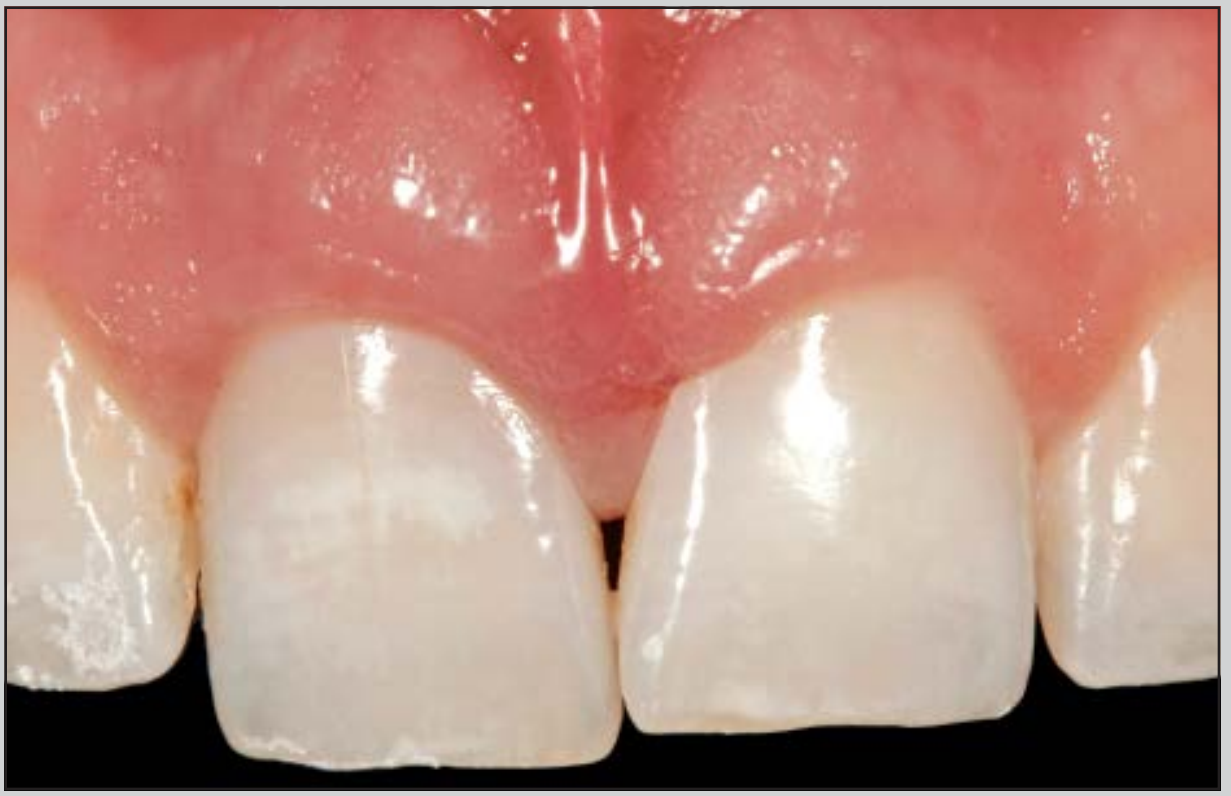
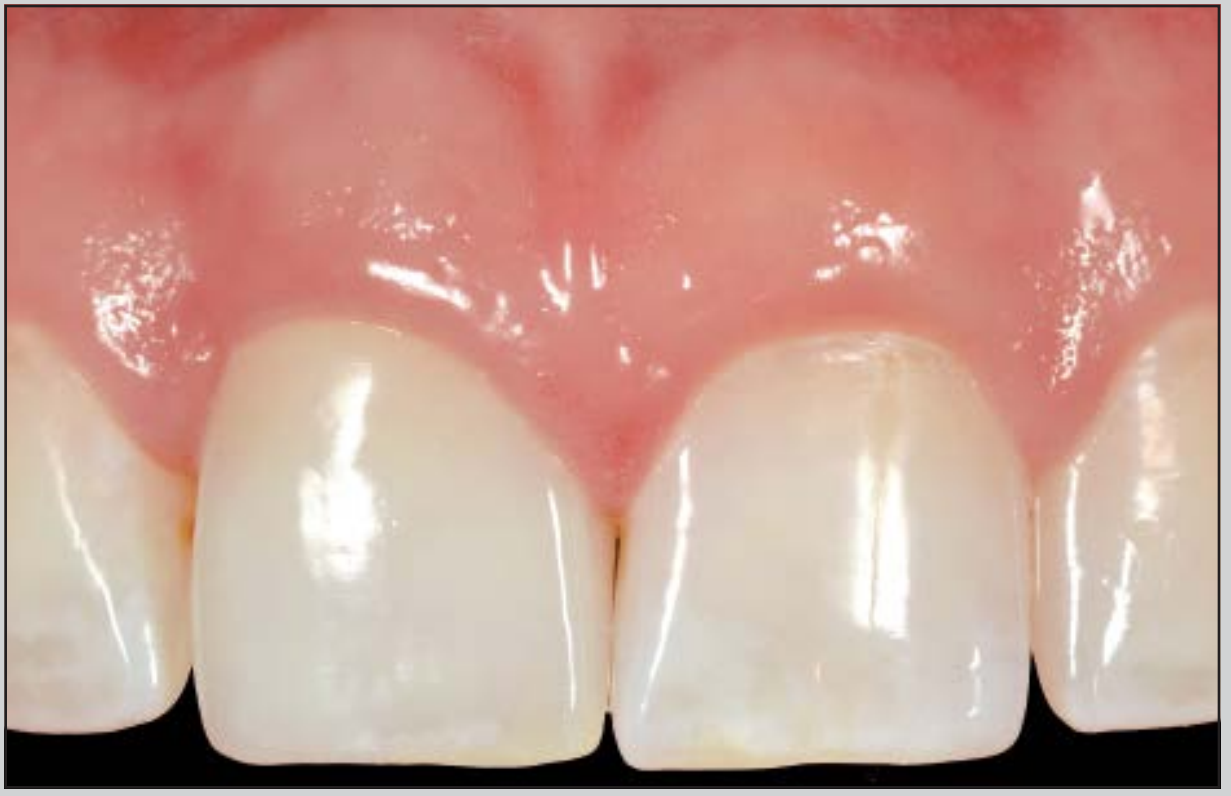
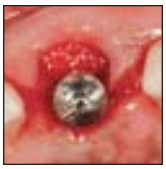




Flapless Postextraction Socket Implant Placement in the Esthetic Zone: Part 1. The Effect of Bone Grafting and/or Provisional Restoration on Facial-Palatal Ridge Dimensional Change—A Retrospective Cohort Study



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The dental literature has reported vertical soft tissue changes that can occur with immediate implant placement, bone grafting, and provisional restoration ranging from a gain or loss of 1.0 mm. However, little is known of the effects of facial-palatal collapse of the ridge due to these clinical procedures. Based upon treatment modalities rendered, an ensuing contour change can occur with significant negative esthetic consequences. The results of a retrospective clinical cohort study evaluating the change in horizontal ridge dimension associated with implant placement in anterior postextraction sockets are presented for four treatment groups: (1) group no BGPR = no bone graft and no provisional restoration; (2) group PR = no bone graft, provisional restoration; (3) group BG = bone graft, no provisional restoration; and (4) group BGPR = bone graft, provisional restoration. Bone grafting at the time of implant placement into the gap in combination with a contoured healing abutment or a provisional restoration resulted in the smallest amount of ridge contour change. Therefore, it is recommended to place a bone graft and contoured healing abutment or provisional restoration at the time of flapless postextraction socket implant placement. (Int J Periodontics Restorative Dent 2014;34:323–331. doi: 10.11607/prd.1821)

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There have been several articles that have dealt with the horizontal dimensional changes of the alveolar ridge after tooth extraction.[1–11] Investigations in humans have shown that considerable facial-palatal dimensional tissue changes take place after approximately 6 months.[6,7,12,13] Two studies reported greater than 4 mm of ridge change in the maxillary anterior region,[12,13] and one showed greater than 50% reduction of the ridge, equivalent to about 5.9 mm[7] for the posterior region. Upon critical review of these investigations, it was realized that flaps were elevated during or after tooth removal to measure the facial bone plate as well as the ridge dimension.

A recent clinical study by Grunder[14] comparing contour change with and without connective tissue grafting showed that only 1.1 mm of facial tissue change measured at 3 mm from the free gingival margin (FGM) occurred if an implant was placed with only a healing abutment and without flap elevation. Neither a bone graft nor provisional restoration was placed in this group of patients. This is considerably less change than reported in

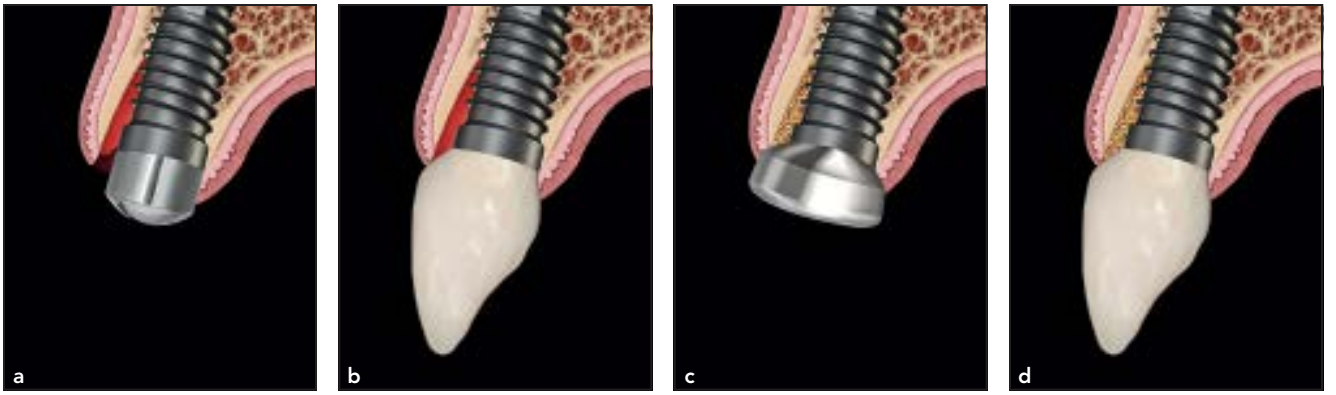


Fig 1 *Four treatment groups.* (a) *no BGPR = no bone graft and no provisional restoration;* (b) *PR = no bone graft, provisional restoration;* (c) *BG = bone graft, no provisional restoration; and* (d) *BGPR = bone graft, provisional restoration.*

the aforementioned studies with flap elevation and intact sockets as part of their measurements and clinical procedures.

There are only three sources of blood supply to the facial plate of bone: the periodontal ligament, the labial periosteum, and the endosseous marrow. Once any tooth is extracted, the ligament blood supply is absent. If a clinician elevates a flap of any kind, then the second major blood supply is interrupted. Even if the flap is immediately repositioned, the bone has lost this blood supply for at least a few days until reanastomosis of the vessels of the flap occurs with the bone.[15]

It has been recently shown[16] that the thickness of the labial bone plate for the maxillary anterior dentition is 1 mm or less for approximately 90% of patients. This is why the anterior labial plate is prone to marked resorption in a facial-palatal dimension, as reported in studies where flap elevation was performed to remove teeth and place implants. Of equal importance is that a 1-mm labial plate thickness does not have any marrow space, being composed of mostly cortical bone.

The objective of this study was to investigate horizontal volumetric changes of the ridge contour after flapless tooth extraction and immediate implant placement with and without a bone graft placed into the gap and/or provisional restoration. Facial-palatal dimensional changes were evaluated from the FGM and apical to the labial bone crest.

The results of a retrospective cross-sectional comparative multicenter clinical report evaluating the change in facial-palatal ridge dimension associated with immediate implant placement in anterior fresh extraction sockets are presented. The concepts of bone graft placement and ridge contour preservation are discussed.[17] Only type I extraction sockets demonstrating an intact labial bone plate and soft tissue conditions[18] are addressed. Four different conditions of therapeutic variables were compared: *(1)* group no BGPR = no bone graft and no provisional restoration; *(2)* group PR = no bone graft, provisional restoration; *(3)* group BG = bone graft, no provisional restoration; and *(4)* group BGPR = bone graft, provisional restoration (Fig 1).

Method and materials

Forty-nine patients with anterior maxillary extraction sockets were treated with postextraction socket implant placement. Seventy percent of the anterior teeth receiving treatment were maxillary central incisors.

The inclusion criteria for implant replacement were: good systemic health of the patient, maxillary anterior teeth (first premolar to first premolar), no periodontal disease or gingival recession, and no endodontic lesions with facial plate perforation or dehiscence (Figs 2 and 3). Exclusion criteria were general medical or psychiatric contraindications, pregnancy,

patients with local or generalized healing limitations, extraction sockets type II and III,[18] bruxism or other destructive parafunctional habits, compromised soft tissue conditions at the surgical or control site, and poor patient compliance.

The surgical treatment protocol entailed atraumatic tooth removal without flap elevation, thereby maintaining the periosteal blood supply to the labial bone plate. Sharp dissection of the supracrestal fibers was performed with a 15c scalpel blade, and teeth were extracted atraumatically. The extraction socket was debrided thoroughly, and osteotomy was performed with a biased palatal placement of the implant (Fig 4). Palatal implant placement in anterior extraction sockets commonly results in avoiding dehiscence of the labial plate, allowing sufficient running room for prosthetic components, and lacking facial bone-implant contact referred to as the "labial gap." Tapered non–platform-switched internal-connection implants at the implant shoulder were placed 3 to 4 mm apical to the FGM. Primary stability was obtained from the macrothread design at the apical third of the implant and confirmed with hand torque (minimum of 35 Ncm) to facilitate immediate full-contour provisional restoration. According to the treatment requirements of each test group, the labial gap either contained only the blood clot (no BGPR and PR groups) or was filled with small-particle bone allograft at the time of implant placement (BG and BGPR groups) (Fig 5).

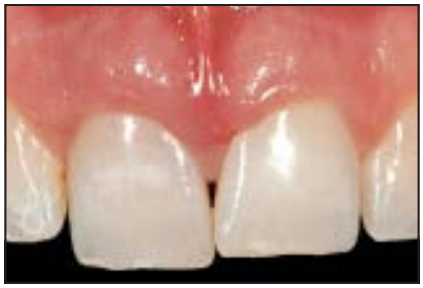


Fig 2 (above) *Patient presents with excessive trauma to the maxillary anterior region due to an automobile accident. Maxillary right central incisor suffered a horizontal root fracture and dislodgement of the coronal tooth structure to the palatal side.*

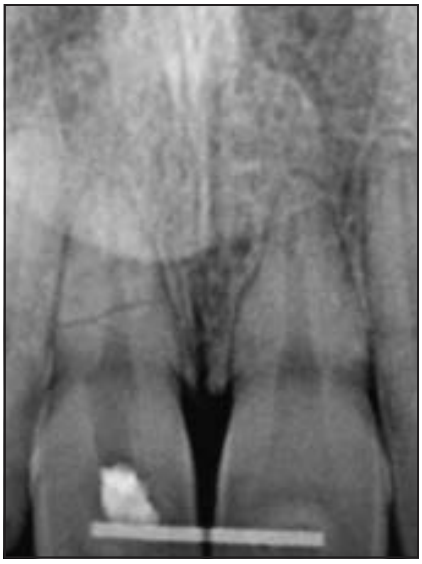


Fig 3 (right) *A periapical radiograph reveals the horizontal root fracture and coronal displacement of the clinical crown.*

Fig 4 *A 4-mm-diameter non–platform-switched tapered implant was placed with a palatal bias position within the extraction socket.*

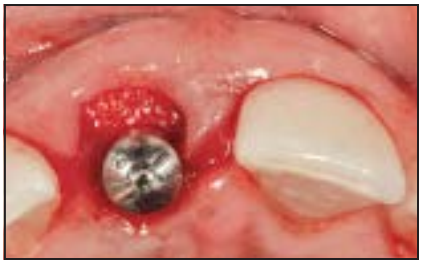


Fig 5 *The extraction socket was treated according to group BGPR. The labial gap was filled with small-particle bone allograft during implant placement. A healing abutment prevented bone particles from entering the inner implant connection.*

Screw-retained provisional restorations were fabricated using autopolymerizing acrylic resin (Super-T, American Consolidated) in infraocclusion for groups PR and BGPR. The provisional restorations had subgingival contours that conform to support the soft tissue profile and help protect the blood clot as well as any graft particles that were placed (Fig 6). In the groups that did not involve immediate provisional restoration, a straight healing abutment for the group no BGPR and a stock contoured healing abutment for group BG, respectively, were placed. An adhesive resin-bonded Maryland prosthesis was adjusted at the solid (acrylic) pontic portion to avoid contact with the healing abutment. The Maryland prosthesis was adhesively bonded to the adjacent natural teeth and adjusted in occlusion. Patients were placed on presurgical antibiotics and an analgesic as needed and seen 7 to 14 days postsurgery for a follow-up examination.

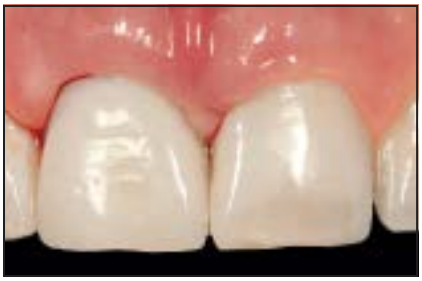


Fig 6 *The straight profiled healing abutment is removed and the completed provisional restoration is reseated onto the implant acting as a "prosthetic socket sealing" device to contain, protect, and maintain the bone graft material that acts as a scaffold for the blood clot.*

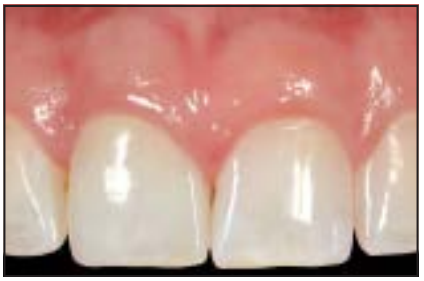


Fig 7 *The definitive metal-ceramic single crown restoration seated and cemented onto the abutment as per Wadhani's cementing technique.[19] Photograph at 3-year recall postinsertion.*

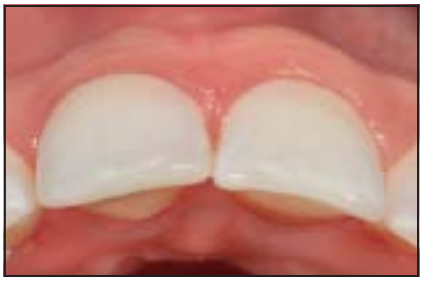


Fig 8 *Occlusal intraoral view of the definitive restoration at 3-year recall showing not only integration of the facial contour of the maxillary right central incisor implant site with the contralateral natural tooth site (left central incisor), but also stability of the ridge contour over time in the protocol for group BGPR.*

After a minimum of 4 months healing time, the adhesive resin-bonded prosthesis was removed for the first time and a screw-retained polyether-ether-ketone (PEEK) abutment with contoured acrylic was joined to the implant. This process started forming the soft tissue profile for at least 3 weeks (groups no BGPR and BG). For groups PR and BGPR, a minimum of 5 months healing time was given before the first removal (disconnection) of the provisional restoration. Subsequently, patients returned for implant-level impression making for fabrication of the definitive restoration. Provisional restorations were removed, and an implant-level impression was made with a monophase impression material (Flexitime, Heraeus). Implant-level transfer copings were attached for an open-tray impression, and pattern resin (GC America) was used to capture the subgingival soft tissue profile. The laboratory fabricated a soft tissue cast that allowed a screw-retained or cement-retained noble metal alloy abutment or subframe to be constructed, respectively. Custom abutment and ceramometal or all-ceramic crowns were fabricated and delivered approximately 3 months after the final impression. The definitive crowns were either cement-retained with temporary cement (TempBond NE) or screw-retained (Fig 7).[19] There was a minimum of three abutment disconnections after final impression taking (metal frame try-in, crown try-in/shade check, and time of crown delivery).

After definitive restoration delivery, patients were placed in maintenance/follow-up (Figs 8 and 9). At their follow-up visits, impressions were taken using irreversible hydrocolloid (alginate) impression material (Jeltrate, Dentsply Caulk) and immediately poured with gypsum stone (Resin Rock, Whip Mix). A digital caliper with a lighted display (SAE/Metric) was used to measure facial-palatal dimensions of the casts (Avenger Measuring Tools). Seven points of reference were measured at the apex of the FGM: 0, 1, 2, 3, 5, 7 and 9 mm apically on the implant site as well as the contralateral untreated (control) tooth site using clear cellophane tape with the aforementioned measurement markings (Scotch, 3M) (Fig 10).[20] One operator in each study site measured each patient's cast using ×2.5 magnification optical loupes. The casts from the alginate impression taken at the latest appointment available were used for the measurement. The designated operators were calibrated for the method of measurement, and the digital caliper was calibrated prior to each measurement of every cast (Fig 11). Measurements were taken three times, and mean values and SDs were calculated for each reference point. Descriptive statistics were calculated for tooth and implant sites, and paired-samples *t* tests were performed for comparisons ($\alpha = .05$). A three-way

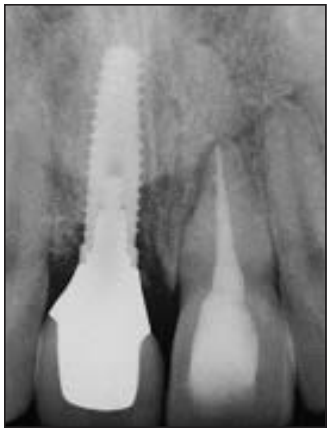


Fig 9 (left) *The 3-year recall periapical radiograph showing a well-integrated single tooth implant replacing a hopeless maxillary right central incisor due to a traumatic horizontal root fracture; the clinical treatment key being an intact facial plate (type I socket) at the time of tooth removal where immediate implant placement, bone grafting, and a provisional restoration act as prosthetic socket seal.*

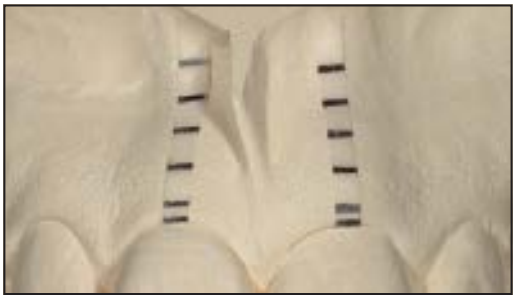


Fig 10 *Clear cellophane tape with the measurement markings (0, 1, 2, 3, 5, 7, and 9 mm) at the edge of the FGM placed on the implant site as well as the contralateral untreated (control) tooth site on the cast.*

Fig 11 *The facial-palatal width was measured using a digital caliper sensitive to 0.01 mm at each measurement point.*

mixed-model analysis of variance (α = .05) with one grouping factor (treatment), two repeated factors (implant/control, distance from the reference point), and a random intercept was performed with SPSS software (IBM) to compare dimensional changes between sides and among groups.

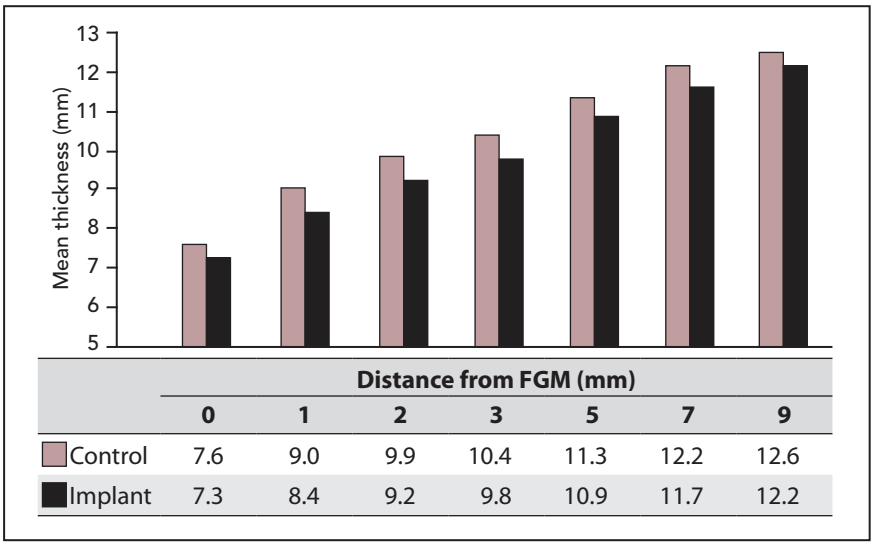
Results

A total of 49 patients were retrospectively enrolled in the multicenter cohort study (20 men and 29 women, aged 22 to 75 years, mean 48.5 years). Thirty-three implants were placed in central incisor (67.3%), 9 in lateral incisor (18.4%), 3 in canine (6.1%), and 4 in first premolar (8.2%) sites. The distribution of the implants was as follows: 5 in the group no BGPR, 17 in group PR, 10 in group BG, and 17 in group BGPR.

Forty-nine type III gypsum casts were made from alginate impressions taken in the range of 6 months to 4 years after delivery of the definitive tooth restoration. It was the aim to collect a total of 686 facial-palatal ridge-dimension measurements in the test and control sites. A total of 664 measurements were valid (96.8%), and 22 measurements (3.2%) were missing due to imperfections of the gypsum casts and anatomical limitations. The total mean ± SD facial-palatal ridge dimension was 10.09 ± 2.01 mm (range, 5.9 to 17.36 mm). The mean (95% confidence interval) ridge dimension of 10.42 mm (10.75–10.1) for contralateral control teeth was significantly higher than that for postextraction socket implant placement sites 9.93 mm (10.26–9.6).

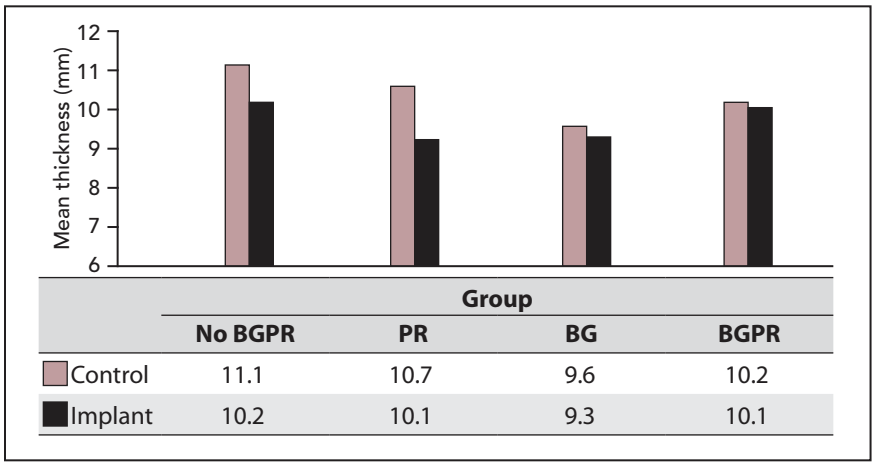
Figure 12 shows a smaller ridge thickness at all measurement points (averaged over conditions) on the implant side. This suggests that all implantation conditions produce a similar reduction in ridge thickness at all distances from the junction or FGM which equals a starting measurement at 0 mm, save the junction itself. While this interaction prevents a clear interpretation of main effects, one may note, in general, that there was increasing thickness as one moved away from the junction ($P < .001$).

The analysis studied implant placement in an extraction socket in regard to ridge thickness, different placement conditions, and at various distances from the junction (FGM) compared with a control tooth in the same individual. Analysis was geared to show that the variable is "cost" of implant placement in an extraction socket to ridge thickness, relative to a control tooth in the same individual, of different implantation conditions (groups no BGPR, PR, BG, and BGPR) and at various distances from the junction. The analysis indicated that the implant was associated with reduced thickness, but that the extent of this reduction varied depending on both condition (treatment rendered) and distance.



	Distance from FGM (mm)						
	0	1	2	3	5	7	9
Control	7.6	9.0	9.9	10.4	11.3	12.2	12.6
Implant	7.3	8.4	9.2	9.8	10.9	11.7	12.2

Fig 12 *Mean facial-palatal ridge thickness at all measurement points (averaged over groups no BGPR, PR, BG, and BGPR) on the control (teeth) and implant sites.*



	Group			
	No BGPR	PR	BG	BGPR
Control	11.1	10.7	9.6	10.2
Implant	10.2	10.1	9.3	10.1

Fig 13 *Mean facial-palatal ridge thickness of the control (teeth) and implant sites sorted by treatment group (no BGPR, PR, BG, and BGPR).*

Figure 13 shows a dimensional reduction of approximately 1 mm (averaged over distances) in the no BGPR and PR groups ($P < .05$) but smaller losses for groups BG and BGPR ($P > .05$). This suggests that bone grafting, either by itself (with a contoured healing abutment) or when combined with a provisional restoration, results in the least and statistically similar difference from the control side. Main changes in facial-palatal tissue contour between implant sites and control tooth sites were demonstrated at 2-, 3-, and 5-mm reference points in the control group (n = 5), and 1-, 2-, 3-, and 5-mm reference points for group PR (n = 17).

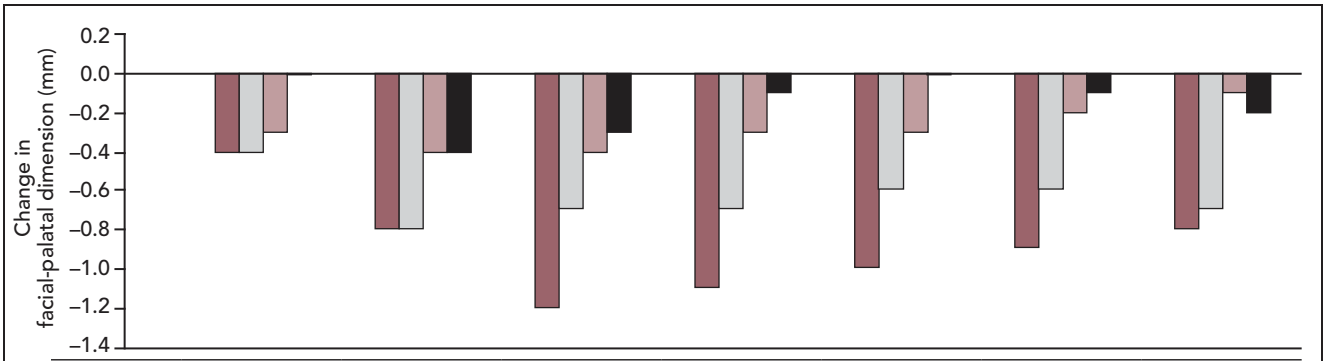
Figure 14 illustrates the mean facial-palatal dimensional changes sorted by conditions and measurement reference points. A recorded dimensional change of 0 mm would imply that no contour change occurred between the control tooth site and the implant treatment (test) site. Yet, reduced thickness values were recorded for almost all implant treatment sites when mean values were calculated.

Treatment groups BG (n = 10) and BGPR (n = 17) showed the smallest amount of facial-palatal dimensional change at all reference points.

Discussion

This study defines therapeutic outcomes in ridge contour whether or not a provisional restoration, bone graft, or both are placed at the time of postextraction socket implant placement without flap elevation. This report differs from prior studies where only vertical dimensional changes were evaluated (ie, midfacial recession).[21–24] Midfacial recession is an important esthetic parameter but not the only relevant one, since it can usually be managed effectively with abutment/crown contour.[25] The defined treatment groups represent clinically relevant and realistic scenarios that practitioners confront on a daily basis.

Ridge changes in the control group were consistent with the dimensional change recently reported by Grunder,[14] with the difference being that the present authors measured seven points of reference (0, 1, 2, 3, 5, 7, and 9 mm) versus one reference point by Grunder (3 mm from FGM). The placement of a



	Distance from FGM (mm)						
	0	1	2	3	5	7	9
No BGPR	–0.4	–0.8	–1.2	–1.1	–1.0	–0.9	–0.8
PR	–0.4	–0.8	–0.7	–0.7	–0.6	–0.6	–0.7
BG	–0.3	–0.4	–0.4	–0.3	–0.3	–0.2	–0.1
BGPR	0.0	–0.4	–0.3	–0.1	0.0	–0.1	–0.2

Fig 14 *Mean facial-palatal dimensional change measured at 0, 1, 2, 3, 5, 7, and 9 mm from the FGM by treatment group (no BGPR, PR, BG, and BGPR). Analysis indicated that the implant was associated with reduced thickness in all groups, but that the extent of this reduction varied depending on both condition and distance.*

bone graft at the time of postextraction implant placement with a contoured healing abutment (group BG) or provisional restoration (group BGPR) exhibited a facial-palatal dimensional mean reduction of 0.4 mm or less over the different measurement points, which may not be of esthetic clinical consequence in the frontal smile of patients. The key elements in preserving ridge contour are protection, containment, and maintenance of the bone graft during the healing phase of treatment, which can extend from 4 to 6 months. A contoured healing abutment or provisional restoration provided these elements to the bone graft. The alternative use of a contoured healing abutment is pertinent to referral-based practices where fabrication of a screw-retained provisional restoration may not be available or applicable during implant surgery.

Placement of the bone graft, not only in the gap between the implant and the labial bony plate, but also in the zone above the implant abutment interface, might provide support and volume to the hard and soft tissues.[17] Araujo et al recently showed histologically that a xenograft material could become incorporated in the peri-implant tissues, acting as a noninflammatory or benign foreign body.[26] More research is required to delineate which bone graft materials are best for peri-implant soft tissue and hard tissue contour preservation as well as the long-term soft tissue biologic response to these materials. It remains uncertain which bone grafting material (allograft, autogenous, or xenograft) or synthetic bone substitute would be most effective for maintaining the labial tissue contour over the long term.

The values displayed for the provisional restoration only (group PR) were unexpected. Placing a provisional restoration at the time of immediate implant placement did little to prevent contour change compared with the control group. Sculpting the tissue with the provisional restoration after the removal of the healing abutment (group G) displayed the same effect in the zone above the implant abutment interface as if the provisional restoration was placed at the time of implant placement (group BGPR). Yet, placing a provisional restoration has merit since the number of procedures afforded to the patient can be decreased, thereby streamlining overall treatment time and increasing comfort to patients receiving this type of therapy.[22,24,26–28]

It should be emphasized that only 1 mm or less and, in several instances, tenths of millimeters of change was shown for all implant treatment groups in type I extraction sockets that were performed as flapless placement procedures. This is far less than the 2 to 6 mm of facial-palatal change associated with tooth removal with flap elevation without implant placement reported by prior studies.[6,7,12,13,29] Recently, a few studies have shown approximately 1 mm of dimensional change on the facial aspect where similar treatment was rendered without flap elevation.[30,31] The rationale for palatal placement is that even though contour change could occur, bone can still be present over the labial aspect of the implant, hence, a new modeled facial plate.[3–5] Even though this paper only focused on the efforts of bone grafting with or without provisional restoration, it is evident that this clinical procedure is necessary to limit the amount of facial contour change that can occur with immediate implant placement.[9,32–36] The remaining question is whether it is necessary to place a bone graft, connective tissue graft, and a provisional restoration at the time of implant placement. One or the other may suffice with the understanding that not all procedures are 100% successful, with risks being loss or infection of the graft.[37]

In summary, postextraction socket implant replacement survival rates are equivalent to those of delayed placement while streamlining the number of clinical procedures.[22,24,27,28,38] In addition, bone grafting is not a requirement for immediate implants even with large gap distances to attain osseointegration of the implant.[39] However, placing a bone graft into the labial gap is helpful to minimize the amount of contour change of the facial aspect of the ridge and is important for esthetic outcomes to clinicians and patients. Clearly, more work is necessary in this dynamic and increasingly expanding field of esthetic implant dentistry.

Conclusion

Placing a bone graft into the residual labial gap around a postextraction socket anterior implant is helpful for limiting the amount of facial-palatal contour change from the FGM to more apical reference points. All treatment groups evaluated in this retrospective cohort study without flap elevation demonstrated some negative contour change (facial collapse) relative to the adjacent contralateral control tooth. However, it was minimal compared with previous studies that elevated full periosteal flaps to extract teeth.

The smallest amount of facial-palatal contour change was achieved using bone grafting of the extraction socket at the time of implant placement and stabilization of the graft material either by placing a contoured healing abutment or custom-contoured provisional restoration.

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