Silicone Implantation into Dental Sockets
—Histological Study in Rats—

by

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Abstract

The use of silicone presents a possible approach in oral surgery. The purpose of this study is to verify, histologically, the dental socket after silicone implantation. Eighty-four albino rats were used and killed from 1 to 40 postoperative days.

It was possible to conclude that silicone does not stimulate an inflammatory reaction nor any changes in the remnants of the periodontal ligament. The implant was incorporated by the dental socket and did not promote a delay in the process of dental socket healing.

Key words: Silicone implants, implants, dental socket, wound healing.

Introduction

At the present time, amongst the most recent alloplasts, “proplast” and “silicone” stand out.

“Proplast” seems to be a good alloplast[1]. One of the few disadvantages of that material is its dark color, due to the presence of carbon, which becomes evident in superficial implants[2]. The potential use of “proplast” in oral surgery[3], however, is inhibited[3].

The silicones are polymers composed of a silicium chain with atoms of oxygen to which inorganic groups are linked. This chemical construction allows the alloplast the rigidity of quartz and the malleability of plastic[4]. They do not contain components against oxidation nor any other additives, as used in plastics and rubbers.

Silicone is considered a non-rigid material, which does not suffer any changes due to time[4].

“Silicone” has a rather wide application in several regions of the body[5,6] and there is interest in its use in the reconstruction of the temporomandibular joint[7], correction of facial defects[1] and the reconstruction of the alveolar ridge covered by flabby gingiva[8].

In contact with this alloplast the oral tissues generally exhibit organization of fibrous connective tissue surrounding the implanted material[9,10,11].

After silicone implantation in edentulous mandibles of dogs, HARRIS[10] observed histologically that after 18 weeks a fibrous capsule surrounded the implanted material and peripheral bone.

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After excessive filling of root canals with silicone in primates Kasman and Goldman[12] have found, histologically, that the material is extremely well tolerated by the periapical tissues. It had been encapsulated by fibrous connective tissue, stimulating an occasional mild inflammatory response.

On the other hand, Sher[11] described the rejection of a silicone implant, due to infection by actinomycetes, 11 months postoperatively which disappeared when the alloplast was removed.

Okamoto et al.[13], however, described a good organic response when the material was implanted in rat subcutaneous tissue. Nevertheless, the implants were able to produce differing reactions, when used in dental sockets, from those encountered in connective tissue from other regions[14].

Therefore, it seems to us that an evaluation of the reactions produced in the dental socket by implantation of silicone, following the methodology previously described[3,15], would be useful. So, the purpose of this work is to study, histologically, the repair of the dental socket in rats after implantation of silicone.

Materials and Methods

Eighty-four male albino rats (Rattus norvegicus, albinus, wistar), weighing between 110/120 g, were selected and maintained on a balanced, solid diet during the whole experiment, except the first 24 postoperative hours when they were allowed water “ad libitum.”

Under general anaesthesia, using sodium pentobarbital, the upper right incisor was extracted with instruments specially adapted for this task by Okamoto and Russo[16].

The animals were divided into two groups: in group I the gingiva was immediately sutured with No. 4-0 polyglycolic acid.

In group II a fragment of silicone, measuring 1 x 1, 5 x 2 mm, was immediately implanted into each dental socket. The material was positioned at the apical third by means of an adapted instrument. The tissues were then sutured in the same manner as for group I.

Six animals from each group were sacrificed by sulfuric ether inhalation, at postoperative periods of 1, 3, 6, 9, 15, 21, and 40 days.

The pieces containing the dental alveolus of the right maxilla were fixed in a 10% formalin solution, decalcified in a formic acid-sodium citrate solution and embedded in paraffin.

The blocks thus obtained were sectioned semiserially at 6 micrometers thick. The sections were stained with hematoxilin and eosin for histological study.

Results

To discern the results, the dental alveolus was divided into thirds, namely cervical, middle and apical, from the free gingiva to the alveolar fundus. The groups are described together and only their differences are emphasized.

In all animals, at 24 hours, the alveolus was filled with a blood clot and remnants of the periodontal ligament, with good vascularization, were observed near the cortical bone. In group II, the material implanted was located between the
Fig. 1  Group I. Newly formed osseous trabeculae at the middle third of the dental socket (arrows). (6 days, Hematoxylin and eosin stain. Original magnification ×63).

Fig. 2  Group II. Implant (I) surrounded by newly formed connective tissue. (6 days, Hematoxylin and eosin stain. Original magnification ×63).
Fig. 3 Group I. Newly formed osseous trabeculae at the middle third of the dental socket. (9 days, Hematoxylin and eosin stain. Original magnification ×63).

Fig. 4 Group II. Implant (I) surrounded by newly formed osseous trabeculae. (9 days, Hematoxylin and eosin stain. Original magnification ×63).
Fig. 5  Group I. Thick osseous trabeculae at the apical third. (15 days, Hematoxylin and eosin stain. Original magnification ×63).

Fig. 6  Group II. Implant (I) surrounded by newly formed osseous trabeculae. (15 days, Hematoxylin and eosin stain. Original magnification ×63).
middle and apical thirds and surrounded by the blood clot. In the apical third of both groups there were some fibroblasts invading the blood clot. The alveolar crest both on the lingual and buccal side was intact. The connective tissue under the gingival epithelium exhibited intense inflammatory exudate.

By the 3rd postoperative day, close to the alveolar fundus and adjacent to the cortical bone, a moderate number of fibroblasts and some capillaries were seen at the middle and apical thirds. In group II, the material was partially surrounded by newly formed connective tissue and in other areas a disorganized blood clot was present. At the cervical third the alveolus was filled up with a blood clot and several histiocites. In some specimens of both groups, at the lingual surface, the alveolar crest was resorbing. The gingival epithelium was discontinuous and some of its cells were infiltrated by a moderate number of polymorphonuclear neutrophils.

By the 6th postoperative day, cellular proliferation with many fibroblasts filled the three thirds of the sockets inclusively, surrounding the implant in group II (Fig. 1). In some instances, at the apical third bone, and sometimes close to the middle third, thin newly formed bone trabeculae were found (Fig. 2). In several cases, the gingival epithelium covered the dental sockets. The underlying connective tissue exhibited a chronic inflammatory reaction. The alveolar crest showed areas of resorption at the lingual surface.

By the 9th postoperative day, in group I, the alveolus showed newly formed osseous trabeculae at the apical and middle thirds, which were thicker and more

Fig. 7 Group II. Implant surrounded by thick osseous trabeculae. (40 days, Hematoxylin and eosin stain. Original magnification ×63).
organized at the alveolar fundus (Fig. 3). In group II, the implant was still located between the middle and apical thirds. It was surrounded by newly formed osseous trabeculae or by connective tissue (Fig. 4). The gingival epithelium covered the socket, but definite characteristics could not be seen in some cases. The alveolar crest presented areas of bone resorption and areas of new bone formation.

On the 15th postoperative day, especially in group I, the whole socket was filled up with newly formed bone trabeculae (Fig. 5). At the apical third, there were thick osseous trabeculae whereas there were thin osseous trabeculae with numerous osteoblasts in their periphery at the cervical third. The implant, encountered in the same position as in the other postoperative periods, was almost totally surrounded by newly formed bone (Fig. 6). The alveolar crest presented areas of bone resorption and of new bone formation. The gingival epithelium was totally regenerated.

By the 21st postoperative day, the alveolus exhibited thick osseous trabeculae and in only two specimens, at the cervical third, the trabeculae were thin but presenting numerous osteoblasts at their borders. The silicone implant was in contact with the newly formed bone. The trabeculae close to the implant, with only one exception, were thicker and well defined. The alveolar crest was remodeled.

On the 40th postoperative day, in group I, the socket was filled up with thick bone. In group II, the implant was totally enclosed by thick osseous trabeculae (Fig. 7).

**Discussion**

As a rule, the materials used in experimental implants may be considered in relation to their porosity, some of them present pores which permit the connective tissue neoformation inside the alloplast. Among those, we can point out the polyvinyl alcohol sponges[17] and polyurethene[18], porous anorganic bone[15] and "proplast"[3].

When those materials are used, the dimensions of the implant become very important. Smaller implants permit the easier development of connective tissue inside the pores. There are some materials inside in which the development of connective tissue is not possible, because the pores are too small. This is the case with silicone.

The results of this experiment corroborate the excellent properties of silicone. The material does not provoke any morphological changes in the process of alveolar healing. Thus on the 21st day, with the exception of the area occupied by the implant, the socket was totally filled up with well developed bone trabeculae.

On the other hand, in the sockets in which the healing was not disturbed, the results are sympathetic to those from Okamoto and Russo[16].

As we know, in the studies dealing with intra-osseous implants, it is very important that the connective tissue neoformation be in close contact with the alloplast[15,19]. This fact seems to be in relation to the irritating properties of the material to the tissue. A greater irritation implies the lesser possibility of cellular and vascular proliferation close to the implant. As a rule, the implants in the dental socket make the organization of the blood clot difficult and irritate, to a greater or
lesser degree, the remaining periodontal membrane[15,18].

The silicone used in this experiment did not delay the organization of the blood clot.

Another outstanding feature was the lack of changes in the remaining periodontal ligament, even when it was in contact with the implanted material. It is probable that the unchanged chronology of the healing process was due to the integrity of that connective tissue, as observed in the initial periods. A similar result was described by SAAD-NETo[3], after implantation of “proplast” into the dental sockets, although that author observed a retardation at the cervical third.

The reactions of the dental alveolus to silicone, however, are distinct from those produced by the implantation of “proplast.” The latter material permits the development of connective tissue within its pores[3], while in the case of silicone the neoformation can be seen only to the limits of the implant. In our work, the newly formed bone was kept almost always in contact with the alloplast, differing from the results described by HARRIS and KASMAN and GOLDMAN[10,12], who observed a fibrous capsule around the implanted material.

An important point was the lack of inflammatory reaction even in the initial periods, when the material was in close contact with the periodontal ligament. In the presence of a foreign body, the retardation on the chronology of the healing process is closely related to the lengthening of the inflammatory phase of that healing process[19].

Another fact, which corroborates the good acceptance of the material, by the organism, was the fact that we did not observe, in any case, resorption of the alveolar cortical bone, even when the silicone was adjacent to this structure.

In other experiments, using a similar methodology but other alloplasts, intense resorption of the alveolar bone was verified, preceded by a pronounced inflammatory reaction[14].

Finally and according to our results, some important features can be synthetized: maintenance of the vitality of the periodontal ligament and lack of inflammatory reaction; connective neoformation in close contact with the implant; lack of resorption of the alveolar cortical bone; total incorporation of the alloplast by the alveolar bone. Although those results suggest the excellence of silicone as an implant, its use in oral surgery would be restricted, especially in relation to the dental socket.

Summary and Conclusions

Silicone implants in dental sockets were analyzed using 84 rats. The animals were killed after 24 hours throughout 40 days and the results, based on histological sections, made it possible to conclude that: the material does not provoke alterations in the remnants of the periodontal ligament; the silicone is incorporated into the dental socket during the healing process; and the chronology of alveolar healing only presents a slight delay.

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