



Comparison of Tissue Responses to Polyglycolic Acid and Polypropylene Sutures in Mice Infected With Intraperitoneal *Staphylococcus Aureus*

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Abstract

Objective: The aim of this study was to compare the tissue reaction to polyglycolic acid and polypropylene sutures in the presence of infection.

Materials and Methods: Twenty healthy male Swiss Albino mice were used as experimental animals and were inoculated intraperitoneally with ATCC 25925 *Staphylococcus aureus*. An incision in the lower abdominal fascia was then closed with either polyglycolic acid or polypropylene sutures. Biopsy specimens including the suture loop and surrounding tissues were obtained after 7 days and processed for histologic analysis. The tissue reactions were evaluated by histological examination on a scale from 0 (no inflammation) to 3 (severe inflammation). The rate of fibrosis, neovascularization and fibroblastic proliferation and the intensity of inflammation, as measured by the numbers of macrophages, lymphocytes, foreign giant body cells and plasmocytes, were observed with an optical microscope.

Results: A more intense inflammatory tissue reaction was observed in subjects closed with polypropylene sutures than in those closed with polyglycolic acid sutures.

Conclusion: This study suggests that polyglycolic acid sutures may be more suitable for use in the presence of an intraperitoneal staphylococcal infection. However, given the semiquantitative nature of the estimation of the inflammatory tissue response and the consequent impossibility of meaningful statistical analysis, this observation remains suggestive rather than allowing a definitive conclusion.

Key words: polyglycolic acid suture, polypropylene suture, *Staphylococcus aureus*

Özet

İntraperitoneal *Staphylococcus Aureus* ile Enfekte Edilen Farelerde Poliglikolik Asit ve Polipropilen Sütür Materyallerinin Doku Yanıtlarının Karşılaştırılması

Amaç: Bu çalışmanın amacı enfeksiyon varlığında poliglikolik asit ve polipropilen sütürlere karşı oluşan doku reaksiyonlarının karşılaştırılmasıdır.

Materyal ve Metot: Çalışmamızda, intraperitoneal olarak ATCC 25925 *Staphylococcus aureus* suşu inoküle edilen, 20 adet erkek Swiss Albino fare kullanıldı. Alt abdominal fasya insizyon yapıldıktan sonra poliglikolik asit veya polipropilen sütür materyali kullanılarak kapatıldı. İşlemden 7 gün sonra sütürü çevreleyen doku sütür ile birlikte eksize edilerek histolojik olarak incelendi. Histolojik doku reaksiyonları, 0'dan (inflamasyon yok) 3'e (şiddetli inflamasyon) kadar değişen bir ölçek ile değerlendirildi. Optik mikroskopta fibrozis oranı, neovaskülarizasyon, fibroblastik proliferasyonla birlikte makrofajlar, lenfositler, yabancı cisim dev hücreleri ve plazmositler sayılarak inflamasyonun yoğunluğu değerlendirildi.

Sonuçlar: Polipropilen sütür kullanılan deneklerde poliglikolik asit sütüre oranla daha yoğun inflamatuvar doku reaksiyonu olduğu gözlemlendi.

Tartışma: Bu çalışma, intraperitoneal stafilokok enfeksiyonu varlığında poliglikolik asit sütür kullanımının daha elverişli olabileceğine işaret etmektedir. Ancak, inflamatuvar doku yanıtının semikantitatif ölçümünün anlamlı bir istatistiksel sonuç verebilmesi olanaksızdır. Bu gözlem, kesin bir sonuç tanımlamakta, ancak bir öneride bulunmaktadır.

Anahtar sözcükler: poliglikolik asit sütür, polipropilen sütür, *Staphylococcus aureus*

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Introduction

Modern sutures are made from a variety of natural and synthetic materials but two of the most popular are polyglycolic acid and polypropylene.

Polyglycolic acid sutures are synthetic polyfilaments made of polyglycolic acid, are absorbable (usually within nine days), have high knot security and high tension and are convenient for manual treatment. They are more flexible (1) and elastic (2) than polypropylene. This can be an advantage but can also result in more postoperative stretching of the wound area (3). They are widely used in facial repairs and in gynecological surgery.

Polypropylene sutures are made of polypropylene monofilaments, are non-absorbable, strong and penetrate through tissues easily.

This study aimed to compare tissue responses occurring against sutures made from polyglycolic acid and polypropylene in mice infected intraperitoneally with *Staphylococcus aureus*.

Materials and Methods

Twenty healthy male Swiss Albino mice 6-8 weeks old and 20-30 g weight were used as experimental animals.

ATCC 25925 *Staphylococcus aureus* reference control strain obtained from Ankara Refik Saydam Health Laboratory was cultivated on 5% sheep blood agar incubated at 36°C for 18 hours. The growth was harvested in normal saline and the turbidity adjusted to 0.5 McFarland Standard ($\approx 1,5 \times 10^8$ cfu/mL). 0,01 mL of this solution was injected intraperitoneally into each of the mice. All mice were monitored for three days from the injection date, during which time no antibacterial treatment was given. At the end of the third day, the mice were anesthetized by ether inhalation and a 1 cm transverse incision was made in the lower abdominal fascia. In 10 mice (Group 1), the incision was closed using 2.0 polyglycolic acid suture (Dexon®, Davis & Geck), while the incision

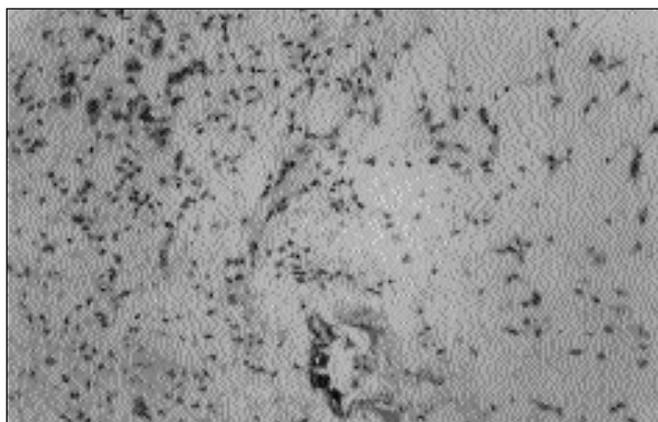


Figure 1. The inflammatory infiltration consisted of plasmocytes, lymphocytes and fibroblasts, HE x100.

of the remaining 10 (Group 2) was closed using 2.0 polypropylene (Prolene®, Ethicon). All subjects were sacrificed; using the cervical dislocation method, on the 7th day following application of the suture material, and the tissue in the suture area was excised and placed in formalin. The extent of tissue reaction was estimated microscopically. Cross-sections of 4 micron thickness were prepared and stained with hematoxylin-eosin (H-E) and examined histopathologically for inflammatory infiltrate, neovascularization and connective tissue ingrowth. The sections were scored blindly by a single observer, using an arbitrary scale from 0 to 3, in which 0 = inflammatory cells absent, 1 = mild, 2 = moderate and 3 = severe inflammatory reaction/tissue fibrosis. The degree of inflammatory reaction was estimated by the number and degree of condensation of cells –macrophages, lymphocytes, foreign giant body cells and plasmocytes– in the vicinity of the implanted thread, and the width of the sphere of the inflammatory reaction. The degree of inflammatory response and tissue fibrosis for each suture was scored and the results were compared. Characteristic reactions were documented photographically.

Results

Both groups showed varying levels of inflammatory infiltration and fibrosis. In the polyglycolic acid group (Group 1), the inflammatory infiltration consisted of plasmocytes, lymphocytes and fibroblasts (Figure 1).

In the polypropylene group (Group 2), an intensive inflammatory infiltration with neutrophils, in addition to plasmocytes and lymphocytes, was found in the suture area. Granulation tissue, hyperemic veins and fibroblast development were also present (Figure 2).

Discussion

All suture materials are in the nature of foreign material for tissue and cause various degrees of tissue reaction. Tissue reaction usually occurs on the 5th day following suture locati-

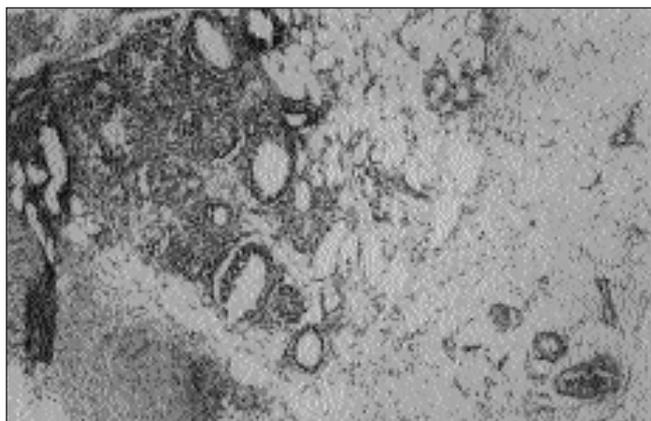


Figure 2. An intensive inflammatory infiltration with neutrophils, in addition to plasmocytes and lymphocytes, was found in the suture area. Granulation tissue, hyperemic veins and fibroblast development were also present, HE x40.



on. However, Smit et al found that, at seven days after surgery, the effect of surgical trauma nullified possible differences between suture materials with respect to tissue reaction (4).

Over a longer time period, Beauchamp et al found polypropylene to produce a smaller tissue reaction than polyglycolic acid at 16 days post implantation but that reactions persisted longer (>42 days) with polypropylene (5). This is probably because of the initial more effective presentation of antigens by the absorbable suture, followed by an effective removal of these antigens.

Similarly, Cham et al found that, after dissolution, tissues with absorbable sutures (including polyglycolic acid) were essentially free of inflammation, whereas those containing nonabsorbable sutures (including polypropylene) showed persistent small local granulomas (6).

Theoretically, polyfilaments, through presenting a greater surface area and by providing possible areas for sequestration, are likely to be more easily contaminated with bacteria, and Chu and Williams found that polyglycolic acid sutures had the highest affinity towards bacteria of the ten suture materials (including polypropylene) they tested (7). However, Cameron et al (8) and Paajanen (9) found no difference in infection rates between polyglycolic acid and polypropylene, and Lewis and Wiegand (10) found that wound infections were slightly more frequent in patients whose incision was closed with polypropylene.

Although it is advisable to eliminate infection before operation, this is not always possible and perioperative antibiotic treatment may not always be effective. Sutures in the presence of infection may provide a nidus of infection that will make the infection more difficult to treat. The possible greater susceptibility of polyglycolic acid to colonization by bacteria must be balanced against its removal as a site of infection by dissolution.

Conversely, infection may be expected to amplify tissue reaction associated with sutures. This increased tissue reaction

will likely increase time to healing and may jeopardize wound closure.

Although inflammation, infiltration and fibrosis in varying degrees were observed histologically with both sutures, inflammatory responses in the polypropylene-sutured subjects were more intense than those in which polyglycolic acid was used. Because of the mild inflammatory reaction of polyglycolic acid in this animal model, this suture seems to provoke a more favourable biologic response in the presence of intraperitoneal staphylococcal infection. However, the semiquantitative estimations of the tissue response used in this study can not provide a definitive conclusion about the possibility of the superiority of polyglycolic acid sutures in infection. Further studies allowing a valid statistical analysis are necessary. The relevance of the observation to humans also remains to be established.

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