The use of dental implants to replace single missing teeth was established in the 1980s, and 97% success rates were reported at the 5-year follow-up. At that time, it was already known that, in actively growing patients with ongoing maxillary skeletal and dental growth, osseointegrated implants do not adapt to positional changes of the natural dentition. Similar to ankylosed teeth, implants remain stationary in the bone and do not follow the changes of the alveolar process with continuous eruption of the natural dentition.

This inability to move with the adjacent teeth causes deficiencies in the alveolar bone and surrounding gingival tissues and leads to a discrepancy in the sagittal and transversal dimension, described as infraocclusion or infraposition of the implant. Vertical growth of the nasomaxillary complex with an anterior and downward displacement of the maxilla usually ceases at the age of 17 to 18 years in girls and somewhat later in boys. However, implant infrapositioning has also been reported in patients who receive implants during adulthood and is related to the continuous eruption of the teeth, which occurs even after occlusal contact is established. From the age of 25 to 46 years, men’s faces tend to grow more in posterior height, whereas women’s faces tend to lengthen as the mandibular inclination increases and the maxilla elongates to compensate; this places women at greater risk of implant infraposition.

Particularly individuals with a hyperdivergent growth pattern (long face type) tend to have more pronounced maxillary growth and a backward rotation of the mandible in relation to the cranial base (SN line). The dentoalveolar complex follows this rotation to compensate, which enhances the vertical movement of the natural dentition.

Given these patterns of growth and eruption, an increased risk for infrapositioning of maxillary anterior single tooth implants has been documented, especially in young women and in patients with a long-face appearance. Because asymmetry that results from an infrapositioned single-tooth implant in this region is most visible and esthetic impairment is pronounced, implant placement should be postponed.

**ABSTRACT**

Single-tooth implants in the maxillary anterior region have the highest risk of esthetic complications from infrapositioning due to continuing maxillary growth and the eruption of adjacent teeth. Although the placement of anterior single-tooth implants should normally be postponed, particularly girls and young women with a hyperdivergent growth pattern, if an infraposition of an implant is present, thorough examination and strategic planning are required. According to the severity, the strategic treatment options are as follows: simple retention; adjustment or replacement of the implant restoration, possibly including adjacent teeth; surgical implant repositioning by segmental osteotomy combined with osseodistraction; or submergence or removal of the implant. With the patient presented, an interdisciplinary approach that combined orthodontic alignment, surgical segmental osteotomy, distraction osteogenesis, and restorative features offered the opportunity to realign the adjacent teeth into the arch and to harmonize the gingival contour by means of continuous soft tissue enlargement and adaptation. (J Prosthet Dent 2015;113:169-174)
and alternative treatment options, including autotransplantation, orthodontic space closure, or a resin-bonded fixed dental prosthesis, should be considered.17,18

### Treatment Strategy for Correcting Implant Infraposition

To assess the treatment requirements and to select the appropriate treatment to correct an infrapositioned implant, a clinical and radiographic examination should include the following: the severity of the vertical discrepancy (infraposition) related to the equivalent contralateral tooth and the position of the incisal edge and gingival margin of the symmetric contralateral tooth as references; the extent of transversal (bucco-oral dimension) changes of adjacent teeth, which possibly become trapped lingually to the stationary implant restoration; the involvement of the opposing dentition, such as compensatory elongation; and 2- or 3-dimensional radiographs to estimate the width of the bone septum, particularly when bone segmentation for osseodistraction is considered.

Indications for treatment options depend on the severity of infrapositioning and can be categorized according to their invasiveness (Table 1). Stabilizing the anterior dentition, including the implant with a fixed retainer is considered as a preventive measure to avoid changes due to the continuing eruption of adjacent and opposing teeth. However, if growth continues, then the retention of the maxillary anterior dentition maintains the teeth in a stable position relative to the implant and possibly causes an open occlusal relationship, or with compensatory elongation of the mandibular incisors, a sagittal step between the anterior and posterior dentition may be induced.

Modifying the implant restoration and/or the contralateral tooth by grinding or even replacing the implant crown is certainly the least-invasive treatment option and, therefore, the most frequently chosen, particularly if the infraposition is minor. This modification also can include adjustments to the gingival contour, for instance, by gingivectomy (Fig. 1). Surgical repositioning of the implant by segmental osteotomy,19 possibly in combination with osseodistraction for gradual movements of the bony segment and enlargement of the soft tissues also is an option (Fig. 2) as is removing the implant restoration, submerging the osseointegrated enossal implant portion, and fabricating a resin-bonded or conventional fixed dental prosthesis. Removing the implant and either augmenting for staged implant placement or performing an alternative restorative treatment (resin-bonded or conventional fixed dental prosthesis) also is an option.

Segmental osteotomy was described in the 1970s as a way to correct the position of teeth that could not be moved orthodontically.20,21 More recently, several case reports documented its application for surgical implant repositioning.19,22 Distraction osteogenesis combines the segmental osteotomy with a subsequent slow movement along a fixed appliance to overcome the limited stretchability of the deficient soft tissues and, therefore, to facilitate a greater translocation of the mobilized segment. This procedure was originally developed to reconstruct vertical alveolar bone defects accompanied by continuous soft tissue expansion23 and also has been used to relocate an infrapositioned dental implant when the soft tissues have to be enlarged simultaneously through continuous gradual traction of the bony segment.24,25 An interdisciplinary approach that uses an external distractor stabilized with an orthodontic arch wire and that involves the maxillofacial surgeon, the orthodontist, and the restorative dentist is described with reference to a patient with progressive implant infraposition.

#### CLINICAL REPORT

A 24-year-old woman reported dental trauma with avulsion of the left maxillary central incisor at the age of 7

---

**Table 1. Treatment options for infrapositioned dental implants**

<table>
<thead>
<tr>
<th>Extent of Infrapositiona</th>
<th>Treatment Option</th>
<th>Indication</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>None or mild (&lt;0.5 mm)</td>
<td>Stabilization (fixed retention)</td>
<td>Craniofacial growth has slowed down</td>
<td>Risk of open anterior occlusion or anterior-posterior step in mandible</td>
</tr>
<tr>
<td>Moderate (≤1 mm) or severe (&gt;1 mm)</td>
<td>Adjustment or replacement of implant restoration (and/or adjacent teeth)</td>
<td>Restoration and/or adjacent teeth allow for modifications</td>
<td>Minimally invasive adjustments</td>
</tr>
<tr>
<td>Severe (&gt;1 mm)</td>
<td>Surgical implant repositioning (segmental osteotomy) possibly with distraction</td>
<td>Sufficient width of bony septa required (≥3 mm); when soft tissue enlargement is required</td>
<td>Prolonged treatment time</td>
</tr>
<tr>
<td></td>
<td>Submerging implant</td>
<td>Segmental osteotomy not feasible and/or implant removal not indicated</td>
<td>Risk of soft tissue perforation and infection; more predictable with 2-part implants that enable removal of transmucosal portion</td>
</tr>
<tr>
<td></td>
<td>Implant removal</td>
<td>Augmentation and staged implant placement and/or alternative restorative treatments</td>
<td>Extended ridge defects, prolonged treatment time</td>
</tr>
</tbody>
</table>

aClassification according to Jemt et al,7 based on clinical assessment in sagittal dimension.
years. The tooth had been repositioned but was removed 3 years later because of external resorption and ankylosis. At the age of 14 years, skeletal growth ceased, and an implant (Standard plus, regular neck, 10 mm length; Straumann AG) was placed at the age of 17 years. After soft tissue grafting, the implant restoration was delivered at age 18 years. Six years later, the patient noticed that the implant restoration was no longer in occlusion and that the implant shoulder was exposed, with gingival recession. Moreover, the adjacent teeth were now lingual to the implant crown.

A clinical and radiographic examination revealed that the implant infraposition was 2 mm sagitally (vertical) and 3 mm facially. The gingival recession at the crown margin amounted to 4 mm (Fig. 3A-C). The width of the bone septa on the mesial and distal measured 4 mm and 3 mm, whereas the bone that was apical to the implant measured only 3 mm, which is the minimum for segmental osteotomy.26 Presurgically, a multibracket appliance was fixed from canine to canine to level the anterior dentition and to resolve the lingual displacement of the adjacent teeth. After 1 month, a 0.017×0.022 stainless-steel wire with an apical bypass in the area of the implant restoration was inserted. With the patient under

Figure 1. Patient (age 32 years, 7 years after implant placement) with severe infraposition (2.5 mm) of implant at right central incisor position. Treatment planning comprised new restorations of both central incisors with preceding gingivectomy on facial aspect of left central incisor. A, Frontal view of clinical situation. B, Periapical radiograph. C, Maxillary anterior teeth assessed for esthetics.

Figure 2. Segmental osteotomy of bone surrounding infrapositioned implant (left lateral incisor position) with parallel vertical incisions in preparation for osseodistraction.
local anesthesia, surgical access was accomplished by a mesial and distal trapezoidal incision from the mucogingival margin to the vestibule, and preserving the papillary structure. Soft tissues were mobilized by a tunneling preparation that protected the periosteum layer that covered the implant segment. A segmental osteotomy with parallel vertical incisions was performed with a rotating surgical fissure bur and further extended through the medullary and palatal bone with thin osteotomes or chisels until the segment was mobilized. No access was made from the palatal side to ensure adequate vascularization. To avoid bone obstructions during movement of the segment, the vertical osteotomies should be positioned parallel or even convergent to the apical region.27 A custom-made external distraction device (Orthognathics GmbH) was adhesively cemented to the buccal surface of the implant crown and to the heavy steel orthodontic arch wire with light-polymerizing composite resin (Fig. 3D). The distractor position and alignment, which determines the vector of movement of the

mobilized bone segment, should be planned according to
the required direction of displacement. 27
After a 7-day latency period for callus formation, the
distraction of the implant-osseous block was initiated
with 0.3 mm of activation per day. The distraction pro-
cedure was monitored for 2 weeks until an implant
extrusion of 4 mm with a palatal inclination of 4 mm was
achieved. The palatal surface and incisal edge of the
implant restoration were continuously adjusted to avoid
occlusal interference. When the definitive position was
reached, the distractor was removed and replaced with a
bracket to facilitate small alignments with a 0.016×0.022
Sentalloy wire (Dentsply Intl) for another 2 weeks.
The fixed appliance and a 0.019×0.025 titanium-
molybdenum alloy wire (Ormco) were then used to
retain the distracted implant during the consolidation
period of 3.5 months until bone healing was complete.
After debonding the fixed orthodontic appliance, a splint
retainer was used for interim stabilization during the
restorative treatment.

The implant restoration and the angulated abutment
were removed, and an impression was made at the
implant level. An individualized angulated titanium
abutment was combined with a zirconia coping to avoid a
grayish discoloration in the marginal area and to facilitate
an optimal contour of the crown margin along the un-
dulation of the gingival margin. After clinical evaluation,
the zirconia coping was adhesively cemented to the
abutment by the laboratory technician. This abutment
was then inserted by applying 30 Ncm torque with a
temporary fixation on the adjacent teeth (Fig. 3E). The
screw access was plugged with a small piece of cotton
and white gutta percha (Dentsply Intl). A ceramic crown
(IPS e.max; Ivoclar Vivadent) was adhesively cemented
(RelyX Unicem; 3M ESPE) and excess cement removed.
A fixed wire retainer was cemented onto the palatal
surfaces from canine to canine to ensure adequate
retention (Fig. 3F-H).

SUMMARY
Because of the potential for complications from infra-
positioning, single-tooth implants in the maxillary
anterior should be postponed until mature adulthood. If
implant infrapositioning occurs, then surgical segmental
osteotomy, combined with orthodontic distractor fixa-
tion, distraction osteogenesis (osseodistraction), and
restorative treatment, is a valuable option for main-
taining the particular implant and improving the soft
tissue contour.

REFERENCES
Osseointegrated implants for single-tooth replacement: a prospective 5-year
2. Kawanami M, Andreasen JO, Borum MK, Schou S, Hjorting-Hansen E,
Kato H. Infraposition of ankylosed permanent maxillary incisors after
3. Cronin RJ Jr, Oesterle LJ, Rainly DM. Mandibular implants and the growing
Fracture resistance of three porcelain-layered CAD/CAM zirconia frame designs

Ferrari M, Giovannetti A, Carrabba M, Bonadeo G, Rengo C, Monticelli F, Vichi A
Dent Mater 2014;30:e163-8

Objectives. Chipping is the most frequent clinical failure of zirconia crowns. Causes of chipping have not been completely understood and different possible reasons have been considered. The study was aimed at evaluating the fracture resistance of 3 different CAD/CAM zirconia frame designs veneered with porcelain.

Methods. Thirty extracted sound premolars were divided into 3 groups (n=10). Chamfer preparations were performed, impressions were taken. Three zirconia frame designs (Aadva, GC) were realized: reproduction of the abutment contour (flat design, FD); wax-up as for porcelain-fused-to-metal crowns (PFM); anatomically guided, designed to keep constant the thickness of the overlying porcelain veneering (AG). Porcelain veneering was made with pressure layering technique (Initial Zr, GC). Crowns were cemented utilizing a self-adhesive resin cement (G-Cem, GC). After a 24-h water storage at 37°C, crowns were loaded in the central fossa in a direction parallel to the longitudinal axis of the tooth. Load at fracture was recorded in Newtons (N). Digital photographs of the specimens were taken in order to assess failure patterns. Between-group differences in fracture strength were statistically analyzed (One-Way Analysis of Variance, Tukey test, p<0.05).

Results. Load at fractures differed significantly among the groups (p=0.004). AG exhibited significantly higher fracture resistance 1721.6 (488.1) N than PFM 1004.6 (321.3) N and FD 1179.5 (536.2) N, that were comparable. Repairable failures occurred in 80% of AG, 70% of PFM, and 50% of FD specimens.

Significance. Anatomically guided zirconia frames resisted significantly higher loads than flat and PFM-like frame designs.