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NATURAL OR PALATAL POSITIONING OF IMMEDIATE POST-EXTRACTION IMPLANTS IN THE AESTHETIC ZONE? FIVE-YEAR OUTCOMES OF A MULTICENTRE RANDOMISED CONTROLLED TRIAL

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PURPOSE. To evaluate whether there is a difference in aesthetic outcomes when positioning immediate post-extractive implants in the "central" position (where the natural tooth would be in relation to adjacent teeth/implants) as opposed to roughly 3 mm more palatally.

MATERIALS AND METHODS. Just after tooth extraction, 20 patients requiring one single immediate maxillary post-extraction implant, from second premolar to second premolar, were randomly allocated to receive one implant positioned in either the natural "central" position (central group; 10 patients), or about 3 mm more palatally (palatal group; 10 patients) according to a parallel-group design at two different centres. When needed, sites were reconstructed, and bone-to-implant gaps were filled with granules of anorganic bovine bone and covered by resorbable collagen barriers. Implants were left submerged for 4 months and rehabilitated with provisional crowns, replaced after 4 months by definitive metal-ceramic crowns. Patients were followed up to 5 years after loading. Outcome measures were: crown and implant failures; complications; aesthetics, assessed using the pink aesthetic score (PES); peri-implant marginal bone level changes; and patient satisfaction, recorded by blinded assessors.

RESULTS. Three patients from each group dropped out within 3 years after loading. Five years after loading, there were no significant differences between the two groups in median PES score, assessed by a blind assessor, (central: 10 [IQR: 5.5], palatal: 8.5 [IQR: 6.75], median difference = -1.0; 95% CI: -7.0 to 4.0; P = 0.571); median bone level (central: 0.45 mm [IQR: 1.76], palatal: 0.45 mm [IQR: 1.93], median difference = 0 mm; 95% CI: -1.7 to 3.0; P = 1.000); bone level changes (central: 0.15 mm [IQR: 0.70], palatal: -0.05 mm [IQR: 1.23], median difference = -0.20 mm; P = 0.471); implant failures (one in each group, 14%, difference in proportion = 0.00; 95% CI: -0.39 to 0.39; P = 1.000); or complications (two palatal group patients and one central group patient, difference in proportion = 0.14; 95% CI: -0.28 to 0.52; P = 1.000). Furthermore, patients from both groups were equally satisfied with both function and aesthetics (both P = 0.699).

CONCLUSIONS. These preliminary results suggest that positioning of immediate post-extraction implants 3 mm more palatally may not, in fact, improve aesthetics; however, the sample size of the present study was very limited, and larger trials are therefore required to confirm or refute these findings.

CONFLICT OF INTEREST STATEMENT. Mozo-Grau, Valladolid, Spain, the manufacturer of the implants used in this investigation, donated the implants and partially supported this trial; however data belonged to the authors and the sponsor by no means interfered with the conduct of the trial or the publication of its results.

INTRODUCTION

Immediate post-extraction implants, i.e. those placed in fresh sockets immediately after tooth extraction, have gained popularity over the years. Indeed, they shorten treatment duration, since patients do not have to wait for soft tissue healing (2 to 6 weeks) or bone healing (4 to 6 months), although they might be at higher risk of complications and failures[1].

Of particular interest for both clinicians and patients is the aesthetic aspect. Despite several randomised controlled trials (RCTs) having evaluating aesthetics at post-extraction implants compared to delayed implant placement[2-12], the matter of which procedure would be preferable is still unresolved, since contradictory findings were reported by different groups. However, some evidence does exists to suggest that grafting at immediate post-extraction sites may improve the aesthetic outcome[13,14], whereas the use of large diameter implants at immediate post-extraction sites is to be avoided because of the poorer aesthetic outcome[15,16]. Another aspect that has often been presented in courses and conferences over the last decade is the idea that immediate post-extraction implants should be placed in a slightly more palatal position than the ideal centre of the socket in order to obtain an improved aesthetic outcome at these sites. This suggestion, based on clinical observations and experience, has become a general rule, even though nobody has really attempted to evaluate whether this procedure actually confers the desired aesthetic improvement, which would be useful to know.

Hence, the aim of this multicentre RCT was to compare the aesthetics of single immediate post-extraction maxillary implants placed in a slightly palatal position *versus* implants placed in the position central to where the natural tooth would be. At the protocol stage, it was decided to follow the patients up to 5 years after loading. The present article reports the outcomes 5 years after loading according to the CONSORT statement for improving the quality of reports of randomised parallel-group trials (http://www.consort-statement.org/). This follows previous articles reporting the data at 1 year after loading by three centres[17] and the data from two centres only at 3 years after loading[18](18), since one centre abandoned the study in the interim. This report describes the 5-year follow-up of the same sample as presented in the latter[18].

MATERIALS AND METHODS

Trial design

The study was designed as a multicentre randomised controlled trial of parallel-group design. All outcomes were assessed blind, with the exception of complications, which were dealt by the treating dentists. Aesthetics and peri-implant bone levels were evaluated centrally by a single assessor.

Patient selection

Any patient requiring at least one single immediate post-extraction implant in the maxilla from second premolar to second premolar between two natural or crowned teeth or implants who was at least 18 years old and able to sign an informed consent form was eligible for inclusion. There was also to be sufficient bone to allow the placement of one single implant at least 10 mm long with a 3.3 mm diameter. Exclusion criteria were:

- General contraindications to implant surgery;
- Immunosuppression or immunocompromised;
- Irradiation to the head or neck area;
- Uncontrolled diabetes;
- Pregnancy or lactation;

- Untreated periodontitis;
- Poor oral hygiene and motivation;
- Substance abuse;
- Psychiatric disorders or unrealistic expectations;
- Acute infection (abscess) or suppuration at the site scheduled for implant placement;
- Previous or ongoing treatment with intravenous aminobisphosphonates;
- Inability to commit to 5-year post-loading follow-up;
- Referral for implant placement alone (i.e., the patient could not be followed-up at the study centre);
- Participation in other clinical trials that would interfere with the present protocol.

Future implant sites were categorised by the treating dentists into two groups: as having i) a thick biotype or ii) a thin biotype. Patients were further divided into three groups based on the number of cigarettes they declared smoking per day:

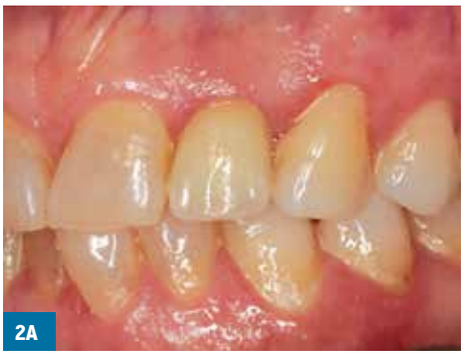
- non-smokers;
- moderate smokers (up to 10 cigarettes per day);
- heavy smokers (more than 10 cigarettes per day).

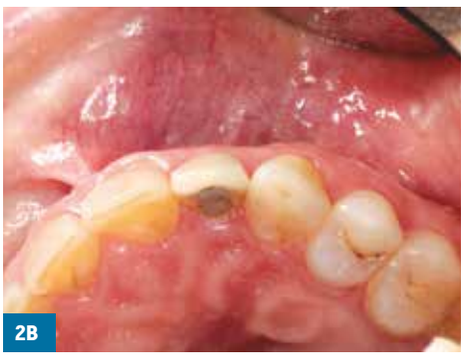
Patients were recruited and treated by two different dentists using similar standardised procedures: Peñarrocha (P) in a university clinic and Fernández (F) in private practices. Each clinician/centre treated 10 patients (5 in each group). All patients received thorough explanation, were invited to ask any related questions, and signed an informed written consent form prior to enrolment in the trial to show that they had understood and agreed to the clinical procedures. After tooth extraction, patients were randomised according to a parallel-group design to receive one post-extractive implant placed either in the natural 'central' position where the tooth should have been (**FIGS. 1A-C**) or about 3 mm more palatally (**FIGS. 2A-C**).

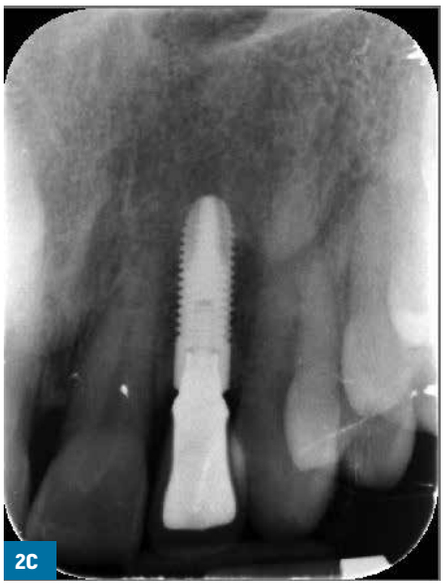
Clinical procedures

Patients received a single dose of prophylactic antibiotic 1 hour prior to the intervention, namely 2 g of amoxicillin or 600 mg of clindamycin if allergic to penicillin. Patients rinsed with chlorhexidine mouthwash 0.2% for 1 minute prior to the intervention. Patients were treated under local anaesthesia using articaine with adrenaline 1:100.000. After crestal incision and flap elevation, teeth were extracted, seeking to minimise trauma and preserve the buccal alveolar bone. Sockets were carefully cleaned of any residual granulation tissue. The widest

FIGS. 1A-C: *Clinical (A, B) and radiographic (C) views 5 years of an implant in position 22 after loading in a representative patient randomised to the central position group, treated by Dr. Peñarrocha.*







FIGS. 2A-C: *Clinical (A, B) and radiographic (C) views of an implant in position 22 5 years after loading in a representative patient randomised to the palatal position group, treated by Dr. Peñarrocha.*

diameter of the extraction socket was measured in mm, rounded to the nearest half mm, using a graduated periodontal probe. Sockets were divided into:

- "'well preserved'", when the buccal plate was intact;
- "'partially preserved'", when up to 4 mm of buccal bone was missing;
- "'poorly preserved'", when more than 4 mm of buccal bone was missing.

The height of the buccal bone was assessed using the highest peak of the palatal wall as a reference point. If the investigator judged that no implant could be placed, the patient was excluded from the randomisation procedure and the study. The thickness of the buccal wall was measured at the middle portion of the crest, 1 mm below the crest, using a calliper, and measurements were rounded to the nearest half mm. At this point the patient was finally included in the study, and the sequentially numbered sealed envelope corresponding to the patient recruitment number was opened to ascertain whether to place the implant in a natural position in the centre of the fresh socket or about 3 mm more palatally.

Drills with increasing diameters (2.0, 3.0, and when needed 3.3, 3.8 and 4.3 mm) were used to prepare the implant site as suggested by the manufacturer. Ticare Inhex cylindrical implants (Mozo-Grau, Valladolid, Spain) with internal connection and RBM (Resorbable Blast Media) titanium surface were placed subcrestally about 1 to 2 mm below the most coronal bone peak. Operators were free to choose implant lengths (10, 11.5, 13 and 15 mm) and diameters (3.3, 3.75, 4.25 and 5 mm) according to clinical indications and their preference. The implant insertion torque was measured with the motor set at 25 Ncm, and reported as either greater than 25 Ncm or up to 25 Ncm. Once the implant had been placed, baseline periapical radiographs and clinical photographs were taken, the greatest distance (gap) between the bony wall and the neck of the implant was measured using a periodontal probe and rounded to the closest half mm, and the largest defect location (buccal, palatal mesial or distal) was recorded. Operators

reconstructed all poorly preserved sockets and partially preserved sockets and filled the gaps in well preserved sockets with granules of anorganic bovine bone (Bio-Oss, Geistlich Pharma AG, Wolhusen, Switzerland). In the presence of insufficient buccal bone to achieve ideal aesthetics, the area was also buccally augmented with the same bone substitute. The grafted areas were then covered with a resorbable collagen membrane derived from bovine tendon fibres (MG-Reguarde; Mozo-Grau), which was trimmed and adapted to cover the entire socket and at least 2 mm of the surrounding crestal bone. Flaps were sutured, but the wound was to be left partially open if complete soft tissue coverage was unduly difficult to achieve. Implants were left to heal submerged for 4 months.

Ibuprofen 400 mg was prescribed to be taken 2 to 4 times a day during meals as long as required. Patients were instructed to use 0.2% chlorhexidine mouthwash for one minute twice a day for 2 weeks, and to avoid brushing and possible trauma to the surgical sites. Postoperative antibiotics were prescribed, namely amoxicillin 1 g thrice a day for 7 days, or clindamycin 300 mg thrice a day for 7 days in patients allergic to penicillin. After 1 week, patients were examined and sutures were removed. Patients were checked again after 1 month.

After 4 months of submerged healing, implants were exposed using an 'H' incision, making the incision slightly palatal in order to obtain more keratinised tissue on the buccal side. Implants were manually tested for stability; temporary abutments were placed, and provisional acrylic resin crowns were cemented on the same day. Periapical radiographs of the study implants were taken. If the marginal bone levels were not readable, the radiograph was to be retaken. Oral hygiene instructions were delivered. Three months after initial loading, implants were manually tested for stability by local blinded assessors, who tightened the abutments with a 20 Ncm torque using a dynamometrical manual wrench able to deliver a variable tightening torque from 10 to 35 Ncm. Definitive impressions with pick-up impression copings were made using a polyether material. Within the following month, the stability of the implants was tested again. Definitive metal-ceramic crowns were provisionally cemented on Titanium Hex or angled preparable abutments (Mozo-Grau), and the occlusion was checked. Periapical radiographs of the study implants were taken. Patient satisfaction was evaluated, and oral hygiene instructions were reinforced.

Patients attended a maintenance programme with recalls at least every 6 months for the entire duration of the study. At 1 year after the initial follow-up, if the vestibular profile was judged to be deficient, a connective tissue graft was to be harvested from the palate and placed in a pouch, made with a horizontal incision 2 to 3 mm from the implant sulcus without releasing incisions, to make the tissues thicker.

Outcome measures

This study tested the null hypothesis that there would be no differences in clinical outcomes between the two procedures against the alternative hypothesis of a difference.

Outcome measures were the following.

- Aesthetic evaluation of the vestibular and occlusal clinical images including the two adjacent teeth taken 1, 3 and 5 years after loading: performed on a computer screen using the pink aesthetic score (PES)[19]. In brief, seven variables were evaluated: mesial papilla, distal papilla, soft tissue level, soft tissue contour, alveolar process deficiencies, and soft tissue colour and texture. A 0-1-2 scoring system was used, 0 being the lowest and 2 being the highest value, with a maximum achievable score of 14 per implant.
- Implant/crown failures: implant mobility, removal of stable implants dictated by progressive marginal bone loss or infection, and any mechanical complications rendering the implant unusable (e.g., implant fracture) were considered implant failures. If a definitive

crown had to be replaced for any reason, it was counted as a crown failure. Stability of individual implants was measured at initial loading and delivery of definitive crowns, applying a torque of 20 Ncm with a dedicated wrench. Implant stability was re-assessed 1, 3 and 5 years after loading by rocking the crown with the metal handles of two dental instruments.

- Any biological or biomechanical complications: examples of biological complications were fistulae, peri-implant mucositis and peri-implantitis; examples of biomechanical complications were loosening or fracture of the abutment screws.
- Peri-implant marginal bone level changes: evaluated on periapical radiographs taken using the paralleling technique at implant placement before grafting, initial loading, delivery of definitive crowns, and 1, 3 and 5 years after loading. In the event of an unreadable radiograph, a second radiograph was to be obtained. Radiographs were scanned into TIFF format with 600-dpi resolution, and stored on a personal computer. Peri-implant marginal bone levels were measured using DFW2.8 software for Windows (Soredex, Tuusula, Finland). The software was calibrated for each single image using the known implant length or diameter. Measurements of the mesial and distal bone crest level adjacent to each implant were made to the nearest 0.01 mm. Reference points for the linear measurements were the coronal margin of the implant collar and the most coronal point of visible bone-to-implant contact. The measurements at mesial and distal sides of each implant were averaged at the implant level and then at the group level.
- Patient satisfaction: 1, 3 and 5 years after loading, the local blind outcome assessors provided a mirror to the patients, and asked them to express their opinions of their implant-supported crown. Specifically, the patients were asked: "are you satisfied with the function of your implant-supported tooth?"; possible answers were: "yes absolutely", "yes, partially", "not sure", "not really", or "absolutely not". They were then asked: "are you satisfied with the aesthetic outcome of the gums surrounding this implant?"; possible answers were: "yes absolutely", "yes, partially", "not sure", "not really", or "absolutely not". Finally, patients were asked whether they would undergo the same treatment again. Possible answers were: "yes" or "no". The questions were always posed using the same wording.

At each centre there was one local blind outcome assessor who recorded implant stability and patient satisfaction. One blinded dentist (Dr. Xhanari) not involved in the treatment of the patients evaluated aesthetics and marginal bone levels centrally, without knowing group allocation. Therefore, the outcome assessors were blind. Patients were not informed regarding their group allocation.

Statistical analysis

No sample size calculation was performed. Initially, 13 centres agreed to participate in this trial; each centre had to recruit 10 patients to be equally allocated to both interventions, and 130 patients were therefore to be included. Thirteen computer generated restricted randomisation lists were created. Only one investigator (Dr. Esposito), who was not involved in the selection and treatment of the patients, knew the random sequence and had access to the random list, stored on a password-protected laptop. The random codes were enclosed in sequentially numbered, identical, opaque, sealed envelopes. After tooth extraction and quantification of the amount of buccal bone loss, the patient was finally enrolled in the study, and the corresponding envelope was opened sequentially. Therefore, treatment allocation was concealed to the investigators in charge of enrolling and treating the patients.

All data analysis was performed according to a pre-established analysis plan by a clinician with expertise in statistics (Dr. Buti), who analysed the data without being aware of the group codes. The patient was the statistical unit of the analyses. Differences in the proportion of patients with implant failures and complications (dichotomous outcomes) were compared between groups using Fisher's exact probability test. The Mann-Whitney U-test was used to compare the medians of the two groups both for ordinal outcomes (PES and patient satisfaction) and continuous (but not normally distributed) outcomes (bone level and bone level changes). Wilcoxon's signed-rank test was used to detect statistically significant changes in bone levels between baseline/loading and different time points. The Hodges–Lehmann estimator was used to estimate the difference and 95% CIs. It was decided not to compare outcomes from the two centres due to the limited number of patients remaining in the study. All statistical comparisons were conducted at the 0.05 level of significance.

RESULTS

During initial monitoring, it was noticed that most of the centres were not recruiting, and nine centres withdrew without having treated a single case. Another centre did not manage to fulfil the agreed quota of patients, and apparently managed to recruit and treat seven out of 10 patients; however, clinical records (data, radiographs and photographs) were grossly incomplete, and were therefore not considered of any use to this study. Finally, one of the three centres that provided the one-year data[17] discontinued follow-up after 2 years and was unable to supply 3- and 5-year post-loading data.

At the two remaining centres (P and F), a total of twenty patients were screened and consecutively enrolled in the trial. All patients were treated according to the allocated interventions. Three patients dropped out from each group. Two patients, both belonging to the palatal group, dropped out from P's centre after delivery of the definitive crowns: one patient moved to the north of Spain and was unwilling to come back for the follow-up evaluations, and the other patient became unreachable. The other four patients who dropped out were from F's centre, all after 1-year post-loading follow-up: one patient from the palatal group did not respond to phone calls, and of the three patients from the central position group, one moved to another town, one changed dentist and one did not respond to phone calls.

The following radiographs and pictures from F's centre were missing or unreadable:

- nine baseline periapical radiographs at implant placement;
- nine baseline periapical radiographs at implant loading;
- seven periapical radiographs at delivery of definitive crowns;
- four periapical radiographs at 1 year after loading;
- one vestibular and occlusal picture of the same patient at the 3 years after loading.

The main deviations from the protocol were that none of the centres followed the pre-established randomisation procedure precisely; all said that they randomly allocated treatment, but did not adhere to the planned association between patient recruitment number and the number on the random code envelopes. Furthermore, P's centre delivered one definitive crown without a provisional to one patient from the palatal group who experienced one post-operative complication; the patient was tired of attending the practice and the aesthetic demands were not very high.

Patients were recruited and received the post-extraction implants from January 2012 to October 2014. The follow-up of all remaining patients was up to 5 years after implant loading. Patient demographics are presented in **TABLE 1**. There were no apparent significant baseline imbalances between the two groups.

TABLE 1 PATIENT AND INTERVENTION CHARACTERISTICS

	Central [n = 10] (%)	Palatal [n = 10] (%)
Females	5 (50%)	8 (80%)
Males	5 (50%)	2 (20%)
Mean age at implant insertion (range)	50.8 (23 to 70)	51.3 (41 to 65)
Thin biotype	4 (40%)	5 (50%)
Thick biotype	6 (60%)	5 (50%)
Non-smokers	7 (70%)	6 (60%)
Smoking up to 10 cigarettes/day	2 (20%)	1 (10%)
Smoking more than 10 cigarettes/day	1 (10%)	3 (30%)
Socket diameter in mm [SD]	6.6 [1.2]	5.6 [1.7]
Buccal bone thickness in mm [SD]	1.6 [1.1]	1.1 [1.0]
Well preserved sites	8 (80%)	4 (40%)
Partially preserved sites (less than 4 mm buccal bone height loss)	1 (10%)	3 (30%)
Poorly preserved sites (more than 4 mm buccal bone height loss)	1 (10%)	3 (30%)
Implants in the central incisor position	3 (30%)	1 (10%)
Implants in the lateral incisor position	2 (20%)	4 (40%)
Implants in the canine position	0 (0%)	0 (0%)
Implants in the first premolar position	3 (30%)	3 (30%)
Implants in the second premolar position	2 (20%)	2 (20%)
Implants with diameter 3.75 mm	6 (60%)	6 (60%)
Implants with diameter 4.25 mm	4 (40%)	4 (40%)
Implants of length 11.5 mm	4 (40%)	2 (20%)
Implants of length 13 mm	6 (60%)	7 (70%)
Implants of length 15 mm	0 (0%)	1 (10%)
Mean implant length in mm [SD]	12.4 [0.8]	12.9 [1.0]
Insertion torque up to 25 Ncm	7 (70%)	5 (50%)
Mean widest horizontal implant to bone gap in mm [SD]	2.3 [1.2]	3.7 [1.7]
Buccal location of the widest implant to bone gap	7 (70%)	7 (70%)
Mesial location of the widest implant to bone gap	0 (0%)	1 (10%)
Distal location of the widest implant to bone gap	0 (0%)	0 (0%)
Palatal location of the widest implant to bone gap	3 (30%)	2 (20%)
Sites not augmented at implant placement	5 (50%)	5 (50%)
Sites augmented only in the gap at implant placement	4 (40%)	3 (30%)
Sites augmented only buccally at implant placement	1 (10%)	0 (0%)
Sites augmented both in the gap and buccally at implant placement	0 (0%)	2 (20%)
Cases in which full flap closure above the implant was achieved	5 (50%)	6 (60%)
Sites grafted with autogenous soft tissue 1 year after loading	0 (0%)	0 (0%)

- One implant failed in each group; the difference in proportions of implant failures between groups was not statistically significant (difference in proportion = 0.00; 95% CI: -0.39 to 0.39; P [Fisher's exact test] = 1.000). Twelve days after placement of one implant in position 15, a patient from the central position group, a moderate smoker, reported pain at the implant apex, which was diagnosed as a periapical infection. A full-thickness flap was raised and the lesion was debrided. Ten days later the patient presented with a fistula, and the implant was found to be mobile and was therefore removed. When the initial radiograph was examined more closely, it was determined that there was a small apical radiolucency at a root of the neighbouring molar, indicating that previous endodontic treatment had not been correctly performed; the molar was endodontically retreated and the failed implant was successfully replaced with a new implant 4 months afterwards. The other implant failure occurred in a heavy smoker from the palatal group. Her palatal implant, in position 22, was painful and was removed 4 months after placement; it was replaced by another implant, which was, however, never loaded, since the patient received instead a fixed metal-ceramic prosthesis relying on the central incisor and canine as abutment teeth.
- Two complications occurred in two patients from the palatal group *versus* one complication in the central group. The difference in proportions of complications between groups was not statistically significant (difference in proportion = 0.14; 95% CI: -0.28 to 0.52; P [Fisher's exact test] = 1000). Complications in the palatal group were: pain at the implant apex observed 3 weeks after placement; no periapical radiolucency could be seen. An infection was suspected and the implant was surgically treated; a full-thickness flap was raised, the apex was debrided by curette, rinsed with physiological solution and sutured. The implant was closely monitored over 6 months and the complication completely resolved. The other implant became painful after its placement and was removed 4 months later. The only complication that occurred in the central position group was the previously described periapical infection that determined the implant failure.
- The median PES scores, assessed by a blind assessor one year after loading, were 10.0 (interquartile range/IQR: 4.5) in the central position group and 6.0 (IQR: 9.0) in the palatal group, the difference being not significantly different (median difference = -2; 95% CI: -7.0 to 3.0; P [Mann-Whitney U-test] = 0.470; **TABLE 2A**). Three years after loading, they were 12.5 (IQR: 5.0) for the central group and 10.0 (IQR: 10.0) for the palatal group, the

TABLE 2A PES SCORES AT 1 YEAR AFTER LOADING BY GROUPS AND BY DIFFERENT AESTHETIC DOMAINS

	Mesial papilla	Distal papilla	Soft tissue level	Soft tissue contour	Alveolar process deficiencies	Soft tissue colour	Soft tissue texture	Total PES score
Central N = 9 Median (IQR)	2.0 (1.0)	2.0 (1.0)	2.0 (1.5)	1.0 (0.5)	1.0 (1.0)	1.0 (2.0)	1.0 (2.0)	10.0 (4.5)
Palatal N = 7 Median (IQR)	2.0 (1.0)	2.0 (2.0)	1.0 (2.0)	0.0 (2.0)	1.0 (1.0)	0.0 (2.0)	0.0 (2.0)	6.0 (9.0)
Difference Median° (95% CI)	0.0 (-1.0 to 1.0)	0.0 (-1.0 to 1.0)	0.0 (-2.0 to 1.0)	0.0 (-1.0 to 1.0)	-1.0 (-1.0 to 0.0)	0.0 (-2.0 to 1.0)	0.0 (-2.0 to 1.0)	-2 (-7.0 to 3.0)
P-value§	0.758	0.918	0.536	0.210	0.114	0.758	0.606	0.470

IQR: Interquartile range;° Hodges-Lehmann median, 95% CI: 95% confidence interval of the median (Hodges-Lehmann estimation); § Mann-Whitney U-test

TABLE 2B PES SCORES AT 3 YEARS AFTER LOADING BY GROUPS AND BY DIFFERENT AESTHETIC DOMAINS

	Mesial papilla	Distal papilla	Soft tissue level	Soft tissue contour	Alveolar process deficiencies	Soft tissue colour	Soft tissue texture	Total PES score
Central N = 4 Median (IQR)	1.5 (1.0)	2.0 (1.0)	2.0 (2.0)	2.0 (1.0)	2.0 (1.0)	2.0 (0.0)	2.0 (2.0)	12.5 (5.0)
Palatal N = 6 Median (IQR)	2. (0.0)	2.0 (1.0)	1.5 (2.0)	1.5 (2.0)	1.0 (1.0)	2.0 (1.0)	1.0 (2.0)	10.0 (10.0)
Difference Median° (95% CI)	0.5 (0.0 to 1.0)	0.0 (-2.0 to 1.0)	0.0 (-2.0 to 2.0)	0.0 (-2.0 to 1.0)	-1.0 (-2.0 to 0.0)	0.0 (-2.0 to 0.0)	0.0 (-2.0 to 2.0)	-1.5 (-10.0 to 5.0)
P-value§	0.257	0.762	0.610	0.476	0.114	0.476	0.610	0.476

IQR: Interquartile range;° Hodges-Lehmann median, 95% CI: 95% confidence interval of the median (Hodges-Lehmann estimation); § Mann-Whitney U-test

difference being not significantly different (median difference = -1.5; 95% CI: -10.0 to 5.0; P [Mann-Whitney U-test] = 0.476; **TABLE 2B**), and five years after loading they were 10 (IQR: 5.5) in the central group and 8.5 (IQR: 6.75) in the palatal group, the difference being not significantly different (median difference = -1.0; 95% CI: -7.0 to 4.0; P [Mann-Whitney U-test] = 0.571; **TABLE 2C**).

Marginal bone levels were evaluated by a blinded outcome assessor on periapical radiographs taken at implant placement before bone grafting (when performed), at initial loading, 4 months after loading (delivery of definitive crowns), and 1, 3 and 5 years after initial loading (**TABLE 3**). At baseline, the median bone levels around centrally position implants was 0.00 mm (IQR: 0.40), *versus* 0.45 mm (IQR: 1.03) at palatal implants, the difference not being statistically significant (difference = 0.30 mm; 95% CI: -0.30 to 1.80 mm; P [Mann-Whitney U-test] = 0.082). At 1 year, the median bone levels around central implants was 0.70 mm (IQR: 0.90), *versus* 1.00 mm (IQR: 1.10) at palatal implants, a not statistically significant (difference = 0.20 mm; 95% CI: -0.5 to 1.3 mm; P [Mann-Whitney U-test] = 0.530), while at 3 years, the median bone levels around central implants was

TABLE 2C PES SCORES AT 5 YEARS AFTER LOADING BY GROUPS AND BY DIFFERENT AESTHETIC DOMAINS

	Mesial papilla	Distal papilla	Soft tissue level	Soft tissue contour	Alveolar process deficiencies	Soft tissue colour	Soft tissue texture	Total PES score
Central N = 6 Median (IQR)	2 (1.0)	1.5 (1.0)	1.5 (1.25)	2.0 (1.25)	1.0 (1.0)	2.0 (1.25)	1.0 (1.25)	10.0 (5.5)
Palatal N = 6 Median (IQR)	1.5 (1.25)	1.0 (2.0)	2.0 (1.0)	1.5 (1.25)	1.0 (0.5)	0.0 (2.0)	1.0 (2.0)	8.5 (6.75)
Difference Median° (95% CI)	0.0 (-1.0 to 1.0)	-0.5 (-2.0 to 1.0)	0.0 (-1.0 to 1.0)	0.0 (-1.0 to 1.0)	0.0 (0.0 to 1.0)	-1.0 (-2.0 to 0.0)	0.0 (-1.0 to 1.0)	-1.0 (-7.0 to 4.0)
P-value§	0.523	0.341	0.523	0.718	0.387	0.181	0.798	0.571

IQR: Interquartile range;° Hodges-Lehmann median, 95% CI: 95% confidence interval of the median (Hodges-Lehmann estimation); § Mann-Whitney U-test

TABLE 3 PERI-IMPLANT MARGINAL BONE LEVELS IN MM AT UP TO 5 YEARS AFTER LOADING BY STUDY GROUP

	Central implants N Median (IQR)	Palatal implants N Median (IQR)	Difference Median (95% CI)°	P-value§
Implant placement	5 0.00 (0.40)	6 0.45 (1.03)	0.30 (-0.30 to 1.80)	0.082
Initial loading	4 0.20 (0.45)	5 0.50 (0.50)	0.15 (-0.50 to 0.70)	0.413
4 months post-loading	4 0.55 (0.60)	7 0.60 (0.50)	-0.05 (-0.50 to 0.60)	0.927
1 year post-loading	5 0.70 (0.90)	7 1.00 (1.10)	0.20 (-0.5 to 1.3)	0.530
3 years post-loading	6 0.80 (1.45)	6 0.80 (1.80)	0.00 (-1.30 to 2.40)	1.000
5 years post-loading	6 0.45 (1.76)	6 0.45 (1.93)	0 (-1.7 to 3.0)	1.000
Changes from placement to 5 years Median° (95% CI)	4 0.15 (0.70) (-0.50 to 0.70)	4 -0.05 (1.23) (-1.40 to 0.85)	-0.20 (-)	0.471
P-value (placement–5 years)˙	0.625	0.750		
Changes from loading to 5 years Median° (95% CI)	4 0.15 (0.55) (-0.44 to 0.54)	3 -0.20 (0.40) (-0.70 to 0.30)	-0.30 (-)	0.285
P-value (loading–5 years)˙	0.875	0.500		

IQR: Interquartile range, 95% CI: 95% confidence interval; ° Hodges-Lehmann median, 95% confidence interval of the median (Hodges-Lehmann estimation); -: sample too small to evaluate 95% confidence interval of the median; § Mann-Whitney U-test; ˙Wilcoxon Signed-Rank test

0.80 mm (IQR: 1.45), *versus* 0.80 mm (IQR: 1.80) at palatal implants, the difference not being statistically significant (difference = 0.00 mm; 95% CI: -1.30 to 2.40 mm; P [Mann–Whitney U-test] = 1.000). At 5 years, the median bone levels around central implants was 0.45 mm (IQR: 1.76), *versus* 0.45 mm (IQR: 1.93) at palatal implants, and at this timepoint too the difference was not statistically significant (difference = 0 mm; P [Mann-Whitney U-test] = 1000). Bone level changes at 5 years were 0.15 (IQR: 0.70) mm at central implants and -0.05 (IQR: 1.23) mm at palatal implants, a not statistically significant difference (median difference = -0.20 mm; 95% CI: could not be estimated due to the small sample; P [Mann-Whitney U-test] = 0.471).

Patient satisfaction was assessed at 1, 3 and 5 years after loading only in those patients who did not experience implant failure. Regarding function at 1 year after loading, nine patients from the central position group declared that they were completely satisfied *versus* five completely satisfied and two partially satisfied from the palatal group. Regarding aesthetics, 9 patients from the central position group declared that they were completely satisfied *versus* four completely satisfied and three partially satisfied from the palatal group. There were no statistically significant differences between the groups in terms of satisfaction with either the function or aesthetics of their implant-supported crowns (function: P [Mann-Whitney U-test] = 0.351, aesthetics: P [Mann-Whitney U-test] = 0.174). At both 3 and 5 years after loading, all patients declared that they were fully satisfied with both aesthetics and function, with the exception of two patients from the palatal group, who were only partially satisfied: one with the aesthetics and one with the function (P [Mann-Whitney U-test] = 0.699). That being said, at 1, 3 and 5 years after loading, all patients declared that they would undergo the same procedure again.

DISCUSSION

This trial was designed to assess whether it would be advantageous, from an aesthetic perspective, to position immediate post-extractive implants about 3 mm more palatally or to place them in the 'central' position where the natural tooth would be in relation to adjacent teeth/implants. Only one implant failed in each group, one complication occurred in the central position group and two complications in the palatal group, and this is within the range of what could be expected.

Regarding the aesthetic outcome, no statistically significant differences in PES scores were observed between groups at any time points. Although on the face of it, this could be interpreted as both procedures achieving similar aesthetic outcomes, it must be stressed that this apparent finding should be interpreted critically in view of the insufficient sample size. Indeed, a tendency favouring implants positioned in a central position was observed at all timepoints, an observation that goes totally against the current way of thinking clinicians, almost universally, recommend placing implants slightly more palatally to achieve a better aesthetic outcome. However, the ability to achieve the best aesthetics is most likely mainly dependent on the manual skills and experience of the individual operators, as suggested by comparing the aesthetics data of the three centres[16]. In fact, there was a statistically and clinically significant difference in PES scores between centres at 1-year post-loading, with one centre having substantially lower scores than the other two (5.67 *versus* 11.20 and 11.57)[16].

Regarding peri-implant marginal bone levels, no differences or trends could be discerned between the two procedures.

No comparisons with the outcomes of other research can be made, since at the time of writing this report no other studies had been published on this topic.

The main limitations of the present trial were the insufficient sample size and the lack of some of the patient radiographs and clinical photographs, which, in addition to the high drop-out rate, further reduced the sample size. Unfortunately, out of the 13 centres that originally agreed to participate in this trial, only two centres actually delivered the required information up to 5 years post-loading. To avoid the common problem of studies being sabotaged by non-complaint clinicians, a more careful and strict selection of centres should be implemented, inviting only those clinicians who are highly motivated, reliable and able to conduct clinical research to join clinical trials.

Nevertheless, acknowledging all of its limitations, the results of the present study seem to indicate that the common notion that implants should be placed in a slightly palatal position in order to achieve better aesthetics may not, in fact be true. Since we tested both procedures in real clinical conditions, having implemented broad patient inclusion criteria, our results should be generalisable to a wider population with similar characteristics. However, in order to state with any confidence that the palatal position is not, in fact, aesthetically preferable to the 'natural' position in terms of post-extraction implant placement, further trials with larger samples, as originally provided for in our study design, will be required.

CONCLUSIONS

These preliminary results seem to cast doubt on the widely held belief that positioning immediate post-extraction implants about 3 mm palatally from the natural centre improves aesthetics, and it will be interesting to see whether larger trials confirm or refute this notion.

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