ORIGINAL ARTICLE

Do palatal implants remain positionally stable under orthodontic load? A clinical radiologic study

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Introduction: The aim of this study was to determine the positional stability and success rate of palatally placed length-reduced temporary anchorage devices (LRTADs) (length, 4 or 6 mm). **Methods:** Twenty-two patients (ages, 21-62 years; 14 women, 8 men) were enrolled in the study. Each received 1 LRTAD (Orthosystem, Straumann, Switzerland) placed in the midsagittal palate for multifunctional anchorage tasks. Standardized cephalograms were taken directly after implant placement and at the end of treatment to analyze any implant movements. The cephalometric tracings were superimposed on anterior nasal spine to posterior nasal spine in posterior nasal spine to analyze changes in implant angulation and position during treatment. The LRTADs were also evaluated clinically for mobility. **Results:** Two of 22 implants showed mobility during the healing period (first 10-12 weeks after placement). Thus, the success rate was 91%. The remaining 20 palatally placed LRTADs had no mobility during healing (10-12 weeks) or the loading period (18 months 1 week) and were evaluated radiographically. The mean differences between the initial and final cephalometric evaluations (n = 20) were 0.5° for changes in implant angulation and −0.6 mm for changes in implant position. These changes were most likely due to inaccuracies in cephalometric landmark identification rather than to LRTAD movements because no mobility was recorded. **Conclusions:** One palatally placed LRTAD was sufficient for multifunctional stationary anchorage tasks in the maxilla under clinical loading conditions. The success rate was 91%. Implant loss occurred during the healing period. (Am J Orthod Dentofacial Orthop 2009;136:695-9)

Temporary anchorage devices (TADs) have been developed to establish stationary anchorage conditions.[1] They can be placed in various anatomic sites: interradicular, supra-apical, retromolar, and palatal. TADs can be classified into 2 groups: diameter-reduced TADs (DRTADs) (compared with conventional dental implants)[2-8] and length-reduced TADs (LRTADs) (compared with conventional dental implants).[9-14]

The median and paramedian regions of the anterior palate have been used as suitable placement sites for LRTADs because of practical clinical considerations.[9-14] The reason is that bone support available in the median and paramedian palate might be relatively low.[15] In this case, DRTADs (length, 6-12 mm) are not the devices of choice because they might perforate the nasal cavity. Perforation of adjacent anatomic structures such as the nasal cavity for only orthodontic anchorage purposes should be avoided because of potential risks and legal aspects.

An important factor for the use of TADs is positional stability under orthodontic load due to osseointegration. With respect to LRTADs (palatal implants), clinical parameters such as implant mobility and sound on percussion have been used to analyze whether an implant is osseointegrated.[10-14] Immobility and a clear crystalline sound on percussion were interpreted as signs of osseointegration of implants.[16] These criteria, however, do not absolutely prove whether implants (especially DRTADs and LRTADs) retain their position under long-term orthodontic loading conditions in clinical practice. Implants might appear to be immobile even if they have only some direct bone-to-implant contact.[16] Whether immobility indicates positional stability of LRTADs under long-term orthodontic loads is not clear.

Our aim in this study was to analyze with radiologic measurements in cephalograms before and after orthodontic loading whether LRTADs of 4 or 6 mm in length remain positionally stable under long-term orthodontic loading conditions. In addition, clinical parameters were investigated and compared with the radiologic results.

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MATERIAL AND METHODS

Only patients who had completed growth and whose treatment plan required stationary anchorage were considered for participation in the study. They were told about the different conventional (intraoral and extraoral) and skeletal anchorage devices to establish stationary anchorage conditions. With respect to skeletal anchorage devices, the patients were informed about the treatment options with miniscrew (DRTAD) or palatal implant (LRTAD) anchorage. Twenty-two patients decided to have 1 palatal implant plus supraconstruction (eg, transpalatal arch, implant anchored pendulum). Because of the anchorage needs (see orthodontic indications), 2 or more miniscrews would have been necessary. The patients were 21 to 62 years of age (8 men, 14 women).

Orthodontic indications for stationary maxillary anchorage by palatal implants (LRTADs) in the sagittal and vertical plane were (1) stationary anchorage of posterior teeth for anterior tooth retraction or torque after bilateral premolar extraction (bilateral Angle Class II malocclusion: n = 10), (2) stationary anchorage of posterior teeth for anterior tooth retraction or midline correction after unilateral premolar extraction (unilateral Angle Class II malocclusion: n = 1), (3) bilateral distalization of posterior teeth followed by anterior tooth retraction (bilateral Angle Class II malocclusion: n = 5), (4) unilateral distalization of posterior and anterior teeth to achieve symmetric conditions before bimaxillary surgery in a skeletal Class III patient (n = 1), (5) protrusion of anterior maxillary teeth and mesialization of posterior teeth (Angle Class III malocclusion, n = 2), (6) control of vertical dimension of posterior teeth for intrusion of anterior teeth in a periodontally compromised dentition (elongated anterior teeth, n = 1) or palatally impacted canine elongation (n = 1), and (7) stationary anchorage of anterior teeth to mesialize the posterior teeth (missing second premolars of permanent dentition, n = 1).

After the diagnostic procedures and implementation of the treatment plan, the initial cephalogram was analyzed with respect to the vertical bone support available in the prospective implant site as described by Wehrbein et al.[17] So that the nasal cavity would not be violated, 6 patients received a implant 4 mm in length, and 16 patients an implant 6 mm in length (Orthosystem, Straumann, Switzerland).

Placement was carried out under local anesthesia and involved the following steps: removal of soft tissue with a punch, predrilling of the implant cavity with a spiral bur, drilling the implant bed with a countersink, and manual placement of the self-cutting implant with a wrench. All measures were carried out under irrigation with sterile saline solution. In no patient did probing of the bony cavity before implant placement show perforation to the nasal sinus.

After a mean implant healing period of 10 weeks, impressions were made and laboratory work carried out to fabricate the suprastructures. These consisted of palatal implant anchored transpalatal or unilateral palatal bars and pendulum appliances. Thus, both indirect and direct implant anchorage was used. After 1 to 2 weeks, the suprastructures were integrated. They were screwed to the palatal implants. Thereby, rigid 3-dimensionally stable anchorage units were created. The mean unloaded implant healing period was 11.4 weeks. In some patients, the suprastructures had to be modified during treatment: eg, stationary anchorage of posterior segments for anterior tooth protrusion and premolar mesialization followed by anterior tooth or premolar anchorage for posterior tooth mesialization.

The following force systems were used: (1) open or closed-coil springs (activated to traction and compression, respectively) or elastic chains for tooth movements in the horizontal plane (mesialization or distalization of posterior teeth, retraction, and protrusion of anterior teeth), with the magnitudes of force between 1.5 and 2 N; (2) segmented arch technique for intrusion and torque movements of anterior teeth, and the force magnitude of the segmented arches for intrusion or extrusion was adjusted to 0.8 to 1 N; and (3) pendulum appliance for distalization of posterior teeth, with the lever arms (springs) of the appliance exerting a force of 1.5 N per spring.

The force magnitudes were measured during placement of the force system by a spring balance (Correx, Haag Streit, Switzerland).

The analyzing parameters were (1) implant mobility (1, immobile; 2, mobile), (2) sound on percussion (1, clear crystalline; 2, subdued), (3) implant angulation (angle between anterior nasal spine (ANS) and posterior nasal spine (PNS) and the implant axis), and (4) implant position (distance between the implant axis and PNS on the line ANS-PNS in millimeters).

Implant angulation (in degrees) was measured as the anterior superior angle between the implant (line through the anterior implant border) and the palatal plane (ANS-PNS). Implant distance was measured between PNS and the line through the anterior implant border on ANS-PNS. For this purpose, a calibrated slide gauge was used (nearest 0.1 mm). The Figure shows the measurement methods.

Lateral cephalograms were taken directly after implant placement (T1) and then after active orthodontic treatment (T2) shortly before implant removal. The