International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor (2018): 7.426

Advanced Methods of Total Arch Distalization in Orthodontics: A Literature Review

Sharath Kumar Shetty[1], Mahesh Kumar Y[2], Lekshmi G Vijayan[3], Vijayananada K Madhur[4]

[1]Professor and HOD, Department of Orthodontics and Dentofacial Orthopaedics, K V G Dental College and Hospital, Sullia, Karnataka, India
[2]Professor, Department of Orthodontics and Dentofacial Orthopaedics, K V G Dental College and Hospital, Sullia, Karnataka, India
[3]Post Graduate student, Department of Orthodontics and Dentofacial Orthopaedics, K V G Dental College and Hospital, Sullia, Karnataka, India
[4]Reader, Department of Orthodontics and Dentofacial Orthopaedics, K V G Dental College and Hospital, Sullia, Karnataka, India

Abstract: ***The treatment of skeletal malocclusion often needs repositioning of maxillary or mandibular arch. Unlike the conventional means of resorting to orthognathic surgery, current technology enables predictable displacement of entire dental arch. The aim of this review article is to conduct a review of current literature to update the knowledge about advanced methods of total arch distalization in orthodontics.***

Keywords: full arch distalization, mini screws

1. Introduction

In contrast to conventional biomechanical concepts in orthodontics where a segment of teeth has been the target of orthodontic movement, current technology enables predictable displacement of the whole arch, mainly based on the relationship between the center of resistance of entire dental arch and the location of the force vector.[1]

The clinical implication of the so-called 'total arch movement' includes efficient tooth movement without round-tripping during treatment, compliance-free treatment and higher possibility of non-surgical and/or non-extraction treatment in non-growing subjects.[1]

Location of the center of resistance

Center of resistance of entire dental arch was localized at the mesial side of the 2nd premolar in the maxillary arch, and at the interradicular area between the 2nd premolar and the 1st molar in the mandibular arch respectively.[1]

For instance, a rotational movement would be resulted by a line of force passes far from the center of resistance, which a force vector that runs through the center of resistance would lead to translation of the dental arch in the horizontal and/or vertical direction.[1, 2, 3, 4]

Current evidence of total arch movement

Numerous designs for molar distalization appliances have been reported in the literature including the Hilgers pendulum appliance, the Cetlin headgear and removable appliance, the Jones jig distalization apparatus, and open nickel-titanium (NiTi) push coils. Most of these devices suffer from a loss of anterior anchorage and relapse after removal of the distalization appliance.[5, 6, 7, 8, 9]

The concept of simultaneous movement of the whole dental arch has already been in clinical use for more than a decade. Sugawara et al introduced the use of miniplates for respective maxillary or mandibular molar distalization without causing undesired movement of incisors[1, 10]

Bechtold et al found an intrusion of the whole dental arch using dual interradicularminiscrews in the maxilla. Additional force vector created by interradicularminiscrew positioned between the 1st and 2nd premolar changed the relationship between the imaginary centre of resistance of the whole arch and the line of force, leading to simultaneous upward and backward displacement of the entire dental arch.[16]

Multiple interdental screws for distalization

The distalizing force applied from a single mini screw inserted at the level of mucogingival junction between the first molar and second premolar can result in total distalization of the maxillary dentition. But may result in mild clockwise rotation of occlusal plane. Thus to overcome this biomechanical issue and to induce a "total impaction like effect" additional mini screws are to be inserted between the premolars to create a line of force that passes near the center of resistance of maxillary arch. Thus by using two mini implants placed between premolars and between second premolar and first molar, full arch distaization of maxillary and mandibular arch can be achieved.[17]

Disadvantage

Placement of mini screws between the interradicular spaces can result in interference with the distalization process, and mini screw might require relocation during distalization.[18]

Timely relocation of mini implants for uninterrupted full arch distalization

Entire dental arch can be more effectively distalized by planning the procedure in two phases

1) Distalizing the maxillary 1st and 2nd molar by using mini implants placed mesialy to the maxillary first molar to achieve a class 1 molar relationship
2) Repositioning the same mini implants between the newly distalized maxillary first and second molar to retract the anterior dental segments (premolar, canine and incisors)

Advantage:
Technique helps to reduce the cost of multiple mini implants during treatment progress

Disadvantage:
1) The bone quality of the new position can be questionable in achieving optimal primary stability because of the recent bone remodelling in the maxillary molar distalization
2) The new position is more distal than the original mini implant position, its placement and instrument accessibility might be more challenging for replacement.[5]

Bone screws (IZC&Buccal shelf) for distalization
Bone screws can be used for full arch distalization of maxillary and mandibular dentition to camouflage a ClassII or ClassIII malocclusion and for distalization of an arch in retreatment a case of anchorage loss which are otherwise difficult to be done with a regular micro implant or is time consuming.[21]

Bone screws are generally placed in areas of DI(>1250HU) quality bone and therefore requires greater fracture resistance. Stainless steel is preferred than Ti for bone screws since it provide greater fracture resistance.

Buccalshelf bone screws can also be placed in the external oblique ridge of the mandible if buccal shelf area is found to be too thin or deep.`[19]

Biological limit of distalization with orthodontic bonescrews Maxillary arch :
The limits of distalization follow the Rickett's criteria (age-dependent and sagittal distance from the pterygoid vertical). Ideally fully erupted third molars are to be removed to create space and aid in the distalization process. For un-erupted third molars placed below the cement-enamel junction of the 2nd molars in young individuals, distalization is possible without their extraction if the criterias are full filled, extractions are however indicated at a later date to prevent relapse.

Mandibular arch:
Limit of distalization is the proximity of the roots of the 2nd molar to the lingual cortical plate (angle of inflection).For distalization in mandibular arch; almost invariably 3rd molar extraction is mandatory.[21]Placement of Bone Screws

Maxilla
For placement of bone screws in the IZC (1st and 2nd molar region) – initial point of insertion is inter-dentally between the 1st and the 2nd molar and 2 mm above the muco-gingival junction in the alveolar mucosa. The self-drilling screw is directed at 90° to the occlusal plane at this point. After the initial notch in the bone is created after couple of turns to the driver, the bone screw driver direction is changed by 55°–70° toward the tooth, downward, which aid in bypassing the roots of the teeth and directing the screw to the infra-zygomatic area of the maxilla. The bone screw is screwed in till only the head of the screw is visible outside the alveolar mucosa. No pre-drilling, raising of flap or vertical slit in the mucosa is required for insertion of IZC screws. Immediate loading is possible and a force of up to 300–350 g can be taken up by a single bone screw.[19, 20.]

Mandible
For placement of bone screws in the BS area of mandible (2nd molar region), initial point of insertion is inter-dentally between the 1st and the 2nd molar and 2 mm below the mucogingival junction. The self-drilling screw is directed at 90° to the occlusal plane at this point. After the initial notch in the bone is created after couple of turns to the driver, the bone screw driver direction is changed by 60°–75° toward the tooth, upward, which aid in bypassing the roots of the teeth and directing the screw to the buccal shelf area of the mandible. In the mandible, however, sometimes pre-drilling or vertical slit in the mucosa is necessary if the bone density is too thick, however, raising of flap is never required. Immediate loading is possible and a force of up to 300–350 g can be taken up by a single bone screw.[19.20]

Biomechanical Perspectives and Arch Form Considerations for Distalization with Bone Screws
Extra-radicular bone screws are safer and provide greater stability when full archdistalization is done. The negative side effects of retraction with bone screwsare lesser as compared to mini-implant retraction – like development of posterior openbite and anterior deepbite. Due to the very position in which bone screws are placed-the point of application of force is more parallel and close to the occlusal plane which reduces the chance of occlusal plane rotation so commonly associated with mini-implant supported retraction. However, the height of the hook and the vector of force from the bone screw still determine the overall control on the occlusal plane. With respect to arch form considerations – bone screw-supported retraction has serious implications. Since the force is applied from a more buccally positioned anchorage unit the chances of rolling in of molar is higher, which needs to be compensated with an expanded archform or a torque in the wire whichever is suitable for the clinical situation.[19, 20]

Advantages
1) No risk of root contact
2) Hardly any complication associated with insertion process of bone screw except for minor bleeding.
3) Less chances of occlusal plane rotation and development of posterior openbite and anterior deep bite compared to mini screws.
4) Stability and success rate of bone screw are far more superior purely because of their larger dimension and placement site having excellent quality of cortical bone[22]

Disadvantage
Chances of gingival over growth on screws

Modified C Palatal Plate for distalization(MCPP)
MCPP is a distalization appliance with a large range of action that can be easily placed without raising a flap. Three mini screws with a palatal bar with 2 hooks extending along the gingival margins of the teeth connecting to maxillary first molar. Immediately after placement, distalization can be initiated by engaging elastics.

Advantages:
Significant greater distalization and intrusion with a smaller amount of distal tipping of first molar can be achieved with MCPP compared to buccal mini screws.[24, 25]

Mini plates for distalization
In cases requiring complete retraction of the arch (symmetrical or asymmetrical, maxillary or mandibular), anchorage miniplates offer an ideal complement to miniscrews. They avoid possible interference with the roots of teeth being displaced and, with their force application point located close to the arch center of rotation; the movement induced will be effective, continuous and reliable. No cooperationis required of the patient. Maximum efficacy is achieved even with asymmetrical retractions.[26]

Perforated miniplate can be fixated using long osseosynthesis screws. This plate is fixated above the roots and can be shaped to fit the anchorage area. The screws are inserted only in the cortical part of the supporting bone, thus avoiding any interference with underlying anatomical obstacles, especially teeth. Depending on the insertion area and the treatment requirements, this plate will be vertical and L-shaped or horizontal and either L- or T-shaped (Fixation is achieved using two or three screws, according to need.[26]

Mandibular total arch distalization using a ramal plate
The placement of single retromolarmini screw on each side may not be sufficient to withstand the force required for full arch distalization. A case report described the use of ramal plates placed in the retromolar fossa between the anterior border of the mandibular ramus and temporal crest. After a mucoperiosteal flap opening was created in the retromolararea, L plate was adapted to fit the bone surface. The hook on the plate was located 3mm lateral to the buccal surface of the second molar between the buccal groove and 3mm anterior to the distal surface anteroposteriorly. Third molars were extracted during plate installation. Each plate was fixed with two mini screws 5mm in length(with pilot drilling).Efficient total arch distalization was achieved without significant change in the vertical position of mandibular molars nor in the mandibular plane angle.[18]

Ramal plane can be considered a viable treatment option for mandibular total arch distalization in Class III patients who are reluctant to undergo extraction or orthognathic surgery.[18]

2. Conclusion

The current technology in orthodontics enables predictable displacement of both maxillary and mandibular arches with minimal patient compliance, unlike the conventional orthodontic biomechanics where majority of tooth movement resulted from reciprocal traction. The introduction of temporary anchorage devices have changed the paradigm of orthodontic biomechanics by help converting many border line surgical cases to non surgical cases and extraction cases to nonextraction and even bringing about esthetic impact which was difficult to be achieved by conventional mechanics.

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