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# Immediate Implants Placed into Infected Sites: A Histomorphometric Study in Dogs

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To study the effect of chronically infected sites on the immediate placement of implants, periapical lesions were induced in the third and fourth premolars of four dogs and the contralateral teeth were used as controls. Nine months after the induction of periapical lesions, experimental and control teeth were extracted, and 28 IMZ implants were immediately placed. After a healing period of 12 weeks, the animals were sacrificed, the hemi-mandibles were removed, and specimens were prepared to be hard-sectioned and stained with toluidine blue. All areas healed without inflammation or exudation and all implants were clinically immobile and were radiographically determined to be surrounded by normal-appearing bone. Histologically, there were no signs of infection, and the histomorphometric analyses revealed that 28.6% and 38.7% had osseointegrated for the experimental and control implants, respectively. The difference was not statistically significant. It was concluded that chronically infected sites, such as those showing signs of periapical pathosis, may not be a contraindication for immediate implants, if certain clinical measures and preoperative and postoperative care are taken.

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**Key words:** immediate implants, implants, IMZ, infected site, osseointegration

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Since the work of Lazzara<sup>1</sup> and others,<sup>2-7</sup> immediate placement of implants has been considered a routine clinical procedure. However, some prerequisites have been established for the indication of immediate implants, such as the extent of bone resorption, the morphology of the defect and whether it will allow placement of the implant at an ideal

angle for an esthetic restoration,<sup>8</sup> and the presence or absence of infection. Some authors<sup>3,9-12</sup> consider the presence of infection, such as periapical pathosis, to be a contraindication for the procedure.

In a recent clinical report, Novaes Jr and Novaes<sup>13</sup> described three patients in whom immediate implants were successfully placed into infected sites. They reported that chronically infected sites may not necessarily be a contraindication for the placement of immediate implants if appropriate clinical procedures are carefully followed.

The objective of this study was to determine histomorphometrically whether chronically infected sites, induced in dogs, would affect the osseointegration of immediate implants.

## Materials and Methods

Four young healthy dogs, weighing 12 to 14 kg, were used in the study in accordance with the Institutional Animal Care and Use Committee.

**Phase I.** The dogs were not fed the night before the procedure. They were anesthetized with an intravenous injection of sodium pentobarbital (30 mg/kg, 500 mg of pentobarbital diluted in 20 mL sodium

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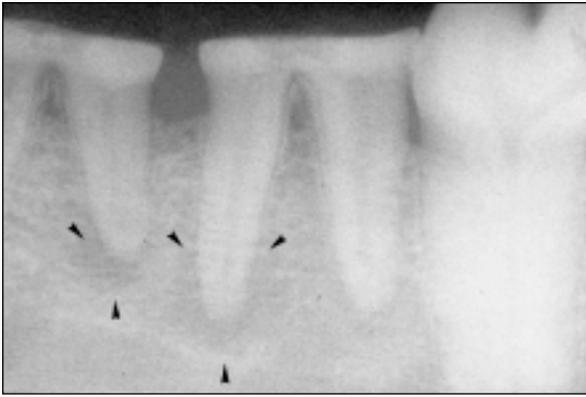
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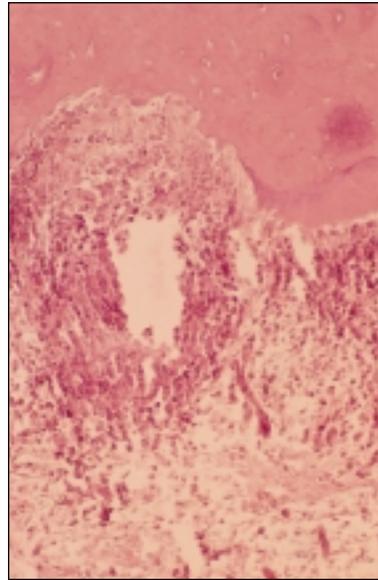
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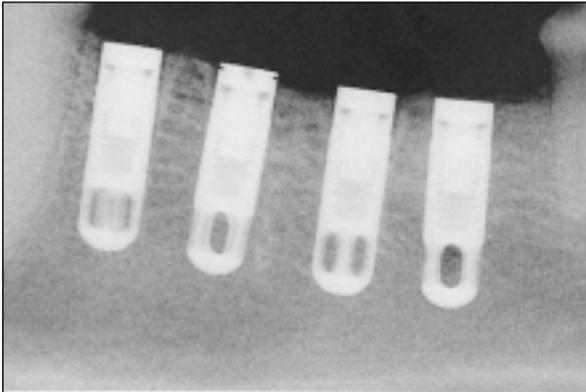
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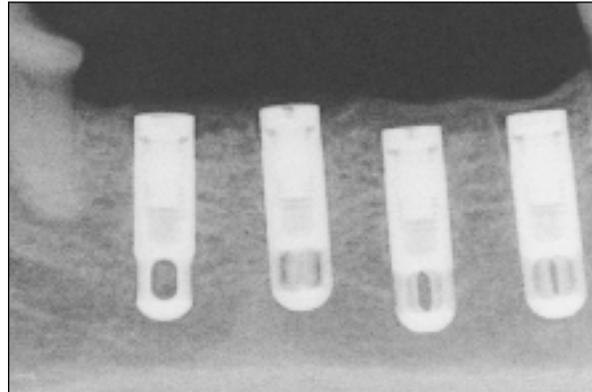
**Fig 1** (Above) Radiograph of experimental side 9 months after root canal instrumentation. Arrows indicate periapical lesions.



**Fig 2** (Right) Apex of extracted root from the experimental side showing areas of root resorption and presence of chronic inflammatory process indicative of periapical pathosis.



**Fig 3** Experimental side 12 weeks after implant placement. Good quality bone around implants and no evidence of radiolucent areas indicating residual infection.



**Fig 4** Control side 12 weeks after implant placement. Note normal-appearing bone around implants.

chloride, resulting in a 25% solution). Bilateral third and fourth mandibular premolars were used, the right side as experimental and the left side as control.

On the experimental side, the crowns of the teeth were cut with burs at the cemento-enamel junction and removed, exposing the roots and root canals. The pulpal tissue was removed, and the roots were gently instrumented with endodontic files without care to avoid contamination of the canals, since the objective of this procedure was to induce periapical lesions. Radiographs were taken every 3 months to evaluate the size of the developing periapical lesions, and only after 9 months were the lesions large enough to proceed to Phase II (Fig 1). The control side underwent no treatment in this phase. The lesions were considered to be infected because of the experiment design

that allowed contamination of the canals for 9 months; the development of periapical lesions, which were visible on the radiographs (Fig 1); the presence of the inflammatory process around the apex of the extracted roots (Fig 2); and the fact that, prior to the surgical procedure, compression of the soft tissues induced purulent exudate to drain through the gingival sulcus and/or the open root canals.

**Phase II.** Nine months after the periapical lesions had been induced in the experimental teeth, the animals were anesthetized in the same manner as described for Phase I. The night before surgery, the animals received an intramuscular injection of 20,000 IU of penicillin and erythromycin (Pentabiótico Veterinário Pequeno Porte, Laboratório Fontoura-White, São Paulo, Brazil) at a dose of 1.0 g/10 kg

body weight. This is a broad-spectrum antibiotic commonly used to treat infections in small animals. Since each dose allows antibiotic coverage for 4 days, another dose was injected 4 days later, providing 8 days in total of antibiotic coverage.

Full-thickness flaps in the area of the third and fourth mandibular premolars were created on the experimental and control sides. The teeth were sectioned in a buccolingual direction at the bifurcation so that the roots could be individually extracted without damaging the bony walls. At the time of extraction, two roots fractured on the control side and were not removed. Following extraction, the alveoli were meticulously debrided and rinsed with a 50 mg/mL solution of tetracycline hydrochloride. IMZ implants (Interpore International, Irvine, CA),  $3.3 \times 10$  mm and slightly larger than the extracted roots, were placed immediately after debridement and rinsing. Fifteen implants were placed on the right side (experimental), and only 13 were placed on the left side (control) since the two roots that fractured were not extracted. (Currently, placement of implants slightly larger than the extracted roots is also possible in humans because of the availability of wide-diameter and wide-tapered implants.) The implants were placed according to the manufacturer's instructions, and flaps were sutured over them to achieve complete coverage. The animals were kept in separate cages and on a soft diet until the sutures were removed 10 days later. They were sacrificed after 12 weeks with an overdose of pentobarbital.

Hemimandibles were dissected, radiographed, (Figs 3 and 4), and fixed in a 4% solution of phosphate-buffered formalin (pH 7.0) for 48 hours and then transferred to a solution of 70% ethanol until processing. The specimens were dehydrated in ascending concentrations of alcohol up to 100%, infiltrated and embedded in resin (Technovit 7200 VLC; Kulzer, Werheim, Germany), hard-sectioned using the technique described by Donath and Breuner,<sup>14</sup> and stained with toluidine blue.

The roots removed from the experimental side were fixed in 10% formalin, processed for histology, and stained with hematoxylin and eosin to ascertain the presence of the periapical inflammatory process.

**Histomorphometric Analysis.** One longitudinal histologic section from each implant was evaluated using an optic microscope (Carl Zeiss, Oberkochen/Wurett, Germany) with a magnification  $\times 250$ . The image selected in the microscope was captured by a video camera and transferred to a Targa Plus plaque connected to a computer with morphometry software (Vidas 21 v2.1, Kontron Electronic, Munich, Germany) through which the sections were ana-

lyzed. With this system, the percentage of implant-bone contact, which was determined from the middle one third of the implants, was considered as percentage of osseointegration. The analysis was performed by a single investigator (GMV Jr), who had no knowledge of which were experimental or control sections.

**Statistical Analysis.** The results were analyzed through the confidence interval at the 95% level and using Student's *t* test.

## Results

**Clinical and Radiographic Findings.** Healing progressed uneventfully during the 12-week postoperative period, without evidence of significant inflammation or exudation on either the experimental or the control sides.

At the time of sacrifice, clinical inspection revealed that all implants were clinically immobile and had no signs of infection. Radiographs taken just before sacrifice showed normal-appearing bone, both around the 15 experimental implants, which showed no evidence of the preexisting periapical lesions (Fig 3), as well as around the 13 control implants (Fig 4).

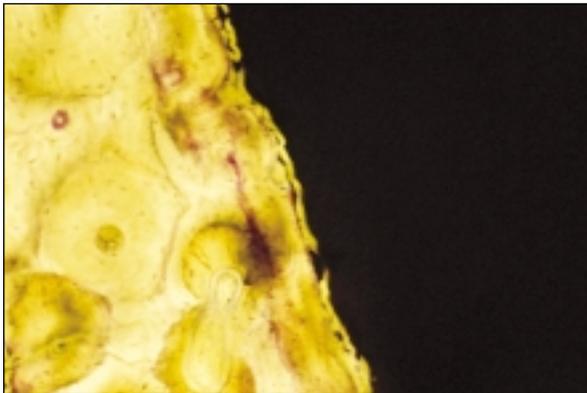
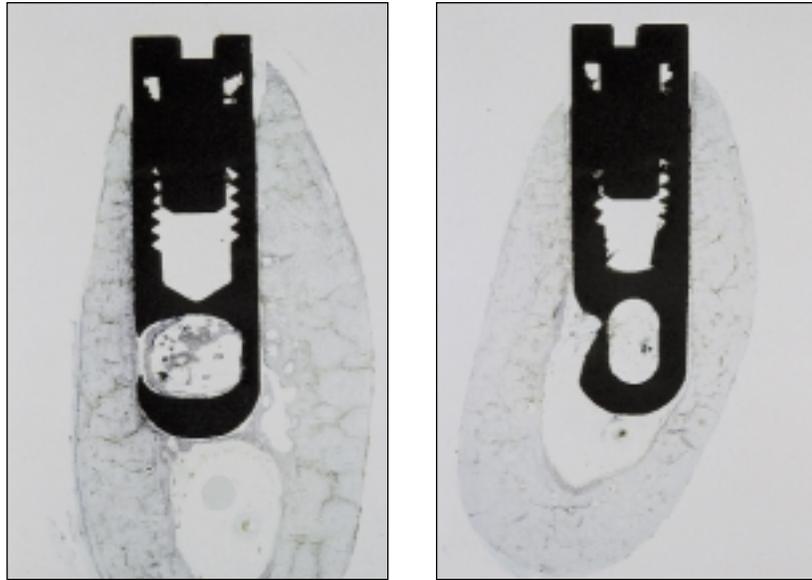
**Histologic and Histomorphometric Findings.** Histologic processing of the roots extracted from the experimental side confirmed the presence of a chronic inflammatory process around the apex of the roots, along with areas of root resorption (Fig 2). One of the initial 15 experimental implants was also excluded because an oblique section of the block was obtained, and it was therefore not possible to perform the histomorphometry. All remaining implants were included in the study. Histologic analysis showed implants placed in predominantly medullary bone with tissues well healed around them (Figs 5 and 6) and no evidence of the chronic infection on the experimental sides.

Histomorphometric measurement around titanium plasma-sprayed implants was found to be somewhat more difficult than around smooth surface implants performed by the authors in other studies, because the plasma spray was separated from the body of the implants in some areas (Fig 7). In areas where this phenomenon did not occur, measurement was easier (Fig 8).

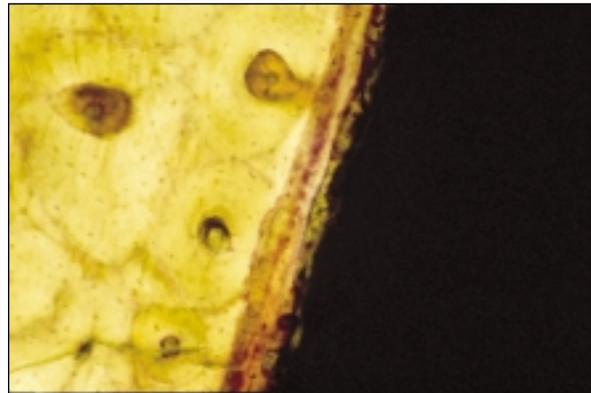
The mean percentage of direct bone-implant contact around the midportion of the 14 experimental implants was  $28.6 \pm 24.8\%$ , with a range of 2.5 to 100%; the mean percentage of bone-implant contact around the 12 control implants was  $38.7 \pm 25.5\%$ , with a range of 3.9 to 91.2%. The difference was not statistically significant ( $t = 1.01$ ;  $P > .05$ ) (Table 1).

**Fig 5** (Left) Low-power photomicrograph (magnification  $\times 4$ ) of implant 12 weeks after placement. Note highly medullary bone but normal tissues around implant.

**Fig 6** (Right) Low-power photomicrograph ( $\times 4$ ) of implant in the control side 12 weeks after placement.



**Fig 7** High-power photomicrograph ( $\times 80$ ) showing direct bone-implant contact and presence of portions of the plasma spray separated from the body of the implant.



**Fig 8** High-power photomicrograph ( $\times 80$ ) showing area of osseointegration; compact bone-implant interface highlights the Haversian system in the compact bone.

## Discussion

Although the issue of immediate implant placement in infected sites has not itself been studied, some authors<sup>3,9-12,15</sup> consider it a contraindication for the procedure. This investigation had the objective of studying this issue in dogs, following the induction of periapical lesions in the mandibular third and fourth premolars, using the contralateral teeth as controls.

After a 12-week healing period following implant placement, the results showed that healing occurred uneventfully; all implants, control and experimental, were clinically immobile at the time of sacrifice, and there was no significant inflammation or exudation. Radiographically, all implants were surrounded by

normal-appearing bone, and they showed no signs of the preexisting radiolucent lesions on the experimental sides.

For the histomorphometric analysis, the middle one third of the implant was used, as suggested by Evans et al,<sup>16</sup> for several reasons: to avoid misinterpreting loss of crestal bone and epithelial down-growth adjacent to the polished collar of implants, commonly seen in dogs as reported by Block et al,<sup>17</sup> Gammage et al,<sup>18</sup> and Weber et al<sup>19</sup>; to avoid the apical one third because of the vent present in the apical region of the implant; and because the implants approximated or slightly penetrated the superior wall of the inferior alveolar canal. However, the main interest in the middle one third was because it corresponded to the area where the periapical lesions had

**Table 1** Percentage of Bone-Implant Contact at Experimental and Control Sites

Implants	Bone-implant contact (%)	
	Experimental	Control
1	2.7	56.7
2	13.9	91.2
3	28.3	41.2
4	28.5	62.2
5	40.1	3.9
6	29.5	12.6
7	2.5	20.0
8	16.3	45.4
9	21.2	5.6
10	5.2	35.9
11	44.3	50.7
12	100.0	39.0
13	26.1	—
14	42.4	—
Mean	28.7	38.7
SD	24.8	25.5

Difference between control and experimental = 10.1% (38.7 to 28.7). 95% confidence interval for difference: -10.4 to 30.5;  $t = 1.016$  with 24 degrees of freedom;  $P = .320$ .

been. As can be seen in the preoperative radiographs (Fig 1), the lesions were several millimeters above the superior wall of the inferior alveolar canal.

The percentages of osseointegration in this study were 38.7% for the control implants and 28.6% for the experimental implants, a difference that was not statistically significant. Our findings are lower than the 47.9% reported by Ettinger et al,<sup>20</sup> which can be explained in part by the fact that the implants in this study were placed in highly medullary bone, a finding only observed during the histologic evaluation of the sections. Furthermore, three experimental and two control implants (Table 1) had very low percentages of osseointegration (less than 6.0%), far below the average seen for the remaining implants. If one were to exclude these implants from the analysis, the results would be comparable. The small percentages of osseointegration for these five implants could perhaps be explained, as pointed out by Ettinger et al,<sup>20</sup> by the quality of bone at those sites, by the remodeling process going on at that time, and by the use of a single longitudinal section for analysis. The commonly used single longitudinal section has limitations, since different specimens from the same implant may reveal higher percentages of osseointegration because the implant-bone interface is a dynamic three-dimensional entity.<sup>20</sup>

According to the objectives of this study, the presence of chronically infected sites did not compromise healing and osseointegration of the immediately placed implants. Residual infection was not detected (1) clinically—both sides healed well without signifi-

cant inflammation and without exudation; (2) radiographically—all implants had good quality bone around them without radiolucent areas that could indicate the presence of residual lesions; or (3) histologically, which was most important.

## Summary

The results of this study support the clinical findings in humans reported previously<sup>13</sup> and permit the conclusion that chronically infected sites, such as those showing the presence of periapical pathosis, may not be a contraindication for immediate implants if appropriate antibiotics are administered preoperatively and postoperatively, and if meticulous cleansing and debridement of the alveoli are performed before implant placement, as described previously.<sup>13</sup>

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