

# Comparative Study of Tissue Response to Polyglecaprone 25, Polyglactin 910 and Polytetrafluorethylene Suture Materials in Rats

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The authors evaluated the biocompatibility of three suture materials, polyglecaprone 25, polyglactin 910 and polytetrafluorethylene, implanted into subcutaneous tissue in the dorsal region of 20 Wistar albinus rats. After periods of 2, 7, 14 and 21 days, the rats were sacrificed and the specimens were processed for routine histotechnical analysis and stained with hematoxylin and eosin. The rate of fibrosis, angioblastic and fibroblastic proliferation, and also the intensity of inflammation were observed with the optic microscope. The results showed that polyglecaprone 25 suture material induced a mild inflammatory reaction, followed by polyglactin 910 and polytetrafluorethylene, respectively. Such biological behavior must be considered during the selection of the suture material to be used in oral surgery.

Key Words: polyglecaprone 25, polyglactin 910, polytetrafluorethylene, suture material.

## INTRODUCTION

Sutures play an important role in wound healing after surgical interventions and thus the selection of suture material, especially in oral procedures, must be made carefully. This location differs from other body sites due to the constant presence of saliva, specific microbiota, high vascularization, as well as its functions related to speech, mastication, and swallowing (1). The search for more appropriate suture material has resulted in a variety of natural and synthetic, absorbable and nonabsorbable sutures available commercially. These features influence biological reactions to the suture, permitting a great diversity of clinical applications.

Several clinical and experimental studies have tried to establish the ideal suture (2-7) taking into account factors such as their intrinsic biological com-

patibility, physical features, permeability to oral fluids and clinical applicability.

Recently available on the market, polyglecaprone 25 monofilament suture material, a copolymer of glycolide and  $\epsilon$ -copralactone, absorbable by hydrolysis in a period of 91 to 119 days, presents excellent strength, reduced memory and large malleability. It is a synthetic suture, and because of its favorable characteristics can be used not only deeply in tissues, but also in superficial tissues of oral mucosa (6). However, despite these commercial considerations, a comparative study between this specific suture and those commonly used in dental practice is needed.

The aim of this study was to observe the biological reactions of polyglecaprone 25 suture implanted in subcutaneous tissue of rats compared to polyglactin 910 and polytetrafluorethylene sutures with well known results and clinical applicability (6,8,9).

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## MATERIAL AND METHODS

Twenty male Wistar albinus rats, weighing about 250 g and fed a solid diet and water *ad libitum*, were divided into 4 groups of 5 rats each. The animals were anesthetized with sulfuric ether, and after shaving and scrubbing the dorsal area with an antiseptic solution, a 4-cm longitudinal incision was made along the medial line in the dorsal subcutis.

Each animal received three sutures: polyglecaprone 25 (Monocryl, Ethicon, São José dos Campos, SP, Brazil), polyglactin 910 (Vicryl, Ethicon, São José dos Campos, SP, Brazil) and polytetrafluoroethylene (e-PTFE, Gore-Tex, Flagstaff, AZ, USA) with a 1.5-cm interval between them. The sutures had the same thickness (4-0) and needle (semicircular, nontraumatic with triangle section). After 48 h, 7, 14 and 21 days, the animals were sacrificed and the sutures and the subcutaneous tissue were removed from the dorsal area. The specimens underwent routine histotechnical processing and were stained with hematoxylin and eosin for histological analysis.

Inflammation, rate of fibroblastic and angioblastic proliferation, and the presence of fibrous tissue surrounding the sutures were observed in each group and period, and scored according to their presence and intensity: 0 = absent; 1 = mild; 2 = moderate; 3 = severe.

For statistical analysis, median and semi-amplitude were calculated from the scores, and the Friedman test was applied.

## RESULTS

### *Polyglecaprone 25*

Microscopically, this suture was a homogeneous and bright material. Forty-eight hours after its implantation, focal neutrophilic inflammatory infiltrate was noted surrounding the suture. Areas of connective tissue alternated with areas of granulation tissue rich in ovoid and spindle cells (Figure 1a). On the seventh day, next to the suture, moderate mononuclear infiltrate was observed, with eventual neutrophils, although an initial fibroblastic and angioblastic proliferation could be seen (Figure 1b). The organization of the connective tissue was observed after 14 days, with collagen fibers and fibroblasts, and abundant capillaries. A few foreign body multinucleated giant cells were seen in this period

(Figure 1c). On the 21st day, organized connective tissue surrounding the suture was noted (Figure 1d).

### *Polyglactin 910*

After 48 h of suture implantation, optic microscopic analysis showed the presence of neutrophilic infiltrate ranging from moderate to intense surrounding the suture. These leucocytes could also be seen among the filaments of the suture. Disorganized connective tissue was seen, and no evidence of fibroblastic or angioblastic proliferation was noted (Figure 2a). On the 7th day, a slight organization of the connective tissue with angioblastic and fibroblastic proliferation was noted, as well as a moderate number of mononuclear leucocytes (Figure 2b). Foreign body giant cells were seen associated to the suture filaments after 14 and 21 days. Connective tissue was present surrounding the suture at 21 days (Figures 2c,d).

### *Polytetrafluoroethylene*

After 48 hours, extensive neutrophilic inflammatory infiltrate was seen close to the polytetrafluoroethylene suture, irregular and brown in color (Figure 3a). The same infiltrate was still present after 7 and 21 days (Figures 3b,c); however, in distant areas, a vascularized and cellular granulation tissue could be seen, becoming an organized connective tissue in the last period. Foreign body multinucleated giant cells were also present at 21 days (Figure 3d).

### *Statistical Analysis*

Forty-eight hours after suture implantation, no statistically significant difference was noted between polyglactin 910 and polytetrafluoroethylene sutures in terms of intensity of neutrophilic inflammatory infiltrate. However, polyglecaprone 25 showed mild acute inflammatory reaction in this period that was statistically different from polytetrafluoroethylene. During the following periods, statistically significant differences were observed between polytetrafluoroethylene sutures and the others, with polytetrafluoroethylene showing a more aggressive behavior to the subcutaneous tissue, with persistence of neutrophils until the last period of this study.

Mononuclear leukocyte infiltrate in the

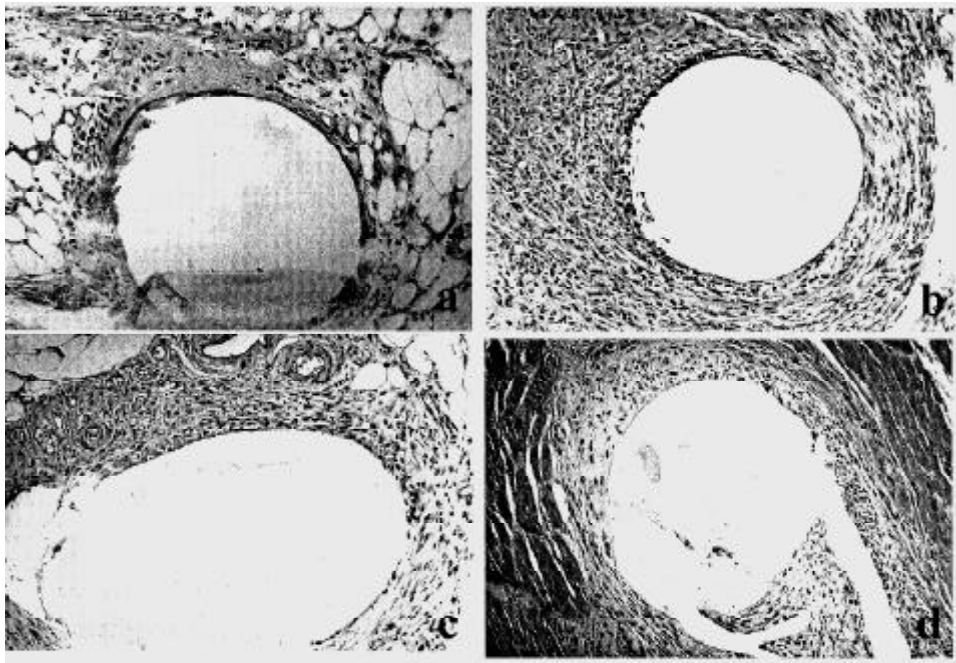


Figure 1. Polyglecaprone 25. a) 48 h: discrete areas of granulation tissue can already be seen, and areas of organized connective tissue; b) 7 days: fibroblastic and angioblastic proliferation can be noted; c) 14 days: vascularized connective tissue surrounds the suture; d) 21 days: presence of organized connective tissue around the suture material (H&E; original magnification 40X).

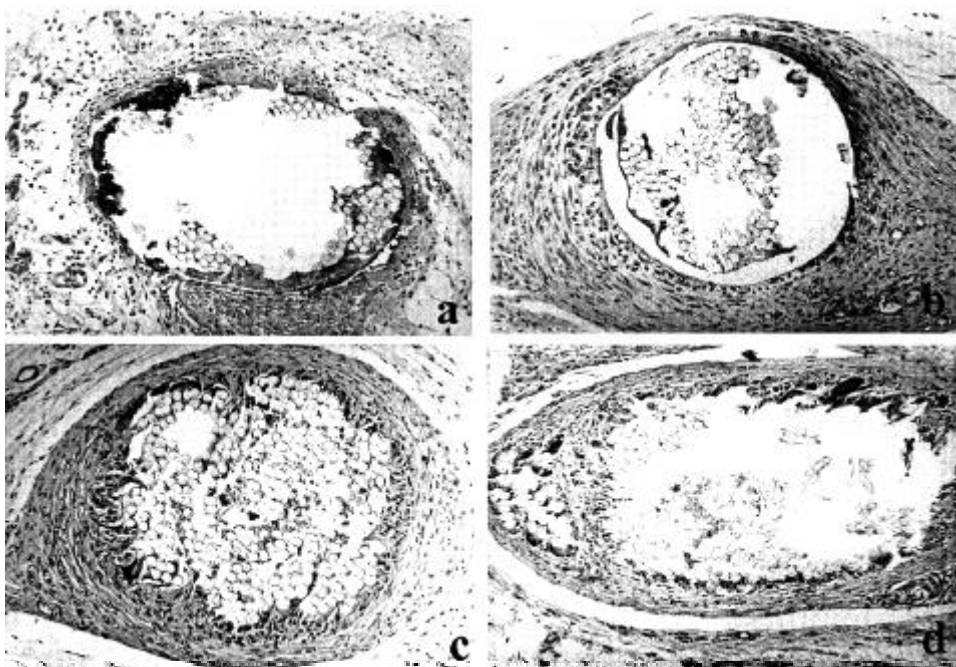


Figure 2. Polyglactin 910. a) 48 h: moderate acute inflammatory infiltrate can be seen next to the suture; b) 7 days: angioblastic and fibroblastic proliferation is noted; c) 14 days: presence of foreign body giant cells associated to the filaments of the suture; d) 21 days: organized connective tissue can be seen surrounding the material, as well as foreign body giant cells (H&E; original magnification 40X).

polyglactin 25 group was significantly less than that of the polytetrafluorethylene group only at 48 hours.

Differences related to fibroblastic and angioblastic proliferation were not regularly noted, with tissues surrounding the suture materials showing similarity in relation to the presence of angioblastic or fibroblastic cells.

Fibrosis observed around the sutures was statistically different between polytetrafluorethylene and the others, confirming the lack of collagen fiber organization around polytetrafluorethylene sutures up to the last day of the experiment with granulation tissue persisting. Statistical results can be better visualized in Table 1.

## DISCUSSION

Sutures used in oral surgery behave differently from other parts of the body due to the quality of the tissues involved, presence of saliva, and specific microbiota. They represent a pathway communicating the internal and external regions of the tissues, influencing the quality of wound healing (1).

Searching for ideal suture materials implies not only biological compatibility, but also clinical behavior. They must present good resistance to traction, dimensional stability, lack of memory, good knot security, and enough flexibility not to damage oral mucosa. At the same time, they must avoid or limit bacterial adhesion and proliferation to those parts exposed to oral fluids, avoiding contamination inside the wound (2,10). A good suture material must show a brief exudative phase, not interfering with cellular proliferation or connective tissue organization.

Among the available suture materials, polyglactin 910 is one of the favorites in dental practice. Despite being braided, it is resistant to traction and easily manipulated. Clinical observations also show an excellent behavior, not permitting the adhesion of plaque, nor intense inflammatory reactions around it. Thus, this suture is often selected for oral surgeries, even when its removal is not intended, or for deep sutures. It was used for comparison in the analysis of polyglactin 25 suture, showing a good biological reaction, inducing moderate acute inflammatory response in early periods and early fibroblastic and angioblastic proliferation. It

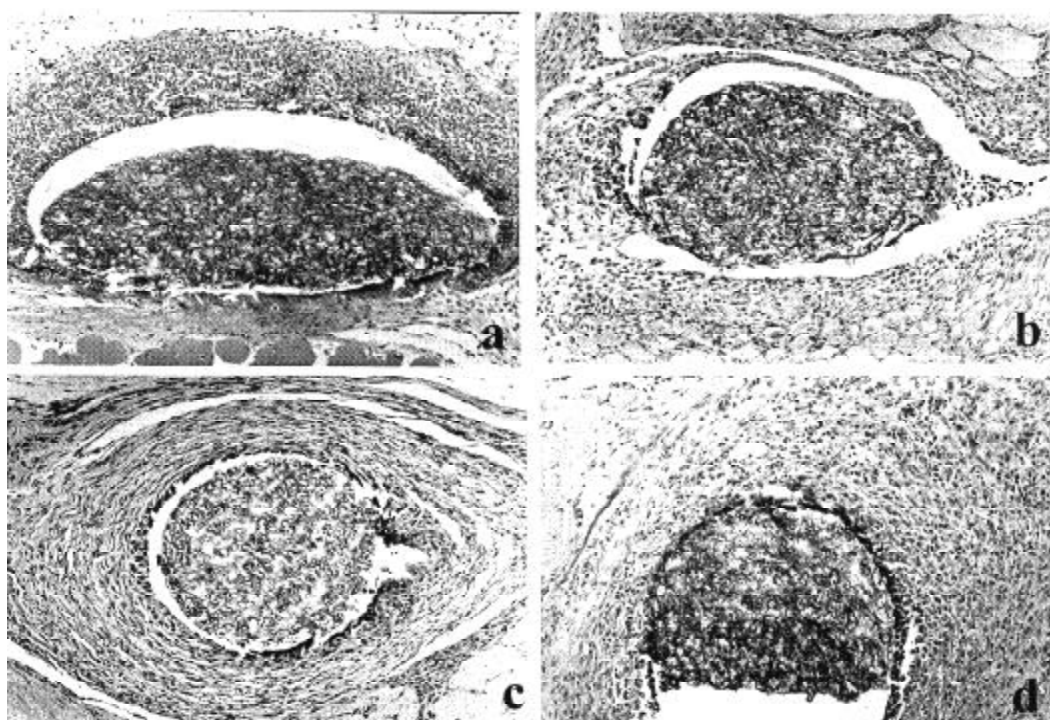


Figure 3. Polytetrafluorethylene. a) 48 h: extensive neutrophilic infiltrate next to the suture; b) 7 days: persistence of inflammatory infiltrate; c) 14 days: small areas of granulation tissue can be noted; d) 21 days: presence of foreign body giant cells and slight organization of the connective tissue surrounding the suture (H&E; original magnification 40X).

also permitted the organization of the fibrous connective tissue around itself at late periods, showing similar behavior as reported by Pavan et al. (4). Polyglecaprone 25 showed biological behavior similar to polyglactin 910. In the first period, 48 h, it was possible to observe a better biocompatibility with a less intense inflammatory reaction, organization of the connective tissue and a few areas of degenerated tissue.

Intense reactions during the initial periods are common features of the materials used in this study. In the first days after the surgery, the influence of trauma has to be considered, favoring a more intense tissue reaction. However, the better behavior of polyglecaprone 25 can be related to its chemical composition, 25%  $\epsilon$ -coprolactone and 75% glycolid, and also to its monofilament characteristic. Physical configuration of the sutures is an important factor, despite the use of deep sutures in the present study, seen by the more aggressive reactions promoted by braided suture (2,10). When it is used in oral mucosa, the possibility of bacterial adhesion to its filaments exists (3).

Polytetrafluorethylene suture is a polymer of carbon chain with fluoride atoms surrounding it, and it has been largely used in orthopedic and vascular surgeries. In oral surgeries, its use was proposed due to the procedure using membranes made from the same material (5). However, in the present study, it clearly presented the worst biological behavior in comparison to the other materials. From the first periods, it showed more aggressive inflammatory reaction, which persisted until the end of the experiment. Neutrophilic infiltrate present in the last period indicates an irritating characteristic of the suture, confirmed by the values of fibroblastic and angioblastic proliferation in comparison to the other sutures. These results differ from those found by Checchi et al. (9) who recommended this suture due to its favorable biological response. The similarity of the physical properties between polytetrafluorethylene and polyglecaprone 25 sutures, both are monofilaments, leads to the conclusion that the biological behavior of the former is due to its chemical composition.

Sutures in oral surgeries are often removed after a period of 7 to 10 days, when the differences among the materials are not as significant. However, under some circumstances, such as dealing with children or non-collaborative patients, sutures are not removed at all. In an attempt to offer a more comfortable post-operative time, especially for these patients, new suture

Table 1. Statistical analysis using the Friedman test from the results of the median and semi-amplitude, comparing the three suture materials and the periods of study.

Variable	Polyglactin 910	Polyglecaprone 25	Polytetrafluorethylene
<b>Fibrosis</b>			
48 hours	1.0 ± 0.5	1.0 ± 1.0	0.0 ± 0.5
7 days	2.0 ± 0.5	2.0 ± 0.5	1.0 ± 1.0*
14 days	3.0 ± 0.0	3.0 ± 1.0	2.0 ± 1.0*
21 days	3.0 ± 0.0	3.0 ± 1.0	1.0 ± 0.5*
<b>Angioblastic proliferation</b>			
48 hours	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
7 days	2.0 ± 0.5	1.0 ± 1.0	0.0 ± 1.0
14 days	2.0 ± 1.0 <sup>b</sup>	0.0 ± 1.0 <sup>a</sup>	1.0 ± 0.0 <sup>ab</sup>
21 days	3.0 ± 0.5 <sup>b</sup>	2.0 ± 1.5 <sup>ab</sup>	1.0 ± 0.5 <sup>a</sup>
<b>Fibroblastic proliferation</b>			
48 hours	0.0 ± 0.5	0.0 ± 0.0	0.0 ± 0.0
7 days	2.0 ± 0.5	2.0 ± 1.0	2.0 ± 1.5
14 days	2.0 ± 0.5	2.0 ± 1.0	3.0 ± 1.0
21 days	4.0 ± 0.0	3.0 ± 1.5	3.0 ± 0.5
<b>Mononuclear inflammatory infiltrate</b>			
48 hours	2.0 ± 1.0 <sup>ab</sup>	1.0 ± 1.0 <sup>a</sup>	2.0 ± 0.5 <sup>b</sup>
7 days	1.0 ± 0.5	1.0 ± 0.5	2.0 ± 0.5
14 days	1.0 ± 0.5	1.0 ± 0.5	1.0 ± 0.5
21 days	1.0 ± 0.5	1.0 ± 0.5	1.0 ± 0.5
<b>Polymorphonuclear inflammatory infiltrate</b>			
48 hours	2.0 ± 1.5 <sup>ab</sup>	1.0 ± 0.5 <sup>a</sup>	3.0 ± 1.0 <sup>b</sup>
7 days	0.0 ± 0.0	0.0 ± 0.5	4.0 ± 1.5*
14 days	0.0 ± 0.5	0.0 ± 0.0	1.0 ± 1.5
21 days	0.0 ± 0.5	0.0 ± 0.0	2.0 ± 0.5*

\*p<0.05 compared to polyglactin 910 and polyglecaprone 25 at same time period. Different superscript letters indicate statistically significant differences at p<0.05 at the same time period.

materials are being produced, giving special attention to absorbable sutures, justifying the necessity of specific studies on their use in dentistry (6,7,12,13).

In this comparative study, polyglecaprone 25 suture material produced the best biological response. In addition to its chemical and physical properties, its indication in oral surgery procedures is recommended.

## RESUMO

Nary Filho H, Matsumoto MA, Batista AC, Lopes LC, de Sampaio Góes FCG, Consolaro A. Estudo comparativo da resposta tecidual aos fios de sutura poliglecaprone 25, poliglactina 910 e politetrafluoretileno em ratos. *Braz Dent J* 2002;13(2):86-91.

Os autores avaliaram a resposta tecidual, em região subcutânea de ratos, frente a fios de sutura: poliglecaprone 25, poliglactina

910 e politetrafluoretileno. Para tanto foram utilizados 20 ratos *Wistar albinus*, onde praticou-se três pontos de sutura em planos profundos na região dorsal, com os diferentes materiais em estudo. Após períodos de 2, 7, 14 e 21 dias, grupos de cinco animais foram sacrificados para obtenção de espécimes que foram processados e corados pela hematoxilina e eosina. Na análise microscópica adotou-se como parâmetros o grau de fibrosamento, o índice de proliferação angioblástica, fibroblástica e a severidade do infiltrado inflamatório presente. Através desta análise pôde-se constatar que o fio de poliglecaprone 25 induziu reação inflamatória menos intensa, seguido pelos fios de poliglactina 910 e politetrafluoretileno, respectivamente. Tais resultados de comportamento biológico devem ser considerados quando da escolha do fio de sutura a ser empregado em cirurgias bucais.

Unitermos: poliglecaprone 25, poliglactina 910, politetrafluoretileno, fio de sutura.

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