Journal of Clinical Periodontology
Official Journal of The European Federation of Periodontology
Founded by the British, Dutch, French, German, Scandinavian, and Swiss Societies of Periodontology

J Clin Periodontol 2008; 35: 640–648 doi: 10.1111/j.1600-051X.2008.01237.x

Journal of Clinical Periodontology

Ridge alterations following immediate implant placement in the dog: flap *versus* flapless surgery

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Blanco J, Nuñez V, Aracil L, Muñoz F, Ramos I. Ridge alterations following immediate implant placement in the dog: flap versus *flapless surgery. J Clin Periodontol 2008; 35: 640–648. doi: 10.1111/j.1600-051X.2008.01237.x.*

Abstract

Objective: To assess the healing process after flap or flapless surgery in immediate implant placement.

Material and Methods: This study was carried out on five Beagle dogs. Four implants were placed in the lower jaw in each dog immediately after tooth extraction. Flap surgery was performed before the extraction on one side (control), and flapless on the contrary (test). After 3 months of healing, the dogs were sacrificed and prepared for histological analysis.

Results: Ten implants were placed in each group. Two failed (one of each group). The percentage of bone–implant contact was very similar in both groups: 64.8% and 65.1% for the flap and the flapless group, respectively. The difference between the mean distance from the peri-implant mucosa margin to the first bone–implant contact at the buccal aspect was statistically significant between both groups (3.02 mm. flapless and 3.69 mm. flap group). The mean first bone–implant contact at the buccal aspect was located in relation to the sand-blasted and acid-etched level at 0.82 mm for the flapless group and 1.33 mm for the flap group. This difference was not statistically significant.

Conclusion: Flapless immediate implant surgery produces a significant reduction in the vestibular biologic width and a minor reduction in buccal bone plate resorption.

Key words: bone resorption; flapless surgery; immediate implants

Accepted for publication 28 February 2008

There are multiple causes of tooth loss, creating a wound, whose healing process has been monitored in biopsies sampled from extraction sites in humans (Boyne 1966, Amler 1969, Evian et al. 1982) as well as in experimental animals (Huebsch & Hansen 1969, Kuboki et al. 1988, Lin et al. 1994, Cardaropoli et al. 2003). In a recent animal model study, Cardaropoli et al. (2003) assessed the healing events occurring in the socket following tooth extraction. The findings of this study demonstrated that the healing of an extraction socket involved a series of events including the formation of a coagulum that was replaced by a provisional connective tissue matrix, woven bone and lamellar bone and bone marrow. On day 30, mineralized bone occupied 88% of the socket volume. Hard tissue formation had started already after 2 weeks of healing, and then, after a month, the socket was filled with woven bone. Later, the woven bone was gradually replaced by lamellar bone and bone marrow. After 3 months of healing, a hard tissue bridge was consistently found to cover the marginal portion of the extraction site, which was formed by woven bone and lamellar bone.

It has to be pointed out that none of these studies mentioned bone alterations (resorption and atrophy) that occur in the outer part of the socket.

It has been shown that after removing all teeth in humans, the alveolar bone undergoes a process of resorption and atrophy (Atwood 1957, Hedegard 1962, Tallgren 1972), varying considerably between different individuals (Atwood 1962, Carlsson & Persson 1967, Tallgren

Conflict of interest and source of funding statement

The authors declare that they have no conflict of interests.

This study was partially supported by Straumann Iberian (Straumann, Madrid, Spain).

1972). Clinical and radiographic studies (Johnson 1963, 1969, Pietrokovski & Massler 1967, Lekovic et al. 1997, 1998, Camargo et al. 2000, Schropp et al. 2003) have shown important reductions in the height and width of the alveolar crest following tooth extraction (single or multiple). The resorption of the buccal bone plate is seemingly more significant than that of the lingual/palatal bone plate. Pietrokovski & Massler (1967) studied the amount of tissue lost following single tooth extractions using plaster models. The authors concluded that there was a significant resorption in the buccal bone plates in both the upper and the lower jawbones with respect to the palatal/lingual plate, displasing the crest towards the latter. However, this resorption seems to be more pronounced during the initial phase of healing than in the later stages. Johnson (1969) indicates that the majority of crest size alterations (horizontal and vertical) occurred during the first months of healing. Schropp et al. (2003) evaluated the changes produced in hard and soft tissue after 46 individual extractions (molar and premolar) at 3, 6 and 12 months of healing, concluding that approximately two-thirds of this reduction occurred in the first 3 months following extraction. Araújo & Lindhe (2005) analysed the size changes produced in the alveolus following tooth extraction, concluding that the resorption of the buccal and lingual walls was produced in two overlapping phases:

- Phase 1. The bundle bone that lost its function was resorbed and replaced with woven bone. Vertical resorption was considerably greater in the crest of the buccal bone plate because this is formed entirely by bundle bone.
- Phase 2. Resorption that occurred from the outer surfaces of both bone walls (buccal and lingual). The reason for this additional resorption has not been clearly ascertained. The hypothesis could be: imparing vascularization by raising a flap; adjusting to the lack of continuous function; or reestablishing of the shape the genetically determined crest in the absence of teeth.

This process of resorption and bone collapse, both vertically and horizontally, could have negative consequences from a prosthetic and an aesthetic point of view or, in more advanced cases, could make it impossible to place dental implants without bone regeneration (grafts, guided bone regeneration, etc.). In order to avoid this clinical situation different authors describe several surgical techniques: regenerative techniques for socket preservation (Lekovic et al. 1997, 1998) or immediate implant placement (Denissen et al. 1993, Watzek et al. 1995).

Since the first report of the placement of a dental implant into a fresh extraction socket (Schultze et al. 1978), there has been increasing interest in this technique for implant treatment. Some authors have listed the advantages of this procedure: reduction in the number of surgical procedures and in the treatment time required (Lazzara 1989, Parel & Triplett 1990), ideal orientation of the implant (Werbitt & Goldberg 1992, Schultz 1993), bone preservation at the area of extraction (Shanaman 1992, Denissen et al. 1993, Watzek et al. 1995) and optimal soft tissue aesthetics (Werbitt & Goldberg 1992). However, most of the previously cited advantages have not been tested in experimental models or controlled trials.

Paolantonio et al. (2001) stated that early placement of an implant may preserve alveolar anatomy, and that the placement of a fixture in a fresh extraction may help to maintain the alveolar bone structure. However, the results from other studies (Botticelli et al. 2004, Araújo et al. 2005) failed to prove this hypothesis. Araújo et al. (2005) showed, in a recent experimental model in the beagle dog, that placement of immediate implants does not prevent post-extraction alveolar bone resorption. However, it must be pointed out that surgery (dental extraction, placement of immediate implants) in these studies was always carried out with vestibular and lingual flap elevation. In this context, we must emphasize that this surgical trauma (flap elevation), implying the separation of the periostium and its disconnection from the underlying bone surface, will cause vascular damage and an acute inflammatory response, which in turn will mediate the resorption of the exposed bone surface (Wilderman 1963, Staffileno et al. 1966, Wood et al. 1972, Bragger et al. 1988). This could partly explain the size changes produced in the alveolar process after tooth extraction with or without immediate implant placement in those experimental models.

For this reason, the aim of the present experiment was to perform a comparative histomorphometric study to assess wound healing (alveolar bone loss) after implant placement in fresh extraction sockets, between flap or flapless surgery in an animal model (Beagle dog).

Material and Methods

Once approval from the Ethics Committee of the University of Santiago had been given, this research was carried out using five Beagle dogs. They were provided by the Faculty of Veterinary Studies at the University of Cordoba, and were installed in the Animal Experimentation Service facility at the Veterinary Teaching Hospital Rof Codina of Lugo. The animals were maintained in individual kennels in a 12:12 light/dark cycle (lights on at 07:00 hours) and $22 \pm 2^{\circ}$C, with regular chow and tap water. All experiments were performed according to the Spanish Government Guide and the European Community Guide for animal care.

This project was carried out using:

- Five neutered female Beagle dogs, of adult age (mean age 1.91 years) and with a mean weight of 14.2 kg. Each of the dogs was identified through a number of chips located subcutaneously, which were read using a chip reader.
- Twenty endosseous implants (Straumann®; standard implant; 3.3 mm in diameter and 8 mm long; Straumann® Dental Implant System; Straumann, Waldenburg, Suitzerland). Four implants were placed per dog (two in each of the lower quadrants).
- Material for the installation of the implants according to the guidelines provided by the manufacturer (Straumann® Dental Implant System).

Surgical procedure

The surgical procedure was performed under general anaesthesia. The anaesthetic protocol was as follows: firstly, the dogs were premedicated with acepromazine (0.05 mg/kg/i.m.) and the pain was controlled with the administration of morphine (0.3 mg/kg/i.v.). The dogs were then given propofol (2 mg/kg) and during surgery they were maintained on a concentration of 2.5–4% of isoflurane.

The dogs were monitored throughout the anaesthetic process. The parameters measured were cardiac frequency, respiratory frequency, oxygen saturation, expired carbon dioxide (capnography) and arterial pressure.

Study groups

The experimental surgery was carried out on the third and the fourth premolar in each quadrant of the lower jaw. Surgery was characterized by the elevation of a mucoperiosteal flap before the extraction of the premolars in one of the quadrants. On the opposing side, the same surgery was performed but without raising a flap. The quadrant in which the flap was elevated was alternated in the different dogs; therefore, flapless surgery was performed in the right mandibular quadrant of dogs 1, 3 and 5, while the left quadrant underwent flap surgery. Whereas, in dogs 2 and 4, the flap was elevated in the right quadrant before extraction, in the left one flapless surgery was performed.

This produced two split-mouth groups: a flap group (10 control implants) and a flapless group (10 test implants).

Surgery

In the control group, a continuous intrasulcular incision was made from the distal root of the second premolar to the mesial part of the first molar, on both vestibular and lingual sides. Following this, elevation of the flap was performed with the help of a periosteal elevator, and a full-thickness flap was raised to the muco-gingival junction.

Both premolars were carefully removed, separating the roots by means of tooth hemisectioning with the use of a fissure bur and extracting them individually with elevators and forceps. After the extraction, immediate implants were placed into the socket of the distal roots. Four implants were placed in each dog (two in each lower quadrant) according to the manufacturer's protocol (Straumann® Dental Implant System). The implants were placed so that the marginal level of the sand-blasted and acid-etched (SLA) – coated surface was flush with the buccal bone crest. In order to achieve this in the flapless group, bone sounding was performed immediately before implant installation and keeping in mind that the smooth surface of the implant has a height of 2.8 mm. Finally, healing abutments were inserted in both groups aiming at a non-surmeged healing (Figs. 1 and 2).

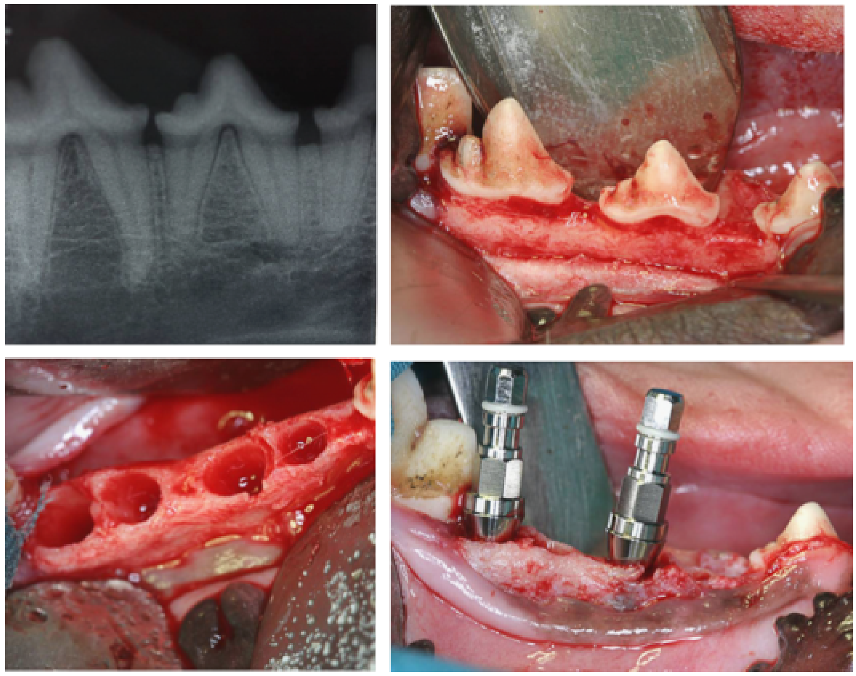

Fig. 1. Immediate implant placement in fresh extraction sockets with flap surgery.

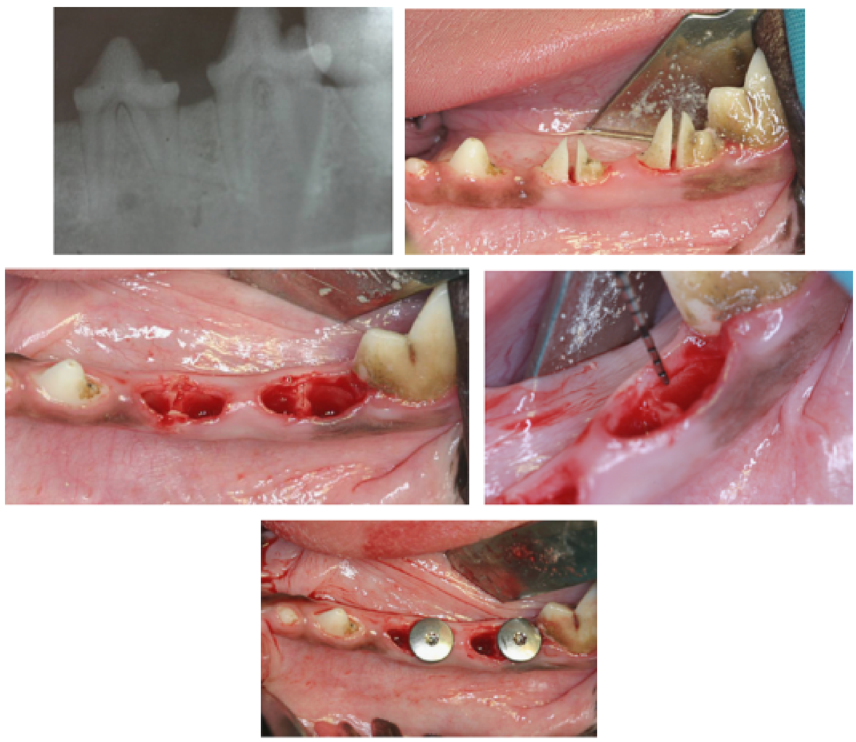

Fig. 2. Immediate implant placement in fresh extraction sockets with flapless surgery.

In the group with an access flap, the flap was secured with interrupted sutures (4-0 Vicryl).

Antibiotic prophylaxis was administrated to the dogs during the first week after surgery with amoxicillin (22 mg/kg/b.i.d./p.o.). The dogs' diet throughout the trial period was granulated dog feed.

The animals were enrolled in a plaque-control programme consisting in cleaning the teeth and the implants three times a week with a brush and toothpaste.

The healing period was 3 months in order to be able to obtain the best results from the neoformation and bone remodelling process.

Sacrifice of the dogs

The dogs were sacrificed by means of an anaesthetic overdose with an intravenous injection of sodium pentobarbital. Subsequently, the lower jaws were dissected whole. Once removed, the lower jaws were sectioned along the mid line, thus creating two semi-mandibles per dog. These were placed in 10% formalin for fixation.

Histological preparation of the samples

The four implants were separated from each mandible using a diamond saw (Exact 300CL® Apparatebeau, Nordestedt, Hamburg, Germany). The biopsies were processed for ground sectioning in conformity with the Donath method (1993). The samples were dehydrated and infiltrated with resin (Technovit 7200®, VLC-Heraus Kulzer GMBH, Werheim, Alemania). Finally, the samples were sectioned in a bucco-lingual direction using the grinding technique (Exact 400CS® Apparatebeau, Hamburg, Germany) up to approximately 20 μ using the Levai Laczko staining method.

The samples on the permanent ports were observed using the Olympus® SZX9 microscope (Tokyo, Japan). By means of the Olympus® DP12 digital camera (Tokyo, Japan), the images were captured and transferred to the computer. With the Microimage® program, the points of interest were identified from the digital histological images in order to subsequently measure the distances, which were expressed in millimetres. The researcher carrying out the measurements was blind with respect to the group to which each sample belonged.

A line was traced along the digital image parallel to the implants' longitudinal axis. The following marks were then made on both the vestibular and the lingual side of each implant (Fig. 3):

- S: implant shoulder.
- SLA: marginal border of the SLA-coated surface that was located 2.8 mm apical of S.
- PM: peri-implant mucosal margin.
- BC: first contact point of the bone with the implant.
- aBE: apical end of the barrier epithelium.

From each of the points, a perpendicular line was traced towards a parallel line along the implants longitudinal axis and the following measures (expressed in millimetres) were taken:

- PM–BC: Distance from the peri-implant mucosal margin to the bone crest.
- PM–S: Distance from the peri-implant mucosal margin to the implant shoulder, or rather mucosal recession, measured in millimetres.
- PM–aBE: Distance from the peri-implant margin to the apical end of the epithelial attachment, or rather the length in millimeters of the junctional epithelium.
- aBE–BC: Distance from the apical end of the barrier epithelium to the first bone implant contact, or rather the length in mm. of the connective tissue of the peri-implant mucosa.
- S–BC: Distance from the implant shoulder to the first bone implant contact, that is, the bone resorption in millimetres.

Moreover, in each of the implants, the percentage of bone-to-implant contact was measured from the implant shoulder. To carry out this measurement on the digital image, the entire surface of the implant was scanned from the shoulder. This was calculated dividing the length of the implant surrounded by bone by the total length of the implant, with the resulting value multiplied by 100. This figure indicates the implant's level of integration with the surrounding bone.

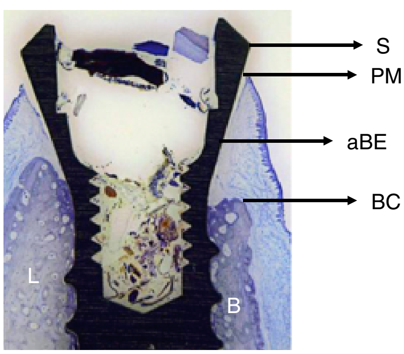

Fig. 3. Implant marks for the histomorphometric measurements. S, shoulder of the implante; PM, peri-implant mucosal margin; aBE, apical barrier epithelium; BC, bone crest.

Statistical analysis

The statistical analysis was performed using the Sigma-Stat® statistics program.

Descriptive statistics were taken for each of the variables and groups (mean values and standard deviation).

To compare the two groups in each variable, the Student t-test for paired observations was used.

We have used the dog as the unit for analysis ($n = 5$), using average results across similarly treated implants in the same dog, and then performed comparisons. p-values <0.05 were considered to be statistically significant.

Results

Clinical observations

Out of the 20 implants installed, two were lost – one from each group: the first before the 3-month healing period probably due to poor primary stability achieved in the surgery (1L42: 1, dog number 1; L, left side; 4, premolar 4; 2, distal root. Control group), and the second was present at the point of sacrifice, although it showed mobility (2L42: 2, dog number 2; L, left side; 4, premolar 4; 2, distal root. Experimental group). The histology later confirmed the presence of fibro-osseointegration (Fig. 4). The remaining implants healed without alterations or complications. In none of the implants was the SLA surface exposed.

The mean socket diameter was 3.9 mm mesial-distal (3P3: 3.7 mm/

Fig. 4. Failed implant. Fiber-osseointegrated.

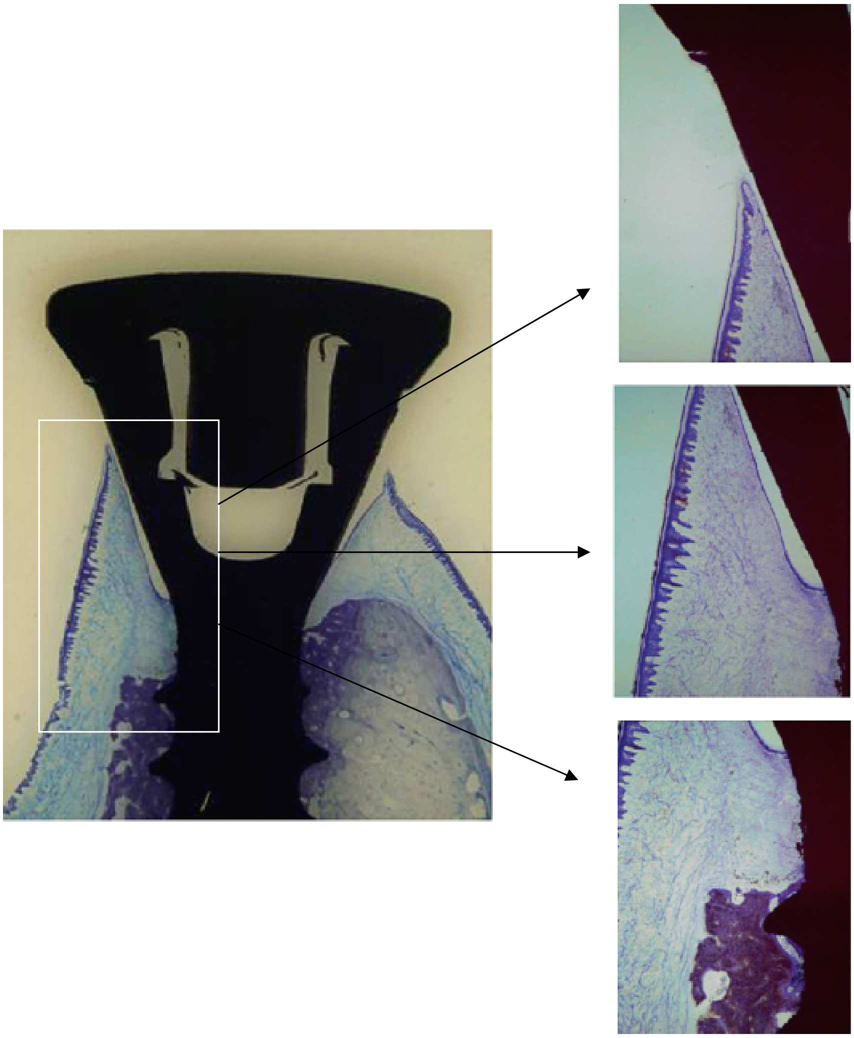

Fig. 5. Histological image of the oral keratinized epithelium, barrier epithelium and connective tissue ''attached'' to the implant of the peri-implant mucosa.

4P4: 4.1 mm) and 3.6 mm vestibular-lingual (3P3: 3.4 mm/4P4: 3.9 mm).

Histological observations

The histological study showed that the buccal and lingual mucosa in each implant of both groups was covered by a keratinized oral epithelium that continued with the sulcus lining epithelium, and this in turn with an epithelial attachment connecting to the implant. Apical to this epithelium was an area of fibre-rich connective tissue, which apparently maintained strong contact with the implant (''attached-connective tissue'') (Fig. 5).

The central and external parts of the buccal and lingual bone plates were made up of lamellar bone characterized by a large density of secondary osteons. The bone immediately lateral to the implant seemed less mature than the external bone and was separated from it by evident separation lines (reversal lines) (Fig. 6).

Histomorphometric results (Table 1)

Percentage of bone-to-implant contact

The percentage of bone-to-implant contact was very similar in both groups. The mean was 64.81% for the flap group, and 65.19% for the flapless group. No statistically significant differences were recorded.

Distance between peri-implant mucosa margin (PM) – apical end of the barrier epithelium (aBE) (length of the junctional epithelium).

In the flapless group the mean distance was 2.54 mm at the buccal aspect and 2.11 mm at the lingual aspect. In the flap group, the results were very similar: 2.59 mm at the buccal aspect and 2.07 mm lingual aspect, with no significant differences observed between the groups.

Distance between aBE – bone crest (BC) (length of the connective tissue)

In the flapless group, this was 0.68 mm at the buccal and 0.54 mm at the lingual aspect, and in the flap group 1.09 mm at the buccal and 0.91 mm at the lingual aspect, with no significant differences between groups.

Distance between PM–BC (biological width)

In the flapless group, this was 3.02 mm at the buccal and 2.75 mm at the lingual aspect. In the flap group, this was 3.69 mm at the buccal and 2.99 mm at the lingual aspect. In this case, the buccal difference (3.02/3.69) was statistically significant between both groups.

Distance between implant shoulder (S) – BC

In the flapless group, this was 3.62 mm (buccal) and 3.17 mm (lingual). In the flap group this was 4.13 mm (buccal) and 3.13 mm (lingual). This implies that in the flapless group, on the buccal aspect, the bone crest was located 0.8 mm apical to the SLA surface, and 0.37 mm on the lingual aspect. However, in the flap group, this distance was 1.33 mm on the buccal and 0.33 mm on the lingual aspect. This means there was a greater vestibular bone resorption in the flap group; nevertheless, this difference between both groups was not statistically significant.

Distance from the implant shoulder (S) to the peri-implant mucosa margin (PM) (mucosal recession)

Both groups showed minimal recession, with no significant differences between groups. The flapless group showed averages of 0.60 mm buccal and 0.42 mm lingual. In the flap group, these were 0.67 and 0.13 mm, respectively.

Table 1 shows a summary of all the histomorphometric results, the most notable being the existing differences between both groups with respect to the distances from the peri-implant mucosa margin to the bone crest and

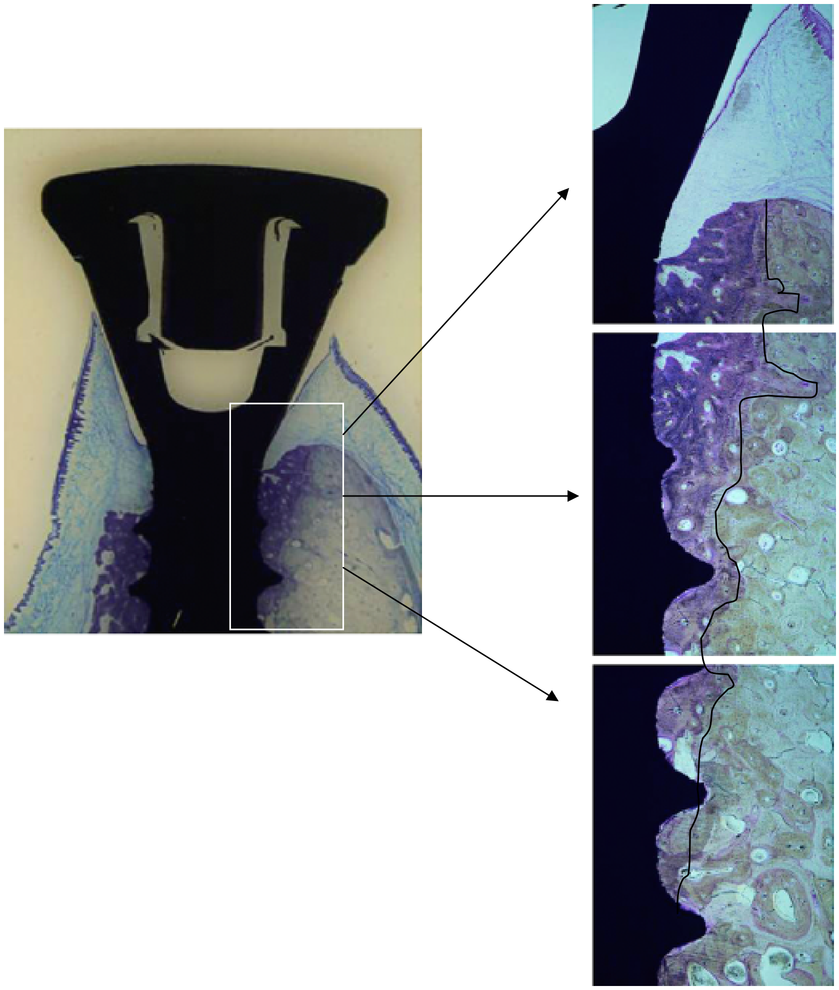

Fig. 6. Histological image of the osseointegration and the differentiation between the old (brown colour) and new bone (blue colour). Black line indicates the separation between the two types of bone (reversal line).

Table 1. Results of the histomorphometric measurements

	PM–aBE		aBE–BC	
	buccal	lingual	buccal	lingual
Flap	2.59 (0.71)	2.07 (0.63)	1.09 (0.32)	0.91 (0.50)
Flapless	2.54 (0.53)	2.11 (0.38)	0.68 (0.39)	0.54 (0.35)
	PM–BC		S–BC	
	buccal	lingual	buccal	lingual
Flap	3.69 (0.57) $p = 0.008$	2.99 (0.79)	4.13 (0.77)	3.13 (0.75)
Flapless	3.02 (0.61)	2.75 (0.58)	3.62 (0.28)	3.17 (0.37)
	%BIC	S–PM		
Flap	64.81 (7.67)	0.67 (0.55)		0.13 (0.64)
Flapless	65.19 (7.90)	0.60 (0.35)		0.42 (0.26)

Data are expressed as mean (SD).

PM, peri-implant mucosal margin; aBE, apical barrier epithelium; BC, bone crest; S, shoulder of the implant; % BIC, bone implant contact percentage.

from the implant shoulder to the bone crest.

Discussion

Although classifications that define the timing for implant placement in relation to dental extraction have been published in the past, the latest one (Hammerle et al. 2004) divides the timing into the following:

- Type 1: implant placement immediately following tooth extraction and as part of the same surgical procedure.
- Type 2: complete soft tissue coverage of the socket. 4–8 weeks after extraction.
- Type 3: substantial clinical and/or radiographic bone fill of the socket. 12–16 weeks after extraction.
- Type 4: healed site. More than 16 weeks after extraction.

Studies referring to the survival rate of type 1 immediate implants show very similar results to implants placed in healed bone, using both submerged (Yukna 1991, Gelb 1993, Becker et al. 1994, Watzek et al. 1995, Rosenquist & Grenthe 1996) and non-submerged techniques (Lang et al. 1994, Bragger et al. 1996, Gomez-Roman et al. 2001), although there are no sufficient data on the results regarding aesthetics (height of the papilla, recession of the gingival margin, etc.) and on the influence of the immediate placement of implants in bone preservation/resorption. For this reason, the main objective of our study was to analyse and compare, using histomorphometric techniques, any possible impact arising from applying this treatment (type 1 immediate implants, not submerged) with flap and flapless surgery, in terms of gingival recession and, moreover, bone resorption.

Different authors describe bone resorption as a consequence of post-extraction alveolus healing, having a greater impact during the initial periods (Atwood 1957, Hedegard 1962, Johnson 1963, 1969, Carlsson & Persson 1967, Pietrokovski & Massler 1967, Tallgren 1972, Lekovic et al. 1997, 1998, Camargo et al. 2000, Schropp et al. 2003). However, some clinical (Shanaman 1992, Denissen et al. 1993, Watzek et al. 1995, Paolantonio et al. 2001) and histological (Paolantonio et al. 2001) studies defend the use of immediate implants to preserve the bone crest and thus obtain better aesthetic results. Nonetheless, there are other authors who confirm that despite the use of immediate implants, resorption still occurs (Botticelli et al. 2004).

A number of recently published studies carried out on animals proved firstly that after dental extraction, both healing and maturation of the alveolus occurred, but with size changes both internally and externally after 3 months of healing (Cardaropoli et al. 2003, Araújo & Lindhe 2005), and, secondly, it was proved that despite placing immediate implants resorption was produced, 2.6 mm in the vestibular bone plate and 0.2 mm in the lingual aspect (difference of 2.4 mm) (Araújo et al. 2005). This suggests that the immediate placement of implants would not preserve the crest, and could imply and aesthetic risk due to its loss of height when placing implants using this technique in the upper-front group (Araújo et al. 2005, 2006b). In our study, we showed that remodelling after extraction was also more pronounced in the vestibular plate than that in the lingual aspect. However, in the cases we treated with flap surgery, the average bone resorption obtained in the vestibular plate was 1.33 and 0.33 mm in the lingual (1 mm difference) and in the flapless group 0.82 mm for the buccal and 0.37 mm for the lingual aspect (0.45 mm difference). This difference from the Araújo study (difference of 2.4 mm) may be partly due to the size of the implant used. In our case, we used a 3.3 mm diameter implant, taking into account that the average vestibular-lingual diameter of the alveolus was 3.6 mm (3.9 mm for premolar 4 and 3.4 mm for premolar 3), whereas in the Araújo study a 4.1 mm diameter implant was used, the alveolus vestibular-lingual diameter being 3.5 mm for premolar 3 and 3.9 mm for premolar 4; that is to say, the diameter of the implant was greater than the alveolus itself, possibly causing an initial bone loss. This could explain the increased loss in comparison with our study. In addition, in an other study (Araújo et al. 2006a) where the healing process of immediate implant installation in premolar (reduced alveolar diameter) and molar (larger alveolar diameter) sites in the Beagle dog was compared, less bone resorption has been obtained in the molar areas. Therefore the authors stated that the thinner a bone wall, and the closer the implant is placed to this wall, the higher the risk of compromised healing and occurrence of bone dehiscence.

On the other hand, it has been proved that the use of a mucoperiosteal flap for periodontal surgery will produce a loss of bone height, due to the acute inflammation produced during wound healing (Wilderman 1963, Staffileno et al. 1966, Wood et al. 1972, Bragger et al. 1988). This could also partly influence the results from studies by Araújo & Lindhe (2005) and Araújo et al. (2005, 2006a, b). Also, in Araújo et al. (2005), the histological examination of the control sites demonstrated that untreated teeth (not included in the surgical field) were associated with a normal periodontium, and all involved teeth sites (included in the surgical field) exhibited signs of attachment loss. The results of our study confirm this fact. However, the difference between the flap and the flapless group in terms of bone resorption (1.33 mm/0.82 mm) was not statistically significant ($p = 0.08$).

This difference in bone resorption did not infer a difference in soft tissue recession (peri-implant mucosa margin), where the results were 0.60 mm in the flapless group and 0.67 mm in the flap group, thus significantly increasing the difference in distance between the peri-implant mucosa margin and the bone crest (biological width) in the flap group. We must take into account that the study lasted only 3 months, which may represent an insufficient time to establish differences in soft tissues, because the study by Kan et al. (2005) showed an average gingival recession of 1 mm 1 year after loading.

The main observation from our study was, therefore, that we could obtain some advantageous results in the procedure for immediate implant surgery at the same time of extraction, if we placed the implants in the confines of the alveolus and probably with flapless surgery, as has already been pointed out in the classical periodontal literature. However, we have to be aware and cautious while carrying out this kind of surgery because it only explains a minor reduction of the large bone loss that several authors have already reported after tooth extraction. Moreover, we have to take into account that this is a 3-month healing study after immediate implant installation in an animal model, and we donot really know whether the modelling (resorption) of the buccal/lingual plates has finished at that time, as occurs in the studies by Araújo (2006a, b), where the bone-to-implant contact that was stablized during the early phase (4 weeks) of socket healing following implant installation was in part lost when the buccal wall underwent continued resorption (12 weeks). Therefore, more histological and clinical research will be necessary to confirm or reject this hypothesis.

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Clinical Relevance

Scientific rationale for the study: There is an increasing interest in immediate implant placement, but from a biological point of view there are some aspects (flap/flapless, bone resorption, etc.) that need to be clarified before recommending such a technique in daily practice. We present the results of an experimental study in the Beagle dog, where we have compared immediate implant placement conducted with flap or flapless surgery.

Principal findings: Flapless immediate implant surgery produces a significant reduction of the vestibular biologic width, and a minor reduction in buccal bone plate resorption.

Practical implications: This is a study in an animal model and the implants placed (diameter 3.3 mm) were well within the confines of the extraction socket (alveolus). In such a way, immediate implant placement conducted with flapless surgery produces a significant reduction of the vestibular biologic width and a minor reduction in the buccal bone plate.