routine clinical observations and physician records.

Statistical analysis

Statistical analyses were performed using SPSS (IBM Inc., Armonk, NY, USA). The distribution characteristics of continuous variables were assessed using the Shapiro-Wilk test. Data with a normal distribution are presented as the mean and standard deviation whereas data without a normal distribution are presented as the median and minimum-maximum values. For intergroup comparisons, the Kruskal-Wallis test was used for continuous variables, and the chi-squared test was used for categorical variables. Where necessary, pairwise comparisons were performed using the Mann-Whitney U test. Statistical significance was set at $p<0.05$.

Results

Study population

A total of 3,947 births occurred at our center during the study period. Of these, 292 pregnancies that met the inclusion criteria were included in the study. All participants underwent glucose screening and/or diagnostic testing between the 24th and 28th weeks of pregnancy, and gave birth at the same center.

Participants were divided into three groups based on their OGTT results: Group A, those diagnosed with GDM (n=28, 9.6%); Group B, those with normal glucose tolerance (n=224, 76.7%); and Group C, those with a single abnormal OGTT value (n=40, 13.7%).

Maternal characteristics

The maternal demographic and obstetric characteristics are shown in Table 1. The mean maternal age across the entire cohort was 29.6±5.9 years. Most cases were multiparous, with a median gravida of 3 (range 1-10) and a median parity of 2 (range 0-9).

Statistically significant differences were observed in maternal age, gravida, and parity when the groups were compared according to OGTT results (Table 2). Women in the GDM group were older than those in the normal glucose tolerance group (median age: 32.0 vs. 28.0 years; p=0.01). Similarly, gravida and parity values were higher in the GDM group (p=0.011 and p=0.003, respectively). However, no significant difference was found between the groups in terms of BMI (p=0.431).

Obstetric outcomes

The obstetric outcomes of the entire cohort are summarised in Table 3. The median gestational age at delivery was 39 weeks (range 24-42 weeks). The most common mode of delivery was cesarean section (55.1%), followed by vaginal delivery (44.5%). A statistically significant difference in gestational age at delivery was found when comparing OGTT groups (p=0.040) (Table 2). However, the absolute value of this difference was limited, with the median gestational age at delivery falling within the term range for all groups.

Table 1. Maternal demographic and obstetric characteristics (n=292)

Variables	n (%)/mean ± SD/median (min-max)
Maternal age (years)	29.6±5.9 (18-47)
Gravidity	3 (1-10)
Parity	2 (0-9)
Number of abortions	0 (0-5)
Body mass index (kg/m²)	29 (19-47)
History of intrauterine fetal demise	Yes: 8 (2.7%) No: 284 (97.3%)
Maternal comorbidities	
– None	187 (64.0%)
– Hypothyroidism	35 (12.0%)
– Hypertension	11 (3.8%)
– Cardiac disease	3 (1.0%)
– Other conditions	56 (19.2%)
Prenatal ultrasound findings	
– Normal	252 (86.3%)
– Soft marker (+)	20 (6.8%)
– SGA/FGR	7 (2.4%)
– Macrosomia	4 (1.4%)
– Polyhydramnios	4 (1.4%)
– Macrosomia + polyhydramnios	2 (0.7%)
– Cardiac anomaly	1 (0.3%)
– Oligohydramnios	1 (0.3%)
– SGA/FGR + soft marker	1 (0.3%)
Placental pathology	
– None	287 (98.3%)
– Placenta previa	5 (1.7%)
50 g glucose challenge test	
– Not performed	234 (80.2%)
– <140 mg/dL	48 (16.4%)
– ≥140 mg/dL	10 (3.4%)
75 g OGTT	Performed: 218 (74.4%) Not performed: 74 (25.6%)
100 g OGTT	Performed: 21 (7.2%) Not performed: 271 (92.8%)
Classification according to OGTT results	
– One abnormal value (impaired glucose tolerance)	40 (13.7%)
– Gestational diabetes mellitus (GDM)	28 (9.6%)
– Normal glucose tolerance	224 (76.7%)
Method of GDM diagnosis	
– 50 g >180 mg/dL	2 (0.7%)
– 75 g OGTT	22 (7.5%)
– 100 g OGTT	5 (1.7%)
– Subsequent fasting glucose follow-up	4 (1.4%)
GDM management	
– None	238 (81.5%)
– Diet only	49 (16.8%)
– Insulin therapy	5 (1.7%)
Antenatal blood glucose monitoring	Performed: 20 (6.2%) Not performed: 274 (93.8%)

OGTT: Oral glucose tolerance test, SGA/FGR: Small for gestational age/fetal growth restriction, SD: Standard deviation, min: Minimum, max: Maximum

Neonatal outcomes

Neonatal outcomes are presented in Tables 2 and 3. The mean birth weight for the entire cohort was 3,233.8±567.8 g, with median first- and fifth-minute Apgar scores of 8 and 9, respectively.

No significant difference in birth weight was observed among the OGTT groups (p=0.651). Although a statistical difference was observed between the groups in terms of first-minute Apgar scores (p=0.019), no significant difference was found in the pairwise comparison between the GDM and normoglycemic groups (p=0.16). A small difference in fifth-minute Apgar scores was observed between the GDM and normoglycemic groups (p=0.038); however, all group values were within the clinically normal range.

Neonatal intensive care unit admissions

A total of 20 newborns (6.8%) were admitted to the NICU (Table 2). NICU admission rates according to OGTT groups were: GDM group 12.5%; normal glucose tolerance group: 5.8%; single abnormal OGTT value group: 10.0%.

No statistically significant difference was found among the groups in terms of NICU admission rates (p=0.29). The reasons for NICU admission are summarized in Table 4. The most common causes were maternal complications (severe preeclampsia, placental abruption, intrahepatic cholestasis), accounting for 35% of all NICU admissions. Respiratory and metabolic causes related to the newborn include transient tachypnea, respiratory distress syndrome, hypoglycemia, and polycythemia.

Early childhood follow-up observations

Early childhood data were available for a subset of the cohort from routine pediatric outpatient records. It is important to note that these data were not collected using standardized developmental assessment tools but represent descriptive clinical observations recorded by physicians. Based on these records, it was noted that 76.7% of infants could sit unsupported at six months and 60.3% were walking by twelve months. At the 24-month follow-up, 57.9% of children were documented as "healthy". No notable differences were observed across the OGTT groups based on these limited, descriptive follow-up data (Table 3).

Discussion

This retrospective cohort study comparatively examined the effects of different levels of impaired glucose tolerance during pregnancy on perinatal, neonatal and early childhood outcomes. Our main finding was that, in terms of most adverse perinatal outcomes examined, pregnant women with a single abnormal OGTT value (Group C), those diagnosed with GDM (Group A), and those with normal glucose tolerance (Group B) had similar outcomes. In particular, no significant differences were found between the groups in critical outcome metrics, such as birth weight and admission rates to the NICU. These results contribute valuable data to the ongoing debate about the clinical management and prognostic significance of mild glucose intolerance during pregnancy.

There is no consensus in the literature regarding the clinical significance of an abnormal OGTT result. Our results contradict those of a comprehensive systematic review and meta-analysis conducted by Roeckner et al. (18), which included 25 studies. This meta-analysis revealed that women with an abnormal OGTT result were at significantly higher risk of adverse outcomes such as macrosomia, large-for-gestational-age babies, neonatal hypoglycemia, cesarean section and pregnancy-related hypertension, compared to women with normal glucose tolerance. This risk profile was similar to that

Table 2. Maternal and neonatal characteristics across study groups

Variable	Group A (n=28)	Group B (n=224)	Group C (n=40)	p-value (KW/χ^2)	p-value (A vs. B)
Age (years)	32.0 (21-42)	28.0 (18-47)	31.5 (18-41)	0.0066**	0.019
Gravidity	3.0 (1-6)	2.0 (1-10)	2.0 (1-7)	0.0355*	0.011
Parity	3.0 (1-6)	2.0 (0-9)	2.0 (0-6)	0.0135*	0.003**
Abortions	0.0 (0-2)	0.0 (0-5)	0.0 (0-2)	0.546	0.694
BMI (kg/m²)	29.4 (22.6-40.6)	28.4 (19.1-46.7)	30.0 (22.2-38.5)	0.431	0.370
Gestational age at delivery (weeks)	38.5 (29.3-41.2)	39.0 (24.0-42.2)	38.6 (29.4-41.4)	0.0402*	0.022
Birth weight (g)	3265 (1295-4600)	3290 (710-4740)	3225 (1270-4215)	0.651	0.844
Apgar score, 1 min	8.0 (6-9)	8.0	8.0 (5-9)	0.0192*	0.160
Apgar score, 5 min	9.0 (7-9)	9.0 (7-10)	9.0 (7-9)	0.0372*	0.038*
NICU admission (%)	4 (12.5)	13 (5.8)	4 (10.0)	0.29	0.20

Values are presented as median (minimum–maximum) unless otherwise specified; NICU: Neonatal intensive care unit, BMI: Body mass index, KW: Kruskal–Wallis test, *p<0.05 was considered statistically significant,**p<0.01

of patients diagnosed with GDM. However, in our study, no significant increase in risk was observed between the group with a single abnormal value and the group with normal glucose tolerance. Reasons for this discrepancy may include the heterogeneity of the study populations, differences in diagnostic and screening strategies, and center-specific follow-up and treatment protocols. Furthermore, the limited sample size of our study, particularly in Groups A and C, may have reduced our ability to detect smaller effect sizes.

However, our findings are indirectly consistent with some studies suggesting that the risk increases gradually as the number of abnormal OGTT values increases. Indeed, Eteläinen et al. (19) reported that the risk of adverse perinatal outcomes in women with two or more abnormal OGTT values was significantly higher than in those with a single abnormal value. The fact that no significant difference was found between the GDM group and the other groups in our study can be interpreted as the limited sample size, as well as the strict metabolic monitoring and treatment approaches applied to cases diagnosed with GDM in our clinic, which may have reduced the occurrence of adverse perinatal outcomes.

Table 3. Perinatal and neonatal outcomes (n=292)

Variables	n (%)/mean±SD/median (min–max)
Gestational age at delivery (weeks)	39 (24-42)
Mode of delivery	
– Vaginal delivery	130 (44.5%)
– Cesarean section	161 (55.1%)
– Operative vaginal delivery	1 (0.3%)
Neonatal birth weight (g)	3233.8±567.8 (710-4740)
Apgar score, 1st minute	8 (5-10)
Apgar score, 5th minute	9 (7-10)
NICU admission	No: 272 (93.2%) Yes: 20 (6.8%)
Primary indications for NICU admission	Respiratory distress, transient tachypnea, hypoglycemia, polycythemia, maternal complications (preeclampsia, placental abruption, cholestasis)
Maternal hospital stay (days)	2 (1-7)
Developmental milestones	
– Sitting without support at 6 months	224 (76.7%)
– Walking independently at 12 months	176 (60.3%)
– Healthy child at 24 months	169 (57.9%)

Follow-up data unavailable for remaining cases; NICU: Neonatal intensive care unit, SD: Standard deviation, min: Minumum, max: Maximum

Another notable finding of our study relates to NICU admission rates. While the differences between the groups did not reach statistical significance, we noted that the admission rates were numerically higher in the GDM (12.5%) and single abnormal OGTT (10.0%) groups compared to the normal glucose tolerance group (5.8%). Given the study's limited sample size, this non-significant trend should be interpreted with caution. It may suggest a potential area for future investigation in larger cohorts, where sufficient statistical power could clarify whether a clinically meaningful difference exists. In a large-scale cohort study published by Hillick et al. (20) in 2025, the NICU admission rate was reported as 12.5% in 3,712 GDM cases, which is significantly lower than that in pregnant women with pregestational diabetes (type 1 diabetes 41.8%, type 2 diabetes 31.1%). The NICU admission rates obtained in our study are consistent with these data, supporting the notion that GDM has a lower risk profile than pregestational diabetes regarding neonatal morbidity.

In contrast, Geng et al. (21) showed that a single abnormal OGTT value did not increase the risk of NICU admission in pregnant women undergoing early screening, and that the risk increased only with three or four abnormal OGTT values. These findings indicate that pregnant women with a single abnormal OGTT value should not automatically be considered high-risk. However, in a study conducted by Ostlund et al. (22) in cases of untreated impaired glucose tolerance, although NICU admission rates were lower than the control group in absolute terms, an increased risk of NICU admission was detected in adjusted analyses (adjusted odds ratio 2.0, 95% confidence interval 1.1-3.8). When all these data are considered together, the degree of glucose intolerance and treatment status emerge as possible key factors that significantly influence neonatal

Table 4. Risk factors associated with NICU admissions (n=20)

Risk factor category	n (%)	Representative examples*
Maternal complications	7 (35%)	Severe preeclampsia; placental abruption; intrahepatic cholestasis
Fetal/perinatal causes	2 (10%)	Intrapartum fetal distress; preterm premature rupture of membranes after cerclage
Neonatal respiratory	5 (25%)	Respiratory distress; transient tachypnea of the newborn
Neonatal metabolic/ hematologic	4 (20%)	Hypoglycemia; polycythemia with feeding difficulty; jaundice due to ABO incompatibility
Combined (maternal + neonatal)	2 (10%)	Severe preeclampsia with neonatal respiratory distress syndrome

*Based on manual review of case notes; NICU: Neonatal intensive care unit

outcomes. Prospective studies with larger sample sizes are necessary to statistically confirm this relationship and define it in different populations.

Study limitations

The fact that women in the GDM group in our study were older and had higher gravidity/parity is consistent with known risk factors for GDM. However, this retrospective study had significant limitations. The retrospective collection of data makes it difficult to control for potential confounding factors. The reliance on routine clinical records rather than a standardized screening scale for early childhood developmental data and the unavailability of these data for the entire cohort limit the interpretation of the findings in this area. Furthermore, the lack of detailed data on specific management strategies (diet, exercise, blood glucose monitoring, etc.) for women with a single abnormal OGTT value prevents a full explanation of why this group did not show similar adverse outcomes to the GDM group.

Conclusion

The findings of this study suggest that pregnant women with one abnormal OGTT value did not demonstrate a statistically significant increase in the risk of key adverse perinatal and neonatal outcomes, such as macrosomia and NICU admission, when compared to women with normal glucose tolerance. Their outcome profile was also comparable to that of the GDM group, potentially reflecting the impact of effective management in GDM patients. These results suggest that a single abnormal OGTT value may not automatically place a pregnancy in a high-risk category for the primary outcomes studied. However, to establish definitive clinical guidelines for this intermediate group, larger prospective studies are essential to validate these findings and inform management strategies.

Ethics

Ethics Committee Approval: *This study was approved by the Clinical Research Ethics Committee of University of Health Sciences Türkiye, İstanbul Training and Research Hospital (approval number: 310, date: 24.11.2023).*

Informed Consent: *This study was conducted using a retrospective cohort design. As our center is a teaching and research hospital, routine informed consent was obtained from all patients who applied, stating that their medical data may be used in scientific research.*

Footnotes

Author Contributions: *Surgical and Medical Practices: T.İ., A.K.K., Concept: T.İ., Ç.A., Design: T.İ., Ç.A., Data Collection or Processing: T.İ., Ç.A., A.K.K., Analysis or Interpretation: Ç.A., Literature Search: T.İ., Ç.A., Writing: T.İ., Ç.A., A.K.K.*

Conflict of Interest: *No conflict of interest is declared by the authors.*

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Impact of cervical preservation on vaginal length and female sexual function after hysterectomy for benign conditions: a retrospective cohort study

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Abstract

Objective: To evaluate how preserving the cervix and maintaining vaginal length influenced sexual function in patients undergoing hysterectomy for benign disorders.

Material and Methods: This retrospective analysis included patients who had either total or subtotal hysterectomy for benign disorders between 2020 and 2022, with vaginal lengths recorded both before and after surgery. The female sexual function index (FSFI) was completed by the patients before surgery and again 24 months postoperatively, while their partners were given the International Index of Erectile Function.

Results: Eighty-five patients were included, with 42 (49%) in the total hysterectomy group and the remainder in the sub-total group. While no significant change in vaginal length was observed in women who underwent subtotal hysterectomy ($p>0.05$), the total hysterectomy group showed a marked reduction in vaginal length postoperatively (10±1 cm vs. 6.6±1.1 cm, $p<0.001$). The reduction in FSFI scores for the subtotal hysterectomy group was notably lower compared to the total hysterectomy group [1.4 (0.8-2.1) vs. 9.2 (8.2-10.1), $p<0.001$].

Conclusion: While both total and subtotal hysterectomy procedures were associated with decreased sexual function, patients who underwent total hysterectomy showed lower FSFI scores. Previous research has suggested this may be due to lack of cervical ring protection and loss of erogenous zones in the posterior vagina through nerve damage. [J Turk Ger Gynecol Assoc. 2026; 27(2): 107-13]

Keywords: FSFI, hysterectomy, IIEF, sexual function, subtotal hysterectomy, vaginal lengths

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Introduction

Globally, hysterectomy is one of the most common gynecologic operations, second in frequency only to cesarean section (1). Based on the surgical technique used, it may be conducted through vaginal, laparoscopic, or open abdominal approaches. Furthermore, depending on the patient's specific clinical condition, the procedure can be executed either as a complete (total) or partial (subtotal) removal of the uterus (2). In total hysterectomy, both the uterus and cervix are entirely excised, which may lead to a reduction in vaginal length. Earlier research has shown that removal of the cervix can lead to deep dyspareunia, so the importance of the cervix for sexual response and sensory function has become increasingly recognized (3). Assessing sexual function after hysterectomy is therefore important to understand the broader impact on

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intimate health and emotional well-being. Validated tools, such as the female sexual function index (FSFI), provide a structured and reliable way for healthcare providers to evaluate sexual difficulties and develop individualized management strategies (4).

One of the most commonly expressed worries among women during pre-hysterectomy consultations is how the procedure might affect their sexual health (5). Worries about a decline in sexual function after the procedure are common and well-documented. In addition to sexual concerns, possible disruptions in urinary or bowel function remain relevant issues following hysterectomy (6). This topic is especially pertinent since a large proportion of individuals undergoing the procedure are still of reproductive age and maintain active sexual lives. Sexual difficulties after hysterectomy may manifest in various ways, including reduced libido, discomfort or pain during intercourse, insufficient vaginal lubrication, challenges in reaching orgasm, or even a complete lack of orgasmic response. In particular, shortening of the vaginal canal post-surgery has been associated with painful intercourse and reduced sexual satisfaction (7). However, existing studies have offered inconsistent conclusions regarding how hysterectomy influences sexual function, creating uncertainty for both clinicians and patients seeking guidance (8). While findings are mixed, some research suggests that diminished vaginal length following hysterectomy may contribute to sexual dysfunction (6). The physical dimensions of the vagina, particularly its length, may influence sexual experiences. Though vaginal length naturally varies across individuals, it typically ranges from 7 to 9 centimeters (9). Certain studies have indicated that a longer vaginal canal may be associated with increased sexual satisfaction and a greater likelihood of orgasm during penetrative sex (7).

Although numerous studies have examined the effects of different hysterectomy techniques on female sexual function, the distinct contributions of vaginal length preservation and cervical retention have received relatively little focus. The aim of the present study was to shed light on how maintaining vaginal length and conserving the cervix may influence sexual health outcomes in women undergoing subtotal or total hysterectomy for benign gynecological disorders.

Material and Methods

This retrospective analysis included patients who visited the gynecology outpatient department between 2020 and 2022 and subsequently underwent either a total or subtotal hysterectomy during that period. The study was approved by the İstanbul Esenyurt University Ethics Committee overseeing the review and authorization of clinical research (approval number: 2024-01-26, date: 15.02.2023).

All patients were thoroughly counseled regarding the surgical alternatives available, and the final decision on the type of procedure was made in agreement with individual preferences. The study population consisted of individuals who underwent surgery for benign gynecological conditions, including treatment-resistant abnormal uterine bleeding, uterine leiomyomas (fibroids), or persistent endometrial polyps. Exclusion criteria were patients who had surgery for non-benign indications, were lost to follow-up, had changed sexual partners within two years or had multiple partners, were less than 24 months postoperative, or had missing critical preoperative data. Patients who underwent concurrent oophorectomy, were postmenopausal, or had conditions that could independently affect sexual function, such as pelvic pain or endometriosis, were also excluded.

Demographic data, detailed medical history, FSFI scale, pelvic examination and vaginal ultrasound data routinely obtained preoperatively in our institution were collected by retrospective file review. Preoperative Pap smear and human papilloma virus (HPV) screening results were also recorded to provide additional background information regarding cervical status. A Samsung Hera W9 Obstetrics/GYN ultrasound device was used during the examinations. Vaginal lengths were measured preoperatively and postoperatively by a physician, with patients awake and positioned in the lithotomy position. Using a speculum, the posterior vaginal fornix was identified and the speculum was removed to avoid unnecessary vaginal tension. The distance between the vaginal posterior fornix and the hymen was measured with forceps and noted in centimeters.

Surgical techniques

All surgical interventions were performed by a single specialist surgeon using a uniform and well-structured surgical approach.

Abdominal total hysterectomy: Abdominal total hysterectomy is a surgical procedure involving the complete excision of the uterus and cervix via an opening made in the abdomen. In this procedure, the entire uterus along with the cervix is surgically excised. Energy devices and uterine manipulators were not used. The point where the external cervical os ends was determined as the surgical margin. The paravaginal tissues were preserved as far as possible.

Subtotal abdominal hysterectomy: Subtotal abdominal hysterectomy is a surgical technique where the uterus is removed via an abdominal incision while the cervix is left intact. Therefore, during this procedure, the uterus is excised partially, preserving the cervix. No uterine manipulator was used during total abdominal hysterectomy, and the cervix of all patients was sutured with a continuous suture. The point where the internal cervical os begins was accepted as the surgical margin.

Laparoscopic hysterectomy: Laparoscopic hysterectomy is a minimally invasive surgical technique carried out through several small abdominal incisions, using a laparoscope. Throughout the procedure, a uterine manipulator was employed to assist in positioning, and the cervix of all patients was sutured with a continuous suture.

No surgical complications or injuries were reported among the patients during hysterectomy procedures. Those included in the study were planned for follow-up assessments 24 months postoperatively. Informed consent was obtained from all participants prior to their enrollment in the study. Sexual function was evaluated using the FSFI scale, a detailed questionnaire designed to measure six key aspects: sexual desire; arousal; vaginal lubrication; orgasm; overall satisfaction; and discomfort or pain during sexual activity. The assessment consisted of 19 items aimed at providing a thorough understanding of sexual health. Each section is structured to detect particular aspects of sexual dysfunction. Moreover, the International Index of Erectile Function (IIEF) questionnaire was administered to the patients' partners to assess their sexual function (10). The IIEF is a standardized tool composed of several questions aimed at evaluating erectile function in men. These questions cover various areas such as the rigidity of erections, ability to achieve and maintain erections, sexual desire, orgasm function, and sexual intercourse satisfaction. Various subscales of the IIEF are used to evaluate an individual's overall sexual function. The questionnaires were manually completed by the same physician, who provided patients and their partners with privacy and adequate time for thoughtful completion in a designated private room.

Statistical analysis

Statistical analyses were performed with SPSS, version 27 (IBM Inc., Armonk, NY, USA). Parametric tests were applied to data that met the assumptions of normality. The independent samples t-test was used to compare measurements between two independent groups, while the paired samples t-test was used for comparisons within paired groups. Non-parametric techniques were used for non-normally distributed data. Continuous variables with normal distribution were reported as means with standard deviations (±), whereas non-normally distributed variables were presented as medians with interquartile ranges (25^{th} to 75^{th} percentiles). Descriptive statistics and frequency distributions were employed to summarize the findings. A p-value less than 0.05 was regarded as statistically significant.

To assess the statistical power of the sample size for identifying the observed effect, a post-hoc power analysis was conducted using G*Power 3.1 software. Using the FSFI score differences between total and sub-total hysterectomy groups, with a Cohen's d of 0.83, a total sample size of 85, an alpha value of 0.05, and applying the Mann-Whitney U test, the study's power was determined to be 0.97.

Results

Table 1 presents the demographic characteristics of the patients categorized by groups. The study included a total of 85 patients, with 42 (49%) undergoing total hysterectomy, of whom 20 (48% were operated via the abdominal route and 22 (52%) via laparoscopic route. The remaining 43 (515) of patients underwent subtotal hysterectomy via the abdominal route. Among patients who underwent total hysterectomy, 16 (38%) had uterine myoma, 16 (38%) had abnormal uterine bleeding resistant to treatment, and 10 (24%) had endometrial polyps. In the subtotal hysterectomy group, 31 (72%) were diagnosed with uterine myoma, nine (21%) had abnormal uterine bleeding resistant to treatment, and three (0.7%) had endometrial polyps.

Preoperative cervical screening data were available for 73 (85.9%) patients. Among these, Pap smear results were normal in 65 of women. HPV results were available only in a limited number of patients, all of which were negative.

Participants in the subtotal hysterectomy group were notably younger compared to those in the total hysterectomy group ($p<0.001$). However, no meaningful differences were detected between the groups regarding the number of pregnancies, number of births, or body mass index ($p>0.05$) (see Table 1).

Figure 1 illustrates the vaginal length measurements in the total hysterectomy group before and after surgery. The preoperative and postoperative vaginal length measurements in the subtotal hysterectomy group did not differ significantly (9.9±1.2 vs. 9.8±1.3, $p>0.05$). However, in the total hysterectomy

Table 1. Demographic data of groups undergoing total and subtotal hysterectomy

	Total hysterectomy (n=42)	Subtotal hysterectomy (n=43)	Statistical analysis
Age (year)	44.1±2.8	41.7±2.3	p<0.001
Gravida	3.4 (2-4)	3.4 (3-4)	p=0.773
Parity	2.2 (2-3)	2.3 (2-3)	p=0.856
BMI (kg/m^2)	25.7±2.3	25.6±2.7	p=0.867
BMI: Body mass index			

group, a significant reduction in vaginal length was observed postoperatively compared to the preoperative measurements (6.6±1.1 cm vs. 10±1 cm, respectively; p<0.001). Vaginal tissue loss observed after the operation was not related to the type of surgery (abdominal or laparoscopic) performed or indication. (p>0.05).

The comparison of preoperative and postoperative FSFI scores for the groups is shown in Table 2. Analysis of the subtotal hysterectomy group's FSFI subscales revealed a statistically significant decline in sexual arousal, lubrication, orgasm, satisfaction, and total scores (p<0.001). Nonetheless, sexual desire and pain/discomfort scores remained largely unchanged, showing no statistically significant differences (p>0.05). Likewise, the total hysterectomy group experienced a marked reduction in every FSFI domain along with a significant decline in overall scores (p<0.001).

When comparing preoperative and postoperative FSFI scores, the decline in FSFI scores was significantly less pronounced in the subtotal hysterectomy group compared to the total hysterectomy group (p<0.001) (Table 3).

No notable changes were observed in erectile or orgasmic function scores when comparing preoperative and postoperative assessments of partners in both the total and subtotal hysterectomy groups (p>0.05).

Discussion

The present study found that the decrease in FSFI scores in both total and sub-total hysterectomy groups highlighted the adverse impact of the operation on sexual function, regardless of cervix preservation. However, the significantly larger decrease in FSFI scores among patients who underwent total hysterectomy compared to the subtotal hysterectomy group suggests a potential association with neural damage resulting from the loss of erogenous zones along with the cervix. These findings further suggest the benefit of choosing subtotal hysterectomy whenever possible, as it may better preserve sexual function and reduce adverse outcomes.

In the literature, the influence of vaginal tissue loss on sexual functions remains unclear. Previous studies have not established a direct connection between vaginal length and sexual function (11). Damage to the autonomic and somatic nerves in the upper vaginal region may result in reduced lubrication, potentially hindering the ability to achieve orgasm. Potential reasons for sexual dysfunction following hysterectomy involve injury to branches of the pelvic plexus located in various anatomical areas, including the nerve networks traversing the paravaginal tissue (12). Furthermore, scar formation secondary to the operation may also contribute to changed sexual function (13). It has been suggested that the cervix may be associated with sexual arousal and orgasm through the uterovaginal nerves via the Frankenhauser plexus. Therefore, these authors suggested that the cervix should be protected in appropriate cases to avoid nerve damage. Another study comparing vaginal hysterectomy with abdominal hysterectomy associated the dyspareunia observed after vaginal hysterectomy with vaginal shortening (13). Dyspareunia arising from vaginal tissue loss may adversely affect sexual functions. This may lead to issues such as reduced sexual desire and difficulty achieving orgasm. Moreover, the discomfort and pain resulting from dyspareunia can potentially heighten emotional strain and interpersonal stress. In the current analysis, individuals who underwent total hysterectomy demonstrated a more pronounced reduction in vaginal tissue compared to those who had a subtotal procedure. This tissue reduction, coupled with the significant

Table 2. Comparison of preoperative and postoperative FSFI scores of total and subtotal hysterectomy groups

	Total hysterectomy (n=42)		Statistical analysis	Subtotal hysterectomy (n=43)		Statistical analysis
	Pre-op	Post-op		Post-op	Pre-op	
	Median (Q1-Q3)	Median (Q1-Q3)		Median (Q1-Q3)	Median (Q1-Q3)	
Desire	4.8 (4.8-4.8)	3.6 (3.4-4.2)	p<0.001	(4.8-6)	(4.8-5.4)	p=0.033
Arousal	4.3 (4.2-4.8)	3.0 (2.7-3.6)	p<0.001	(4.2-5.4)	(3.9-5.1)	p<0.001
Lub.	5.2 (4.8-6)	(3.6-4.5)	p<0.001	(4.8-6)	(4.5-5.7)	p<0.001
Orgasm	4.5 (4.3-4.8)	(2.8-3.2)	p<0.001	(4.4-5.6)	(4-5.2)	p<0.001
Satis.	4.5 (3.9-4.8)	(2.8-4)	p<0.001	(4.8-6)	(4 -5.2)	p<0.001
Pain	5.7 (5.6-6)	(2.4-3.2)	p<0.001	(5.6-6)	(5.2-6)	p=0.007
Total	29.2±3.1	20.3±2.2	p<0.001	30.8±2.8	29.3±2.8	p<0.001

Lub: Lubrication, Satis: Satisfaction, FSFI: Female sexual function index

Table 3. Comparison of within-group reduction rates of preoperative and postoperative FSFI scores

	n	Median (Q1-Q3)	p
Total hysterectomy	42	9.2 (8.2-10.1)	<0.001
Subtotal hysterectomy	43	1.4 (0.8-2,1)	
FSFI: Female sexual function index			

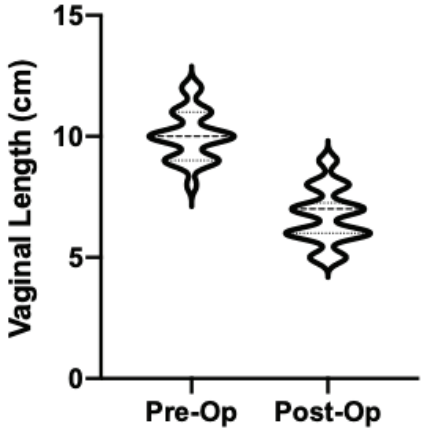

Figure 1. Comparison of vaginal length means before and after total hysterectomy. (Pre-op mean: 6.6±1.1; post-op mean:10±1, p<0.001)

drop in FSFI scores observed among the total hysterectomy group, may relate to the removal of sensitive areas within the vaginal wall and potential nerve disruption, as earlier studies have proposed.

However, it should also be acknowledged that in countries where regular cervical screening programs are not in place, leaving the cervix *in situ* carries the potential risk of retaining precancerous lesions or developing cervical malignancy later, which may complicate subsequent management with both surgery and radiotherapy (2).

Interestingly, despite improvements in sexual satisfaction, no significant reduction in pain scores was observed in either group. This could be related to persistent pelvic floor tension or psychological adaptation following surgery, as previously reported by Dedden et al. (14).

The variability in findings related to sexual function post-hysterectomy highlights the need for a deeper exploration of how vaginal structure impacts sexual well-being. Some studies have shown that the frequency of orgasm significantly declined within the first year following total hysterectomy compared to the period before surgery, whereas this decline was not observed in those undergoing supracervical procedures (3). Another study comparing total laparoscopic hysterectomy to supracervical laparoscopic hysterectomy noted improved sexual function among premenopausal participants (13). Similarly, in a study involving premenopausal women, FSFI scores improved after total laparoscopic, supracervical laparoscopic, and vaginal hysterectomies, regardless of the approach taken (15). Bastu et al. (16) investigated the role of vaginal length, a factor frequently overlooked, and found a positive, albeit statistically non-significant, correlation between vaginal length and FSFI scores. These findings are consistent with earlier research in heterosexual women over 40 years, which suggested a slight positive link between increased vaginal length and elevated FSFI scores (17).

There may be a critical length threshold, beyond which additional preservation of the vaginal canal does not produce significant functional gains. Although both total and subtotal hysterectomy procedures have been linked to declines in sexual function, women who underwent total hysterectomy experienced more pronounced reductions in FSFI scores. This discrepancy may stem from the more extensive removal of nerve-dense, sensitive tissues and an increased risk of nerve damage, as noted in previous reports. Such evidence highlights the potential advantages of subtotal hysterectomy in well-selected patients, as it may help preserve vital anatomical features, including vaginal length, and support better sexual health outcomes.

Radosa et al. (15) proposed that hysterectomy could improve sexual function by addressing the underlying physical causes that negatively influence it, irrespective of the surgical approach used. Similarly, Dedden et al. (14) observed a significant rise in sexual function scores measured by FSFI after the procedure. Supporting studies have included patients suffering from conditions such as endometriosis and chronic pelvic pain, both known to profoundly affect sexual health, and documented sexual dysfunction prior to surgery. By surgically removing these pathogenetic cause of these problematic conditions, patients may experience better sexual function despite a decrease in vaginal tissue length. Moreover, factors such as having lower sexual function before surgery, being younger, and experiencing a shorter period of pelvic pain are associated with more pronounced improvements following hysterectomy, whereas psychological factors such as catastrophizing, may negatively influence recovery. In contrast, our study found that patients' existing medical conditions did not significantly affect sexual function, and none exhibited sexual dysfunction before undergoing surgery. The use of the IIEF questionnaire to assess the sexual function of patients' partners further ensured that partner-related dysfunction did not confound the results.

Numerous investigations than those who had a total abdominal hysterectomy (17). However, a more recent study comparing laparoscopic, abdominal, and vaginal hysterectomies reported similar postoperative reductions in vaginal length across all three groups (7). Kiremitli et al. (18), who investigated how various hysterectomy techniques affect vaginal length

and sexual function, included patients undergoing vaginal hysterectomy in their analysis. Their findings also demonstrated a significant reduction in FSFI scores among patients who experienced marked loss of vaginal tissue. Similarly, Kiyak et al. (19) suggested that the use of uterine manipulators during hysterectomy procedures might help minimize vaginal tissue damage, thereby aiding in the preservation of sexual function. Their study further revealed no significant difference in vaginal tissue loss between patients who underwent laparoscopic total hysterectomy and those who had an abdominal total hysterectomy. Nonetheless, the application of uterine manipulators in abdominal hysterectomy remains a debated topic within the surgical community.

Study limitations

The retrospective, single-center design of this study restricts the generalizability of its findings to wider populations. In addition, our sample did not include a group undergoing laparoscopic subtotal hysterectomy, which restricts direct comparison with the abdominal subtotal hysterectomy cohort. Nevertheless, a post-hoc power analysis demonstrated that the study maintained strong statistical power. The IIEF evaluations were conducted on the patients' partners both pre- and postoperatively, effectively accounting for potential confounding variables related to the spouse; nonetheless, parameters like penile length were not measured, which might have impacted the findings. Other limitations may stem from participants' discomfort or embarrassment when responding to sensitive questions about their sexual lives. On a positive note, all surgical procedures were carried out by the same experienced surgeon using consistent techniques, thereby minimizing variability in pre- and post-operative outcomes related to surgical methods.

In this study, preoperative Pap smear and HPV results were included when available; however, not all patient records contained complete cervical screening data, which we acknowledge as a limitation.

Although there was a modest sample size, the post-hoc power analysis indicated a statistical power of 0.97 with the observed FSFI differences, suggesting that the study had sufficient strength to detect clinically meaningful effects despite its retrospective nature.

This study highlights the considerable negative impact that loss of vaginal tissue has on sexual function, regardless of the hysterectomy method used. Consequently, opting for a subtotal hysterectomy when appropriate may be more advantageous in preserving sexual health compared to a total hysterectomy. Further research is required to gain a deeper understanding of how various surgical techniques affect sexual outcomes and how these are related to changes in vaginal tissue and cervical preservation, ultimately aiding in the improvement of patient care. We believe this research offers a stimulus for healthcare providers to increase their attention to a frequently overlooked and under-researched aspect of hysterectomy. Better understanding of this may serve as a valuable foundation for improving patient counseling and tailoring treatment plans for women undergoing hysterectomy for benign conditions.

While hysterectomy is a long-established surgical procedure, the preservation of sexual function and vaginal length remains a contemporary and clinically relevant issue, particularly with the growing focus on patient-reported outcomes and quality-of-life measures.

Conclusion

The findings of the present study highlight the importance of cervical preservation and anatomical factors influencing sexual health. It is hoped that this will encourage additional research in this field and renew attention to individualized surgical planning.

Ethics

Ethics Committee Approval: *The study was approved by the İstanbul Esenyurt University Ethics Committee overseeing the review and authorization of clinical research (approval number: 2024-01-26, date: 15.02.2023).*

Informed Consent: *Informed consent was obtained from all participants prior to their enrollment in the study.*

Footnotes

Author Contributions: *Surgical and Medical Practices: O.D., Concept: O.D., Design: O.D., H.E.C., Data Collection or Processing: O.D., D.U.K., Analysis or Interpretation: M.Y., Literature Search: P.K., Writing: P.K., M.Y.*

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Bone mineral density in adolescents and young women with hypogonadism: a DXA-based comparative analysis

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Abstract

Objective: To evaluate bone mineral density (BMD) in adolescent girls and young women with hypogonadism from a gynecologic perspective, and to compare their results with those of patients referred for clinical indications associated with bone health, such as fracture history or chronic medication use.

Material and Methods: This retrospective study included females aged 12-21 years who underwent dual-energy X-ray absorptiometry (DXA) between January 2020 and April 2025 in a tertiary university hospital. Patients were categorized as hypogonadal or non-hypogonadal according to the indication for DXA. Lumbar spine (L1-L4) Z-scores were compared between these groups, with height adjustment applied for patients below the 3rd percentile. Demographic characteristics, vitamin D levels, and BMD Z-scores were analyzed across groups and among hypogonadism subtypes (hypergonadotropic, congenital hypogonadotropic, and functional hypothalamic amenorrhea).

Results: Of the 74 participants, 29 (39.1%) underwent DXA because of hypogonadism. Patients with primary amenorrhea had significantly lower lumbar spine Z-scores than those with secondary amenorrhea ($p<0.01$). The mean lumbar spine Z-score was numerically lower in the hypogonadism group (-1.95±1.04) compared with others (-1.38±1.31), however; this was not significant ($p=0.051$). No significant differences were observed among hypogonadism subtypes. Mean serum 25-hydroxyvitamin D levels were low across all groups (12.9±7.7 ng/mL), indicating widespread deficiency.

Conclusion: Adolescent girls and young women with hypoestrogenic conditions, particularly those with primary amenorrhea exhibited lower BMD, emphasizing the essential role of estrogen in bone mass accrual during adolescence. Early diagnosis, hormone replacement, and optimization of vitamin D and calcium intake will be important for preserving bone health in this high-risk population. [J Turk Ger Gynecol Assoc. 2026; 27(2): 114-9]

Keywords: Adolescent, hypogonadism, bone mineral density, vitamin D deficiency, estrogen deficiency, dual-energy X-ray absorptiometry

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Introduction

Osteoporosis is the most common bone disease, affecting approximately one in four women over the age of 50 years, and prevalence increases with age (1). However, approximately 90% of peak bone mass, the key determinant of lifelong bone health, is acquired by the end of adolescence, particularly during puberty (2,3).

Dual-energy X-ray absorptiometry (DXA) is widely used to assess bone health (4) and, in adolescents, is recommended only for those with clinical conditions associated with impaired bone health rather than low-risk individuals (5). In this age

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group, DXA results are interpreted using Z-scores and a Z-score below -2 is considered "low bone mineral density (BMD) for age" (4). The International Society for Clinical Densitometry (ISCD) recommends that a diagnosis of pediatric osteoporosis requires both low BMD and a clinically significant fracture history (5).

Peak bone mass is influenced by both genetic and modifiable factors including nutrition, vitamin D status, body mass index (BMI), chronic illnesses, and hormonal status (5,6). Hypogonadism represents a key risk factor because estrogen deficiency impairs bone formation and accelerates resorption (7,8). Therefore, BMD assessment is recommended in reproductive-age women with persistent hypogonadism (8).

Several studies have investigated DXA indications in pediatric populations at risk (9,10). However, to the best of our knowledge, none have specifically evaluated hypogonadism-related bone outcomes in adolescents from a gynecologic perspective. Therefore, this study compared BMD and DXA indications in adolescents and young women with hypogonadism versus those referred for assessment because of other forms of clinical risk. Furthermore, within the hypogonadism cohort, we compared outcomes across etiologies (hypergonadotropic vs. hypogonadotropic hypogonadism) and between primary versus secondary amenorrhea to explore how variations in estrogen deficiency may influence bone mineralization.

Material and Methods

This retrospective study was conducted in the gynecology outpatient clinic of a tertiary university hospital in accordance with the Declaration of Helsinki (Clinical Trial ID: NCT07164248), after ethical approval was obtained from the University of Health Sciences Türkiye, Bağcılar Training and Research Hospital Ethics Committee (approval number: 2025/05/05/048, date: 22.05.2025). Female patients aged 12-21 years who underwent DXA between January 2020 and April 2025 were included. DXA data were retrieved from the hospital electronic medical record system.

DXA scans had been ordered by various specialties, including orthopedics, physical medicine and rehabilitation, neurology, pediatrics, endocrinology, and gynecology. Demographic information (date of birth, age, height, weight), clinical diagnosis, DXA indication, and 25-hydroxyvitamin D (25-OHD) levels (when available) were recorded. Patients were categorized according to DXA indication into hypogonadism and other clinical risk groups. The non-hypogonadal group comprised patients referred for a range of clinical conditions, including fracture history, scoliosis, chronic inflammatory or neurological disorders, and chronic medication use such as glucocorticoids, which may adversely affect bone health.

All scans were performed on the same densitometer (Stratos DR). BMD (g/cm^2) was measured at the lumbar spine (L1-L4) and total hip but only lumbar spine measurements were used in the analysis. As per the ISCD Pediatric Position Development Conference recommendations (11), DXA results were expressed as Z-scores based on chronological age. In patients whose height was <3rd percentile, lumbar spine Z-scores were adjusted using previously published regression equations (12,13).

Within the hypogonadism group, patients were further classified as hypergonadotropic or hypogonadotropic hypogonadism; the latter subgroup was categorized as congenital hypogonadotropic hypogonadism (CHH) or functional hypothalamic amenorrhea (FHA). Demographic parameters, vitamin D levels, and lumbar Z-scores were compared across groups.

Statistical analysis

Descriptive statistics for continuous variables included mean, standard deviation, median, minimum, and maximum; categorical variables were expressed as numbers and percentages. Normality was assessed using the Shapiro-Wilk test. The independent samples t-test was used for normally distributed variables and the Mann-Whitney U test for non-normally distributed variables. IBM SPSS, version 20 (SPSS, Chicago, IL, USA) was used for analysis. A $p<0.05$ was considered statistically significant.

Results

Data were obtained from 74 females aged 12-21 years. Of these, 29 (39.1%) were evaluated because of hypogonadism, and primary amenorrhea was the presenting complaint in approximately one-third of these patients. The remaining cases were referred for other risk factors associated with impaired bone health, occasionally with more than one indication. Overall, 17 patients (22.9% of all participants and 37.7% of those evaluated for non-hypogonadal reasons) had a history of fractures. Scoliosis was present in nine patients, and five were evaluated in the postpartum lactation period after adolescent pregnancy, most commonly due to back pain, with a mean lumbar spine Z-score of -2.44. Among non-hypogonadal referrals, multiple sclerosis and chronic steroid exposure each accounted for 13.3% of indications, and the most frequent clinical presentation was back pain and/or vertebral deformities.

As shown in Table 1, no significant differences were observed between the hypogonadism and non-hypogonadal groups in terms of age, height, weight, BMI, or serum 25-OHD levels (all $p>0.05$), indicating that the two cohorts were demographically and anthropometrically comparable.

The mean lumbar spine BMD (L1-L4) Z-score was lower in patients with hypogonadism (-1.95±1.04) compared with

Table 1. Comparison of patients who underwent DXA due to hypogonadism with patients who underwent DXA due to other risk factors

	Total (n=74)	Hypogonadism (n=29)	Other risks (n=45)	p-value
	Mean ± SD Median (min-max)	Mean ± SD Median (min-max)	Mean ± SD Median (min-max)	
Height (cm)	159.11±6.25 160 (136-170)	159.00±6.66 160 (143-170)	159.18±6.05 160 (136-169)	0.906[a]
Weight (kg)	55.07±11.84 54 (33-85)	55.41±11.01 55 (39-78)	54.84±12.46 53 (33-85)	0.842[a]
BMI (kg/m^2)	21.75±4.59 20.9 (13.9-36.2)	22.08±5.17 20.9 (15.0-36.2)	21.54±4.22 21.0 (13.9-31.2)	0.624[a]
Age (years)	17.48±2.64 17 (12-21)	17.48±1.95 17 (14-21)	17.16±3.02 17 (12-21)	0.933[b]
L1-4 Z score	-1.54±1.28 -1.8 (-3.9-1.7)	-1.95±1.04 -1.9 [-3.9-(-1.0)]	-1.38±1.31 -1.6 (-3.9–1.7)	0.051[b]
25-OHD (ng/mL)	Total 47 patients 12.96±7.74 10 (3-31)	15 patients 14.00±8.70 10 (4-31)	32 patients 12.63±7.48 10 (3-31)	0.609[b]

[a]Independent groups t-test (independent samples t-test)
[b]Mann-Whitney U test
BMI: Body mass index, SD: Standard deviation, min: Minimum, max: Maximum, DXA: Dual-energy X-ray absorptiometry, L1-L4: Lumbar spine, 25-OHD: 25-hydroxyvitamin D

those evaluated for other risk factors (-1.38±1.31), however, this difference was not significant (p=0.051).

Serum 25-OHD values were available for 47 patients (59.5%), with an overall mean concentration of 12.96±7.74 ng/mL. Consistent with the group comparisons, no significant difference was observed between the hypogonadism and non-hypogonadal groups (p=0.609).

Of the 29 patients diagnosed with hypogonadism, 17 (58.6%) had hypergonadotropic hypogonadism, including 12 with secondary and five with primary amenorrhea. Notably, one patient with galactosemia presented with primary amenorrhea and had a markedly low lumbar spine (L1-L4) Z-score of -3.6. Among the chromosomal etiologies, one patient with Turner syndrome (16 years old, height 145 cm) had a raw Z-score of -3.9, which improved to -2.4 after height adjustment; another with Down syndrome (18 years old, height 143 cm) had a corrected Z-score of 1.0. Two patients with a history of chemotherapy (one for leukemia, one for osteosarcoma) were also present in this group.

Seven patients (24.1%) had FHA, all presenting with secondary amenorrhea, while four patients (13.8%) were diagnosed with CHH, all with primary amenorrhea. One patient (3.4%) had hyperprolactinemia related hypogonadism. Among patients with secondary amenorrhea, the mean age at menarche was 13.05±1.90 years and the mean duration of amenorrhea before DXA assessment was 16.1±9.9 months.

A significant difference was found between the lumbar spine (L1-L4) Z-scores of patients with primary amenorrhea and those with secondary amenorrhea (p<0.01). Patients with primary amenorrhea had lower L1-L4 Z-scores compared to those with secondary amenorrhea (Table 2).

Lumbar spine (L1-L4) Z-scores among hypogonadism subtypes are presented descriptively in Table 3. Mean Z-scores were lowest in patients with CHH, followed by those with hypergonadotropic hypogonadism, while patients with FHA exhibited relatively higher mean values. Given the small sample size, particularly in the CHH subgroup, no inferential statistical comparisons were performed, and these findings are presented for descriptive purposes only.

Discussion

In this study, adolescent girls with hypoestrogenic conditions exhibited lower BMD compared with patients evaluated for other clinical risk factors, although this difference did not quite reach statistical significance. Nevertheless, estrogen plays a well-established and critical role in skeletal development and the attainment of much of peak bone mass during adolescence, as consistently demonstrated in previous studies (14,15). In particular, patients with primary amenorrhea exhibited markedly reduced lumbar spine Z-scores compared with those with secondary amenorrhea, which may reflect earlier onset and longer duration of estrogen deficiency during the pubertal period. However, this difference should be interpreted with caution, as delayed skeletal maturation is common in adolescents with hypogonadism presenting with primary amenorrhea, and Z-scores calculated based on chronological

Table 2. Comparison of L1-4 Z score values between patients with primary amenorrhea and patients with secondary amenorrhea

	Primary amenorrhea (n=9)	Secondary amenorrhea (n=20)	p-value
	Mean ± SD Median (min-max)	Mean ± SD Median (min-max)	
L1-4 Z score	-2.94±0.93 -3.30 (-3.9-1.5)	-1.68±0.69 -1.8 (-2.9-0.1)	**0.002**[b]

[b]Mann-Whitney U test
SD: Standard deviation, min: Minimum, max: Maximum, L1-L4: Lumbar spine

Table 3. Comparisons of L1-4 Z score values between diagnoses in patients who requested DXA examination due to amenorrhea

	Hypergonadotropic hypogonadism (n=17)	FHA (n=7)	Congenital hypogonadotropic hypogonadism (n=4)
	Mean ± SD Median (min-max)	Mean ± SD Median (min-max)	Mean ± SD Median (min-max)
L1-4 Z score	-2.14±1.10 -1.9 (-3.9-0.1)	-1.77±0.60 -1.9 [-2.4-(-0.8)]	-2.52±0.75 -2.6 [-3.3-(-1.5)]

SD: Standard deviation, min: Minimum, max: Maximum, DXA: Dual-energy X-ray absorptiometry, L1-L4: Lumbar spine, FHA: Functional hypothalamic amenorrhea

age may overestimate the severity of low bone mass in this group. These findings support the importance of timely diagnosis and treatment in girls who fail to achieve menarche, while highlighting the need for bone age-adjusted assessments in future studies to more accurately characterize bone health.

Although the cohort size was relatively small, the inclusion of a well-defined adolescent population highlights the vulnerability of this age group, in whom estrogen deficiency may disrupt the acquisition of peak bone mass and increase lifetime fracture risk. Beyond hypoestrogenism, several other clinical conditions, such as chronic inflammatory disease, glucocorticoid exposure, neurological disorders, and adolescent pregnancy and lactation, also contributed to reduced BMD in our cohort. The comparison between hypogonadal and non-hypogonadal risk groups, as well as among distinct hypogonadal etiologies, suggests that various conditions leading to reduced estrogen exposure may influence lumbar spine bone density although not all differences reached statistical significance. The lack of a statistically significant difference in BMD between hypogonadal patients and the comparison group may be partly attributable to the non-healthy nature of the control population, which included individuals with clinical conditions known to adversely affect bone health. In this context, the absence of significance likely reflects underlying bone vulnerability in both groups rather than a true lack of effect of hypoestrogenism. Early recognition of high-risk profiles is therefore essential to guide individualized management strategies.

Among hypogonadal patients, the majority had hypergonadotropic hypogonadism, including individuals with primary ovarian insufficiency (POI). POI and related causes of ovarian failure are recognized contributors to hypoestrogenism and low BMD, with greater impact when diagnosis and hormonal treatment are delayed (14,16). Additional etiologies in our cohort, such as Turner syndrome, galactosemia, and treatment-related ovarian dysfunction, similarly impair bone accrual through a combination of estrogen deficiency and intrinsic skeletal vulnerability (17-19). Although the specific mechanisms differ, the common pathway involves disruption of pubertal estrogen exposure and consequent reduction in trabecular bone, particularly in the lumbar spine.

FHA and CHH represented additional hypoestrogenic states in our study. FHA is frequently associated with secondary amenorrhea in adolescents, while CHH typically presents as primary amenorrhea due to impaired GnRH secretion (7,20). In both conditions, delayed estrogen replacement may result in insufficient bone mineralization during adolescence, supporting recommendations for early evaluation and pubertal induction in individuals with persistent hypoestrogenism (21).

Of note, vitamin D deficiency was widespread in 60% of our cohort (mean serum 25-OHD: 12.96 ng/mL), consistent with previous reports linking low vitamin D status to impaired bone development during adolescence (22,23). Concentrations below 10-12 ng/mL are associated with impaired bone mineralization, whereas values <20 ng/mL indicate biochemical deficiency (22,23). Nevertheless, vitamin D levels did not differ significantly between hypogonadal and non-hypogonadal groups, suggesting

that low estrogen exposure rather than vitamin D deficiency may be the dominant determinant of BMD in this setting.

Study limitations

The main strength of this study is the evaluation of BMD in adolescents and young women with a spectrum of risk factors, allowing a gynecologic comparison of hypoestrogenic conditions within a broader at-risk population. The interdisciplinary referrals enabled examination of diverse etiologies that may affect peak bone mass during this critical developmental period.

Another strength is the demographic homogeneity between groups, which reduces confounding related to age, anthropometry, and vitamin D status and supports the validity of the observed differences in lumbar spine Z-scores.

However, the retrospective design limited the availability of potentially relevant variables such as nutritional status, physical activity, detailed medication history, and familial predisposition. Furthermore, menstrual history and age at menarche were often undocumented in patients referred from non-gynecologic specialties, limiting a more comprehensive endocrine assessment. The relatively small sample size also limits generalizability. It is important to note that the comparison group in this study comprised patients referred for DXA due to various clinical indications, including conditions known to be associated with reduced BMD, such as chronic steroid use. As a result, the true difference in BMD between hypogonadal patients and healthy adolescents may be greater than that observed in the present study but would require a healthy control group to confirm.

Although height-adjusted Z-scores were used in patients with short stature in accordance with pediatric DXA recommendations, the absence of bone age assessment remains a limitation of this study. In adolescents with hypogonadism and delayed puberty, bone age is frequently delayed. Consequently, Z-scores calculated based on chronological age may overestimate the severity of low bone mass (24). Future studies incorporating bone age adjusted assessments may help distinguish delayed skeletal maturation from true osteopenia.

Conclusion

This study highlights a significant difference in BMD between adolescents and young women with primary and secondary amenorrhea, with markedly lower lumbar spine Z-scores observed in those with primary amenorrhea. This finding suggests that earlier onset and longer duration of estrogen deficiency may adversely affect bone mineral accrual during adolescence, although this interpretation should be considered in light of delayed skeletal maturation in this group. The comparison between hypogonadal patients and those referred for other bone health-related indications did not demonstrate a significant difference in BMD. In addition, the uniformly low serum 25-OHD levels across the cohort indicate a widespread deficiency that may further compromise skeletal health.

Taken together, these results emphasize the importance of early identification of amenorrhea, particularly primary amenorrhea, and timely evaluation of bone health. Prompt hormonal management, along with optimization of vitamin D and calcium intake and lifestyle interventions, may be important for preserving bone mass during this vulnerable developmental period.

Ethics

Ethics Committee Approval: *Ethical approval for this study was obtained from the University of Health Sciences Türkiye, Bağcılar Training and Research Hospital Ethics Committee (approval number: 2025/05/05/048, date: 22.05.2025).*

Informed Consent: *Due to the retrospective design of the study, informed consent was waived by the Ethics Committee.*

Footnotes

Author Contributions: *Concept: N.K., Design: N.K., Data Collection or Processing: N.K., N.H., Analysis or Interpretation: N.K., N.H., Literature Search: N.K., N.H., Writing: N.K.*

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The association of pathological findings in HPV-31 positive women with high-grade squamous intraepithelial lesions

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Abstract

Objective: To evaluate pathological findings in patients positive for human papillomavirus (HPV)-31.

Material and Methods: This retrospective study included patients evaluated in a tertiary colposcopy clinic. The 3,546 patients tested for high-risk HPV were evaluated from September 2019 to December 2023. The study comprised 130 (3.7%) patients who tested positive for HPV-31. Isolated HPV-31 positivity indicated the presence of HPV-31 alone. Combined positivity indicated coexistence with other high-risk HPV types. If the following lesions were positive, high-grade squamous intraepithelial lesions (HSILs), adenocarcinoma *in situ*, microinvasive cancer, and cervical cancer, we classified the final pathology as ≥HSIL. Statistical analysis was performed using IBM SPSS Statistics version 20.0.

Results: The mean age was 44.4±9.24 years. Isolated HPV-31 positivity was present in 69 (53.1%) patients. The final pathologic result was ≥HSIL in 9 (6.9%) patients, with only 1 (0.8%) patient had squamous cell cervical cancer. No significant association was observed between HPV-31 positivity type (isolated or combined) and ≥HSIL (respectively, 7.2% vs. 6.6%; p=0.578).

Conclusion: Approximately 7% of women positive for HPV-31 have HSIL and higher lesions. The isolated or combined HPV-31 positivity does not affect the existence of HSIL or higher lesions. [J Turk Ger Gynecol Assoc. 2026; 27(2): 120-4]

Keywords: Cervical dysplasia, cytopathology, gynaecological oncology, human papillomavirus

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Introduction

Worldwide, millions of women aged 15 years and older are at risk of developing cervical cancer (1). GLOBOCAN 2020 data shows that there are approximately 604,000 new cases of cervical cancer and 342,000 deaths each year and ranks as the fourth most common cancer among women worldwide, following breast, colorectal, and lung cancers. In addition, cervical cancer ranks second among cancers in women aged 15-44 years worldwide (1,2). Persistent human papillomavirus (HPV) infection is the main etiological factor in cervical cancer development. Long-term persistence of oncogenic HPV genotypes may result in cervical intraepithelial lesions, which can subsequently progress to invasive cervical cancer (3,4). The use of HPV nucleic acid testing in cervical cancer screening programs has increased detection of high-grade squamous intraepithelial lesions (HSILs) but reduced cervical cancer incidence (5,6).

Over 200 HPV genotypes have been identified, and nearly 40 of these infect the anogenital epithelium. These genotypes are broadly grouped into high-risk and low-risk categories, based on their oncogenic potential (7). Among oncogenic HPV types, HPV-16 and HPV-18 are responsible for nearly 70% of cervical cancer cases. The prevailing high-risk subtypes of HPV,

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following HPV-16/18, include HPV-31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 68, 73 and 82 (1).

There is limited knowledge about how HPV-31 is related to cervical intraepithelial lesions, particularly HSIL and cervical cancer, although HPV-31 is the second most prevalent HPV subtype associated with these lesions (8). Previous studies have reported that HPV-31 infection is associated with a cumulative risk of HSIL [cervical intraepithelial neoplasia (CIN) 2-CIN 3] ranging between approximately 9% and 11% (8-10).

This study evaluated final histopathological outcomes in patients positive for HPV-31. A secondary aim was to determine whether the coexistence of other high-risk HPV genotypes together with HPV-31 influenced the final pathological findings.

Material and Methods

Data were collected from a tertiary care colposcopy outpatient clinic and the study was conducted retrospectively. A total of 3,546 patients tested for high-risk HPV between September 2019 and December 2023 were evaluated. The study population consisted of 130 patients (3.7%) who tested positive for HPV-31. The exclusion criteria included pregnant women, patients receiving immunosuppressive therapy, individuals who were not positive for HPV-31, and HPV-positive patients with unknown genotypes. Ethical approval for this study was obtained from the Ankara Bilkent City Hospital Ethics Committee (approval number: TABED 1-24-481, date: 25.09.2024).

Cervical cancer screening in Türkiye is conducted using HPV testing and the pap smear program. Using the HPV polymerase chain reaction (PCR) kit, the obtained DNA was subsequently detected and classified. Cervical samples were collected using a cytobrush, and the samples were subsequently used for genomic DNA extraction. HPV DNA isolation was performed using the QIAsymphony DSP Virus/Pathogen Midi Kit, and detection and genotyping were carried out with the QIAscreen HPV PCR Kit (Qiagen Inc., Germany). Liquid-based cytology preparations were prepared using the NOVAprep® system (Novaprep Inc., Russia). Liquid-based cytology samples were prepared using the Max-prep cytology system (Corebiotech Co. Ltd, Korea).

Isolated HPV-31 positivity indicated detection of HPV-31 alone, whereas combined HPV-31 positivity indicated detection of HPV-31 together with other high-risk HPV strains. Patients in our clinic are managed based on the American Society for Colposcopy and Cervical Pathology guidelines. Patients diagnosed with HSIL, microinvasive cancer, or adenocarcinoma *in situ*, based on colposcopic biopsy findings, as well as cases with inconsistency between biopsy results and clinical evaluation, underwent conization. The final pathological result was determined based on the highest-grade lesion identified from smear, cervical biopsy, conization, or hysterectomy specimens (Table 1). If the following lesions were positive, HSIL, adenocarcinoma *in situ*, microinvasive cancer, and cervical cancer, we classified the final pathology as ≥HSIL. Gynecologic oncologists performed all colposcopic examinations and conization procedures. Experienced gynecologic pathologists evaluated the surgery specimens.

Statistical analysis

Statistical analyses were conducted with SPSS, version 20.0 (IBM Corp., Chicago, IL, USA). Descriptive data are presented as mean ± standard deviation, median (range), and number (percentage).

Table 1. Final pathology decision

Cervicovaginal smear	ECC pathology	Colposcopic biopsy pathology	Conization pathology	Final pathology
Benign/LSIL/ASCUS	Benign/LSIL	Benign/LSIL	Benign/LSIL	Benign/LSIL
HSIL	Benign/LSIL	Benign/LSIL	Benign/LSIL	HSIL
Any result	HSIL	Benign/LSIL	Benign/LSIL	HSIL
Any result	Benign/LSIL	HSIL	Benign/LSIL	HSIL
Any result	Benign/LSIL	Benign/LSIL	HSIL	HSIL
Any result	Benign/LSIL	HSIL	HSIL	HSIL
Any result	HSIL	Benign/LSIL	HSIL	HSIL
Any result	HSIL	HSIL	Benign/LSIL	HSIL
Any result	HSIL	HSIL	HSIL	HSIL
Any result	If any of the result is squamous cell cancer or adenocancer			Cancer

ECC: Endocervical curettage, ASCUS: Atypical squamous cells undetermined significance, LSIL: Low-grade squamous intraepithelial lesion, HSIL: High-grade squamous intraepithelial lesion

Results

The analysis included 130 patients, and their mean age was 44.4±9.24 years. Isolated HPV-31 positivity was detected in 69 patients (53.1%), whereas combined HPV-31 positivity was present in the remaining 61 (46.9%). Among patients with combined HPV-31 positivity, high-risk HPV strains were distributed as follows: HPV-16 HPV-16 in seven patients (11.4%), HPV-18 in eight (13.1%), HPV-33 in five (8.2%), HPV-35 in nine (14.7%), HPV-39 in seven (11.4%), HPV-45 in five (8.2%), HPV-51 in 12 (19.7%), HPV-52 in eight (13.1%), HPV-56 in 10 (16.4%), HPV-58 in five (8.2%), HPV-59 in three (4.9%), and HPV-68 in four patients (6.5%) (Table 2).

The final pathologic result was ³HSIL in nine (6.9%) patients. The final pathologic results were benign in 68 (52.3%), low-grade squamous intraepithelial lesion in 53 (40.8%), HSIL (CIN 2) in five (3.8%), HSIL (CIN 3) in three (2.3%), and cancer in one (0.8%) patient (Table 2). The patient was diagnosed with squamous cell carcinoma following a colposcopic biopsy, tested positive for isolated HPV-31, presented with atypical squamous cells of undetermined significance from a smear, and had a 3.5 cm mass in the cervix spreading into the endocervical canal. Following this, type III radical hysterectomy with bilateral salpingo-oophorectomy and bilateral pelvic lymphadenectomy was performed. The patient, classified as stage 1b2 according to the 2018 FIGO staging system, did not undergo adjuvant therapy. The association between isolated or combined HPV-31 positivity and ≥HSIL is shown in Table 3. No significant association was found for isolated or combined HPV-31 positivity and the presence of ≥HSIL. ≥HSIL lesions were observed in five isolated HPV-31 positive patients (7.2%) and in four patients with combined HPV-31 positivity (6.6%) (p=0.578).

Discussion

In our tertiary care center HPV-31 positivity was detected in 3.7% of HPV-positive women. Nearly half of the cases (46.9%) demonstrated co-infection with at least one additional high-risk HPV genotype, with HPV-51 being the most frequently accompanying type (19.7%). High-grade cervical pathology (≥HSIL) was identified in 6.9% of women with HPV-31 positivity, and the presence of any additional high-risk HPV types accompanying HPV-31 did not increase the possibility of ≥HSIL. Cervical cancer was detected in only one patient (0.8%) in the final pathological evaluation.

Table 2. Age, HPV-31 type and final pathologic result

Features		**Mean ± SD**	**Median (range)**
Age		44.4±9.24	42 (28-66)
		n	%
HPV-31	**Isolated HPV-31**	69	53.1
	Combined HPV-31	61	46.9
HPV-31 and other HPV type	**HPV-16**	7	11.4
	HPV-18	8	13.1
	HPV-33	5	8.2
	HPV-35	9	14.7
	HPV-39	7	11.4
	HPV-45	5	8.2
	HPV-51	12	19.7
	HPV-52	8	13.1
	HPV-56	10	16.4
	HPV-58	5	8.2
	HPV-59	3	4.9
	HPV-68	4	6.5
Final pathologic results	**Benign**	68	52.3
	LSIL	53	40.8
	HSIL (CIN 2)	5	3.8
	HSIL (CIN 3)	3	2.3
	Cancer	1	0.8

HPV: Human papillomavirus, LSIL: Low grade squamous intraepithelial lesion, HSIL: High grade squamous intraepithelial lesion, CIN: Cervical intraepithelial neoplasia, SD: Standard deviation

Table 3. The relationship between HPV-31 type and ≥HSIL lesion in final pathologic results

HPV-31 type	Benign or LSIL	≥HSIL[1]	p-value
	n (%)	n (%)	
Isolated HPV-31	64 (92.8)	5 (7.2)	0.578
Combined HPV-31	57 (93.4)	4 (6.6)	

[1]: CIN 2 or CIN 3 or cancer
HPV: Human papillomavirus, LSIL: Low grade squamous intraepithelial lesion, HSIL: High grade squamous intraepithelial lesion, CIN: Cervical intraepithelial neoplasia

The distribution of high-risk HPV genotypes varies considerably across different geographical regions. Even within the same country, regional variations in HPV prevalence have been reported (11,12). The worldwide prevalence of HPV-31 is 0.8%, while in Europe it is 2.3% (11). A study reported that the prevalence of HPV-31 was 17.3%, making it the second most prevalent type after HPV-16 (8). In Türkiye, 4 million women were screened as part of a nationwide HPV-based screening program. One of the largest published screening series reported an HPV-31 prevalence of 8.6%, ranking third after HPV-16 (21.9%) and HPV-51 (10.3%) (13). Another study conducted between 2006 and 2010, including 6,388 patients, reported an HPV-31 prevalence of 6%, identifying it as the third most prevalent high-risk HPV type (14). In the present study, which evaluated data from one of the largest tertiary hospitals in Türkiye, the prevalence of HPV-31 was 3.7%.

Current evidence regarding the relationship between HPV-31 infection and cervical cancer remains limited. In our study population, cervical cancer was diagnosed in only 0.8% of women positive for HPV-31. A meta-analysis published in 2007 reported that the prevalence of HPV-31 was 3.8% in squamous cell cervical cancer and 8.6% in HSIL (15). A worldwide meta-analysis published in 2011 evaluated 30,848 cervical cancer patients and reported an HPV-31 prevalence of 3.8% (12). Another study reported a detection rate of HPV-31 in HSIL samples of 23.5%, whereas HPV-31 was not detected in all cases of cervical cancer (8).

The impact of isolated versus multiple high-risk HPV infections on the development of HSIL or more advanced lesions remains unclear. One study compared the effect of HPV-16–HPV 18 co-infection on ≥HSIL lesions with women positive only for HPV-16 and reported no significant difference (16). Another study demonstrated no significant difference in cervical pathology between isolated HPV-31 infection and combined HPV-31 infection (17). No significant association was found between isolated or combined HPV-31 infection and ≥HSIL in the present study but the sample was only 130 women positive for HPV-31. However, another study reported that the HSIL rate increased from 5.8% with isolated infection to 13.1% with combined infection (p=0.089) (18).

Study limitations

This study has certain limitations, including the very small study population, its retrospective design, limited information on previous HPV positivity, and insufficient data on vaccination status. In addition, the study was restricted to a specific region which limits the generalizability of the results. Despite these limitations, our study represents one of the relatively larger series evaluating HPV-31 positivity although much larger populations are required for reliable epidemiological findings. A strength of the present study is that all patients were evaluated in a tertiary care center by experienced gynecologic oncologists and gynecologic pathologists.

Conclusion

Approximately 7% of HPV-31–positive women have HSIL or higher-grade cervical lesions. However, in this HPV-31- positive population, cervical cancer incidence was below 1%. Isolated HPV-31 positivity when compared to combined HPV-31 plus other high-risk HPV types did not appear to increase the risk of HSIL or more severe cervical lesions.

Ethics

Ethics Committee Approval: *Ethical approval for this study was obtained from the Ankara Bilkent City Hospital Ethics Committee (approval number: TABED 1-24-481, date: 25.09.2024).*

Informed Consent: *Informed consent was waived due to the retrospective design of the study.*

Footnotes

Author Contributions: *Surgical and Medical Practices: A.B., H.A., Y.Ö.U., A.A.T., G.T.G., O.A., F.K., T.T., Concept: A.B., H.A., T.T., Design: A.B., H.A., Data Collection or Processing: A.B., Y.Ö.U., A.A.T., G.T.G., O.A., F.K., Analysis or Interpretation: A.B., O.A., F.K., Literature Search: A.B., Y.Ö.U., Writing: A.B., T.T.*

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Pelvic neurovascular anatomy and avascular spaces: a pictorial essay of key surgical landmarks

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Abstract

A precise understanding of pelvic neurovascular anatomy is essential for minimizing complications during advanced gynecological and pelvic surgery. Retroperitoneal dissection requires a clear appreciation of spatial relationships between vascular, neural, and fascial structures. This pictorial essay provides an anatomically oriented overview of key pelvic compartments and pelvic avascular spaces, including the paraaortic, presacral, pararectal, paravesical, prevesical, and laterovascular spaces, through a curated series of our high-resolution intraoperative and cadaveric dissections. These illustrations emphasize surgical landmarks and neurovascular trajectories that are critical during radical hysterectomy, pelvic lymphadenectomy, deep endometriosis surgery, and other pelvic procedures. The anatomical content correlates with practical surgical applications, including the identification of danger zones, safe dissection planes, and routes for nerve-sparing techniques. Autonomic plexuses, somatic nerves, and vascular variants are also highlighted to support accurate and reproducible dissection. In particular, visual representations of the hypogastric nerve, pelvic splanchnic nerves, and inferior hypogastric plexus aid understanding of the pelvic autonomic pathways involved in continence and sexual function. The presented illustrations offer an operative roadmap that supports surgical planning, enhances intraoperative orientation, and promotes the preservation of neurovascular integrity. This visual anatomical reference aims to improve both surgical safety and functional outcomes in advanced gynecological procedures. [J Turk Ger Gynecol Assoc. 2026; 27(2): 125-46]

Keywords: Neuropelviology, hypogastric nerve, nerve-sparing, pelvic avascular spaces, internal iliac artery

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Introduction

The pelvic cavity is enclosed by the pelvic bones on the outside, while the parietal peritoneum internally covers the abdominopelvic cavity. The space beyond this layer is called the extraperitoneal space, comprising predominantly fatty connective tissue and loose areolar tissue with potential surgical spaces and planes. The anatomical compartments within the extraperitoneal space include the retroperitoneal, subperitoneal, and preperitoneal spaces. Among these, the term "retroperitoneum" refers specifically to the space located posterior to the parietal peritoneum. Therefore, all potential spaces posterior to the parietal peritoneum, extending from the diaphragm cranially to the pelvic floor muscles (levator ani, coccygeus) caudally, can be defined as the retroperitoneum. These compartments contain essential anatomical structures,

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such as the ureter, major blood vessels, autonomic nerves, and the parametrium, and are of high importance in pelvic (gynecological) surgery. The parametrium is a densely organized area incorporating critical neurovascular and lymphatic pathways, which are often encountered during deep pelvic dissection.

What does this study add to the literature?

This pictorial essay delineates the pertinent surgical anatomy of these pelvic avascular spaces and key retroperitoneal structures through images obtained via laparoscopic, open surgical, and cadaveric dissection techniques. It emphasizes their significance and use in surgical procedures to optimize exposure, ensure safe dissection, and preserve neurovascular integrity during radical pelvic surgery.

Application of the retroperitoneal spaces in surgical practice

Incising the parietal peritoneum in the abdomen guides dissection toward the retroperitoneal spaces. Figure 1 shows the entrance to the retroperitoneal area, especially for the dissection of the pararectal and paravesical spaces. The paraaortic, presacral, pararectal, paravesical, prevesical spaces, and laterovascular plane maintain integrity.

Paraaortic space

Dissection of the posterior parietal peritoneum between the root of the mesentery and the mesentery of the sigmoid colon exposes the aorta and inferior vena cava, along with the surrounding lumbo-aortic lymph nodes. The space extends cranially from the diaphragm to the aortic bifurcation at the lumbar (L) 4-5 vertebral level.

Further dissection of the peritoneum in the sub-duodenal area and craniolateral mobilization of the horizontal part of the duodenum toward the right side reveal the renal vessels. The right ureter is typically attached to the posteromedial side of the ascending colon, and the ovarian vessels are located medial to the ureter. On the left, the ureter lies posterior to the sigmoid mesentery, also with the ovarian vessels medial to it. An intraoperative image highlighting the paraaortic space is presented in Figure 2.

Borders

- Median-central: Abdominal aorta (left), inferior vena cava (right).
- Lateral: Psoas major muscle and ureters bilaterally.
- Posterior: Anterior longitudinal ligament and L vertebrae.
- Anterior: Posterior parietal peritoneum.

Contents

Paraaortic lymph nodes, intermesenteric plexus, superior hypogastric plexus, sympathetic chain, L plexus nerves, and cisterna chyli.

Surgical relevance

Paraaortic lymphadenectomy, nerve-sparing paraaortic lymphadenectomy, aorto-iliac operations.

Presacral space

Dissection of the presacral space is initiated by incising the peritoneum adjacent to the sigmoid colon at the level of the sacral promontory. The retrorectal space is another term used to describe this area. The lateral border of the promontory serves as a landmark point for the pelvic brim, where vessels, nerves, and the ureter run toward the pelvis. The presacral space and its relationship to adjacent neurovascular structures and the rectosigmoid colon are illustrated in the intraoperative image shown in Figure 3.

Borders

Anterior: Visceral fascia of the rectum (mesorectal fascia)
Posterior: Presacral parietal fascia (overlying the sacrum)
Lateral: Common iliac arteries and ureters.

Contents

Hypogastric nerves, presacral veins.

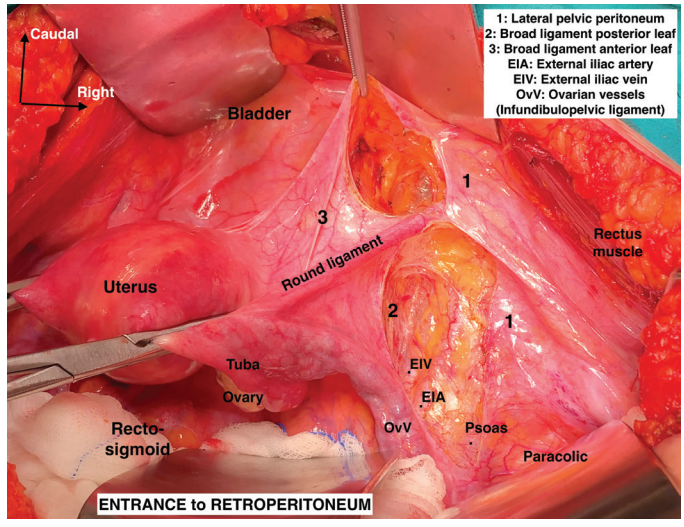

Figure 1. Entrance to the retroperitoneal area. [all surgical and cadaveric dissections were performed by the author (Dr. İlker Selçuk) and his team]

Surgical relevance

The presacral space is crucial for mobilizing and excising the rectosigmoid colon, performing radical pelvic surgeries (1), nerve-sparing techniques, and sacrocolpopexy procedures.

Pararectal and paravesical space

The pararectal and paravesical spaces are key surgico-anatomical areas in the pelvis, important in gynecological, colorectal, and urological procedures. Recognizing the landmarks and contents is essential for deep pelvic operations. Incision of the lateral pelvic peritoneum, along the lateral extension of the broad ligament, lateral to the rectum and bladder, exposes the dissection planes for the pararectal and paravesical spaces in the posterolateral and anterolateral regions of the pelvis, respectively. Intraoperative images demonstrating the anatomical boundaries and surgical exposure of the pararectal and paravesical spaces, including adjacent vascular and neural structures, are shown in Figures 4 and 5.

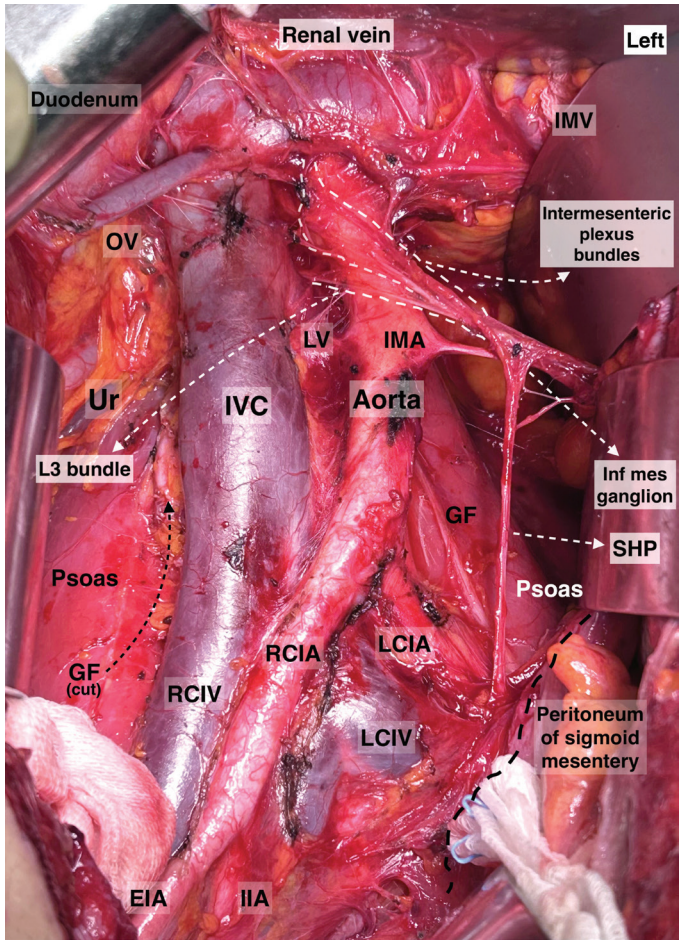

Figure 2. Paraaortic space and components
IVC: Inferior vena cava, RCIA: Right common iliac artery, RCIV: Right common iliac vein, LCIA: Left common iliac artery, LCIV: Left common iliac vein, EIA: External iliac artery, IIA: Internal iliac artery, IMA: Inferior mesenteric artery, IMV: Inferior mesenteric vein, OV: Ovarian vein, LV: Lumbar vein, Ur: Ureter, GF: Genitofemoral nerve, SHP: Superior hypogastric plexus, L: Lumbar, Inf mes: Inferior mesenteric

Pararectal space

The pararectal space is a potential anatomical compartment located bilaterally alongside the rectum. Upon dissection and mobilization of the ureter from the broad ligament posterior leaf, the space is divided into two distinct compartments: the medial pararectal space (Okabayashi) and the lateral pararectal space (Latzko) (2). The ureter lies within the same fascial sheet as the hypogastric nerve, commonly referred to as the ureterohypogastric fascia. Anatomically, the pararectal space represents a continuation of the presacral space. Figure 6 presents an intraoperative view of the pararectal space, clearly demonstrating its relationship to adjacent vascular and neural structures, including the ureter and internal iliac vessels.

Borders

Lateral: Internal iliac artery and associated veins.

Medial: Rectum or mesorectum, ureter, and rectouterine ligament (uterosacral ligament).

Anterior: Parauterine and paracervix tissue with the uterine artery and vein (cardinal ligament).

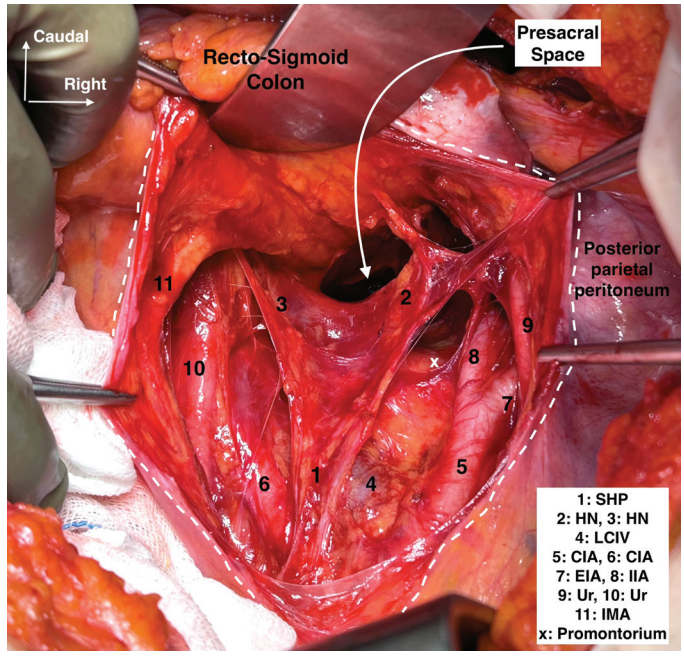

Figure 3. Presacral (retrorectal) space
SHP: Superior hypogastric plexus, HN: Hypogastric nerve, LCIV: Left common iliac vein, CIA: Common iliac artery, EIA: External iliac artery, IIA: Internal iliac artery, Ur: Ureter, IMA: Inferior mesenteric artery

Posterior: Sacrum and presacral fascia.
Inferior: Pelvic floor, levator ani (mainly iliococcygeus).
Superior: Peritoneal reflection of the parietal peritoneum extending toward the lateral pelvic wall.

Contents

Hypogastric nerve, pelvic splanchnic nerves, inferior hypogastric plexus, and middle rectal artery.

Surgical relevance

Radical pelvic surgery, lateral and dorsal parametrectomy, nerve-sparing applications, internal iliac artery ligation, uterine artery ligation, ureteral mobilization, deep endometriosis surgery, and rectal resections.
The pararectal space is the most critical region when performing nerve-sparing pelvic procedures, as it allows the surgeon to identify the pelvic autonomic nerves. However, this is the initial step in nerve-sparing surgery; subsequent efforts focus on preserving the target branches during ongoing surgical maneuvers.

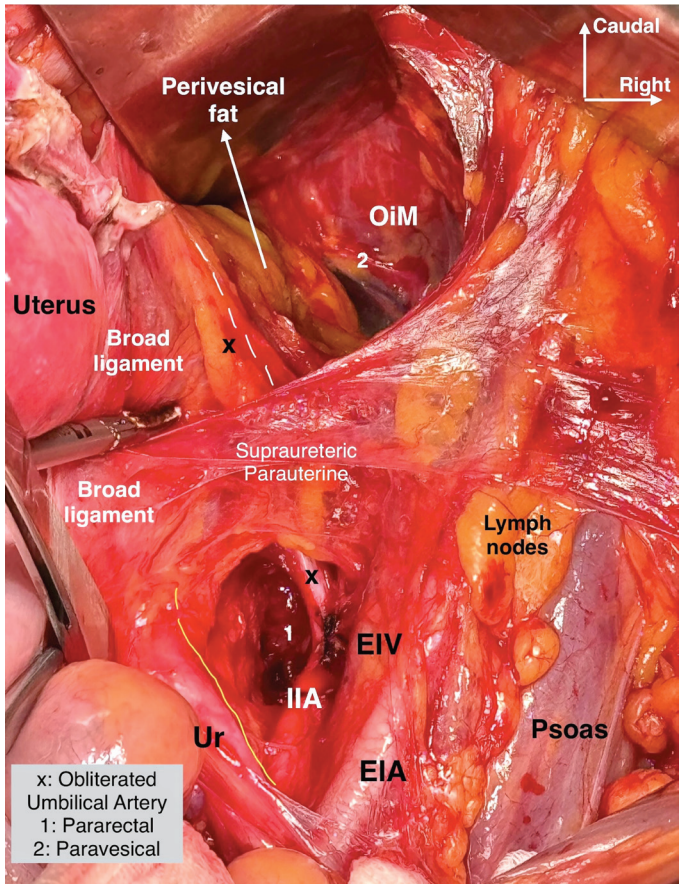

Figure 4. Lateral spaces of the pelvis, surgical landmarks for the paravesical and pararectal spaces
EIA: External iliac artery, EIV: External iliac vein, IIA: Internal iliac artery, Ur: Ureter, OiM: Obturator internus muscle

Paravesical space

The paravesical space is a potential compartment located bilaterally between the bladder and the pelvic sidewall. The obliterated umbilical artery lies attached to the perivesical fatty tissue and forms a fascial sheet, known as the umbilicovesical fascia. Dissection and mobilization of the obliterated umbilical artery divides the space into the medial and lateral paravesical spaces. Figure 7 displays an intraoperative view of the paravesical space, illustrating its dissection planes and anatomical relationships with key vascular and neural structures.

Borders

Lateral: Pelvic sidewall, caudal part of the external iliac vessels, obturator internus muscle, and obturator neurovascular bundle
Medial: Urinary bladder, visceral fascia of the bladder, obliterated umbilical artery, superior vesical artery.
Anterior: Pubic bone, superior pubic ramus.
Posterior: Parauterine and paracervix tissue with the uterine artery and vein (Cardinal ligament).

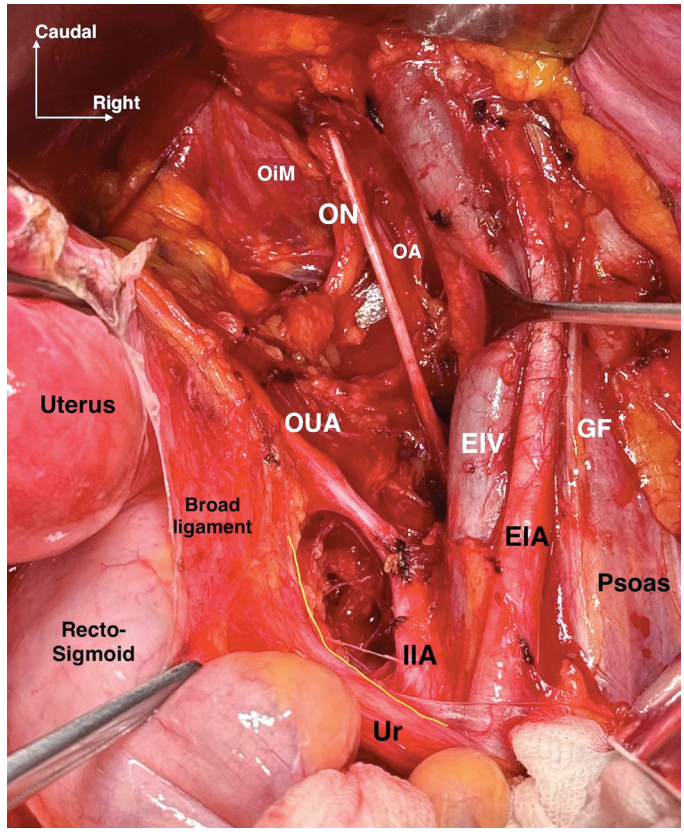

Figure 5. The paravesical and pararectal space
GF: Genitofemoral nerve, EIA: External iliac artery, EIV: External iliac vein, IIA: Internal iliac artery, Ur: Ureter, OUA: Obliterated umbilical artery, ON: Obturator nerve, OA: Obturator artery, OiM: Obturator internus muscle

Inferior: Pelvic floor, levator ani (mainly pubococcygeus).
Inferolateral: Tendinous arch of levator ani.
Superior: Peritoneal reflection of the parietal peritoneum extending over the bladder.

Contents

Obturator nerve, artery, and vein, pelvic lymph nodes, superior vesical artery, bladder nerve branches of the inferior hypogastric plexus, pubic anastomotic vessels (corona mortis vessels).

Surgical relevance

Radical hysterectomy, lateral and ventral parametrectomy, pelvic lymphadenectomy, ureteric dissection, urogynecological procedures, and bladder surgeries.

Prevesical space

The prevesical space lies between the bladder and the pubic bone and allows the bladder to expand. This potential space permits expansion of the bladder and serves as an essential surgical corridor in urogynecological procedures, such as pectineal or Cooper's ligament fixation procedures (3). Dissection begins by incising the peritoneum overlying the bladder dome, posterior to the pubic bone, and continuing anterior to the bladder. The prevesical and paravesical spaces are contiguous, forming a continuous dissection plane. Figure 8 shows a surgical view of the prevesical space, demonstrating its anterior location and continuity with the paravesical compartment, as well as its relevance in procedures involving the bladder neck and urethra.

Borders

Anterior: Pubic symphysis and posterior surface of the pubic bone
Posterior: Anterior surface of the bladder.
Lateral: Obliterated umbilical artery.
Inferior: Pelvic floor, levator ani, and pubocervical fascia.
Inferolateral: Tendinous arch of the pelvic fascia.
Superior: Peritoneal reflection over the bladder (continuous with the anterior leaf of the broad ligament).

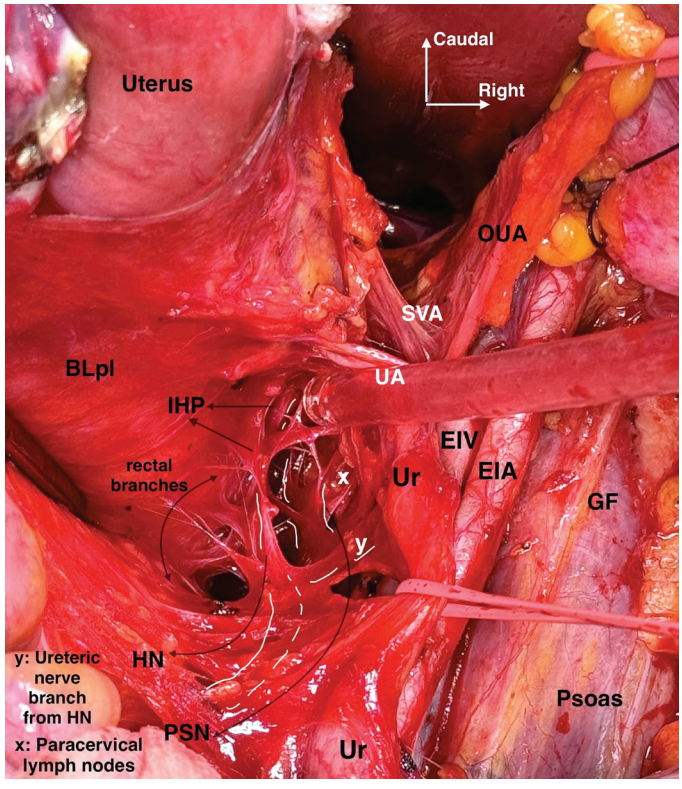

Figure 6. The pararectal space and its components after dissection and lateralization of the ureter from the broad ligament posterior leaf, exposing the medial pararectal approach
GF: Genitofemoral nerve, EIA: External iliac artery, EIV: External iliac vein, Ur: Ureter, OUA: Obliterated umbilical artery, SVA: Superior vesical artery, UA: Uterine artery, IHP: Inferior hypogastric plexus, HN: Hypogastric nerve, PSN: Pelvic splanchnic nerves, BLpl: Broad ligament posterior leaf

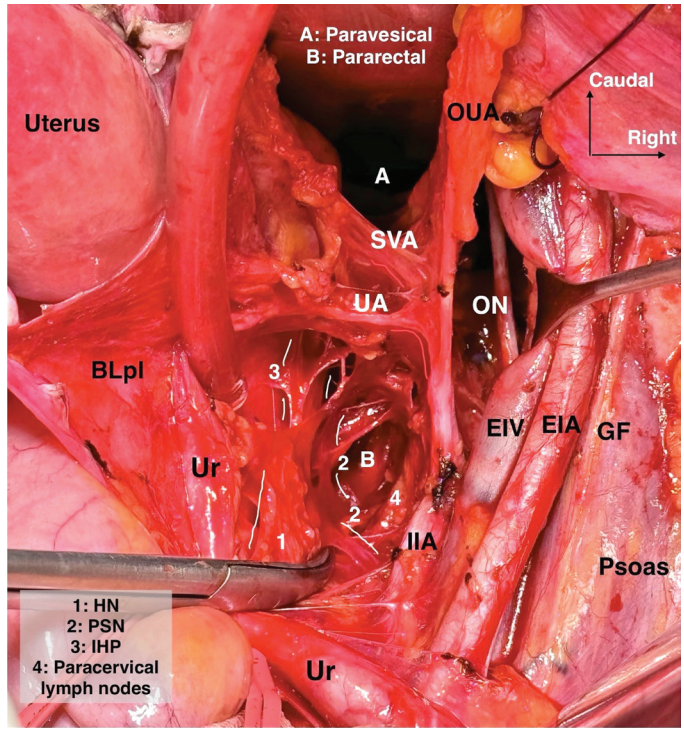

Figure 7. Medial and lateral paravesical space with the pararectal space
GF: Genitofemoral nerve, EIA: External iliac artery, EIV: External iliac vein, ON: Obturator nerve, IIA: Internal iliac artery, OUA: Obliterated umbilical artery, SVA: Superior vesical artery, UA: Uterine artery, Ur: Ureter, BLpl: Broad ligament posterior leaf, IHP: Inferior hypogastric plexus, HN: Hypogastric nerve, PSN: Pelvic splanchnic nerves

Contents

Pubovesical ligament, pubourethral ligament, dorsal vessels of the clitoris, urethra, and prevesical venous plexus.

Surgical relevance

Access to the urethra, anterior vaginal wall, and bladder base; mid-urethral sling procedure (e.g., transvaginal tape); bladder suspension procedure (e.g., Burch colposuspension); and bladder resection procedures.

Laterovascular plane (medial psoas space)

The laterovascular plane, also referred to as the medial psoas space, is accessed by dissecting and medially mobilizing the external iliac vessels away from the psoas major muscle. This dissection reveals a deep anatomical plane critical for advanced pelvic surgery.

Within this anatomical region lie the paracervical and deep common iliac lymph nodes, which are frequently targeted during oncological procedures. The obturator nerve is typically identified in the superficial compartment where it emerges from the psoas major muscle. Inferomedial to the obturator nerve and psoas major muscle, the lumbosacral trunk can be observed on the lateral side of the internal iliac vein (4). The greater sciatic notch is a significant anatomical landmark located laterally to the lumbosacral trunk. Figure 9 illustrates a detailed surgical dissection of the laterovascular plane, emphasizing the spatial relationships between the external iliac vessels, obturator nerve, and lumbosacral trunk, relative to the psoas major muscle.

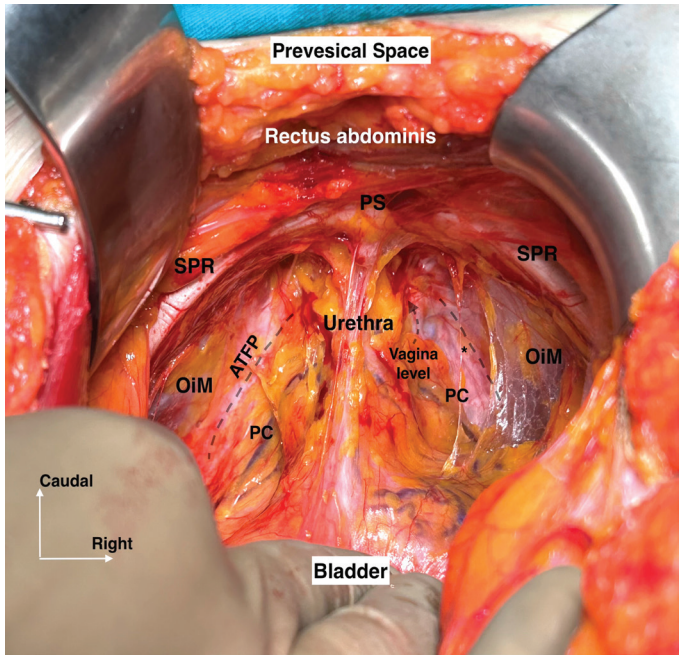

Figure 8. Prevesical space
PS: Pubic symphysis, SPR: Superior pubic ramus, OiM: Obturator internus muscle, PC: Pubococcygeus, ATFP: Arcus tendineus fascia pelvis

Surgical relevance

The laterovascular plane is a crucial access route in laterally extended parametrectomy, deep infiltrating endometriosis surgery, and pelvic or paracervical lymphadenectomy. Clear identification of neurovascular structures within this space is essential to avoid complications and ensure complete resection during oncological procedures.

How to apply this anatomical knowledge to difficult pelvic surgery?

When the pelvic anatomy is distorted, the retroperitoneal route enhances the precision of surgical maneuvers. The sacral promontory on the posterior aspect may be used to identify the entry to the pelvic cavity (pelvic brim) and facilitates further identification of critical anatomical structures for meticulous dissection and safe surgical procedures, including the ureter, common iliac artery, and/or superior hypogastric plexus. Anteriorly, the pubic bone and its superior portion can be similarly used to identify the prevesical and paravesical spaces. Laterally, the round ligament or the psoas major muscle provides the dissection plane for the external iliac

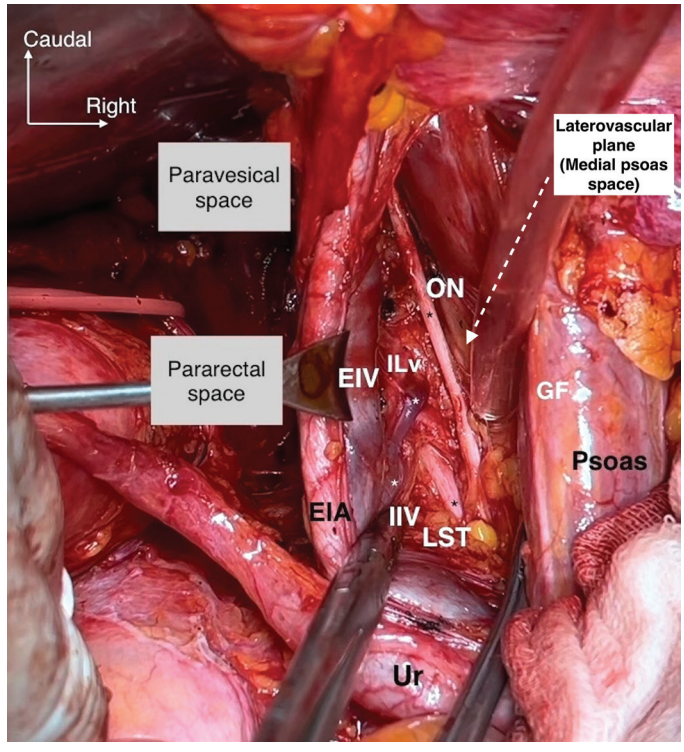

Figure 9. Laterovascular plane (medial psoas space)
GF: Genitofemoral nerve, EIA: External iliac artery, EIV: External iliac vein, ON: Obturator nerve, LST: Lumbosacral trunk, IIV: Internal iliac vein, ILv: Iliolumbar vein, Ur: Ureter

vessels, as well as the paravesical and pararectal spaces. Since all the pelvic avascular spaces are continuous (presacral, pararectal, paravesical, and prevesical), once one space is encountered, the adjacent spaces can also be developed.

Pelvic neurovascular anatomy

Retroperitoneal vascularization

The abdominal aorta delivers arterial blood to the abdominopelvic structures, while venous return ultimately drains into the inferior vena cava. The vascular components of the abdominopelvic cavity are primarily located in the retroperitoneal space. Upon incising the posterior parietal peritoneum of the posterior abdominal wall, between the root of the mesentery and the sigmoid mesocolon, the fatty and lymphoid tissues overlying the aorta and inferior vena cava become visible. In the pelvis, incising the pelvic peritoneum lateral to the visceral organs reveals the pelvic vessels.

Arterial system

Abdominal aorta

The aorta enters the abdominal cavity at the level of the thoracic (T) 12th vertebra, between the crura of the diaphragm, and is referred to as the abdominal aorta. The abdominal aorta bifurcates into the right and left common iliac arteries at the level of the L 4th vertebra, known as the aortic bifurcation. This area is approximately at the superposed level of the umbilicus. The abdominal aorta lies anterior to the L vertebrae and the anterior longitudinal ligament, on the left side of the midline, left to the inferior vena cava (Figure 2).

Major branches of the abdominal aorta

a. Single visceral branches (anterior/antero-lateral origin):
   1. Celiac trunk (upper L1 vertebra level)
   2. Superior mesenteric artery (mid L1 vertebra level, between the celiac trunk and renal arteries)
   3. Inferior mesenteric artery (L3 vertebra level, anterolateral origin)
b. Double visceral branches (lateral origin):
   1. Middle suprarenal arteries (lower L1 vertebra level)
   2. Renal arteries (L1-L2 vertebra level)
   3. Ovarian arteries (L2 vertebra level)
c. Parietal branches
   1. Inferior phrenic arteries (T12 vertebra level)
   2. L arteries (L1-L4 vertebrae level, from the posterolateral surface)
   3. Median sacral artery, at the L4 vertebra level, as the terminal branch of the abdominal aorta, arises from the posterior surface.

Common iliac arteries

The abdominal aorta divides into the right and left common iliac arteries at the level of the L4 vertebra. The common iliac arteries lie caudolaterally on the lateral sides of the L5 vertebra and are medial to the psoas major muscle. The right common iliac artery crosses superior to the confluence of the inferior vena cava. It is slightly longer than the left common iliac artery because the aortic bifurcation occurs on the left side.

Between the right and left common iliac artery, the left common iliac vein lies obliquely toward the left caudal side at the upper part of the presacral space. The left common iliac artery is positioned anterolateral to the left common iliac vein. Anterior to the left common iliac vein is the superior hypogastric plexus, while the sympathetic trunk is situated posterior to the left common iliac artery.

Both ureters cross superior to the distal part of the common iliac arteries. On the right side, the crossing of the ureter may shift toward the beginning of the external iliac artery. Common iliac arteries divide into the external and internal iliac arteries anterior to the sacroiliac joint, at the level of the L5-sacral (S) 1st intervertebral disc, where the iliac bifurcation occurs.

Surgical relevance

Numerous renovascular variations, venous or arterial, may be encountered within the paraaortic space. Arterial variations may appear as accessory arteries or as main renal arteries with a low origin or low-lying attitude. On the left side, such variations predominantly arise from the supramesenteric lateral aspect of the aorta, whereas on the right, they may also originate from the interaortocaval area (Figure 10).

External iliac artery

The external iliac artery represents the longitudinal continuation of the common iliac artery, located at the medial superior edge of the psoas major muscle (Figure 11). Lateral to the external iliac artery, the genitofemoral nerve is found on the anterior surface of the psoas major. Upon passing posterior to the inguinal ligament (posterior in anatomical position, which appears inferior in the surgical supine position), it continues as the femoral artery within the femoral triangle.

Major branches of the external iliac artery include:

1. Inferior epigastric artery
2. Deep circumflex iliac artery

Surgical relevance

Importantly, no vascular structures are typically encountered at the 12 o'clock position relative to the external iliac artery. Therefore, lymphadenectomy dissection planes that run

parallel to the artery in this zone are generally considered safe and pose minimal risk of vascular injury.

Inferior epigastric artery

The inferior epigastric artery originates from the caudal anteromedial edge of the external iliac artery at the posterior side of the inguinal ligament. It runs obliquely medial, anterior to the peritoneum and posterior to the rectus abdominis muscle. The inferior epigastric artery and the surrounding peritoneum at the posterior part of the anterior abdominal wall form the lateral umbilical fold. The inferior epigastric artery supplies the lower deep medial part of the anterior abdominal wall.

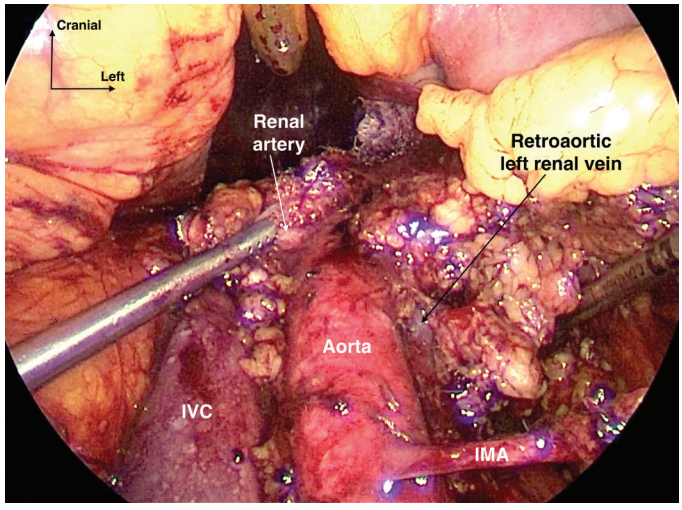

Figure 10. Renovascular variation at the paraaortic area, retroaortic left renal vein and the right renal artery is arising from a low level, detected during inter-aortocaval dissection
IMA: Inferior mesenteric artery, IVC: Inferior vena cava

Surgical relevance

The inferior epigastric artery may give rise to the pubic anastomotic artery and contribute to the arterial corona mortis. This can be observed on the lateral part of the superior pubic ramus, at the posterior aspect of the pectineal ligament. Additionally, during secondary trocar insertions in laparoscopic pelvic procedures, the reflection of the inferior epigastric artery should be identified via the abdominal exposure of the posterior side of the anterior abdominal wall by the laparoscopic camera.

Deep circumflex iliac artery

The deep circumflex iliac artery originates from the caudal anterolateral end of the external iliac artery on the posterior side of the inguinal ligament, proximal to the origin of the inferior epigastric artery. It runs parallel to the inguinal ligament and anastomoses with the superior gluteal artery over the iliac crest. The deep circumflex iliac artery supplies the lower deep lateral part of the anterior abdominal wall.

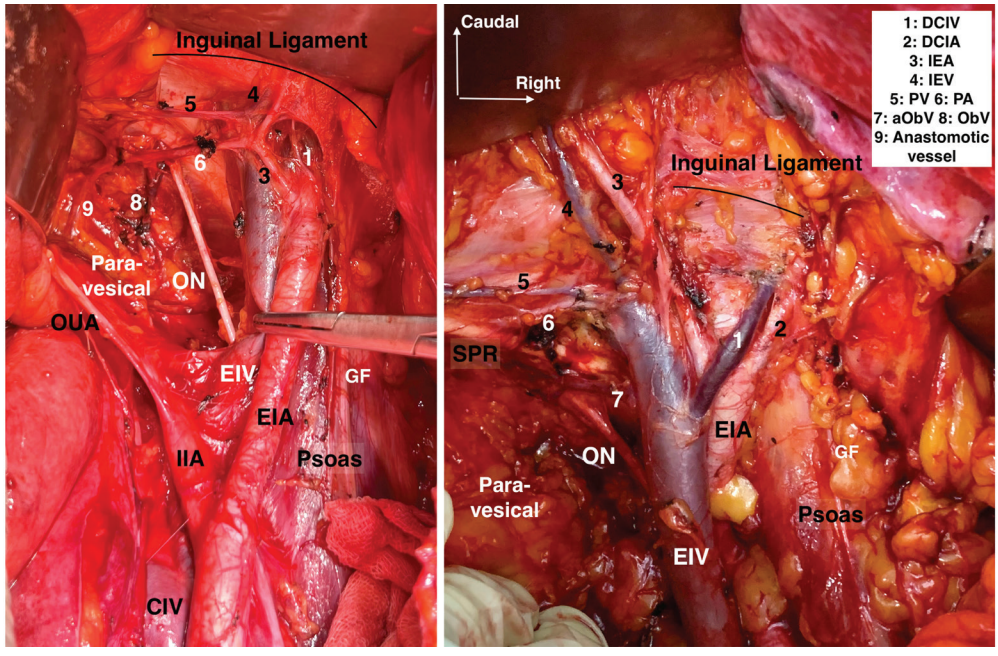

Figure 11. Branches of the external iliac artery and tributaries of the external iliac vein, with the Corona Mortis anastomotic vessels
GF: Genitofemoral nerve, EIA: External iliac artery, EIV: External iliac vein, IIA: Internal iliac artery, CIV: Common iliac vein, OUA: Obliterated umbilical artery, ON: Obturator nerve, ObV: Obturator vein, aObV: Aberrant obturator vein, PA: Pubic artery, PV: Pubic vein, SPR: Superior pubic ramus, IEA: Inferior epigastric artery, IEV: Inferior epigastric vein, DCIA: Deep circumflex iliac artery, DCIV: Deep circumflex iliac vein

Internal iliac artery

After the iliac bifurcation, the inferomedial (posterior in anatomical position and inferior in surgical supine position) branch of the common iliac artery in the pelvis is the internal iliac artery. The internal iliac artery lies inferolateral to the ureter at the lateral edge of the pararectal space. It courses downward into the pelvis, supplying the pelvic viscera and parietal structures. It divides into anterior and posterior trunks with many branches at the upper part of the greater sciatic foramen. The branching pattern of the internal iliac artery varies. Figure 12 illustrates a cadaveric dissection of the right hemipelvis, demonstrating the internal iliac artery and its major branches in relation to surrounding pelvic nerves and visceral structures.

Branches of the internal iliac artery:

a. Posterior trunk
   1. Superior gluteal artery
   2. Iliolumbar artery
   3. Lateral sacral artery

b. Anterior trunk
   1. Inferior gluteal artery
   2. Internal pudendal artery
   3. Middle rectal artery
   4. Inferior vesical artery/vaginal artery
   5. Obturator artery
   6. Uterine artery
   7. Superior vesical artery
   8. Umbilical artery

Posterior trunk and superior gluteal artery

The superior gluteal artery is primarily a continuation of the posterior trunk of the internal iliac artery. The iliolumbar and lateral sacral branches may arise directly from the superior gluteal artery or as early branches within the proximal 2 cm of the internal iliac artery (5). It courses in a posterolateral direction between the S1 nerve and the lumbosacral trunk (L4-L5), toward the upper part of the greater sciatic foramen, above the piriformis muscle. The superior gluteal artery forms an anastomosis with the deep circumflex iliac artery, which connects the external and internal iliac arterial systems.

Surgical relevance

Since the branches of the internal iliac artery supply the pelvic viscera and parietal structures, ligation of the internal iliac artery during pelvic hemorrhage can reduce bleeding and arterial pulse pressure. The posterior trunk of the internal iliac artery originates within 4-5 cm of the internal iliac artery from the iliac bifurcation. The deep circumflex iliac artery anastomoses with the superior gluteal artery, which connects the external and internal iliac arterial systems. The internal iliac artery and its branches have numerous anastomoses; therefore, the risk of tissue necrosis from ligation is low, whether the ligation is proximal or distal to the superior gluteal artery. However, if the patient has disseminated intravascular coagulation, a vascular occlusive disorder, or poor anastomoses due to previous surgery, radiotherapy, or atherosclerosis, those anastomoses may not function effectively. In cases of internal iliac artery ligation, this should be performed bilaterally. The proximal (close to the superior gluteal artery or the iliac bifurcation) and distal (close to the uterine artery/close to the target organ) parts of the internal iliac artery should be ligated separately to block the vascular continuation arising from the anastomotic connections.

Anterior trunk

Inferior gluteal artery

The inferior gluteal artery lies anterior to the sacral plexus and piriformis muscle, between the S1 and S2 nerves at the posterior part of the internal pudendal artery. It exits the pelvis from the inferior edge of the greater sciatic foramen. In that region, the sciatic nerve, pudendal nerve, and internal pudendal artery accompany the inferior gluteal artery. The artery leaves the pelvis from the posterolateral edge of the sacrospinous ligament (6). At this point, the internal pudendal artery is

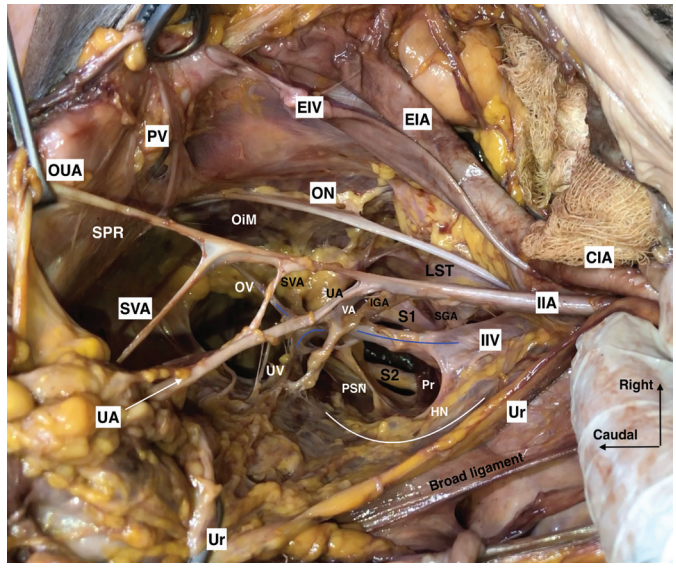

Figure 12. Internal iliac artery and its branches
CIA: Common iliac artery, EIA: External iliac artery, EIV: External iliac vein, ON: Obturator nerve, LST: Lumbosacral trunk, OiM: Obturator internus muscle, PV: Pubic vein, SPR: Superior pubic ramus, OUA: Obliterated umbilical artery, SVA: Superior vesical artery, UA: Uterine artery, VA: Vaginal artery, IGA: Inferior gluteal artery, SGA: Superior gluteal artery, IIA: Internal iliac artery, Ur: Ureter, IIV: Internal iliac vein, UV: Uterine vein, OV: Obturator vein, Pr: Piriformis, S: Sacral, HN: Hypogastric nerve, PSN: Pelvic splanchnic nerves

positioned on the anteromedial side of the inferior gluteal artery (the internal pudendal artery has a variable presence and extension), and the sciatic nerve is on the anterolateral side of the inferior gluteal artery (7). The topographic anatomy of the inferior gluteal artery and its relationship with the sacral plexus and surrounding structures is shown in cadaveric dissection in Figure 13.

Surgical relevance

The inferior gluteal artery lies posterolateral to the sacrospinous ligament. Therefore, to avoid vascular injury, the sacrospinous ligament fixation procedure should be performed 1.5 cm medial to the ischial spine.

Internal pudendal artery

The internal pudendal artery may branch off from the same vessel trunk as the inferior gluteal artery and lies anterior to the inferior gluteal artery at the anterior aspect of the sacral nerve roots and piriformis muscle. It exits the pelvis from the lower edge of the greater sciatic foramen, posterior to the sacrospinous ligament. Then, it rotates around the ischial spine, passes through the lesser sciatic foramen, and enters the perineum via the pudendal canal, which is formed by the obturator fascia inferior to the levator ani muscle. The internal pudendal artery supplies the rectum, perineum, and external genitalia through the inferior rectal artery, perineal arteries, and dorsal-deep arteries of the clitoris. The middle rectal artery and vaginal artery may branch from the internal pudendal artery. These structures exhibit anatomical variability.

Obturator artery

The obturator artery is a branch of the anterior trunk of the internal iliac artery that lies anterolaterally toward the obturator canal, located at the superolateral edge of the obturator foramen. During its course, the obturator artery is found in the obturator fossa and mostly inferior to the level of the obturator nerve (Figure 5). The anastomotic vessel connection between the obturator artery and the inferior epigastric artery is called “Corona Mortis”, which lies over the lateral part of the superior pubic ramus (8) (Figure 11). Sometimes, this anastomotic vessel may open directly into the external iliac artery. Moreover, this anastomosis is mainly found between the venous counterparts of these arteries. The anastomotic pubic vessels, so-called corona mortis vessels, enter the obturator canal from the region of the medial part of the obturator nerve.

Surgical relevance

Sacrifice of the obturator vessels during pelvic lymphadenectomy is generally well tolerated and does not result in adverse outcomes.

Uterine artery

The uterine artery branches from the anteromedial edge of the anterior trunk of the internal iliac artery as the first anteromedial branch (Figure 12). It courses within the broad ligament at the superior part of the lateral parametrium (superior to the ureter), which is termed the parauterine tissue. The tissues of the parauterine (superior to the ureter, containing the uterine artery and adjacent lymphatic tissue) and the paracervix (inferior to the ureter, containing the deep uterine vein, distal part of the pelvic splanchnic nerves as well as the inferior hypogastric plexus with the adjacent lymphatic tissue) constitutes the

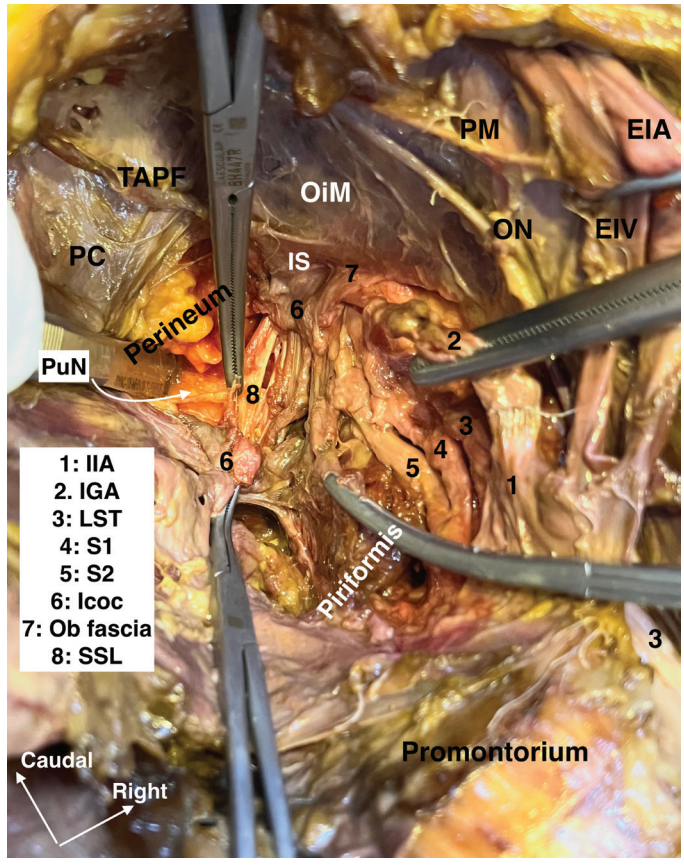

Figure 13. Inferior gluteal artery, sacral nerve roots, and pelvic floor muscles in relation to the greater sciatic foramen

EIA: External iliac artery, EIV: External iliac vein, PM: Psoas major muscle, IIA: Internal iliac artery, ON: Obturator nerve, LST: Lumbosacral trunk, OiM: Obturator internus muscle, TAPF: Tendinous arch of pelvic fascia, PC: Pubococcygeus, Icoc: Iliococcygeus, Ob: Obturator, IS: Ischial spine, SSL: Sacrospinous ligament, S: Sacral, IGA: Inferior gluteal artery, PuN: Pudendal nerve

lateral parametrium, which was historically called the "cardinal ligament"; it is a cellulo-lymphatic tissue and has no suspensory function. It extends to the level of the ischial spine. The uterine artery crosses superior (superior in the surgical supine position, anterior in the anatomical position) to the ureter approximately 1.5 cm lateral to the isthmic part of the uterus. The vaginal artery may arise separately from the anterior trunk of the internal iliac artery. It can be found as a second arterial structure inferior (inferior in surgical supine position, posterior in anatomical position) to the uterine artery and ureter, within the paracervix tissue. Alternatively, sometimes the uterine and vaginal arteries may diverge from the same trunk; the uterine artery crosses superior to the ureter, while the vaginal artery crosses inferior to the ureter and runs toward the upper vagina. The relationship between the uterine artery and ureter (the ureter lies between the uterine artery and the deep uterine vein), as well as adjacent neurovascular structures within the paracervix, is clearly demonstrated in the laparoscopic view in Figure 14.

Surgical relevance

The uterine artery is the main blood supply to the uterus. Ligation or temporary clipping of the uterine artery at its origin is a commonly used method. During this step, there should be at least 1 cm of distance between the uterine artery and the ureter to prevent thermal injury. Closure of the uterine artery at its origin is effective for treating uterine corpus pathologies (myoma or adenomyoma); however, for cervical and vaginal bleeding, its importance diminishes due to the anastomosis between the vaginal and internal pudendal arteries.

Middle rectal artery

The middle rectal artery originates from the anterior trunk of the internal iliac artery or occasionally branches off from the internal pudendal artery. It runs through the deep caudal part of the pararectal space close to the pelvic splanchnic nerves, but it is not always present.

Surgical relevance

The middle rectal artery serves as a landmark to identify the pelvic splanchnic nerves.

Umbilical artery and superior vesical artery

The umbilical artery is an active vessel during fetal development, but it becomes obliterated after birth. It is the anteriorly located longitudinal branch of the anterior trunk of the internal iliac artery that attaches to the perivesical fatty tissue and peritoneum, forming the medial umbilical fold at the posterior aspect of the anterior abdominal wall. This fold serves as a landmark for the paravesical space (Figure 7). The superior vesical artery branches from the proximal patent region of the umbilical artery and supplies the bladder. However, the superior vesical artery can be sacrificed without loss of function. This segment is distal to the branching point of the uterine artery.

Surgical relevance

The umbilical artery acts as a landmark for the paravesical and prevesical spaces.

Venous system

External iliac vein

The femoral vein becomes the external iliac vein as it passes beneath the inguinal ligament, which lies inferior in the surgical supine position. The external iliac vein is situated posteromedially in relation to the external iliac artery. At the caudal aspect of the external iliac artery, the deep circumflex iliac vein traverses superiorly over the artery before draining into the external iliac vein (Figure 11). The deep circumflex iliac vein is the distal caudal border for pelvic lymph node dissection. The inferior epigastric vein similarly drains into the external iliac vein. In addition, an anastomotic vessel may be present between the obturator vein and either the inferior epigastric or external iliac vein and this connection is referred to as the venous corona mortis.

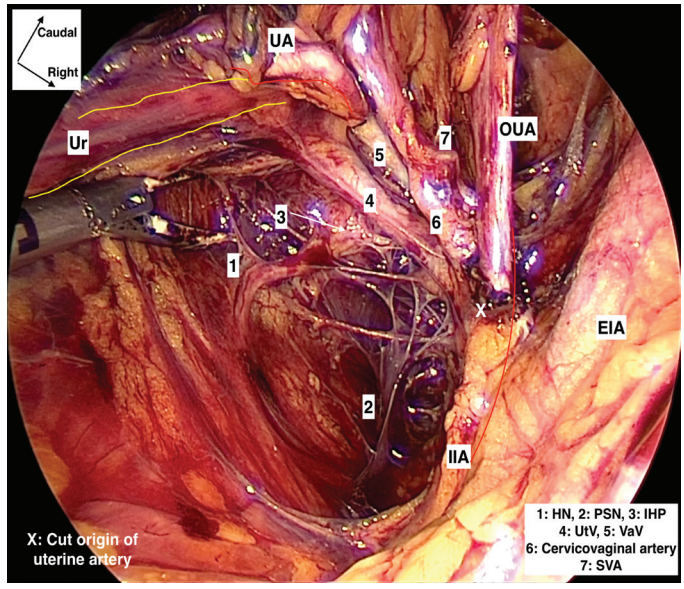

Figure 14. Uterine artery with the parauterine and paracervix tissue, related neurovascular structures
IHP: Inferior hypogastric plexus, HN: Hypogastric nerve, PSN: Pelvic splanchnic nerves, UtV: Uterine vein, VaV: Vaginal vein, SVA: Superior vesical artery, EIA: External iliac artery, OUA: Obliterated umbilical artery, IIA: Internal iliac artery, Ur: Ureter, UA: Uterine artery

Internal iliac vein

The internal iliac vein lies inferior (inferior in surgical supine position and posterior in anatomical position) to the internal iliac artery and slightly at the lateral edge (9). It receives visceral drainage from the vesical, uterine, and rectal plexuses, and parietal drainage from the obturator and gluteal regions (Figure 12). The internal iliac vein is positioned anterior to the sacral plexus, and its tributaries serve as important landmarks for identifying the nerves of the sacral plexus. Pelvic splanchnic nerves are located inferior to the deep uterine/vaginal vein or lie at the same level as the deep uterine vein, a large visceral vein that drains the vesical and vaginal plexuses. The lumbosacral trunk is positioned lateral to the gluteal veins or internal iliac vein, and the cranial aspect of the obturator nerve is located lateral to the main trunk of the internal iliac vein.

Surgical relevance

Injury to the internal iliac vein and its tributaries may result in substantial hemorrhage. These vessels can be ligated in the event of bleeding. The internal iliac vein is positioned inferiorly to the internal iliac artery; therefore, meticulous care must be exercised during internal iliac artery ligation to prevent accidental venous injury.

Several venous plexuses or veins that drain into the internal iliac vein require notable considerations during pelvic surgery, as their extensive anastomoses can lead to hemorrhage. These include the vesical and vaginal veins in the paravaginal area, the sacral veins located at the medial edge of the internal iliac vein anterolateral to the sacrum, and the gluteal veins at the lateral edge of the internal iliac vein.

Common iliac veins

The external iliac vein and internal iliac vein unite anterior to the sacroiliac joint at the cranial part of the obturator fossa, caudal to the iliac bifurcation. The right common iliac vein is located posterolateral to the right common iliac artery, while the left common iliac vein is positioned posteromedial to the left common iliac artery. The left common iliac vein lies in the upper part of the presacral space over the L5 vertebra between the right and left common iliac arteries (Figure 2).

Surgical relevance

The left common iliac vein represents an at-risk anatomical structure for injury during laparoscopic optic trocar insertion via the umbilicus, as well as in the course of paraaortic lymphadenectomy.

Inferior vena cava

The right and left common iliac veins converge approximately 1-1.5 cm caudal to the aortic bifurcation on the right aspect of the abdominal aorta, thereby forming the inferior vena cava (Figure 2). Numerous tributaries are present on the anterior surface of the inferior vena cava, communicating with lymphatic structures. The most prominent of these is associated with the common iliac nodes and referred to as the "Fellow's vein" (10). The L veins drain into the inferior vena cava, with those originating from the left traversing posterior to the abdominal aorta. The right ovarian vein enters the inferior vena cava cranial to the level of the inferior mesenteric artery, while the left ovarian vein drains into the left renal vein. Renal veins enter the inferior vena cava at a point approximately 3-4 cm cranial to the level of the inferior mesenteric artery. Upon mobilization of the horizontal segment of the duodenum, the left renal vein is visualized anterior to the abdominal aorta.

Surgical relevance

Tears in the tributaries of the inferior vena cava, including the "Fellow's vein", may result in bleeding from the vena cava. During paraaortic lymphadenectomy, it is important to be aware of venous renovascular variations, such as retroaortic or circumaortic left renal veins (Figure 15). Therefore, the interaortocaval and supramesenteric lateral aortic zone must be dissected very cautiously.

Retroperitoneal nerves

Both somatic and autonomic nerves from the L and sacral plexus are situated in the retroperitoneal area.

Lumbar plexus

The L plexus is located at the lateral side of the L vertebrae and posteromedial to the psoas major muscle (Figure 16). Nerves from the anterior rami of L1 and L4 spinal roots are part of the L plexus. The 12th thoracic nerve contributes to the L1 nerve. The L5 nerve contributes to L4, forming the lumbosacral trunk (L4-L5).

Nerves of the L plexus

1. Iliohypogastric nerve.
2. Ilioinguinal nerve.
3. Genitofemoral nerve.
4. Lateral femoral cutaneous nerve.
5. Femoral nerve.
6. Obturator nerve.

Iliohypogastric and ilioinguinal nerve

The iliohypogastric nerve originates at the L1 level, with input from T12, while the ilioinguinal nerve arises from L1. Both nerves course along the craniolateral side of the psoas major muscle, pass over the quadratus lumborum posterior to the kidney, and pierce the transversus abdominis muscle to lie between the transversus abdominis and internal oblique muscles as they curve around the iliac crest (Figure 16). The ilioinguinal nerve is positioned caudal and medial to the iliohypogastric nerve. It traverses the inguinal canal without entering through the deep inguinal ring and exits via the superficial inguinal ring. The ilioinguinal nerve accompanies the round ligament within the inguinal canal.

The iliohypogastric nerve provides sensory innervation to the skin above the pubis, mons pubis, and the superolateral gluteal region. It also innervates part of the transversus abdominis and internal oblique muscles. The ilioinguinal nerve supplies sensory innervation to the skin of the superomedial thigh, groin, and labium majus.

Surgical relevance

Lower transverse abdominal incisions, including Pfannenstiel or lateral laparoscopic trocar placement, carry a risk of

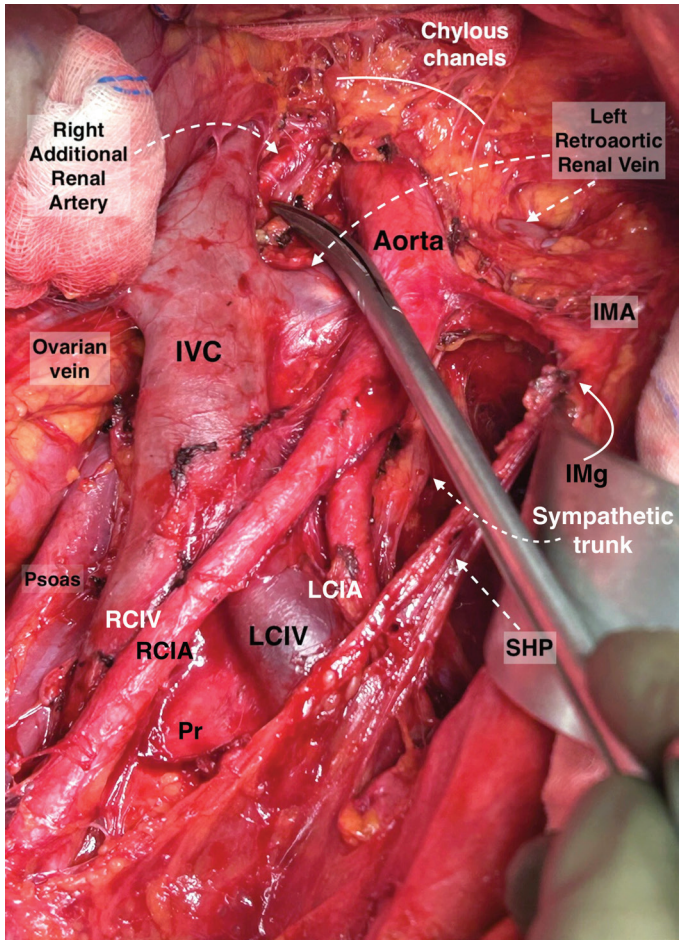

Figure 15. Retroaortic left renal vein and right additional renal artery emposing the danger zones at the supramesenteric lateral aortic space and inter-aortocaval region

IVC: Inferior vena cava, RCIA: Right common iliac artery, RCIV: Right common iliac vein, LCIA: Left common iliac artery, LCIV: Left common iliac vein, Pr: Promontorium, IMA: Inferior mesenteric artery, SHP: Superior hypogastric plexus, IMg: Inferior mesenteric ganglion

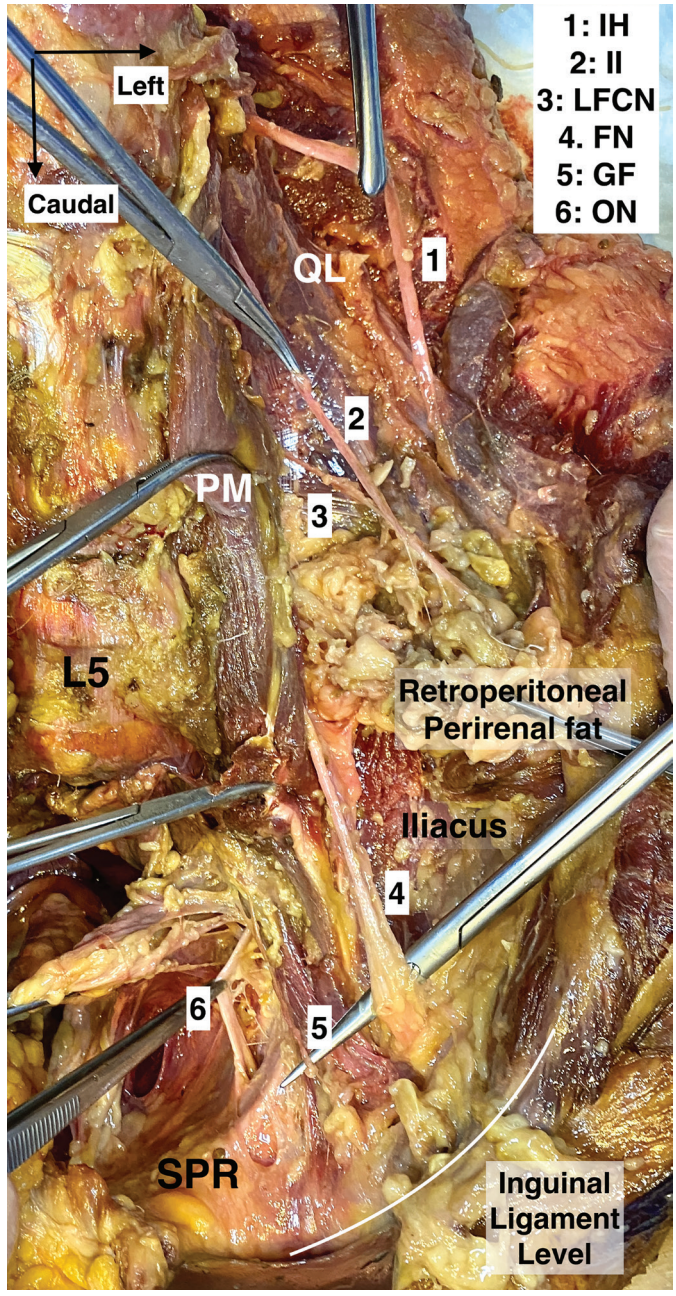

Figure 16. The lumbar plexus nerves

PM: Psoas major muscle, QL: Quadratus lumborum muscle, IH: Iliohypogastric nerve, II: Ilioinguinal nerve, LFCN: Lateral femoral cutaneous nerve, FN: Femoral nerve, GF: Genitofemoral nerve, ON: Obturator nerve, SPR: Superior pubic ramus, L: Lumbar

iliohypogastric nerve injury, potentially resulting in suprapubic burning pain or sensory loss.

Genitofemoral nerve

The genitofemoral nerve arises from the L1 and L2 spinal nerves (7). It pierces the craniomedial portion of the anterior surface of the psoas major muscle and proceeds along the anterior surface of the psoas fascia, lateral to the external iliac artery (Figure 17). Near the level of the iliac bifurcation, it divides into the genital and femoral branches. The genital branch passes through the inguinal canal by entering the deep inguinal ring and travels with the round ligament within the canal. The femoral branch follows the path of the external iliac artery and the femoral nerve. The genitofemoral nerve supplies sensory innervation to the external genitalia via the genital branch and to the skin of the femoral triangle (upper anterior thigh) via the femoral branch. In females, the genitofemoral nerve functions solely as a sensory nerve.

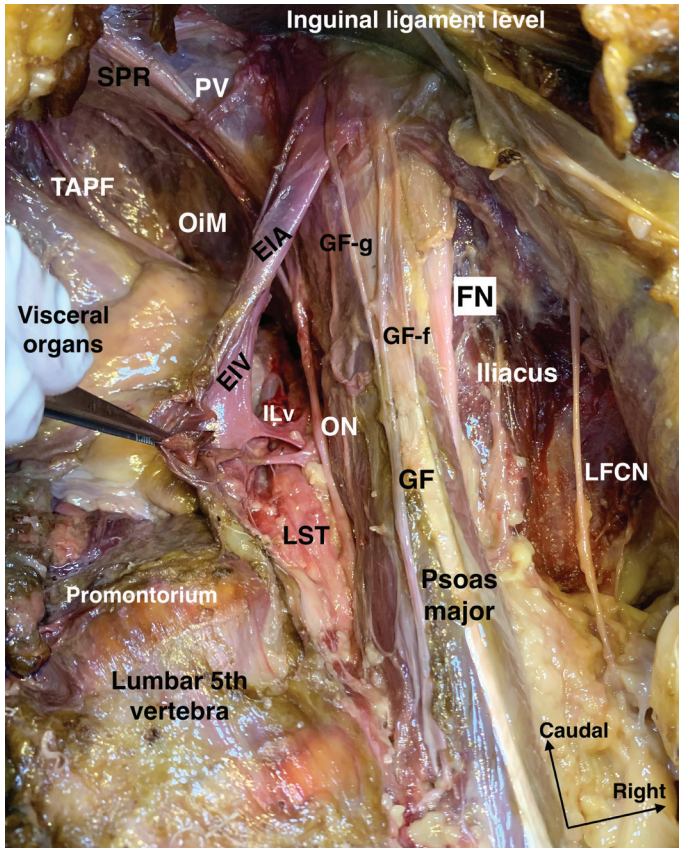

Figure 17. Lumbar plexus nerves at the lateral aspect of the pelvic brim and pelvis
GF: Genitofemoral nerve, LFCN: Lateral femoral cutaneous nerve, ON: Obturator nerve, LST: Lumbosacral trunk, FN: Femoral nerve, GF-g: Genitofemoral nerve genital branch, GF-f: Genitofemoral nerve femoral branch, EIA: External iliac artery, EIV: External iliac vein, SPR: Superior pubic ramus, PV: Pubic vein, OiM: Obturator internus muscle, TAPF: Tendinous arch of pelvic fascia, ILv: Iliolumbar vein

Surgical relevance

The genitofemoral nerve is at risk of injury during pelvic lymphadenectomy, particularly when dissecting laterally to the external iliac artery, and during lateral aortic or lateral caval lymph node dissection (Figure 17). Injury may result in paresthesia in the labial region.

Femoral nerve

The anterior rami of the L spinal nerves form the L plexus. The posterior division of L2-4 forms the femoral nerve, while the anterior division of L2-4 forms the obturator nerve. The femoral nerve is located at the deep posterolateral aspect of the psoas major muscle, positioned between the psoas major and iliacus muscles (11, 12). Due to its posterolateral location to the psoas major muscle, direct identification requires dissection of the iliopsoas fascia and medial mobilization or dissection of the psoas major (Figure 18). The femoral nerve passes posterior to the inguinal ligament (posterior in anatomical position, inferior in surgical supine position) and enters the femoral triangle laterally, lateral to the femoral artery. It provides motor innervation to the anterior thigh muscles, including the iliacus, sartorius, pectineus, and quadriceps femoris, and supplies sensory innervation to the anterior and medial thigh, as well as the medial leg and foot.

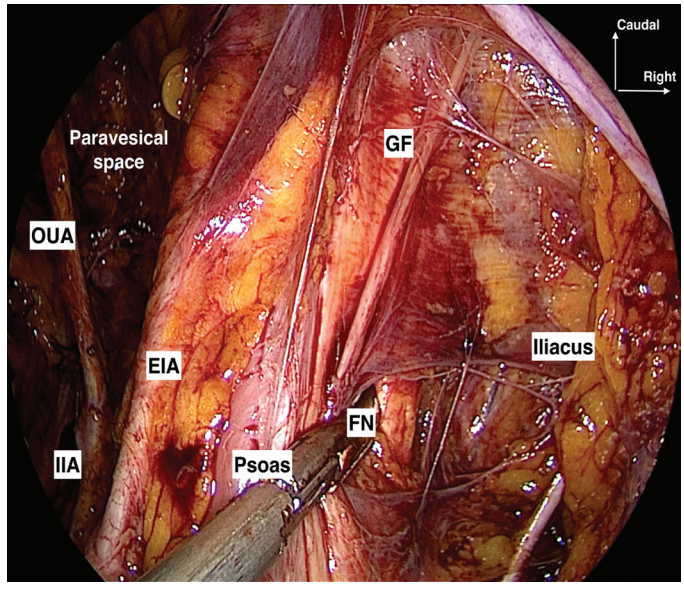

Figure 18. Femoral nerve
GF: Genitofemoral nerve, FN: Femoral nerve, EIA: External iliac artery, IIA: Internal iliac artery, OUA: Obliterated umbilical artery

Surgical relevance

During laterally extended procedures or partial resection of the psoas major muscle due to a tumoral mass, the surgeon should be cautious of the femoral nerve.

Obturator nerve

The obturator nerve is derived from the anterior divisions of the anterior rami of the L2-L4 spinal nerves. It traverses the deep, medial portion of the psoas major muscle caudal to the pelvic brim and lateral to the internal iliac vein. The nerve proceeds through the obturator fossa, situated inferior to the external iliac vein and medial to the obturator internus muscle (12). It exits the pelvis via the obturator canal at the superolateral border of the obturator foramen (Figures 5 and 17). The pubic anastomotic vessel (corona mortis), which forms a connection between the obturator and inferior epigastric vessels, passes medially to the obturator nerve to enter the obturator canal. Typically, the obturator artery and vein lie inferior to the obturator nerve (Figures 5 and 11). The obturator nerve enables adduction of the thigh through the adductor magnus, adductor brevis, gracilis, pectineus, adductor longus, and obturator externus muscles. It provides sensory innervation to the medial thigh area.

Surgical relevance

During pelvic lymphadenectomy at the obturator fossa, inferior to the external iliac vein, the obturator nerve should be identified before excision of the lymph nodes. The pectineus muscle has an adduction function and is mainly innervated by the femoral nerve (the obturator nerve also contributes branches). Therefore, if the obturator nerve is injured, the pectineus muscle may compensate for the adduction of the thigh.

Sacral plexus

The sacral plexus is formed by the anterior rami of S1-S4 (partially S4) spinal nerves, with the contribution of the lumbosacral trunk from L4-L5. The sacral spinal nerves pass through the anterior sacral foramina and run caudolaterally. The sacral plexus is located on the anterior surface of the piriformis muscle, at the posterolateral aspect of the pelvis (13). It maintains close anatomical relations with the internal iliac vessels and can be approached via dissection posterior to the internal iliac artery and vein (inferior in the surgical supine position) (Figure 19). The superior gluteal artery emerges between the lumbosacral trunk and the S1 nerve root; the inferior gluteal artery passes between the S1 and S2 roots; and the internal pudendal artery courses between the sciatic and pudendal nerves.

Branches of the sacral plexus

1. Sciatic nerve.
2. Pudendal nerve.
3. Superior gluteal nerve.
4. Inferior gluteal nerve.
5. Nerve to the obturator internus.
6. Nerve to the quadratus femoris.
7. Nerve to the piriformis.

Lumbosacral trunk

The anterior rami of L4 and L5 form the lumbosacral trunk. It runs toward the inferior edge of the greater sciatic foramen after passing lateral to the promontory and anterior to the sacroiliac joint. It unites with the S1-S3 spinal nerves to form the sciatic nerve. The lumbosacral trunk extends from the

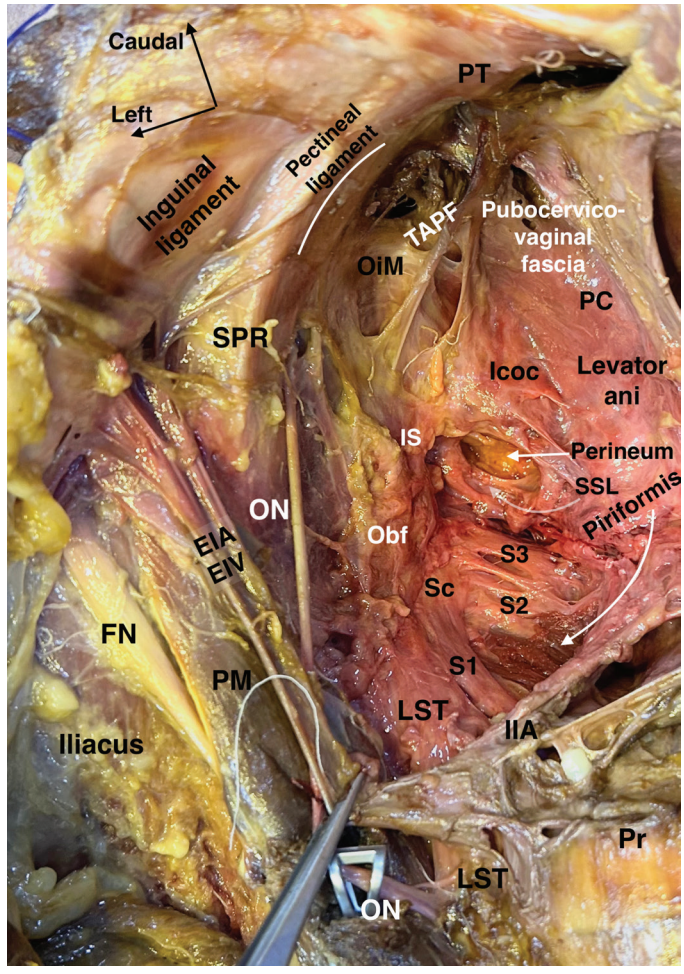

Figure 19. Sacral plexus nerves within the pelvic floor
FN: Femoral nerve, ON: Obturator nerve, LST: Lumbosacral trunk, EIA: External iliac artery, EIV: External iliac vein, PM: Psoas major muscle, S: Sacral, IIA: Internal iliac artery, Sc: Sciatic nerve, IS: Ischial spine, OiM: Obturator internus muscle, TAPF: Tendinous arch of pelvic fascia, PC: Pubocoocygeus, Icoc: Iliococcygeus, SSL: Sacrospinous ligament, Pr: Promontorium, PT: Pubic tubercle, Obf: Obturator fascia, SPR: Superior pubic ramus

craniomedial part of the obturator nerve to its caudolateral edge. The lumbosacral trunk can be dissected lateral to the internal iliac vein or common iliac vein at the medial psoas space/laterovascular plane (Figures 9, 17 and 20).

Sciatic nerve

The L4 and L5 nerve branches unite to form the lumbosacral trunk, which merges with S1-S3 to create the sciatic nerve posterior to the ischial spine (Figures 17, 19 and 20). The sciatic nerve exits the pelvis via the greater sciatic foramen (infrapiriform part), travels through the gluteal region, and splits into the common fibular and tibial nerves (14). These branches supply motor function to the hamstrings, leg, and foot muscles, including the posterior head of the adductor magnus (tibial component). Sensory innervation includes the lateral leg and dorsum of the foot (common fibular), sole and posterior leg (tibial), and posterior thigh.

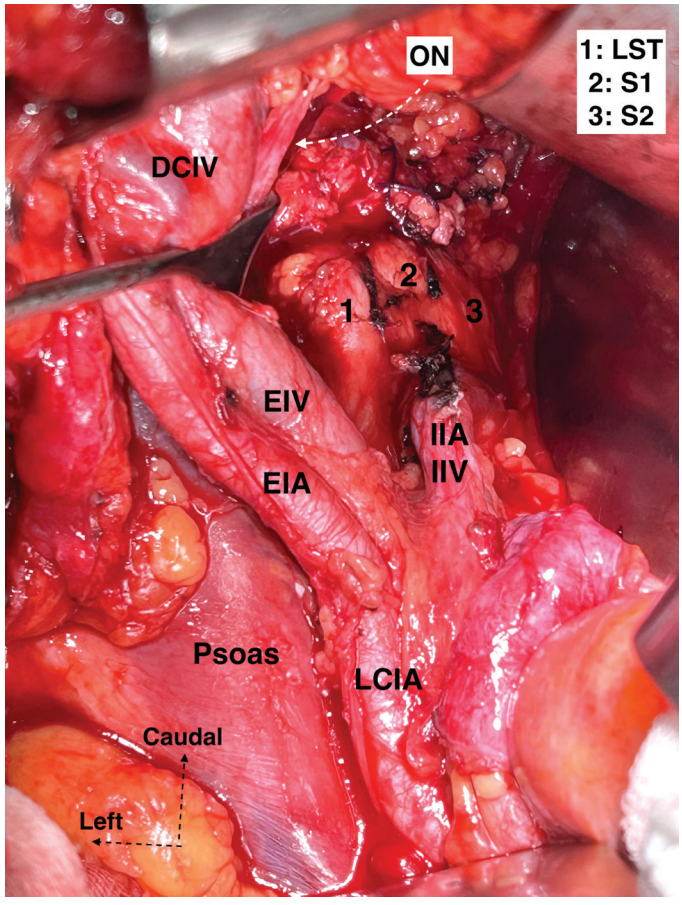

Figure 20. Components of the Sciatic nerve, the lumbosacral trunk, Sacral 1 and 2 nerves, after resection of the internal iliac vessel system and obturator fascia as Type D1 radical hysterectomy

LST: Lumbosacral trunk, S: Sacral, EIA: External iliac artery, EIV: External iliac vein, IIA: Internal iliac artery, IIV: Internal iliac vein, LCIA: Left common iliac artery, DCIV: Deep circumflex iliac vein, ON: Obturator nerve

Surgical relevance

The laterovascular plane (lumbosacral region) is important during paracervical lymphadenectomy and, at times, during resection of endometriotic nodules. The iliolumbar vessels may lie between the obturator nerve and the lumbosacral trunk. As they typically drain into the internal iliac vein, meticulous dissection in this region is essential to prevent a vascular injury. Approach to the sciatic nerve roots from the medial side of the pelvis can be performed after resection or dissection of the internal iliac vessel system. During the medial approach, the key step is to develop the paravesical space and inter-iliac area (Figure 21). Injury to the lumbosacral trunk or the sciatic nerve results in drop foot.

Pudendal nerve

The pudendal nerve originates from S2-S4. It exits the pelvis with the internal pudendal artery through the caudal (lower) part of the greater sciatic foramen, anterior to the piriformis muscle. The pudendal nerve loops around the ischial spine at the lateral part of the sacrospinous ligament and enters the perineum via the lesser sciatic foramen (Figures 13 and 19). It then lies within the duplication of the obturator internus fascia, known as the pudendal canal or "Alcock's canal", located at the lateral part of the ischioanal fossa (15). Branches of the pudendal nerve are the inferior rectal nerve, the perineal nerve, and the dorsal nerve of the clitoris. The pudendal nerve provides voluntary control of urination

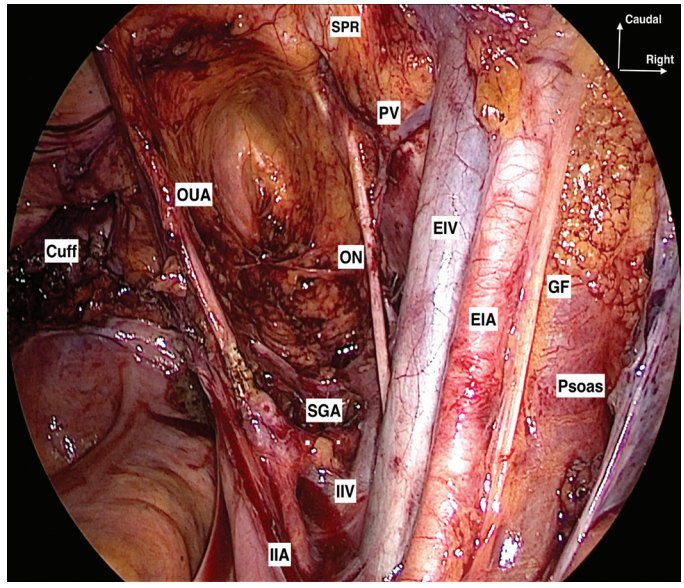

Figure 21. Medial approach, paravesical space and inter-iliac area

GF: Genitofemoral nerve, EIA: External iliac artery, EIV: External iliac vein, ON: Obturator nerve, PV: Pubic vein, SPR: Superior pubic ramus, SGA: Superior gluteal artery, IIV: Internal iliac vein, IIA: Internal iliac artery, OUA: Obliterated umbilical artery

and defecation by the external urethral and anal sphincters, respectively.

Surgical relevance

Pudendal neuralgia causes chronic neuropathic pain in the external genitalia, anus, and perineum. If the diagnosis results from an entrapment, surgery may be considered.

Understanding the autonomic nerves

The peripheral nervous system is divided into two parts: the somatic part, which innervates the skin and skeletal muscles, and the visceral part (autonomic), which innervates organs and other visceral structures, such as smooth muscle and glands. Each part has motor and sensory functions. The autonomic nervous system regulates the body's involuntary responses to internal and external stimuli. While the sympathetic nervous system responds to stress, the parasympathetic nervous system supports homeostasis.

The nerves associated with the autonomic nervous system include cranial nerves (CN) III, VII, IX, and X, which are involved in parasympathetic activity, as well as nerves from the spinal cord levels T1-L2/L3 for sympathetic activity and S2-S4 for parasympathetic activity. Essentially, the presynaptic motor neuron forms synapses with the postsynaptic motor neurons in the ganglion.

Sympathetic system

Presynaptic neurons of the sympathetic system originate from the intermediolateral cell columns in the lateral horns of the T1-L2/L3 spinal cords. They leave the spinal cord through the anterior roots, run within the anterior rami of the spinal nerves toward the paravertebral ganglion (sympathetic trunk) via the white ramus communicans.

There are two types of ganglia: paravertebral and prevertebral. Paravertebral ganglia are located on either side of the vertebral column from the skull base to the coccyx, forming the sympathetic trunk (Figure 15). Each sympathetic trunk converges anterior to the coccyx, forming the ganglion impar. Prevertebral ganglia are situated anterior to the abdominal aorta around the major branches, including the celiac, superior mesenteric, aorticorenal, and inferior mesenteric ganglia.

A presynaptic neuron may synapse within the paravertebral ganglion of the sympathetic trunk at the same level where it originates from the anterior ramus of the spinal nerve. Alternatively, it can ascend and synapse at a higher paravertebral ganglion or descend and synapse at a lower one. The sympathetic trunk, for instance, distributes sympathetic nerve signals. The postsynaptic neurons leave the ganglion through the gray ramus communicans and enter the anterior ramus of the related spinal nerve to innervate sweat glands, blood vessel muscles, and arrector pili muscles.

Presynaptic neurons may traverse the sympathetic trunk (paravertebral ganglion) without synapsing, form the splanchnic nerves, and then synapse at the prevertebral ganglion. Presynaptic nerve fibers from the T5-L2/3 spinal cord levels synapse at the prevertebral celiac, superior mesenteric, aorticorenal, or inferior mesenteric ganglions. Postsynaptic splanchnic nerves are subsequently distributed by the periarterial plexuses, which include the celiac, superior mesenteric, renal, ovarian, inferior mesenteric, and superior hypogastric plexuses. These plexuses form a spider web-like structure anterior to the abdominal aorta and are collectively called the abdominal aortic plexus. They innervate the structures within the abdominopelvic viscera. The human body has five splanchnic nerves: greater, lesser, least, L, and sacral.

Parasympathetic system

The parasympathetic system is innervated by the CN III, VII, IX, X, and by the nerves of spinal cord levels S2-S4. The vagus nerve (CN X) has visceral functions that innervate the thoracic viscera and the upper abdominal organs up to the level of the splenic flexure by contributing to the celiac and superior mesenteric prevertebral plexuses. The pelvic splanchnic nerves originate from the anterior rami of the spinal nerves S2-S4. The parasympathetic motor neurons synapse at the ganglia near the target visceral organs. The postsynaptic parasympathetic nerves are located within the viscera of the target organs. The S2-S4 pelvic splanchnic nerves innervate the lower abdominal organs from the level of the splenic flexure toward the pelvic viscera.

Abdominopelvic autonomic nerves

Sympathetic nerves from the T1-5 spinal cord levels ascend to innervate the thoracic viscera. The thoracolumbar sympathetic nerves from T5-L2/3, along with parasympathetic nerves from the vagus nerve and S2-4, maintain autonomic control of the abdominopelvic organs (16-18). Specifically, T11-L2/3 and S2-4 provide the sympathetic and parasympathetic innervation to the pelvic viscera.

Presynaptic sympathetic nerve fibers from the T5-T9 ganglia form the greater splanchnic nerves, which project to the prevertebral celiac ganglion. Fibers from the T10-T11 ganglia form the lesser splanchnic nerves, terminating in the aorticorenal ganglion. Nerves deriving from the T12 ganglion create the least splanchnic nerves, extending to the aorticorenal ganglion and renal plexus. These thoracic sympathetic nerves travel posterior to the median arcuate ligament of the diaphragm to enter the abdominal cavity. There are four L splanchnic nerves

and associated ganglia. The L1 splanchnic nerve supplies the celiac, renal, and inferior mesenteric plexuses, while the L2 splanchnic nerve contributes to the intermesenteric and inferior mesenteric plexuses.

The caudal extension of these interconnected plexuses (the thoracolumbar splanchnics) forms the superior hypogastric plexus, with contributions from the L3 and L4 splanchnic nerves. The L3 splanchnic nerve contributes to the inferior mesenteric ganglion and the superior hypogastric plexus. The L4 splanchnic nerve contributes to the lower part of the superior hypogastric plexus. The intermesenteric plexus is part of the autonomic abdominal aortic plexus and connects the celiac, superior mesenteric, aorticorenal, and ovarian plexuses to the inferior mesenteric and superior hypogastric plexus (Figures 2 and 15). The superior hypogastric plexus, the inferior mesenteric plexus, and the ganglion are closely related.

The superior hypogastric plexus is located just caudal to the inferior mesenteric artery or anterior to the aortic bifurcation, anterior to the left common iliac vein, and approximately at the level of the 5th L vertebra, between the common iliac arteries and bilateral ureters, at the cranial part of the presacral space, posterior to the rectosigmoid mesentery (Figures 3 and 22). The superior hypogastric plexus primarily carries post-synaptic sympathetic and pre-synaptic parasympathetic nerves. Its sources include mainly sympathetic and parasympathetic nerves from the abdominal aortic plexus, sympathetic nerves from the L ganglia, parasympathetic nerves from the pelvic splanchnic nerves, and visceral sensory fibers.

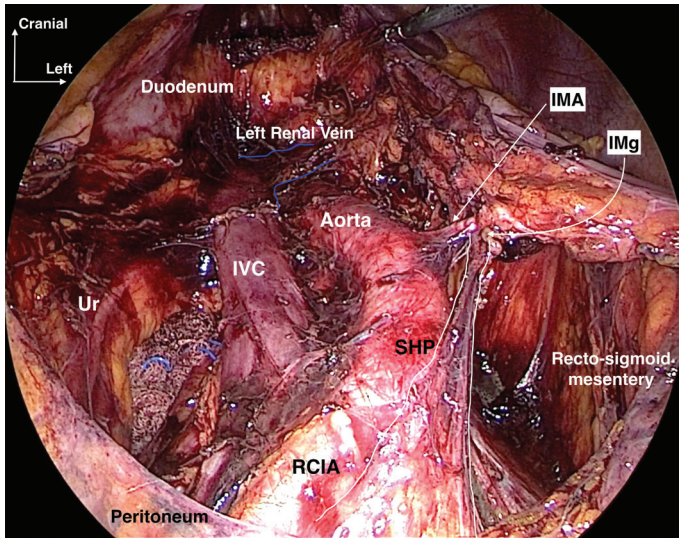

Figure 22. Superior hypogastric plexus and the connective nerve bundles with the inferior mesenteric ganglion, surgical orientation during paraaortic lymphadenectomy
IVC: Inferior vena cava, RCIA: Right common iliac artery, SHP: Superior hypogastric plexus, IMA: Inferior mesenteric artery, IMg: Inferior mesenteric ganglion, Ur: Ureter

The superior hypogastric plexus divides into the right and left hypogastric nerves, which lie caudolaterally on the anterolateral surface of the presacral space or sacrum, posterolateral to the mesorectum. Subsequently, the hypogastric nerve runs within the same fascia sheet as the ureter, approximately 2 cm inferior to the ureter (inferior in surgical supine position and posterior in anatomical position), lateral to the uterosacral ligament, and inferomedial to the internal iliac artery, at the medial part of the pararectal space. The hypogastric nerve transmits sympathetic signals from the superior hypogastric plexus to the inferior hypogastric plexus, as well as parasympathetic signals from the inferior hypogastric plexus back to the superior hypogastric plexus.

The pelvic splanchnic nerves carry presynaptic parasympathetic fibers that originate from the S2-S4 spinal cord levels. After passing through the anterior sacral foramina, they diverge from the somatic nerves and run obliquely medial toward the caudomedial part of the pelvis (Figures 6, 14). They lie at the inferomedial part of the internal iliac vein and its tributaries. This pathway extends from the posterolateral (posterolateral in the surgical supine position and craniolateral in the anatomical position) part of the pararectal space toward the anteromedial (anteromedial in the surgical supine position and caudomedial in the anatomical position) part.

Pelvic splanchnic nerves run at the inferior level of the deep uterine vein (a visceral tributary of the internal iliac vein that drains the vesical and vaginal plexuses) between the pararectal and paravesical spaces, at the deep (inferior) part of the paracervix tissue. They merge with the hypogastric nerve to form the inferior hypogastric plexus (Figure 14). This plexus is located posterolateral to the upper vaginal fornix at the anteromedial part of the pararectal space, lateral to the proximal (uterine) part of the uterosacral ligament and rectum. The rectouterine (superior part) and rectovaginal (inferior part) ligaments, as posterior parametrium, form the uterosacral ligament. This is the primary and only suspensory ligament of the uterus and upper vagina, which extends to the level of the sacral 3 and 4 vertebrae (Figure 23). The sacral splanchnic nerves, presynaptic fibers, originate from the first two sacral ganglia, pass through the sympathetic trunk, and synapse at the inferior hypogastric plexus.

The inferior hypogastric plexus is the pelvic ganglion where the sympathetic and parasympathetic nerve fibers synapse, and postsynaptic fibers extend within the secondary plexuses to reach their target organs (Figures 23-29). The secondary plexuses of the inferior hypogastric plexus include the (inferior) rectal plexus, located at the inferolateral part of the rectum lateral to the uterosacral ligament; the uterovaginal plexus, situated at the lateral part of the upper vaginal fornix and the paracolpium; and the vesical plexus, located at the inferolateral

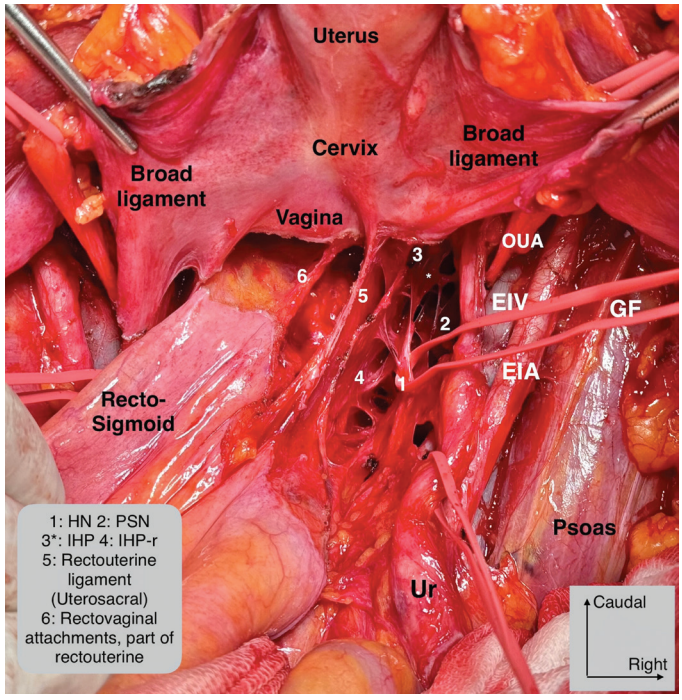

Figure 23. The hypogastric nerve, pelvic splanchnic nerves, and the inferior hypogastric plexus, anatomical relation with the uterosacral ligament (dorsal parametrium)
Ur: Ureter, GF: Genitofemoral nerve, EIA: External iliac artery, EIV: External iliac vein, OUA: Obliterated umbilical artery, IHP: Inferior hypogastric plexus, HN: Hypogastric nerve, PSN: Pelvic splanchnic nerves, r: rectal branches

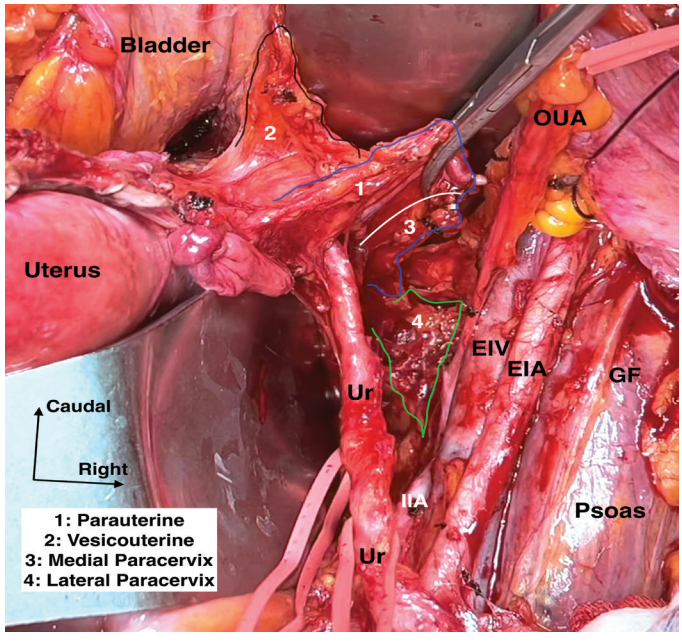

Figure 24. Continuity of the parauterine tissue with the medial paracervix and vesicouterine tissue. Dissection is performed from the superolateral aspect of the ureter, where the ureter courses through the ureteric tunnel
EIA: External iliac artery, EIV: External iliac vein, IIA: Internal iliac artery, OUA: Obliterated umbilical artery, Ur: Ureter, GF: Genitofemoral nerve

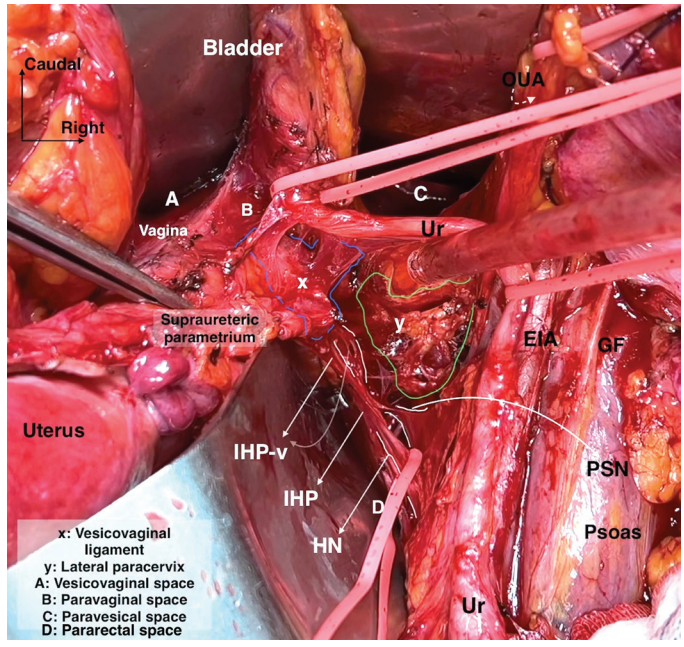

Figure 25. Vesical nerve branches arising from the inferior hypogastric plexus. Following dissection of the supraureteric parametria (parauterine tissue, medial paracervix, and vesicouterine tissue) and lateralization of the ureter from the upper vagina, the paravaginal space is developed, exposing the vesicovaginal ligament. The vesical nerve branches are identified inferior to the vesicovaginal ligament, between the vesicovaginal ligament and the lateral paracervix, along the longitudinal course of the hypogastric nerve and inferior hypogastric plexus
GF: Genitofemoral nerve, EIA: External iliac artery, Ur: Ureter, OUA: Obliterated umbilical artery, IHP: Inferior hypogastric plexus, HN: Hypogastric nerve, PSN: Pelvic splanchnic nerves, v: vesical branches

and anterolateral parts of the paracolpium and just inferior to the distal ureter (ureterovesical junction). The vesical branches of the inferior hypogastric plexus can be noticed inferior to the vesicovaginal ligament and at the medial aspect of the vesicovaginal venous vessels (19,20). Additionally, ganglia are present within these secondary plexuses. The inferior hypogastric plexus plays a crucial role in regulating urinary and fecal continence and sexual function.

The presynaptic parasympathetic nerve fibers, which do not synapse at the inferior hypogastric plexus, run cranially through the hypogastric nerve and pass through the superior hypogastric plexus toward the inferior mesenteric ganglion and target organs, the colon segments distal to the splenic flexure, where they may synapse.

The parasympathetic activity provides contraction of the detrusor muscle and inhibits the internal urethral sphincter to facilitate voiding. Visceral sensory fibers from the bladder base and endopelvic fascia are carried by the parasympathetic

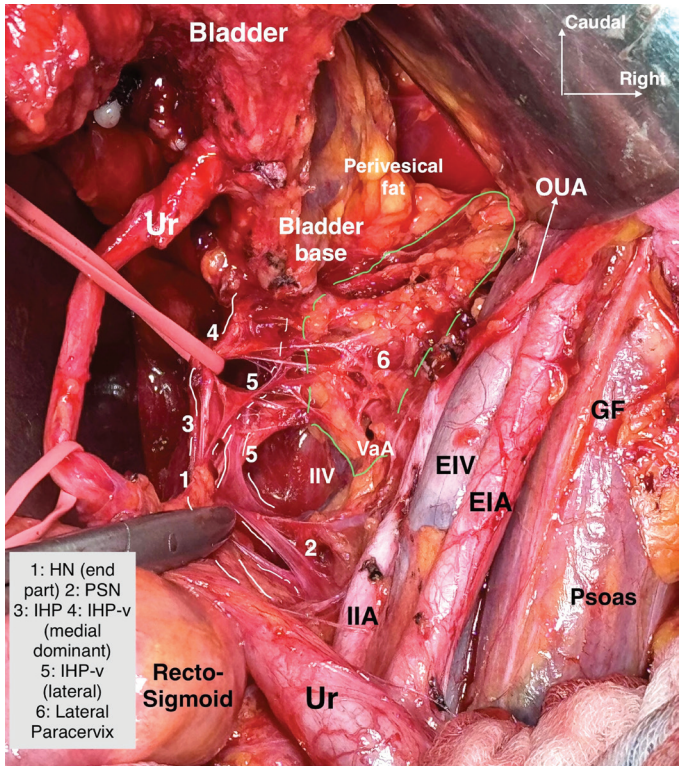

Figure 26. Lateral paracervix and pelvic autonomic nerves as a surgical step during selective systematic nerve-sparing Type C2 radical hysterectomy

GF: Genitofemoral nerve, EIA: External iliac artery, EIV: External iliac vein, IIA: Internal iliac artery, OUA: Obliterated umbilical artery, Ur: Ureter, IIV: Internal iliac vein, VaA: Vaginal artery, IHP: Inferior hypogastric plexus, HN: Hypogastric nerve, PSN: Pelvic splanchnic nerves, v: vesical branches

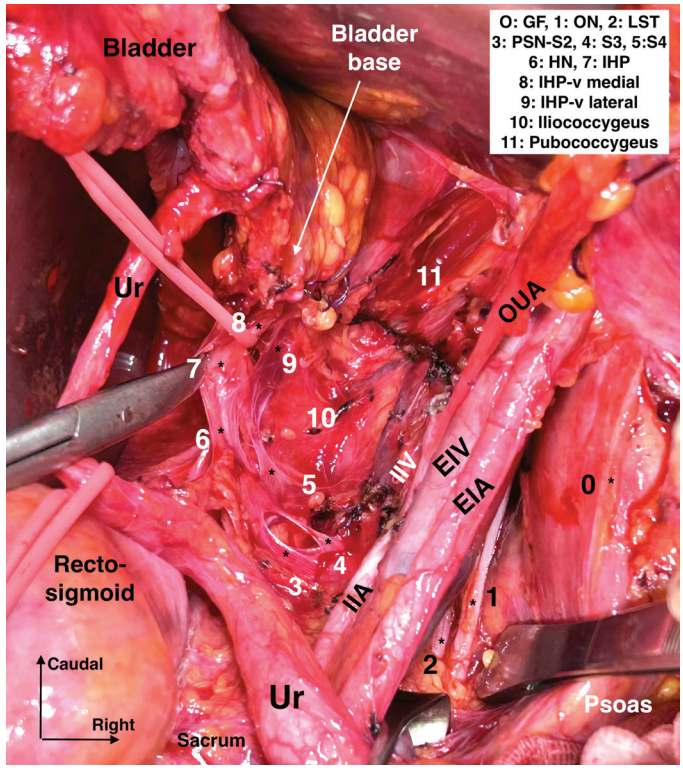

Figure 27. Pelvic autonomic and somatic nerves, exposure after selective systematic nerve-sparing Type C2 radical hysterectomy, open surgery

EIA: External iliac artery, EIV: External iliac vein, IIA: Internal iliac artery, IIV: Internal iliac vein, OUA: Obliterated umbilical artery, Ur: Ureter, GF: Genitofemoral nerve, ON: Obturator nerve, LST: Lumbosacral trunk, S: Sacral, IHP: Inferior hypogastric plexus, HN: Hypogastric nerve, PSN: Pelvic splanchnic nerves, v: vesical branches

afferents, while the sympathetic afferents transmit those from the superior part of the bladder. Typically, reflex efferent fibers follow the course of the parasympathetic nerves. Somatic efferent fibers, which are involved in the voluntary control of the external urethral sphincter, are innervated by the pudendal nerve originating from the S2-S4 spinal cord levels.

Surgical relevance

The superior hypogastric plexus is important during low paraaortic lymphadenectomy or during the excision of the medial common iliac lymph nodes. The hypogastric nerve and the inferior hypogastric plexus with the rectal branches can be injured during dorsal (posterior) parametrium excision or endometriosis surgery. Since the inferior hypogastric plexus is located at the medial paracervix area, it can be injured during lateral parametrectomy. The pelvic splanchnic nerves can be injured during lateral paracervix resection, lateral parametrectomy, and during the excision of the paracervical lymph nodes. The vesical branches of the inferior hypogastric plexus can be injured during ventral (anterior) parametrium, vesicovaginal ligament, and lateral paracervix resection. The pararectal space is the key area for identifying the pelvic autonomic nerves in nerve-sparing procedures (Figure 30). On the other hand, the most important issue is to preserve the target rectal and vesical branches arising from the inferior hypogastric plexus. Following the dissection of the supraureteric parametria (parauterine tissue, medial paracervix, and vesicouterine tissue) and lateralization of the ureter from the upper vagina, the paravaginal space (Yabuki's space-fourth space-Okabayashi's space) is developed between the upper vagina and distal ureter, exposing the inferiorly lying vesicovaginal ligament (Figures 25 and 29). The vesical nerve branches are identified inferior to the vesicovaginal ligament, between the vesicovaginal ligament and the lateral paracervix although it should be noted that some nerve fibers pass through the vesicovaginal ligament, along the longitudinal course of the hypogastric nerve and inferior hypogastric plexus.

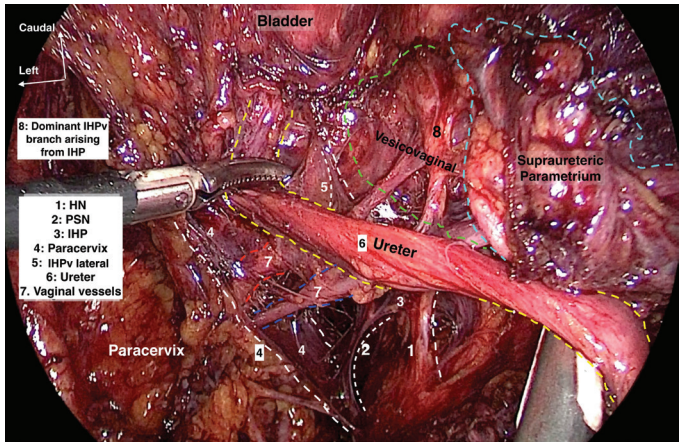

Figure 28. Pelvic autonomic nerves at the paracolpium level, laparoscopic surgery
IHP: Inferior hypogastric plexus, HN: Hypogastric nerve, PSN: Pelvic splanchnic nerves, v: vesical branches

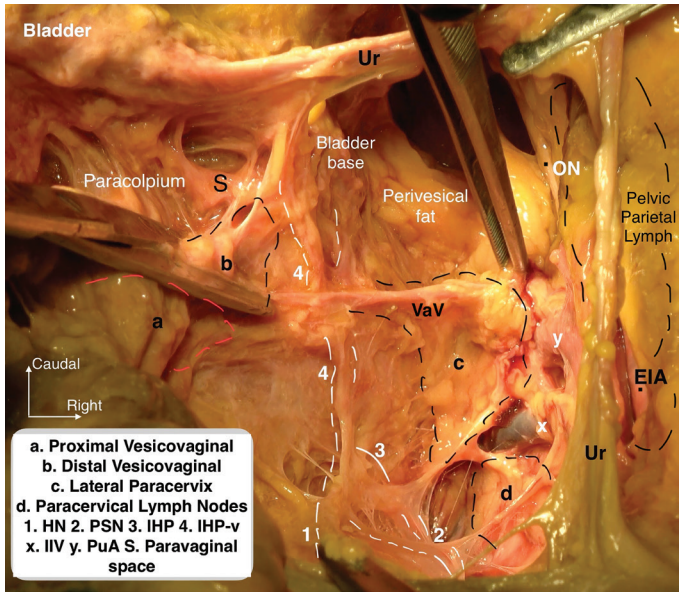

Figure 29. Pelvic autonomic nerves and the parametrium, cadaveric dissection (limited dissection bias)
EIA: External iliac artery, Ur: Ureter, ON: Obturator nerve, IHP: Inferior hypogastric plexus, HN: Hypogastric nerve, PSN: Pelvic splanchnic nerves, v: vesical branches, IIV: Internal iliac vein, PuA: Pudendal artery, VaV: Vaginal vein/Deep uterine vein

Conclusion

Precise knowledge of pelvic neurovascular anatomy and its spatial organization in pelvic avascular spaces is indispensable when performing complex pelvic surgery. This pictorial essay illustrates surgically relevant anatomical planes and key landmarks that guide retroperitoneal dissection and neurovascular preservation. Integrating this anatomical understanding into surgical practice facilitates a safer dissection,

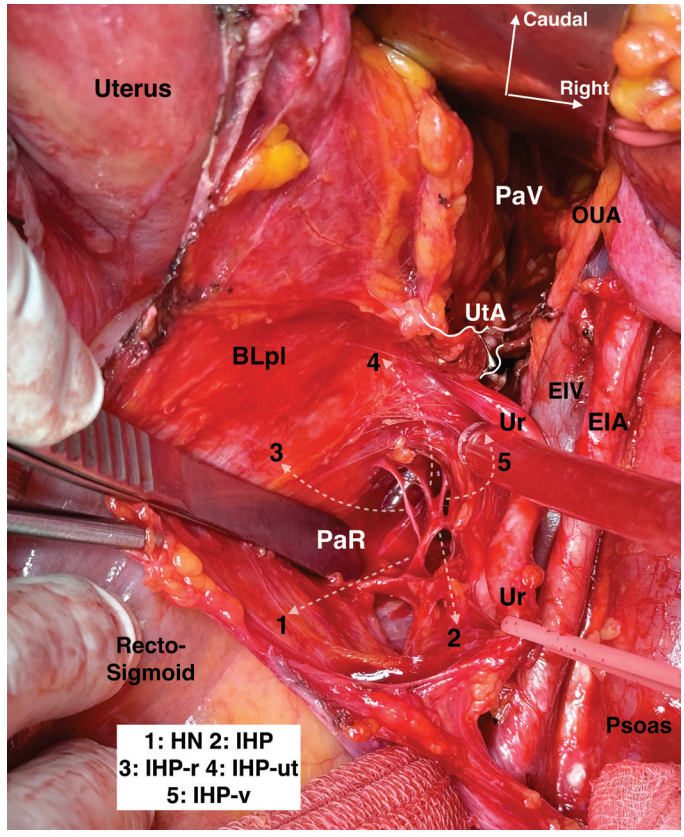

Figure 30. The pararectal space is the key area to identify the pelvic autonomic nerves during the nerve-sparing procedures
EIA: External iliac artery, EIV: External iliac vein, OUA: Obliterated umbilical artery, Ur: Ureter, UtA: Uterine artery, BLpl: Broad ligament posterior leaf, PaV: Paravesical space, PaR: Pararectal space, IHP: Inferior hypogastric plexus, HN: Hypogastric nerve, r: rectal, ut: uterine, v: vesical

reduces the risk of complications, and supports functional outcomes in advanced gynecological and gynecological oncology procedures.

Footnotes

Author Contributions: *Surgical and Medical Practices: İ.S., K.G.S., S.K., M.O., İ.T., E.H., H.R.Y., Concept: İ.S., K.G.S., Design: : İ.S., K.G.S., S.K., M.O., Data Collection or Processing: İ.S., K.G.S., S.K., M.O., İ.T., E.H., H.R.Y., Analysis or Interpretation: İ.S., K.G.S., İ.T., E.H., H.R.Y., Literature Search: İ.S., K.G.S., S.K., M.O., Writing: İ.S., K.G.S.*

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Complex braided true umbilical cord knots (TUCK) and cord entanglement with fetal demise in monochorionic monoamniotic twin pregnancy: a catastrophic sequela-what is your diagnosis?

A 23-year-old Gravida 3, Para 1, with one living and one abortion, with a history of one previous lower segment Cesarean section and a short inter-conception period of 16 months, conceived spontaneously during the lactational period. She was followed up outside and had irregular antenatal visits, with the first visit at 20 weeks. Ultrasound confirmed twin pregnancy with no congenital anomalies. She was taking iron and calcium supplements regularly. She presented late to our institution at 34+2 weeks in latent labour and all her investigations were reviewed. Ultrasonography revealed intrauterine fetal demise of one twin, with an overall liquor volume (amniotic fluid index) of 18 cm (Table 1). On the initial physical examination, the body mass index was 22 kg/m^2, with no signs of tachycardia, fever, pallor, icterus, or edema. On per abdomen examination, the abdomen was over-distended, and multiple fetal parts were palpable with the presence of scar tenderness. On vaginal examination, the cervical os was 1 cm dilated, uneffaced, with intact membranes. A strip NST of the live fetus was reactive, with a baseline fetal heart rate of 150 bpm. Based on these findings, the patient was admitted, and relevant hematological and biochemical investigations were sent (Table 1). The patient underwent an emergency cesarean section. Intraoperatively, the lower uterine segment was well formed and the previous scar was thinned out; the amniotic bag ruptured, and the liquor was clear. Placenta delivered completely with membranes intact (Figure 1). Umbilical cord abnormality was noted and is shown in Figures 2 and 3. Both female babies were extracted as vertex presentation. The first neonate cried after initial steps of resuscitation, had a one minute APGAR score of 3, and weighed 2150 g. On re-evaluation at 5 minutes, the APGAR score improved to 7. The second twin was dead with no signs of life and with a birth weight of 2200 g. An autopsy was performed on the dead fetus (Table 1). Grossly, no congenital anomalies were noted; however, skin peeling was seen (Figure 4). No significant neonatal complications occurred in the surviving twin. After counselling, the placenta was sent for histopathological examination, the umbilical cord and fetal tissue of the intrauterine fetal demise fetus was sent for genetic analysis.

What is the complication and diagnosis in this case?

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Answer

This is a monochorionic monoamniotic (MCMA) twin pregnancy with true umbilical cord knot (TUCK) and cord entanglement with a single intrauterine fetal demise.

Diagnosis of twins is made by ultrasound examination between 11+2 weeks and 14+1 weeks (crown–rump length 45–84 mm) to assess fetal viability, gestational age and chorionicity. Monochorionic twin pregnancies have a single placental mass and a thin inter-twin membrane that inserts into the placenta at a perpendicular plane (T-sign).

Monozygotic twinning occurs rarely in natural conception, with an overall incidence of 0.4–0.45% (1). MCMA twins are quite uncommon, constituting around 1% of all twin pregnancies and 5% of all monochorionic pregnancies (1). Specific complications associated with monochorionic twin (2) pregnancy are shown in Table 2. Pregnancies complicated by TUCK are associated with a 4–10-fold increased risk of stillbirth, attributed to obstruction of umbilical venous return from the placenta and up to 11% perinatal morbidity resulting in intrauterine fetal demise or growth restriction (3). It is therefore important to consider that, in contrast to many other etiologies of stillbirth, umbilical cord accidents are likely acute, and thus affected fetuses are less likely to benefit from the compensatory system of redistribution of oxygenated blood towards essential fetal organs (central nervous system, heart and adrenal glands), as may occur in association with uteroplacental insufficiency (3).

Umbilical proximal cord insertion is common in MCMA placentas (53%) and is a causal factor underlying cord entanglement (4). The ultrasound diagnosis is challenging, and cord accidents are often an incidental finding during delivery (5). Enhanced three-dimensional sonographic resolution, along with the extensive use of colour Doppler, has significantly improved the accuracy of prenatal diagnosis of TUCK. The reliability of detection largely depends on whether

Table 1. Hematological, radiological, biochemical investigations

Date	Investigation	Impression
	Blood group	**A positive**
7/8/25	**Hb (g/dL)** **WBC ($10^3/\mu l$)** **Platelet count ($10^3/\mu l$)**	12.1 9.92 236
7/8/25	**Fibrinogen**	470 ng/mL
7/8/25	**KFT (urea/creatinine)**	8/0.4 mg/dL
7/8/25	**LFT**	Within normal limits
Fetal investigations		
4/3/25	**Anomaly scan outside**	Monochorionic monoamniotic twins (MCMA) ~20+2 weeks Placenta anterior, liquor adequate, no gross anomalies detailed
3/7/25	**Growth scan outside**	Monochorionic monoamniotic twins ~29+5 weeks, AFI-15 cm, placenta anterior, cephalic presentation, normal Dopplers Twin A: EFW-1407 gm Twin B: EFW-1421gm
7/8/25	**Growth scan at institute**	Monochorionic monoamniotic twins, AFI-18 cm, placenta anterior, normal Dopplers Twin A: Live intrauterine fetus ~34+3 weeks, cephalic, EFW-2368 gm Twin B: Intra uterine fetus ~33+3 weeks, with no cardiac activity, EFW-2093 gm
7/8/25	**Fetal autopsy**	Umbilical cord: Length–42 cm, spiralling normal, frilling in the umbilical cord, cord hematoma, reddish discolouration caused by haemolysis. Report: Female fetus of approximately 34 weeks' gestational age, appropriate for age with no external congenital anomalies. Ascending colon with subhepatic caecum → suggestive of intestinal malrotation developmental anomaly. Comma-shaped left kidney → minor renal anomaly
7/8/25	**Fetal radiological imaging X-ray**	Normal
7/8/25	**Chromosomal micro array**	Normal karyotype
7/8/25	**Histopathological examination**	Third-trimester MCMA placenta with mature vascularized villi with intervillous fibrin deposition with dystrophic calcification, with central cord insertion. Both umbilical cords show three vessels. Membranes are unremarkable

CBC: Complete blood count, LFT: Liver function test, RFT: Renal function test, AFI: Amniotic fluid index, EFW: Estimated fetal weight, KFT: Kidney function test, Hb: Haemoglobin, WBC: White blood cell

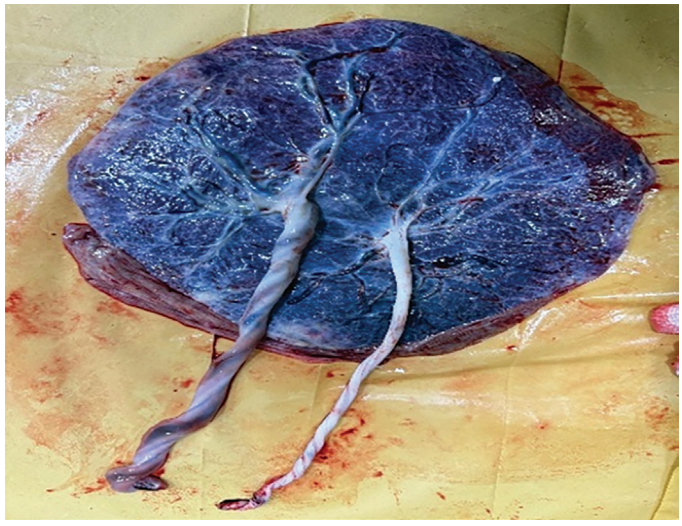

Figure 1. Monochorionic placenta with central insertion of two umbilical cords

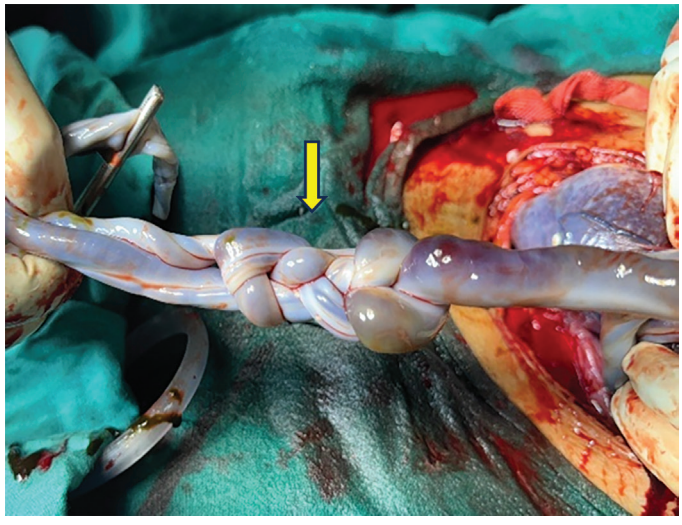

Figure 2. Twisted true umbilical cord knots (yellow arrow)

the knot lies within a visible area during sonographic scanning, the sonographer's expertise and vigilance, and the specific reporting practices of the ultrasound facility (3). However, a study by Rossi and Prefumo (6) reported that ultrasound detection of cord entanglement did not improve perinatal outcomes.

In the presented case, suboptimal monitoring, late referral and presence of undiagnosed complex braided knots contributed to the sudden intrauterine fetal demise. The incidence of single intrauterine demise occurs in 2.6-5% of all twin pregnancies (7). Intrauterine fetal demise in MCMA pregnancy has potentially significant morbid consequences for both the mother and for the co-twin, in the form of death of the surviving twin and neurological abnormality, at rates of up to 15% and 26%, respectively (2). Maternal complications

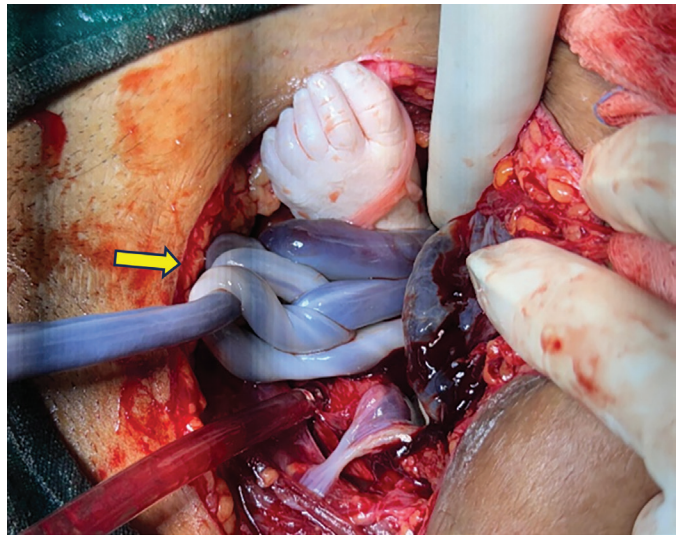

Figure 3. Cord entanglement around the deceased fetal foot (yellow arrow)

Figure 4. Live born female baby (yellow arrow), IUFD fetus (red arrow)
IUFD: Intrauterine fetal death

include coagulopathy, disseminated intravascular coagulation, iatrogenic preterm labour, and infection. Damage to the surviving co-twin after intrauterine fetal demise is explained by two mechanisms. These are thromboembolization through

Table 2. Other specific complications of MCMA twin pregnancy

Complications of MCMA twin pregnancies	Incidence
Selective growth restriction	~20%
Twin-to-twin transfusion syndrome	~15-20%
Twin anaemia–polycythaemia sequence	~13%
Twin reversed arterial perfusion sequence	~1%
Cord accidents (entanglement/true knot)	~28-47%
MCMA: Monochorionic monoamniotic	

placental anastomoses causing coagulation disturbances, or acute hemodynamic imbalance due to shunt reversal into the demised twin, resulting in hypovolemic ischemic injury, predominantly neurological, in the survivor twin (8). Studies showed that the prognosis was better in dichorionic twin pregnancies compared with monochorionic twin pregnancies (9). Hillman et al. (7) reported that the frequency of mortality in the surviving fetus was 15% in monochorionic and 3% in dichorionic twin pregnancies.

Management guidelines recommend intensive antenatal surveillance by an ultrasound scan to measure fetal biometry and umbilical artery Doppler velocimetry at 2-weekly intervals from 16 weeks throughout the pregnancy, and the need to refer women to specialist centres if complications persist. Early elective cesarean delivery planned between 32–34 weeks, may help to prevent unpredictable cord complications (2).

In a study conducted by Pasztor et al. (10), autopsy and placental examination identified the exact cause of stillbirth in 57.9% of cases. The genetic evaluation and autopsy reports mentioned no structural or chromosomal anomalies, supporting cord accident as the most likely cause of fetal demise.

In conclusion, better fetal outcomes can be achieved with greater ultrasound surveillance in a specialist fetal medicine centre. Moreover, there is a need for clinicians to counsel families about the unpredictability of cord accidents in MCMA pregnancies. Guidelines suggest that early delivery of MCMA twins between 32 and 34 weeks of gestation may reduce the risks and complications associated with this type of pregnancy. This is because umbilical cord entanglement is common in these uncommon pregnancies and is associated with an increased risk of stillbirth and intrauterine fetal demise.

Ethics

Informed Consent: *Formal consent was obtained from the patient for publication purposes.*

Footnotes

Conflict of Interest: *No conflict of interest is declared by the authors.*

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SOX10 lights the path: recognizing rare vulvar schwannoma and review of the literature

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Dear Editor,

Benign peripheral nerve sheath tumors are relatively uncommon in the vulvar region, making their recognition important for accurate diagnosis and management. Schwannomas are benign tumors derived from Schwann cells of peripheral nerves. While they are most commonly located in the head, neck, and extremities, involvement of the vulva is exceedingly rare, accounting for less than 1% of benign vulvar neoplasms (1). The differential diagnosis includes neurofibroma, leiomyoma, and other spindle cell lesions, such as cellular angiofibroma and angiomyofibroblastoma (2). The presence of a well-encapsulated mass with Antoni A and Antoni B areas and Verocay bodies is characteristic of schwannoma, although such features may be less prominent in smaller lesions.

We present a case of vulvar schwannoma in a 39 year-old woman, highlighting the critical role of histopathological evaluation and immunohistochemistry (IHC) using Gene - SRY-box transcription factor 10 (SOX10) in establishing an accurate diagnosis. A 39-year-old woman presented with a 1×1 cm, firm, non-tender, mobile swelling over the labia majora for two to three years. There was no history of pain, discharge or neurofibromatosis. The lesion was clinically suspected to be a sebaceous cyst and was excised under local anesthesia. Grossly, the specimen was well-circumscribed with a solid, gray-white to gray-brown cut surface. Histopathological examination revealed an encapsulated tumor composed of spindle cells arranged in fascicles within a collagenous stroma. The nuclei were elongated with tapered ends and pale eosinophilic cytoplasm. No nuclear atypia, mitosis, or necrosis was identified. Numerous thin-walled blood vessels were present. Immunohistochemical staining for SOX10 showed strong nuclear positivity, confirming the diagnosis of schwannoma (Figures 1-3). SOX10, a nuclear transcription factor, has emerged as a highly sensitive and specific marker for Schwann cell differentiation. It aids in distinguishing schwannoma from other spindle cell tumors that may express S-100 or Desmin focally (3). Immunopositivity for SOX10 thus supports the Schwannian origin, reinforcing its diagnostic utility, particularly in rare anatomical locations like the vulva (4). Table 1 summarizes the current literature (published articles) about vulvar spindle cell tumors and lists key histopathological and immunohistochemical features.

Surgical excision with complete removal of the capsule remains the treatment of choice. The prognosis is excellent, with recurrence being rare if the excision is complete (5). Malignant transformation is exceedingly uncommon. Awareness of this entity and appropriate use of IHC are essential to prevent misdiagnosis as other benign or malignant spindle cell tumors. In conclusion, vulvar schwannoma, although rare, should be included in the differential diagnosis of vulvar spindle cell lesions. SOX10 serves as a valuable adjunct marker for confirmation, ensuring accurate diagnosis and optimal patient management.

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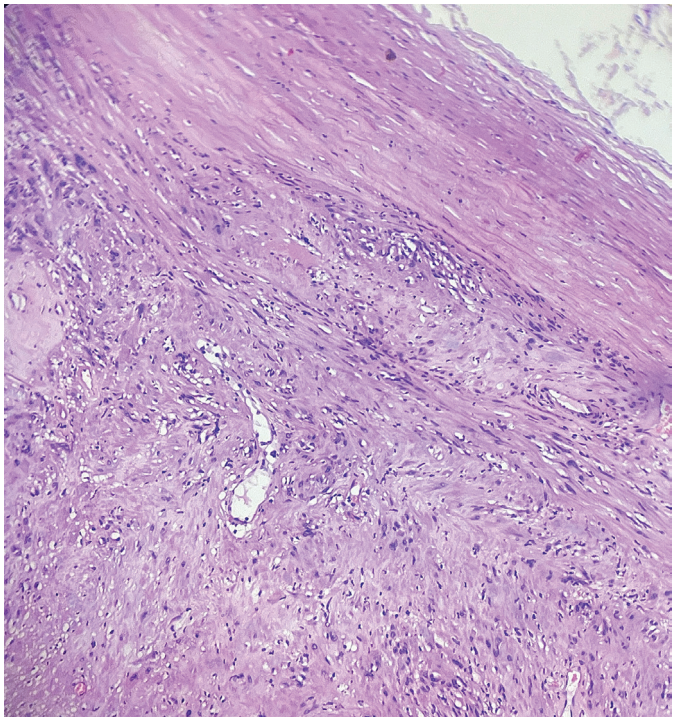

Figure 1. Shows well encapsulated tumor (H&E stain,10x magnification)
H&E: Hematoxylin and eosin

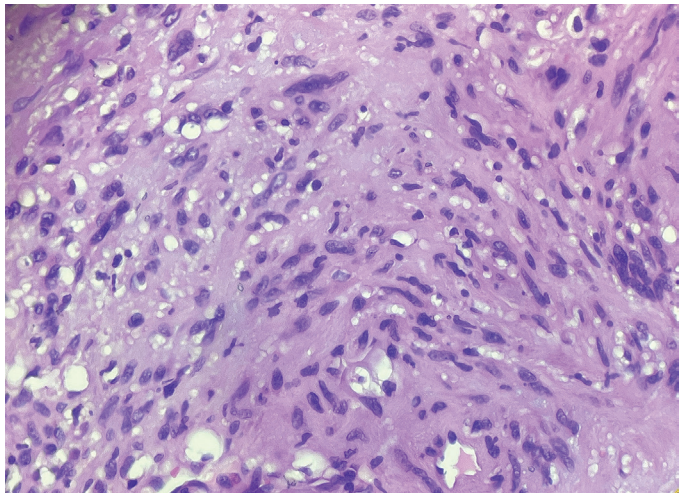

Figure 2. Spindle shaped cells with elongated tapered nuclei (H&E stain, 40x magnification)
H&E: Hematoxylin and eosin

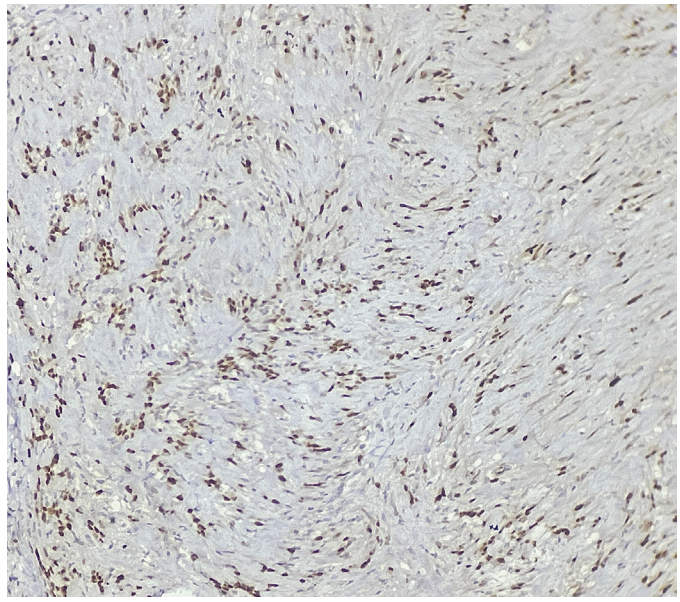

Figure 3. SOX10 IHC shows nuclear staining in the spindle cells (IHC, 10x magnification)
SOX10: SRY-box transcription factor 10, IHC: Immunohistochemistry

Table 1. Vulvar spindle cell tumors and key histopathological and immunohistochemical features

Entity	Key histopathological features	Immunohistochemistry	Distinguishing points
Schwannoma	Encapsulated tumor; Antoni A and Antoni B areas; Verocay bodies	SOX10 positive (diffuse nuclear), S-100 positive; Desmin negative	Well-circumscribed, encapsulated; strong SOX10 confirms Schwann cell origin
Neurofibroma	Unencapsulated; mixed spindle cells with wavy nuclei in myxoid stroma	S-100 variable; SOX10 usually weaker/focal	Lacks capsule and Antoni pattern
Leiomyoma	Interlacing fascicles of spindle cells with blunt-ended nuclei	Desmin positive, SMA positive; SOX10 negative	Smooth muscle differentiation
Cellular angiofibroma	Bland spindle cells with prominent hyalinized blood vessels	CD34 positive; Desmin variable; SOX10 negative	Characteristic thick-walled vessels
Angiomyofibroblastoma	Alternating hyper- and hypocellular areas; perivascular epithelioid cells	Desmin positive; SMA positive; SOX10 negative	Perivascular clustering of tumor cells
SOX10: SRY-box transcription factor 10, SMA: Alpha-smooth muscle actin			

Ethics

Informed Consent: Patient's informed consent was taken for publication.

Footnotes

Conflict of Interest: No conflict of interest is declared by the authors.

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Step-by-step laparoscopic excision of cervical stump for persistent CIN and bleeding in a postmenopausal patient without uterine manipulator

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Abstract

A 51-year-old woman presented with two years of postmenopausal spotting, mainly postcoital. Although vaginal atrophy was considered, prior use of vaginal estrogen at another center had not improved her symptoms. She had a history of persistent human papillomavirus (HPV) 16 infection and abnormal cytology. Initial colposcopy showed CIN 1 but one year later, a biopsy revealed CIN 2, and loop electrosurgical excision procedure (LEEP) was performed with negative margins. At 6-month follow-up, HPV positivity and low-grade squamous intraepithelial lesion persisted, with CIN 2 on colposcopy. Despite being offered repeat LEEP, the patient opted for definitive surgery. Due to a family history of ovarian cancer, she also requested bilateral salpingo-oophorectomy. This case highlights an individualized approach to recurrent cervical dysplasia and postmenopausal bleeding. Despite long-term follow-up, cervical dysplasia persisted, necessitating surgical intervention. The procedure was completed laparoscopically without complications. Cervical stump excision is a rare but important option in patients experiencing persistent symptoms or premalignant lesions after subtotal hysterectomy (SH). This case highlights careful patient selection and thorough counseling regarding potential long-term risks, including bleeding, dysplasia, and cervical malignancy, following SH. [J Turk Ger Gynecol Assoc. 2026; 27(2): 154-6]

Keywords: Cervical stumpectomy, minimally invasive surgery, spotting, subtotal hysterectomy

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Introduction

This video article reports a case of cervical stumpectomy and bilateral salpingo-oophorectomy in a patient with a history of subtotal hysterectomy (SH).

Case report

A 51-year-old patient, who had undergone an emergency postpartum SH 20 years previously due to hemorrhage, presented with persistent postmenopausal spotting ongoing for two years predominantly following sexual intercourse. Although vaginal atrophy was considered as a potential cause, she had previously used vaginal estrogen prescribed at another medical center without resolution of symptoms. Her cervical pathology history included persistent human papillomavirus (HPV) 16 positivity and abnormal cervical cytology findings. A colposcopy performed three years earlier due to a finding of atypical squamous cells of undetermined significance (ASCUS) revealed CIN 1; a follow-up co-test one year later again showed HPV positivity and ASCUS, and colposcopic biopsy confirmed CIN 2, for which a loop electrosurgical excision procedure (LEEP) was performed with negative surgical margins. At her 6-month follow-up, due to ongoing symptoms, repeat testing revealed continued HPV positivity and low-grade squamous

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The study was presented as an oral presentation at MIJID Congress 2024 in Türkiye.

intraepithelial lesion, with colposcopy showing CIN 2. Despite being offered another LEEP procedure, the patient declined and opted for definitive surgical treatment. Given a family history of ovarian cancer in a first-degree relative, she also requested bilateral salpingo-oophorectomy. Hormonal profile showed estradiol < 20 pg/mL and follicle-stimulating hormone 48 mIU/mL, confirming postmenopausal status. The patient was scheduled for laparoscopic cervical stumpectomy and bilateral salpingo-oophorectomy. Written informed consent was obtained for both the surgical procedure and the use of all relevant clinical data and video documentation for publication.

Surgical technique

The surgical procedure was performed laparoscopically. The procedure involved the insertion of a 10-mm trocar from the umbilicus, two 5-mm trocars from the right side, and one 5-mm trocar from the left side. Adhesions resulting from prior surgical interventions were carefully dissected. The retroperitoneum was entered in a patient who was both clinically and biochemically menopausal, for bilateral oophorectomy. The infundibulopelvic ligaments were ligated subsequent to the tracing of the bilateral ureteral tracts. The ligation of the bilateral uterine arteries was performed subsequent to the exiting from the internal iliac artery (Figure 1). Subsequently, the region of the cervicovesical region was meticulously exposed through a sharp dissection technique employing bipolar scissors (Figure 2). The bladder was then detached from the cervical stump. The cervical stump was meticulously separated from the vaginal cuff with the assistance of a tampon placed in the vagina, and was subsequently formed with ring forceps and a sponge (Figure 3). The cuff opening was closed by primary suturing.

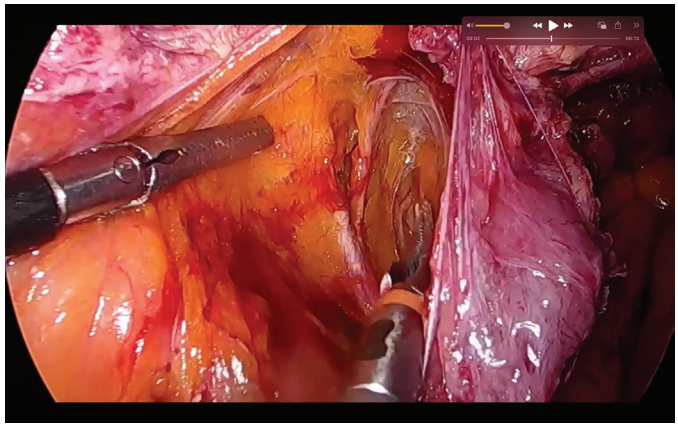

Figure 1. Uterine artery originating from the internal iliac artery

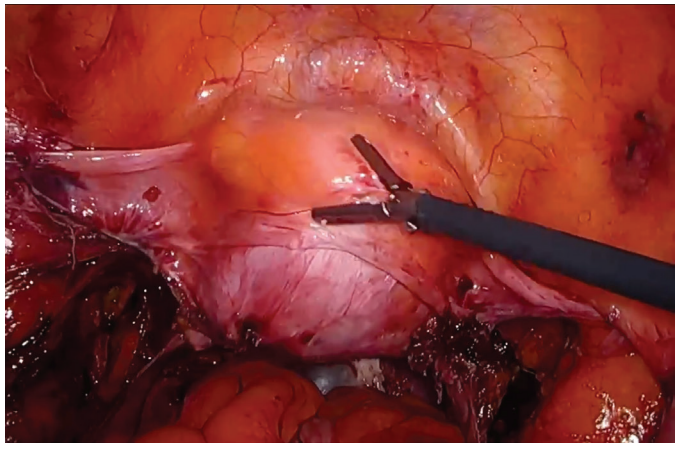

Figure 2. Cervical stump and bladder pushed with ring forceps inserted into the vagina

Discussion

Secondary stumptectomy is a rare procedure performed following SH. The literature does not does not define the frequency frequency for stumpectomy. Minimally invasive approaches may be applied. The three main indications for secondary cervical stump excision are: prolapse (31.4%); spotting (19.0%); and cervical dysplasia (18.2%) (1). Key differences between total laparoscopic hysterectomy and laparoscopic-assisted SH (LASH) include persistent vaginal bleeding (11-19%), de novo urinary incontinence (RR =1.37), and the risk of cervical dysplasia and cervical cancer (1,2). However, patients who undergo LASH tend to return to daily activities more quickly, and sexual function outcomes are generally better. The interval between SH and secondary stumpectomy ranges from 34 to 113 months, depending on the indication. Unlike previously published cases, this case presents a unique scenario of persistent CIN 2 in a postmenopausal woman with a history of SH and HPV 16 positivity. While cervical stump neoplasia remains rare, recent studies report an incidence of up to 3%, often diagnosed late due to insufficient follow-up. In contrast, the present case highlights early surgical intervention based on patient preference and clinical reasoning, underscoring the importance of individualized management and long-term surveillance in this subset of patients (3).

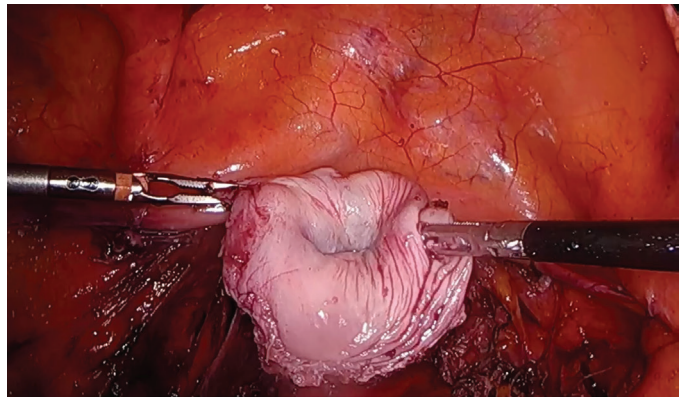

Figure 3. Cervix after separation from the vaginal cuff

Conclusion

Patients undergoing SH should be informed about the risks of spotting, cervical dysplasia, and cancer. This information may reduce the rates of SH. SH should not be performed in patients at risk for cervical dysplasia or cancer, such as those with high-risk HPV. The complication rate of stumpectomy is comparable to that of vaginal and laparoscopic hysterectomy. Careful screening of patients for SH and thorough counseling regarding the potential for incidental malignancy or premalignant conditions during SH are essential.

Video 1.

http://dx.doi.org/10.4274/jtgga.galenos.2025.2025-4-5.video1

Informed Consent: *Written informed consent was obtained for both the surgical procedure and the use of all relevant clinical data and video documentation for publication.*

Conflict of Interest: *No conflict of interest is declared by the authors.*

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CONGRESS CALENDAR

INTERNATIONAL MEETINGS

(for detailed International Meeting please go website: https://www.emedevents.com/obstetrics-and-gynecology)

June 10-13, 2026	International Urogynecological Association (IUGA) 51st Annual Meeting, Rio de Janeiro, Brazil
June 17-29, 2026	The Society of Obstetricians and Gynecologists of Canada Annual Clinical Scientific Conference, Ottawa, Canada
July 05-08, 2026	European Society of Human Reproduction and Embryology (ESHRE) 42nd Annual Meeting, London, UK
September 06-09, 2026	36th ISUOG World Congress, Dubai, UAE
October 04-07, 2026	ESGE 35th Annual Congress, Krakow, Poland
October 24-28, 2026	American Society for Reproductive Medicine (ASRM) 82nd Annual Meeting, Baltimore, USA
November 12-14, 2026	The 34th World Congress on Controversies in Obstetrics Gynecology & Infertility (COGI), Athens, Greece
November 13-16, 2026	The 55th American Association of Gynecologic Laparoscopists (AAGL) Global Congress on Minimally Invasive Gynecologic Surgery (MIGS), Boston, USA

CONGRESS CALENDAR

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(for detailed National Meeting please go website: https://www.kongreuzmani.com/2026)

September 30-October 04, 2026	8. Jinekoloji ve Obstetrikte Tartışmalı Konular Kongresi, Antalya, Türkiye
October 28-31, 2026	Türkiye Maternal Fetal Tıp ve Perinatoloji Derneği 15. Ulusal Kongresi, Antalya, Türkiye

JTGGA CME/CPD CREDITING

Answer form for the article titled “Pelvic neurovascular anatomy and avascular spaces: a pictorial essay of key surgical landmarks” within the scope of CME/CPD

1. **Which anatomical structure primarily divides the pararectal space into the Okabayashi (medial) and Latzko (lateral) compartments?**
   A. Internal iliac artery
   B. Hypogastric nerve
   C. Ureter
   D. Obliterated umbilical artery
2. **During nerve-sparing radical pelvic surgery, which anatomical space is considered the most critical for identification of pelvic autonomic nerves?**
   A. Prevesical space
   B. Pararectal space
   C. Paraaortic space
   D. Paravesical space
3. **Which statement regarding the uterine artery and ureter is anatomically correct?**
   A. The ureter crosses superior to the uterine artery near the pelvic brim
   B. The uterine artery crosses superior to the ureter approximately 1.5 cm lateral to the uterine isthmus
   C. The uterine artery runs within the paracervix inferior to the ureter
   D. The uterine artery originates from the posterior trunk of the internal iliac artery
4. **Which vascular structure forms the “Corona Mortis” through an anastomosis with the obturator vessels?**
   A. Superior gluteal artery
   B. Deep circumflex iliac artery
   C. Inferior epigastric artery
   D. Middle rectal artery
5. **Injury to which neural structure during laterovascular plane dissection may result in postoperative drop foot?**
   A. Pudendal nerve
   B. Obturator nerve
   C. Pelvic splanchnic nerve
   D. Lumbosacral trunk
6. **Which statement best describes the surgical importance of the obliterated umbilical artery?**
   A. It supplies the upper vagina through collateral circulation
   B. It is the main landmark for identifying the presacral space
   C. It serves as a landmark for the paravesical and prevesical spaces
   D. It represents the continuation of the superior gluteal artery

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1st Question

A	B	C	D

2nd Question

A	B	C	D

3rd Question

A	B	C	D

4th Question

A	B	C	D

5th Question

A	B	C	D

6th Question

A	B	C	D

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