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Combined Piezosurgery and Selective Distraction Osteogenesis to Correct Malpositioned Implants: A Case Report

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This case report shows the combined use of piezosurgical and orthodontic procedures to successfully relocate two severely malpositioned implants in the anterior maxilla by moving them separately, with the objective of attaining functional prosthetic restoration and acceptable esthetics. (Int J Periodontics Restorative Dent 2015;35:161–167. doi: 10.11607/prd.2126)

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Implant therapy has become a widely implemented treatment alternative for replacing missing teeth.[1] Although implant treatments have demonstrated favorable long-term results, biologic, mechanical, functional, and esthetic complications due to inappropriate positioning do occur.[2–4] Endosseous osseointegrated implants have no periodontal ligament; consequently, it is only possible to move them jointly to the surrounding bone.

Different approaches have been described for moving segments of bone, including "abruptly" or gradually displacing bone blocks according to osteodistraction principles, usually utilizing osteodistractors.[5]

Combining selective distraction osteogenesis with a surgical approach, the implant is at first mobilized with peri-implant piezosurgery osteotomies and subsequently driven to the new desired position.

Therapeutic solutions

It is crucial to make a correct diagnosis to determine the most

adequate therapeutic approach in order to achieve successful results.

In the case of moderate to extremely compromised clinical situations, five treatment options could be implemented: *(1)* mucogingival procedures to cover the exposed implant components; *(2)* implant submersion, restoring the edentulous space according to conventional protocols; *(3)* implant removal with a trephine bur and subsequent replacement, provided that the correct healing process has occurred; *(4)* complete implant segmental osteotomy in one bony block with the implant in situ, relocating it in a different position; and *(5)* piezosurgical osteotomy plus orthodontic therapy.[6–12] Each of these options presents drawbacks and limitations that must be exhaustively discussed with the patient.

This case report describes the use of a combined approach of piezosurgery and selective distraction osteogenesis to successfully relocate two severely malpositioned implants in the maxillary anterior area by moving them separately, with the objective of attaining functional prosthetic restoration and acceptable esthetics.

Case report

Presurgical evaluation and prosthetic preparation

A 36-year-old woman presented with two malpositioned implants, replacing the maxillary right canine and lateral incisor (Fig 1), with a provisional tooth-supported fixed restoration. Based on an accurate clinical-prosthetic evaluation after a two-stage implant surgery, the two implants were deemed unsuitable for an esthetic restoration. Although the two implants were considered osseointegrated, a radiographic survey (full-mouth periapical radiographs) and computed tomography (CT) scan revealed the following: *(1)* the tooth-implant interproximal space ranged from 2 to 3 mm, mesiodistally; *(2)* the interproximal space between the two implants was an estimated 4 to 5 mm wide; *(3)* a minimal buccal support (< 2 mm) and a slightly reduced lingual crestal bone were residual.

Based on a radiographic evaluation, there was enough space between the central incisor and the implants to perform the corticotomies and to allow for orthodontic movement. Furthermore, the canine implant platform was located coronal to the lateral incisor implant, the opposite of normal gingival architecture.

The orthodontic-periodontal-prosthetic assessment results suggested a surgical and orthodontic repositioning of the two implants by moving them to different levels before realizing a definitive prosthetic fixed restoration.

A complete provisional fixed denture, with an esthetic acrylic resin suprastructure and a cast-metal substructure, was utilized as orthodontic anchorage and to subsequently stabilize the two segments.

Preoperative therapy

The provisional crowns on the two implants were replaced with shorter, single crowns, located at a more apical level compared to the adjacent teeth, to provide enough space for the implant extrusion on the occlusal surface. All findings, treatment options, and preoperative and postoperative instructions were discussed with the patient. Verbal and written consent were obtained.

The patient was premedicated with an antibiotic (2 g of amoxicillin 2 hours prior to surgery).

Surgical phase

Buccal and lingual areas were locally infiltrated with mepivacaine 20 mg/mL with adrenalin 1:100,000 (Pierrel Pharma). A full-thickness mucoperiosteal flap was elevated only on the buccal side (Figs 2 and 3).

The integrity of the interimplant papillary isthmus between the two implants, as well as the tooth-implant papillary tissues, must be preserved to avoid exposure of the interproximal bone and to preserve papillary heights.

The initial intrasulcular incisions were made all around the two implants and then continued to two vertical releasing incisions at the distal aspect of the maxillary right first premolar and at the mesial aspect of the maxillary right central. These incisions were extended beyond the mucogingival line and extended apically for approximately 4 to 5 mm.

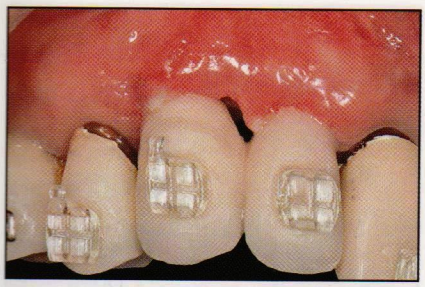

Fig 1 *Buccal view demonstrates an unpleasant gingival architecture and excessive apical positioning of two endosseous implants. In addition, a provisional fixed restoration was supported by few residual natural teeth. A clinical-prosthetic evaluation after the stage-two implant surgery deemed the two implants unsuitable for an esthetic restoration.*

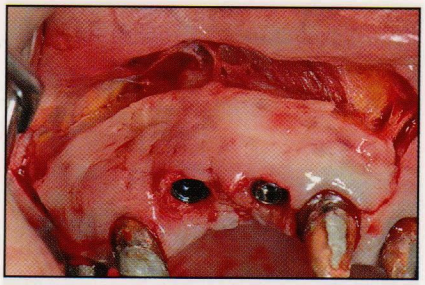

Fig 2 *Flap design. Two vertical releasing incisions are made at the distal aspect of the maxillary right first premolar and at the mesial aspect of the maxillary right central incisor. These incisions are extended high into the vestibule, beyond the mucogingival line, for approximately 4 to 5 mm. A horizontal incision is made in the oral buccal mucosa, apical to the mucogingival junction, connecting the two vertical releasing incisions at their most apical aspect.*

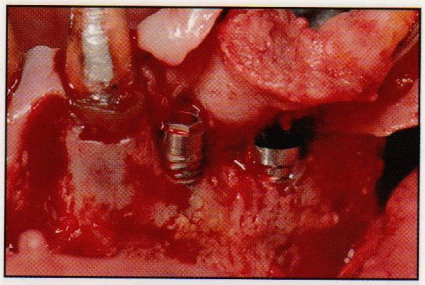

Fig 3 *A full-thickness mucoperiosteal flap is elevated only on the buccal side.*

A horizontal incision was then made in the buccal mucosa, apical to the mucogingival junction, connecting the two vertical releasing incisions at their most apical aspect. A full-thickness flap was reflected from this horizontal incision to the gingival margin, with an apicocoronally dull dissection, utilizing a combination of a small bony chisel, C-GTGO (ST-12840, Nike) and a Prichard elevator PR3 (ST-14425; Nike). A large full-thickness flap was displaced toward the palate through the proximal spaces, maintaining the integrity of the interproximal papillae. The palatal displacement of the buccal flap was avoided in order to

- Maintain better nourishment of the peri-implant bony surfaces
- Preserve the integrity of the isthmus tissues (absolutely mandatory)
- Leave the palatal tissue–periosteum-bone interface intact and undisturbed, preventing the risk of necrosis[5,6]

Both implants exhibited small facial dehiscences, exposing two to three implant threads in the canine implant and only one thread in the lateral incisor implant. The distance between the mesial malpositioned lateral implant and the root of the central incisor was 2 mm, whereas the distance between the distal malpositioned maxillary right first premolar implant and the root of the second premolar was 3 mm. The interproximal space between the two implants was estimated to be 5 mm.

A combination of piezoelectric surgical scalpels using nos. 0T7 and OTS-4 (blade thickness: 0.55 mm and 0.35 mm, respectively; Piezosurgery, Mectron) and SL1 (blade thickness: 0.6 mm; Piezon Master 700, EMS-Swiss) were used to make appropriate corticotomies mesially and distally (Fig 4). Three complete corticotomies, parallel to the long axis of the implants, were performed to get access to the medullary bone and to reach the palatal cortical plates. An additional corticotomy, this one horizontal, connected the three parallel vertical cuts, 3 mm apically to the implants, utilizing angulated piezoelectric surgical micro-saw insert 0T7 (blade thickness: 0.6 mm; Piezon Master 700; Fig 5). This horizontal corticotomy involved the palatal cortical plate, similarly to the three vertical ones. At this point, the osteotomy was completed and the two implants with their surrounding bone were free.

The full-thickness buccal flap was gently returned to the ves-

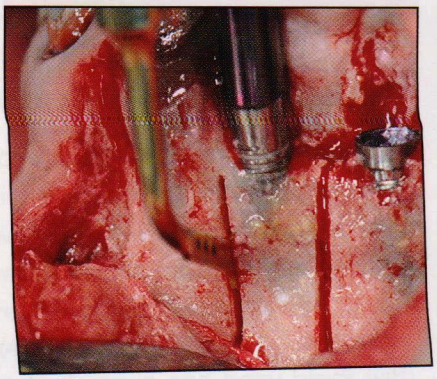

Fig 4 Frontal view of two initial vertical corticotomies.

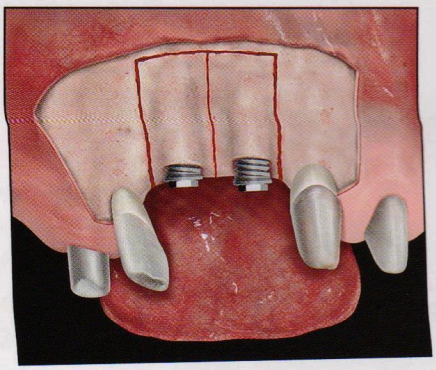

Fig 5a Schematic drawing showing vertical and horizontal corticotomies.

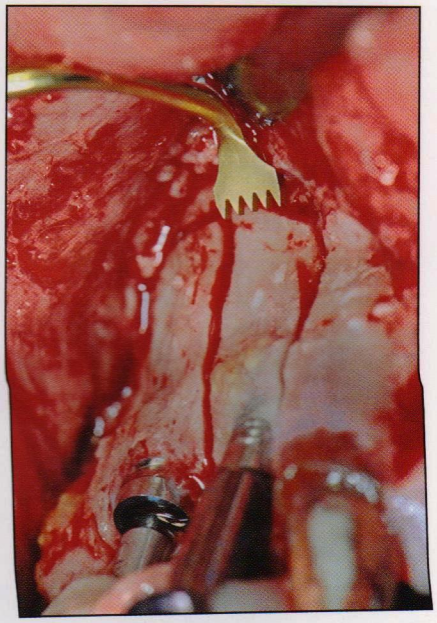

Fig 5b Clinical view of the completed vertical and horizontal corticotomies.

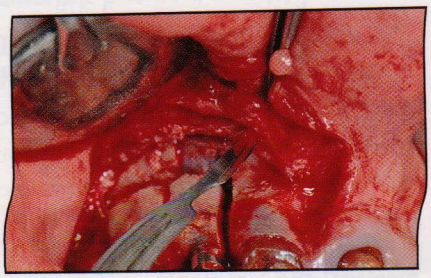

Fig 6 *A periosteal releasing incision is made on the alveolar mucosa immediately apical to the previous horizontal incision, creating a split-thickness mucosal flap to achieve a tension-free flap.*

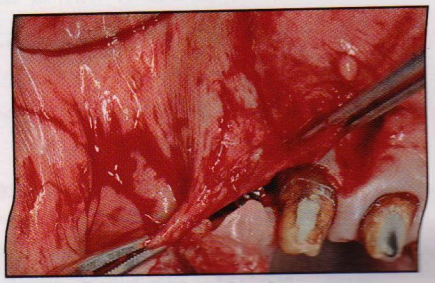

Fig 7 *An atraumatic tissue forceps is used to evaluate the tension-free mucosal flap and its coronal positioning.*

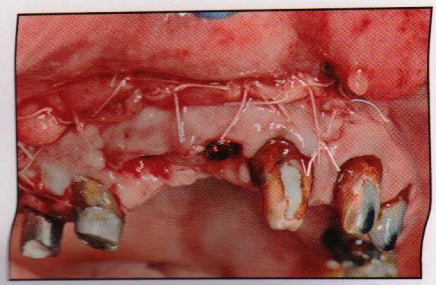

Fig 8 *Suturing techniques.*

tibular aspect through the wide interproximal space, trying not to damage the integrity of the interproximal soft tissues. At this point, the flap was coronally displaced to improve esthetics.

A sharp horizontal incision was made on the alveolar mucosa, immediately apical to the previous horizontal incision, followed by a split-thickness mucosal flap to facilitate its coronal repositioning with a tension-free closure (Fig 6).

An atraumatic tissue forceps was used to evaluate the tension-free flap and its coronal positioning (Fig 7).

Horizontal mattress sutures were used with U stitches, at least 3 mm thick (first line of closure). Interproximal single interrupted sutures were placed to close the mesial and distal vertical flap incisions. Single interrupted U sutures were then placed to close the most coronal aspect of the flap (second line of closure), alternating with the previous horizontal mattress sutures (first line of closure; Fig 8).

No surgical dressing was placed, and no pressure was applied to the surgical area.

Orthodontic therapy

An orthodontic analysis was conducted to evaluate whether adequate anchorage support for the

Fig 9 *At the 5-day healing period. Immediately after the surgery stainless steel archwire has been applied, passing below the brackets of the two implants.*

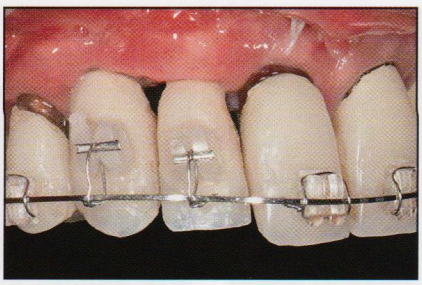

Fig 10 *At the 14-day healing period. A metal ligature extending from the brackets of the maxillary right canine and lateral incisor teeth to the archwire has been applied.*

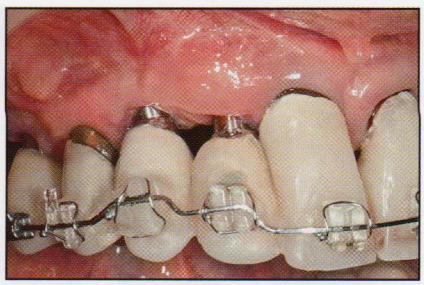

Fig 11 *At the 30-day healing period. Brackets on the two implants are replaced at a higher level. A new stainless steel archwire with passive bends to keep the implants in place at the end of extrusive movement is attached.*

extrusive movement of the two implants could be provided by the adjacent tooth structures.

Complete provisional acrylic dentures with a cast metal substructure supported by mixed dentition (natural teeth and implants) were present in the maxillary arch, and osseointegrated implants were inserted in place of the maxillary right second premolar and left canine; therefore, no additional anchorage was required.

Subsequently, 0.021 × 0.028-inch slot ceramic brackets were placed in the maxillary arch. A passive 0.016 × 0.022-inch stainless steel (SS) archwire (GAC) was applied 1 week before the surgery. The ceramic brackets on implants in position of the maxillary right canine and lateral incisor were replaced by different ones reinforced with metal and provided with a vertical slot (3M-Unitek).

Immediately after the surgery a 0.016 × 0.022-inch SS straight archwire was applied, underpassing the brackets of the two implants (Fig 9).

A metal ligature, extending from the brackets of the maxillary right canine and lateral incisor to the archwire, was applied. The metal ligature was tightened to attain only 1 mm extrusion. The first activation of 1 mm was made after 14 days (Fig 10) and a second one of the same magnitude 3 days later.

At the time of the fourth activation, because the distance from the brackets to the SS archwire was too short, a step-down bend was introduced on the 0.016 × 0.022-inch SS archwire and an additional 0.019 × 0.025-inch SS archwire was added and ligated below the first archwire to increase its stiffness, extending between the brackets of the maxillary right first premolar and the left central incisor. Activation was scheduled every 3 to 5 days, based on the implants' mobility.

Because excessive metal ligature activation can result in unwarranted implant extrusion, an activation inducing 1 mm of extrusion was used at every control. Therefore, in case of poor implant mobility, an increasing force was applied. When the implant mobility was satisfactory and visible (ie, grade 2), the ligature activation was light.

Periapical radiographs guided the amount of differential extrusion of the two implants in order to make a more coronal implant level at the site of the lateral incisor and a more apical level on the canine.

After 1 month, the orthodontic movement was completed (Fig 11). A passive 0.016 × 0.022-inch archwire passing through the horizontal slot of the braces of the canine and lateral incisor was kept in place for 4 weeks before removing the orthodontic appliances.

When the orthodontic appliances were removed, the implant-supported provisional crowns on the lateral incisor and canine teeth were connected to the adjacent teeth with acrylic resin for 6 months.

Implant stability was tested after 6 months. A periapical radiograph was made (Fig 12) and the final prosthodontic rehabilitation completed (Fig 13).

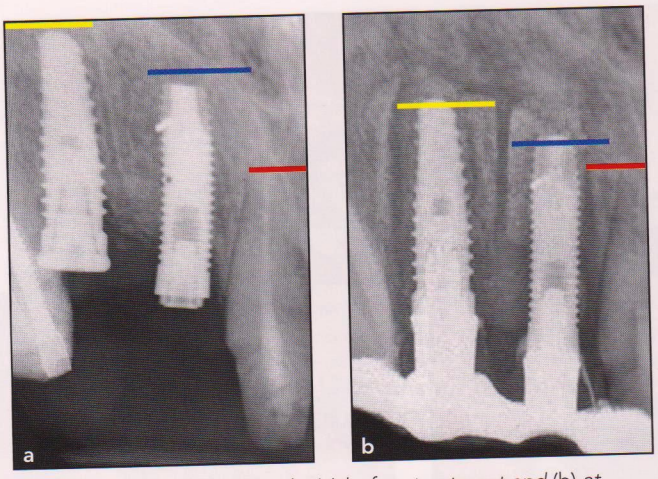

Fig 12 *Periapical radiographs* (a) *before treatment and* (b) *at the 30-day healing period. It is possible to appreciate the coronal positioning of both segments* (blue and yellow lines) *compared to the apex of the maxillary right central incisor* (red line).

Fig 13 *Frontal view of the definitive restoration in place.*

Postoperative care and follow-up therapy

The patient, previously premedicated with antibiotics (2 g of amoxicillin 2 hours prior to surgery), also received 2 g of amoxicillin per day for 5 days postoperatively. She was given proper analgesics and was examined every 3 days for the first 2 weeks. The surgical wound was gently cleansed with 0.12% chlorhexidine on a cotton swab.

Sutures were removed after 15 days and the patient was examined every week throughout the 4-month follow-up healing period. She was instructed to rinse two times a day with 0.12% chlorhexidine. Delicate mechanical tooth brushing using a wet cotton swab was recommended for the first 2 weeks in the treated area. After this period, she resumed mechanical oral hygiene, including interdental cleaning with interproximal brushes, and discontinued chlorhexidine rinses.

Professional tooth cleaning, consisting of supragingival prophylaxis with a rubber cup and chlorhexidine gel application (Corsodyl gel, ICI), was performed every 2 weeks during the 4-month healing period.

The treated site healed uneventfully with little inflammation, and no adverse effects were detected or reported by the patient. Primary closure of the interproximal soft tissues was maintained throughout the healing period.

Discussion

A combined surgical and orthodontic approach was chosen to attain a selective extrusion of the two implants and re-place them at a different vertical position, in respect to their original insertion. This kind of approach could lead to some kinds of difficulties to control the rotation of bone blocks that tend to rotate toward the palate. However, in this case, the authors had a good anchorage source from other previously inserted implants in the maxillary arch. This undesired movement was controlled using a positive torque inserted in the archwire corresponding to the blocks.

Using an orthodontic approach, it was possible to extrude one implant (the one in the lateral incisor position) more than the other.

By using metal ligature, extended from archwire to implant crowns, it was possible to modulate the extrusion amount with millimeter

precision, at each activation, which was crucial for the vitality of the implant bony block.

The implant inserted in the canine site was extruded 5 mm and the one inserted in the lateral incisor area underwent a 3-mm extrusion.

Ideal soft tissue quality has to be present—completely inflammation free—with an adequate band of keratinized tissue. In cases of inadequate bands of keratinized tissue, the clinician may decide whether or not to augment it, before or contextually to the surgical phase.

The authors' clinical experience helped them determine that a keratinized mucosa was a prerequisite to achieve a better seal and an adequate bony quantity, prior to bony cuts, for the bony fragment survival.

Due to bony cuts, the papilla's regeneration could not be expected, from the authors' experience. In fact, some sufferance of the crestal bone could be detected before the surgical procedure. From periapical radiography and cone beam computed tomography investigations, and from the clinical intraoperative picture, the most mesial implant showed exposure of the three most coronal threads and the implant collar.

At the end of the implant extrusion, the authors appreciated the presence of the collar of both implants extruding from soft tissue. A possible explanation could be that soft tissues were not following completely implant-forced extrusion, similarly to the soft tissue behavior as reported in an animal study in which natural teeth were extruded.[13]

The orthodontic activation must follow osteodistraction guidelines and it is the authors' opinion that this clinical approach also could be applied to ankylosed teeth.

Conclusions

- A combined approach of piezosurgical and orthodontic procedures was described to relocate two severely malpositioned implants by repositioning them individually, in the maxillary anterior area, to improve esthetics.
- It can be useful to relocate the implant-bony structure to a specific location because orthodontic treatment can control three-dimensional tooth movement.
- The piezosurgical technology minimized the surgical insult, providing a more favorable bone response.
- An accurate presurgical diagnosis should guide the most adequate and minimally invasive therapeutic approach.
- Additional studies are required to provide long-term evaluation of this proposed technique.

Acknowledgments

The authors reported no conflicts of interest related to this study.

References

1. Tomasi C, Wennström JL, Berglundh T. Longevity of teeth and implants—A systematic review. J Oral Rehabil 2008;35(suppl 1):23–32.
2. Lindhe J, Meyle J. Peri-implant diseases: Consensus Report of the Sixth European Workshop on Periodontology. J Clin Periodontol 2008;35(suppl 8):282–285.
3. Kassolis JD, Baer ML, Reynolds MA. The segmental osteotomy in the management of malposed implants: A case report and literature review. J Periodontol 2003;74:529–536.
4. Stacchi C, Costantinides F, Biasotto M, Di Lenarda R. Relocation of a malpositioned maxillary implant with piezoelectric osteotomies: A case report. Int J Periodontics Restorative Dent 2008;28:489–495.
5. Lehrhaupt NB. Alveolar distraction: A possible new alternative to bone grafting. Int J Periodontics Restorative Dent 2001;21:121–125.
6. Bell WH, Schendel SA, Finn R. Revascularization after surgical repositioning of one-tooth dento-osseous segments. J Oral Surg 1978;36:757–765.
7. Hallman M, Carlsson B. Surgical correction of malpositioned implants. A case report. Clin Oral Implants Res 1996;7:316–319.
8. Poggio CE, Salvato A. Implant repositioning for esthetic reasons: A clinical report. J Prosthet Dent 2001;86:126–129.
9. Warden PJ, Scuba JR. Surgical repositioning of a malposed, unserviceable implant: Case report. J Oral Maxillofac Surg 2000;58:433–435.
10. Vercellotti T. Technological characteristics and clinical indications of piezoelectric bone surgery. Minerva Stomatol 2004;53:207–214.
11. Robiony M, Polini F, Costa F, Vercellotti T, Politi M. Piezoelectric bone cutting in multipiece maxillary osteotomies. J Oral Maxillofac Surg 2004;62:759–761.
12. Vercellotti T, Nevins ML, Kim DM, et al. Osseous response following resective surgery with piezosurgery. Int J Periodontics Restorative Dent 2005;25:543–549.
13. Kajiyama K, Murakami T, Yokota S. Gingival reactions after experimentally induced extrusion of the upper incisors in monkeys. Am J Orthod Dentofacial Orthop 1989;95:115–126.