SEM investigation of bacteria adhesion on polyglecaprone 25

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Summary

Wound infection after surgery can be addressed to bacteria inoculation into the operation site. Sutures can facilitate bacteria colonization on them. Several suture types are used in the oral cavity. The aim of this clinical study was to compare bacterial adhesion tendencies on silk, polyglycolic acid sutures and polyglecaprone 25 sutures.
Eight patients underwent lower impacted third molar surgery and each flap was closed with these three sutures. Sutures were removed on the 7th day and were fixed with 2% glutaraldehyde in order to be examined with scanning electron microscope. Counts of *cocci*, *rods* and *spirochetts* around the sutures were scored. Adherence of bacteria was lower in polyglecaprone 25 than polyglycolic acid and silk. Silk had the highest bacteria count. Polyglecaprone 25 and polyglycolic acid had low bacteria colonization rate, however, none of them was able to impede bacterial immigration in to the tissue.

Key words: polyglecaprone 25, polyglycolic acid, SEM, bacteria, oral cavity.

Introduction

Postoperative infection continues to be one of the most serious complications of surgery. Several factors, like the presence of infection at the wound area, the use of aseptic technique at the operation site and the host resistance play an important role on the development of wound infection. However, host resistance is directly related to the inflammatory response to a foreign body placed in the tissue. As the suture materials are foreign bodies, they may initiate an inflammatory reaction. Infection resistance of the sutured tissue is closely related with the type of the suture material. The chemical and physical properties of a suture material influence its ability to attract bacteria and consequently promote wound infection [1]. Suture materials can serve as vehicle to transport the bacteria into the surgical wounds. Bacterial adhesion capacity of the suture material has been subjected in many clinical and laboratory studies. In the literature, it is concluded that the infection risk is always higher with multifilament or porous materials than with monofilament materials [2]. On that purpose, several study methods have been designed in laboratory conditions [2-5]. Radiolabelling [3], slot immunoblot assay [4], bacterial incubation and counting and scanning electron microscope (SEM) techniques [2, 5] were used to measure the bacterial colonization rates.

Polyglecaprone 25 (PGC25) is a recently introduced suture material that induces a mild inflammatory reaction, followed by polyglactin 910 and polytetrafluorethylene, respectively [6]. Incisional swelling and inflammatory reactions can be seen with PGC25 [7]. Our purpose was to investigate the cause of inflammatory reaction to PGC25 by evaluation of bacterial colonization on this suture material in the oral cavity. With this aim, the following clinical prospective study was designed.

Material and method

Eight medically healthy patients undergoing impacted mandibular third molar surgery were chosen for the study. Oral hygiene of the patients was not regarded. Each patient was operated for one tooth. All teeth were impacted vertically

Table 1. Mean of the bacteria counts adhered on the suture materials

	Polyglecaprone 25			PGA			Silk		
	Zone I	**Zone II**	**Zone III**	**Zone I**	**Zone II**	**Zone III**	**Zone I**	**Zone II**	**Zone III**
Cocci	5.9	5.6	5.3	10	9	5	256	237.3	200.6
Rods	0	0	0	2.8	2.5	1.6	10	9.6	8.3
Spirochetts	0	0	0	0	0	0	0	0	0

(class I) and had full bony retention. After the surgical removal of the wisdom teeth, each flap was closed with three different suture materials (silk, polyglycolic acid and polyglecaprone 25). All sutures were atraumatic, 3/0 gauge had a 16 mm long 3/8 reverse cutting needle.

All patients used a standard prescription consisting of analgesic (sodium naproxen 2 x 550 mg p.o.); antibiotic (amoxycillin 3 x 500 mg p.o.) and a mouth wash combination (clorhexidine digluconate 0.2% twice a day) for 5 days.

Sutures were removed the 7th day postoperatively and fixed immediately with 3% glutaraldehyde per 0.1 M cacodylate buffer solution for 1 hour. Then they were dehydrated to be examined with SEM technique. Specimens were examined in a scanning electron microscope (JEOL JSM-5410LV) at x 1000 magnification. Three zones were determined on each suture sample for bacteria counting. The first zone was one of the free (open ended) arms of the suture, the second was beneath the knot and the third one was selected at the suture site which layed in the tissue. All zones were scanned for existence of *cocci*, *rods* and *spirochetts*. The types and numbers of bacteria adhered on the suture materials were counted for each zone.

Results

Table 1 summarizes the type and count of bacteria for each zone of all suture types. *Spirochetts* were not observed on any type of suture, while *cocci* was the most frequently detected bacteria type. The lowest adhesion of *cocci* was on PGC25 (mean 5.6 per x 1000 mag.) and PGA (mean 8 per x 1000 mag.) respectively *(Figure 1)*. The highest *cocci* colonization rate (mean 231.3 per x 1000 mag.) was found on silk suture *(Figure 2)*.

Rods were also present on PGA and silk sutures, but not on PGC25. The affinity of *cocci* to silk suture is verified. The number of *rods* was higher in PGA (mean 2.3 per x 1000 mag.) and silk suture (mean 9.3 per x 1000 mag.) than in PGC25 (none).

It is concluded that the amount of adhered bacteria depends on the type of suture material and the type of bacteria.

Discussion

The chemical properties of the suture material have also an important role on bacteria colonization. Sutures made of proteins act as a culture

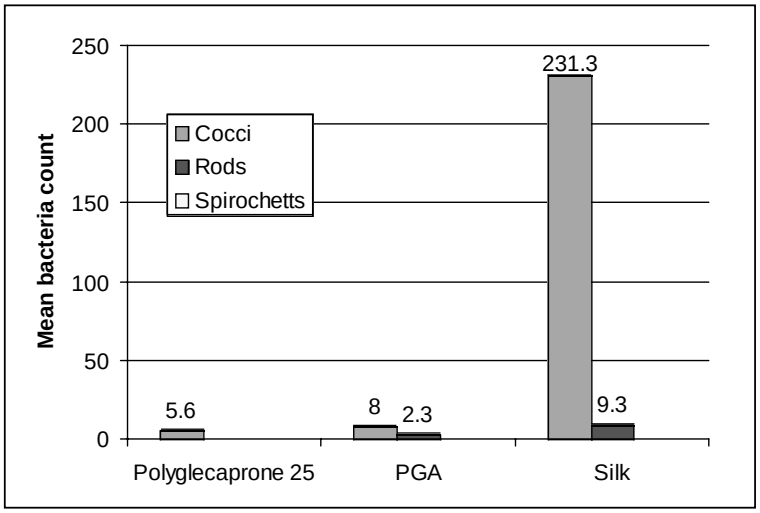

Figure 1. Mean bacteria counts of the three suture types at x 1000 magnification

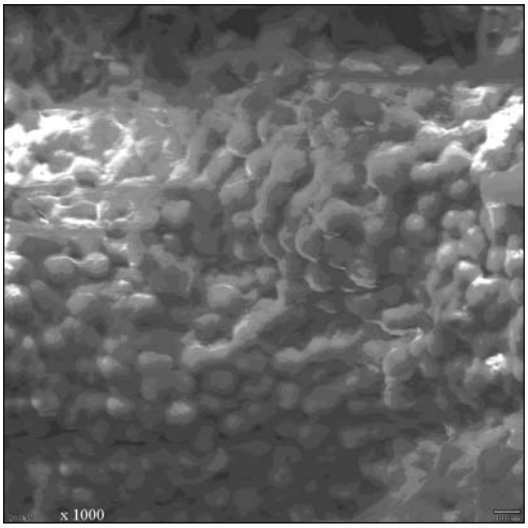

Figure 2. Photomicrograph of silk suture at x 1000 magnification shows the bacteria colonization on it

medium for the bacteria [8] and they lead the infection process into surgery wounds. Silk sutures are one of the most frequently used suture types in oral surgery. It is demonstrated that the number of *Staphylococcus aureus*, which is needed to establish wound infection, could be reduced 10^4 fold by the presence of silk sutures [9]. Thus, the concentration of *Staphylococcus aureus* needed for pus formation was reduced significantly from 10^6 to 10^2 because of the use of silk sutures. It is well documented that, rough surfaces and multifilament structures are more prone to bacteria colonization [3]. Although silk sutures do not cause major tissue reactions, they act as a matrix for debris retention due to their multifilament structure.

In our research, it was shown that silk had the highest bacterial adhesion rate compared to PGA and PGC25. It was also observed that the suture zone under the tissue did show bacterial colonization. *Cocci* and *rods* were evident in all three zones of silk. *Cocci* were the dominant bacteria and adhered in clusters. *Staphylococcus aureus* had a high adherence potential and adhered in clusters too. However, *Escherichia coli* had the highest adhesion rate while *Staphylococcus aureus* had lower adherence ratio on PGA suture samples [3]. In this study, *rods* had a lower colonization rate than *cocci*. No previous study was met in the literature that showed colonization of *spirochetts*. Similarly, in our study, *spirochetts* were not evident in any of the suture types overall.

PGA sutures do not transmit bacteria as readily as silk sutures do [10]. That means PGA inhibits bacterial transmission and this is the major factor in the decreased oral tissue reaction as compared to multifilament non-resorbable sutures. On the contrary, our results showed that comparing to other zones, there was less, but evident, bacteria retention at the zone III of PGA. However, PGA had lower bacterial colonization tendency than silk suture.

There is no available microbiologic study dealing with the bacterial adherence capacity of PGC25 suture. In this SEM study, the least number of bacteria colonization was on PGC25 suture. However, even its low bacteria retention tendency, PGC25 suture presented some bacteria adherence at zone III.

As a summary, we can conclude that *cocci* are dominant microorganisms that are liable to bacteria adherence and colonization on the suture materials. PGC25 suture has a lower bacteria adherence rate than PGA and silk. However, bacteria colonization is not related only with the type of the suture material but also with bacteria immigration from penetration holes of suture. Therefore, further studies are needed to investigate factors affecting the bacteria transmission into the tissue depth.

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