Anchorage Control During Canine Retraction: Wire Bending, Distraction Osteogenesis or TADS?

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INTRODUCTION

This article aims to present and compare different techniques used to provide maximum anchorage during canine retraction in extraction cases. The techniques commonly used may include wire bending to provide maximum anchorage; surgical techniques to facilitate canine retraction using distraction osteogenesis (DO); or temporary anchorage devices, or TADs. The differential moment concept has been introduced many years ago and has been proven to provide anchorage control during canine retraction. According to Profit (1999), orthodontic anchorage is defined as the resistance (to applied forces) that is provided (usually) by other teeth, or (sometimes) by the palate, head or neck (via extraoral force), or by implants in bone. Intraoral sources of anchorage include alveolar bone, individual teeth, dental arches, the palate and mandibular basal bone, as well as the lip and masticatory musculature. The availability of groups of teeth to serve as anchorage units against teeth that are to be moved when orthodontic forces are applied may be directly related to the success of the case. Moreover, the resistance of the anchorage unit must be greater than that offered by the teeth to be moved, otherwise the anchorage will be displaced and the teeth will not move in the desired direction. In extraction treatment, especially in maximum anchorage cases where the extraction sites are to be closed by retraction of the anterior segments, some type of anchorage usually prevents the posterior segments from moving forward. The traditional anchorage augmentation may include a transpalatal bar, a Nance holding arch, or extraoral traction, depending on the needs of the case. It is generally accepted that unless an additional posterior force is directed to the anchor units, maximum anchorage cannot be achieved. Patient compliance then becomes an important factor in achieving an optimal treatment outcome.

DIFFERENTIAL MOMENTS AND ANCHORAGE CONTROL

With the increased demand for noncompliance devices to achieve maximum anchorage, there is a need for a substitute for the conventional headgear and other patient-dependent devices. Maximum anchorage can be achieved without adjunctive appliances by using differential moments; this can be especially helpful in non-compliant patients who are opposed to headgear wear. The differential moment concept is applied, for instance, with the bioprogressive technique, where a utility arch wire is used in extraction cases to control molar tipping. (Mulligan TF, (1982) and Rajcich MM and Sadowsky C (1997)). Differential moment mechanics utilizes the concept of multiple teeth on the anchorage side to form large reactive units, with the belief that it is possible to control anchorage solely with intra-arch bends without adjunctive appliances. A “partial strap-up” can be used where the only teeth banded/bonded are the anchor tooth (molar) and canine on each side of the arch. Canines are retracted on round wire. The placement of an off-center bend creates anchorage; the bend being closer to the molar on each side. Differential moments are thereby produced; mesial root moment of the anchor unit being the strongest and distal root moment on the non-anchor unit the weakest. Because the off-center bend and the resulting mesial root torque mesial displacement of the molar requires bodily movement of that tooth, this in turn increases the anchorage. As space closure progresses, the bends become more centered, resulting in equal and opposite moments on the adjacent teeth, and this gradually produces root parallelism (Rajcich MM and Sadowsky C (1997). It is recommended to use lingual elastics or toe-in bends with this technique to control rotations of the teeth in the horizontal plane. Possible side effects may, however, result from undesirable vertical and transverse forces.

It has been demonstrated clinically and cephalometrically that by using differential moments without auxiliary appliances, canines can be retracted completely with no or minimal anchorage loss in the range of 0.28-0.6 mm virtually undetectable clinically (Hart et al., (1992). With the great advances in orthodontic technology and the tendency of most orthodontic clinicians to depend less and less on patient cooperation, headgear has become more or less obsolete for obtaining maximum anchorage. It is still, however, an important tool in cases where growth modification is needed.
**Figure 1.**

Differential moments using v-bends in the main archwire as well as in the overlay wire for anchorage control during maxillary canine retraction

**Distraction Osteogenesis (DO) and Anchorage Control**

Distraction osteogenesis (DO) is the technique for developing new bone in-between two bony segments that are separated mechanically at a constant rate. While Codivilla first reported the technique in 1905, it was not until 1988 that Ilizarov popularized it. The first application of DO in the craniofacial region was reported experimentally by Snyder in 1973, and since then it has become an accepted technique for craniofacial bone lengthening in selected cases. In 1998 Liou and Huang published the first report on the use of this technique to facilitate canine retraction in extraction cases and then Kisnisci et al. (2002) published a report. Liou and Huang used an osteotomy technique of the first premolar extraction socket and reported that minimal root resorption was observed. Kisnisci et al, on the other hand, used a more invasive technique that involved removal of the cortical plate buccal to the extracted first premolar. With this technique, they found no root resorption and that the canine had moved distally in a bodily movement. The basic advantage in using DO for canine retraction is twofold: first, it retracts the canine very fast and shortens the treatment time; second, it prevents forward movement of the anchor teeth, thereby achieving maximum anchorage utilizing all the extraction space for the canines. The potential risks of using this technique include root injury during surgery with the required osteotomy and root resorption due to the fast tooth movement. Long-term evaluations of the results of DO treatment have not yet been published. In addition, this technique also necessitates surgical intervention that may not be acceptable to all patients regardless of the benefit of finishing treatment in a shorter time. Moreover, canine retraction by DO requires a special distraction device that adds additional costs to the patient. This might further refute the idea of finishing the orthodontic treatment faster than with conventional orthodontic techniques.

Corticotomy-assisted orthodontic tooth movement has been the widely accepted technique nowadays to facilitate tooth movement and preserve posterior anchorage. In a recent clinical trial corticotomy, assisting tooth movement during conventional orthodontic treatment was compared to retracting the front teeth through anterior segmental osteotomy, in cases of dentoalveolar protrusion (Lee et al, 2007). The authors concluded that anterior segmental osteotomy group showed the greatest amount of basal bone retraction, and the least amount of upper incisor inclination change and upper alveolar bone bending among the three groups. It can be argued that although corticotomy may facilitate tooth movements, true skeletal change can only be achieved with segmental osteotomy.

**Temporary Anchorage Devices (TADs)**

In 1969, Linkow first introduced TADs in orthodontics and they have since been applied using different systems and techniques. There are many recent publications, discussions, conferences and workshops that highlight the use of mini-screws as TADs to achieve maximum anchorage. However, it is advisable for orthodontists that support the use of TADs to consider several important issues. For example, there are potential psychological concerns, as patients will need anesthesia for TAD placement and removal. Other concerns include potential risks of root injury, failures of the TADs, and possible malpractice litigation that might follow TAD failure. A recent article by Kravitz and Kusnoto (2007) highlighted the types of complications related to the use of mini-screws in orthodontics. In their summary, they reported four types of complications: complications during insertion; complications under orthodontic loading; soft tissue complications; and complications during mini-screw removal. The complications during insertion involve trauma to the periodontal ligament or dental roots; mini-screw slippage; nerve involvement; air subcutaneous emphysema; nasal and maxillary sinus perforation; and mini-screw bending, fracture, and torsional stress. The complications under orthodontic loading included stationary anchorage failure and mini-screw migration. Soft tissue complications included aphthous ulceration, soft tissue inflammation, infection, and peri-implantitis. Complications during removal included mini-screw fracture and partial osseo integration that can complicate the removal process. They concluded that patient selection and training of the orthodontist are important factors to consider before using mini-screws or TADs in orthodontics. Because of these
potential complications when using TADs, special consent forms should be presented to patients who might need TADs. In this context we should remember that there is no need for patients to sign special consent forms when using creative wire bending to obtain maximum anchorage.

It might be inferred from the existing literature that easy orthodontics is still not always possible. It is still important to reinforce the understanding and practice of biomechanics as well as wire bending in orthodontics to achieve excellent results. This is particularly important for the orthodontist for patients where maximum anchorage is needed and the use of DO or TADs is contra-indicated.

**Figure 2.**

**CONCLUSION**

Recent advances in alternative techniques aimed at either facilitating canine retraction by the use of DO, or maximizing canine retraction using TADs to minimize or prevent posterior anchor loss, are associated with concerns regarding their side effects. The orthodontist should be realistic when deciding to use either of these developing techniques (DO or TADs) and weigh their risks and benefits. It is also important that orthodontists understand and are able to apply the traditional biomechanical principles that utilize differential moments for patients who are not good candidates for these new techniques. These basic biomechanical principles can still provide reliable methods for achieving maximum anchorage in situations where the use of these new techniques may not be appropriate.

**REFERENCES**