Abstract

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Anatomically and biomechanically anchored: optimal TAD positioning for three-dimensional control in aligner treatment

The integration of temporary anchorage devices (TADs) expands the biomechanical possibilities of aligner treatment and enables three-dimensional control of complex tooth movements. In this context, anatomically and biomechanically optimised positioning is crucial for stable force systems and predictable treatment outcomes. Palatal TADs take advantage of the high cortical bone quality in the paramedian palatal region, provide reliable primary stability with minimal risk to anatomical structures, and are particularly suitable for controlled intrusion, distalisation, and transverse movements in the maxilla. Through targeted vector control close to the centre of resistance, tipping moments can be reduced and translational movements facilitated.

TADs in the mandible (buccal shelf) provide extra-alveolar anchorage and enable efficient sagittal control, particularly in distalisation strategies and Class III treatments. The position away from the tooth roots allows the application of higher forces and reduces dento-alveolar side effects.

Computer-aided design and computer-aided manufacturing (CAD/CAM) technology form the basis for precise three-dimensional planning. By combining cone beam computed tomography (CBCT), intraoral scanning, and a digital setup, TAD positions can be defined virtually, placed using surgical guidance, and biomechanically integrated into aligner planning.

Overall, the strategic use of palatal and mandibular TADs in CAD/CAM-supported aligner treatment is an effective approach to achieving complex tooth movements in a controlled, efficient, and clinically predictable manner.