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Tissue Reactions to Polypropylene Mesh Used in Maxillofacial Trauma

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Four 1-cm^2 fragments of polypropylene mesh were implanted in the subcutaneous tissue of each of 10 albino rats to evaluate biocompatibility. A straight longitudinal incision was made on the back of these animals and histological analysis was carried out at 7, 15 and 30 days. At 7 days, there was a mild inflammatory reaction around the implanted material. On day 15, the inflammatory process continued being discrete. The inflammatory reaction decreased significantly by day 30, when mild inflammation with cell infiltrate was observed, as well as the formation of a layer of fibrous tissue surrounding the implanted mesh. These results show the biocompatibility of the polypropylene mesh and support its use in oral and maxillofacial surgery.

Key words: biocompatibility, polypropylene mesh, tissue reconstruction.

INTRODUCTION

Many attempts have been made to substitute damaged bone. The search for an alloplastic material that solves the disadvantages of autografts continues. The most commonly used autografts for the reconstruction of the facial skeleton are the iliac crest, bone, ribs, outer cortex of the cranial vault and the fore part of the maxillary sinus. Autografts present certain disadvantages which limit their usefulness, such as the need for a donor site, a disagreement in the donor and recipient areas, and the inconveniences of a surgical intervention.

Literature reports several alloplastic materials that may be used in humans (1), such as, methylmethacrylate, mersilene, silicone, Teflon, dacron, polyethylene, glass spheres of small diameters, titanium-dacron, and hydroxylapatite. Polypropylene mesh has been used with good results in general surgery, as well as in plastic reconstructive, urological, gynecological, and thoracic surgeries. This material appears to be another option for orbit floor reconstruction when loss of bone substance occurs. However, there is little research published concerning these applications (2-5).

The polypropylene mesh, that is still in clinical use, is composed of a single stranded polymer in a crystalline molecular structure, with high density and resistance to traction and can be sterilized through autoclaving without affecting its properties (6). In the original study, the polypropylene mesh was used for the reconstruction of large wounds, which previously occurred in the abdominal and thoracic wall and the diaphragm of 31 dogs (6). These animals were sacrificed during a period of six weeks to six months. Histological evaluation of the specimens containing the mesh showed uniform infiltration of fibrous tissue, 4-5 mm thick at its margin and on its surface. Due to less infiltration of the fibrous tissue when the polypropylene mesh was used, the results were considered better, when compared to the Teflon mesh. After six months, the post-operative control showed that there was no fragmentation, nor reduction of resistance to traction of the mesh. When implanted in a contaminated area, even in the presence of purulent secretion, it showed resis-

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tance (6-10), and after two weeks, granulation tissue was seen infiltrating its surface.

In similar research, Van Der Velden and Klein (10) used polypropylene mesh to repair abdominal hernias in horses. Six months after surgery, the animals were healthy. Polypropylene mesh was also implanted in the abdominal cavity of 10 ponies with satisfactory results (7). In another animal experiment, the histological evaluation showed a layer of histiocytes of one to three cells, forming the margin around the mesh, and the presence of occasional giant cells. The mesh was stable in all animals, and their pores had infiltrated fibroblasts (8).

Complications inherent to the placing of the mesh, such as intestinal fistula, wound dehiscence, and death when closing the wounds of patients who had septicemia due to a surgical intervention of the abdominal cavity, have been described (9). Formation of granulation tissue covering the mesh was reported when part of the abdomen of a soldier was reconstructed with a polypropylene mesh (11).

In a review of the 120 cases (12), a fragment of polypropylene mesh was placed covering the groin to repair inguinal hernias through laparoscopic transperitoneal surgery. Complications were infections in three patients, groin abscess (in two of them) and pubis osteitis in one. Waldrep et al. (13) reported the development of cysts in the abdominal wall of two patients after the use of a polypropylene mesh.

Success using polypropylene mesh to repair abdominal malformation in over 150 patients was described by Fernandez and O'Leesky (14). In two of these patients, laparotomies were performed within a period of six to eight months after the surgery and the mesh was coated with peritoneum and did not show any adhesion.

Using polypropylene mesh in over 26 abdominal surgeries, Fansler et al. (15) reported serious complications, such as, the folding of the mesh, extrusion, wound contraction and enterocutaneous fistula, all of which originated from the use of the mesh. In the retrospective analysis of 31 cases, Volyes et al. (16) reported that 25 patients, who had received this mesh in the abdominal cavity, developed either infection and fascia necroses, or severe intra-abdominal infection. However, Chan et al. (17) used an 8 x 10 cm polypropylene mesh in the groin to repair inguinal hernia in 39 patients and reported no serious complications.

There is no information available on the biocompatibility of polypropylene mesh in maxillofacial surgery, although Mathog (4) has reported its use. Therefore, the present study evaluates the biocompatibility of the polypropylene mesh, when implanted in the subcutaneous tissue of the rat.

Table 1. Reactions of the subcutaneous tissue of the rat to the implanted polypropylene mesh at 3 time periods.

Period	Histological findings
7 days	Chronic inflammatory cell infiltrate
	Predominance of histiocytes
	Mildly infiltrated plasma cells
	Occasional giant multinucleated cells
15 days	Chronic inflammatory cell infiltrate
	Prevalence of histiocytes and occasional plasma cells
	Occasional giant multinucleated cells
	Fibroblasts
30 days	Very mild chronic inflammatory cell infiltrate
	Presence of histiocytes
	Occasional giant multinucleated cells
	Mild proliferation of fibroblasts
	Fibrosis around the material

MATERIAL AND METHODS

In this study, ten albino rats weighing 150-200 g were used. These animals were fed a commercially prepared solid diet and water ad libitum. The rats were submitted to anesthesia with a mixture of ketamine chloride and xylazime hydrochloride (ip, 0.3 to 0.4 ml). Asepsis with 10% povidone-iodine solution, and trichotomy of the dorsal region were performed. A straight longitudinal incision was made on the back, following the mid-line at a distance of approximately 3 cm, with a #15 surgical scalpel. The division occurred at the subcutaneous connective tissue level, by using curved doll tip scissors, deep enough to insert the four 1-cm^2 fragments of polypropylene mesh to be tested. The wounds were closed with simple mononylon 6-0 sutures. The animals were sacrificed at 7, 15 and 30 days, to remove the portion of the connective tissue containing the implanted material. The specimens were fixed in 10% buffered formalin and submitted to routine histological processing with 5-µm thick paraffin sections, and stained with hematoxylin and eosin (H&E).

RESULTS

Results are shown in Table 1 and Figures 1 to 3. At 7 days, there was a mild inflammatory reaction around the implanted material, and at 15 days, the inflammatory process continued being discrete. The inflammatory reaction decreased significantly by day 30, when mild inflammation with cell infiltrate was observed, as well as the formation of a layer of fibrous tissue surrounding the implanted mesh.

DISCUSSION

In this study, rats were used due to easy handling, control, uniformity in results, and for allowing the analysis and comparison of a large number of variables of the same specie. These animals present tissue response similar to that of humans that allows easier interpretation of the results and evaluation of biocompatibility. Polypropylene mesh was chosen (Figure 4) because it is easy to handle and is made of an inert, single-stranded, flexible material that can be sterilized by autoclaving. It can be cut with scissors, and due to its flexibility, it can be easily adapted to the receptor area. It does not suffer any fragmentation, is highly resistant to traction and can be used in an infected area. These characteristics made it a first-choice material for substituting lost tissues.

The material tested is widely accepted in surgical specialties, mainly in general surgery, where it has

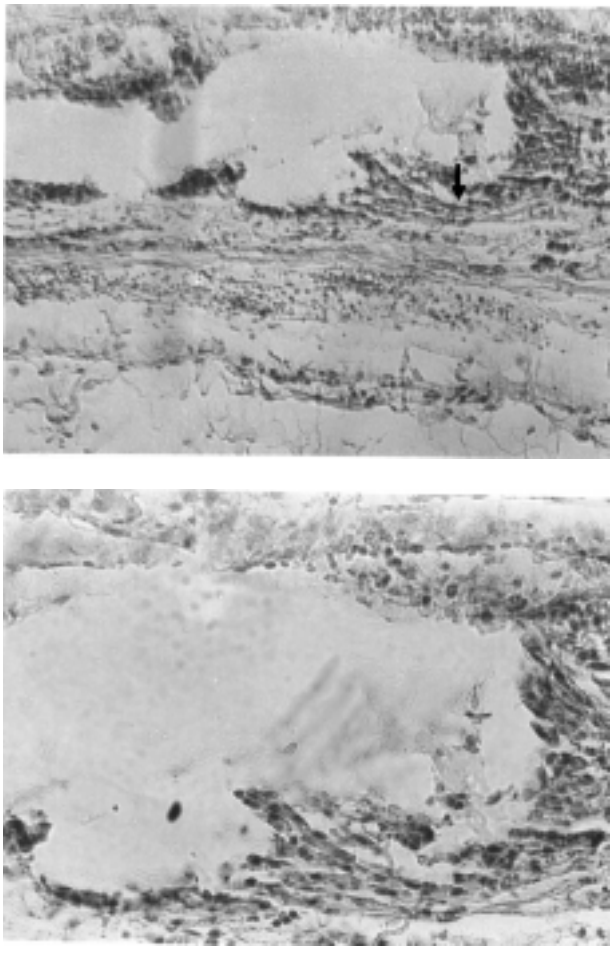

Figure 1. Top, Reaction of the subcutaneous tissue of the rat 7 days after surgery showing discrete inflammatory cell infiltrate. Magnification, 100X (H&E). Bottom, Area shown at arrow in top panel. Magnification, 400X (H&E).

Figure 2. Top, Subcutaneous tissue of the rat at day 15. Magnification, 100X (H&E). Bottom, Area shown at the arrow in top panel showing mild inflammatory cell infiltrate with tendency to fibrosis. Magnification, 400X (H&E).

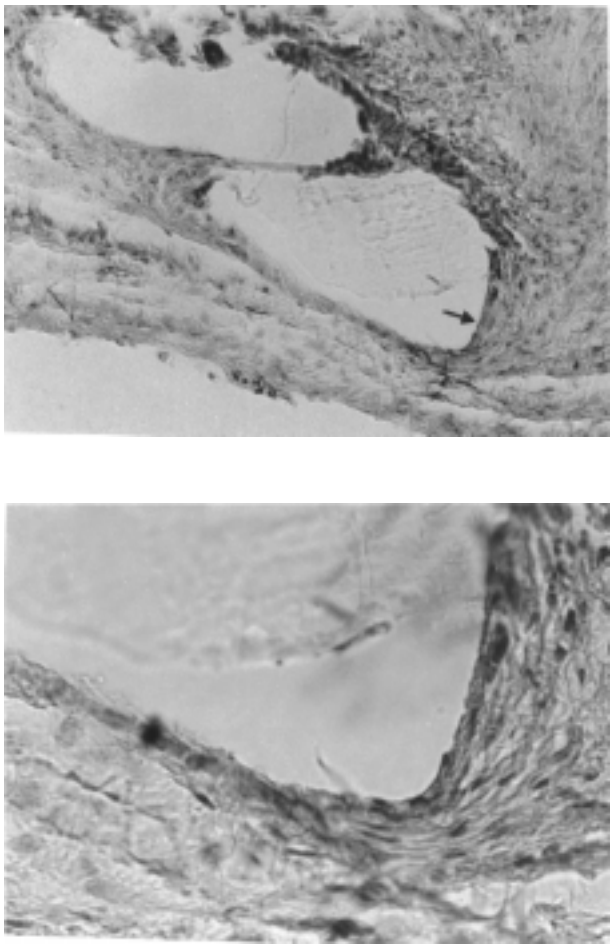

Figure 3. Top, Subcutaneous tissue of the rat at day 30. Magnification, 100X (H&E). Bottom, Area shown at the arrow in the top panel showing the formation of fibers and tissue with an already normal aspect and scarce inflammatory elements. Magnification, 400X (H&E).

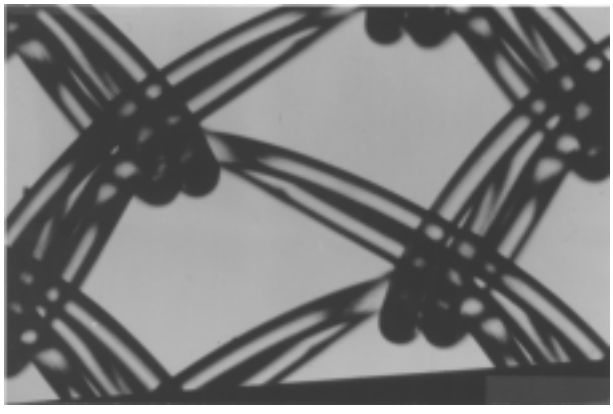

Figure 4. Polypropylene mesh. Magnification, 20X

been used for the closure of abdominal wounds with loss of substance (12,14,15,18). In oral and maxillofacial surgery, the mesh can be used in the reconstruction of the floor of the orbit, when there is a multiple fragment fracture. Having been made in the form of an interlaced-like mesh, it does not suffer any dislocation or extrusion when used in the orbit floor, due to the absence of muscular strength in the site. The adjacent connective tissue infiltrates its pores, fixing it to the wound background.

The results shown in Table 1 and Figures 1-3 indicate its biocompatibility and thus its use in normal tissues. The literature shows that, even in contaminated areas, the mesh presents equally satisfactory results (6-10). Adverse results observed by several authors (15,16) are not related to the biocompatibility of the material. Negative results have been observed when accidents like folding of the mesh, wound contraction, etc. (15) occur. Even when used in critical conditions, good results have been reported (6). In patients who suffered great traumas with loss of substance and where wound closure was not possible, even with flap rotation, the polypropylene mesh was used to close the wound successfully, and 20 days later, there was granulation tissue covering it (11).

Since the polypropylene mesh presents low toxicity to the tissues, it does not maintain an acute inflammatory process. In the present study, there was a decrease in inflammation from the 7th to the 30th day. The cellular involvement pattern in the inflammation of the implanted area followed a pattern already reported in the literature (19). In the evaluation of the histological paraffin sections done on day 7, few neutrophils and eosinophils were observed surrounding the implanted material. The absence of a leukocyte polymorphonuclear infiltrate during this period is due to the low toxicity of the material.

Acute inflammation is a stereotype response to all forms of aggression, whatever the injurious agent may be (19). Plasma cells are hardly seen in normal connective tissue, but they appear in large numbers in areas of chronic inflammation, as can be observed in the results. They are antibody-producing cells, in response to the penetration of foreign molecules in the organism called antigens (20). The low prevalence of these cells at 30 days presents a strong argument for the use of the polypropylene mesh in oral and maxillofacial surgery.

Further studies should be carried out to evaluate the anatomical usefulness of this biocompatible mesh to substitute skeleton and loss of substance in maxillofacial surgery.

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RESUMO

Paula e Silva E, de Rosa ELS, Barbosa SV. Reações tissulares da tela de polipropileno usada em traumatologia. Braz Dent J 2001;12(2):121-125.

A biocompatibilidade da tela de polipropileno foi estudada por meio do implante de quatro fragmentos medindo 1 cm^2 no tecido subcutâneo de cada um dos dez ratos albinos utilizando incisão reta longitudinal no dorso destes animais, e posteriormente feita análise histológica. Foram avaliados nos tempos de 7, 15 e 30 dias. Aos 7 dias, demonstrou discreta resposta inflamatória margeando o material implantado. No 15º dia, o processo inflamatório manteve-se discreto. A reação inflamatória diminuiu sensivelmente no trigésimo dia, quando foi observado leve infiltrado inflamatório e formação de uma camada de tecido fibroso ao redor da tela implantada. Os resultados apóiam seu uso em cirurgia bucomaxilofacial.

Unitermos: biocompatibilidade, tela de polipropileno, reconstrução tecidual.

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