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Temporary Anchorage Devices: A Status Report

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Before the 2004 AAO meeting in Orlando, a group convened to discuss one of the hottest topics in orthodontics—skeletal anchorage or "temporary anchorage devices" (TADs). Hosted by 3M Unitek, the event featured a number of presentations by orthodontists who are using or developing these devices, particularly the new small-diameter implants rather than palatal implants, osseointegrated dental implants, or onplants. The two present authors also moderated a general discussion on relevant issues.

Presentations were made by Drs. George Anka (Japan), Axel Bumann (Germany), Jason Cope (United States), Antonio Costa (Italy), Dagmar Ibe (Germany), Hee-Moon Kyung (Korea; a prerecorded digital presentation), Birte Melsen (Denmark), and Dietmar Segner (Germany). Other participants included Drs. Yossi Bar-Zion (United States), John Bennett (England), Eugene Chan (Australia), Lars Christensen (England), Ali Darendeliler (Australia), Dennis Dionne (Canada), Marc Geserick (Switzerland), Onur Kadioglu (Turkey), Ahmet Keles (Turkey), Juliana Miller (United States), Robert Miller (United States), and Bjorn Zachrisson (Norway).

The overall objective of the meeting was to review the current status of TADs and the impact they may have on orthodontic treatment planning and execution. The open-ended question posed to the group was, "Are we adapting current procedures to new techniques, or are we trying to adapt new techniques to current procedures and materials?" Because the group felt strongly that the information discussed was useful, timely, and educational, we have provided the following summary of the consensus or lack thereof on certain issues.

Nomenclature

The term "temporary anchorage device" refers to all variations of implants, screws, pins, and onplants that are placed specifically for the purpose of providing orthodontic anchorage and are removed upon completion of biomechanical therapy (Fig. 1). Although there was no general agreement on one term to be used, it was noted that "mini-implant" is more appropriate than "micro-implant" from the perspective of scientific nomenclature, since "micro" is defined as 10^{-6}. The shape and design of these devices would make "screw" an appropriate name, but to avoid negative connotations, the group favored words such as "pin", "implant", or "device".

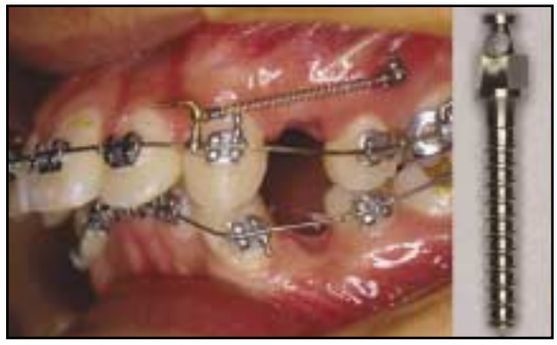

Fig. 1 Absoanchor* temporary anchorage device.

Regulatory Issues

The group was aware of TADs that have received European CE approval. Although the participants were unaware of the status of U.S. FDA approval, at least one TAD is available in the United States.** The group was pleased that outcomes of success and failure are being reported by developers and users of TADs, since these reports could be useful in determining safety and efficacy.

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Indications

Two major areas for use of TADs were discussed:

1. Correction of skeletal discrepancies.
2. Correction of dental discrepancies.

In the first category, clinical cases were shown where TADs were used to assist in the correction of anteroposterior and vertical discrepancies. In one case, TADs were used for direct intermaxillary fixation following orthognathic surgery. A common concern, however, was the stability of skeletal correction produced by TADs. Surgery is more likely to change neuromuscular imbalances, which may lead to a more stable correction, but its superiority over TADs has not been demonstrated in the literature. Although several cases of long-term success (more than two years) with TADs have been reported, the group called for more long-term stability studies.

Applications of TADs in the correction of dental discrepancies were shown for anteroposterior tooth movements, molar uprighting, and intrusion or extrusion of single and multiple teeth. In most cases, TADs were used to supplement dental anchorage; in some, however, they were used as the sole source of anchorage.

Overall, the group believed that there are many possible indications and applications for TADs, and that they can serve as an invaluable component of the orthodontic armamentarium. It was also noted that biomechanics need to be designed to optimize the use of TADs.

Some participants voiced skepticism about placing these devices in young, growing patients. The consensus was that use in a growing patient would not necessarily be contraindicated, but that studies on this topic would be important in broadening the scope of usage of TADs.

Design

There was a solid consensus on the design of TADs. A diameter of 1.2-2mm seemed to be adequate, although some manufacturers refer to the core diameter of the implant without threads, while others include the threads in their measurement. The major concern with devices of core diameters smaller than 1.2mm was breakage. A call was issued for slightly larger-diameter "emergency" implants that could be used in situations where a good mechanical interlocking does not occur with the threads of the planned implant.

The currently available lengths—generally about 6mm, 9mm, and 12mm—were considered suitable for most situations. A tapering, conical design was preferred over a straight screw.

The group favored a head design with an .022" slot for connection to the archwire. There was also a preference for designs that could be used for retention by stabilizing the archwire with light-cured composite. Another popular configuration was the O-ball head, with a retentive cap for rapid attachment and suppression of the soft tissue (particularly the mobile alveolar mucosa). It was believed that these head systems allow for good hygiene and stability, two important factors in the success of TADs.

The group agreed that skeletal anchorage devices should have smooth, polished surfaces. This is important both at the collar, to minimize irritation and inflammation of the gingival mucosa, and on the threads, to prevent osseointegration and allow easy removal.

Surgical Preparation

There was general agreement on placement techniques, including traditional administration of local anesthesia. The group did recommend that anesthetic not be used on the lingual surfaces

for a TAD being placed on the buccal, so that the patient would feel pain and react to warn the operator if the drill or the implant went in too far. Reportedly, anesthetic is not required for removal of about 90% of TADs.

The group felt strongly that the implant area should be cleaned and debrided prior to surgery. Patients should be asked to first brush and then rinse with chlorhexidine. If a circular tissue biopsy punch is used for the initial tissue penetration, it will leave clean-cut tissue margins that will closely approximate the collar of the TAD, preventing leakage and bacterial invasion. Participants found that tissue fragments contribute to plaque retention and leakage around the TAD, which can lead to inflammation and potential failure. In fact, inflammation was thought to be a more significant cause of failure than implant design.

The attached gingiva was preferred over the unattached gingiva, because it seemed more amenable to cleansing and provided better tissue adaptation around the TAD. Less inflammation had been observed from implants in this area. The group advised that extremely mobile tissues such as those around the frenum should be avoided. In any case, oral hygiene and home care were considered critical to success.

Prescription of antibiotics was not recommended unless there were a specific medical indication. It was emphasized that a proper surgical protocol, preventing contamination of the drills and TADs from other surfaces, should be used to ensure asepsis and optimal placement. In general, the participants did not prescribe anti-inflammatory drugs in conjunction with these procedures.

TAD Placement

There was no consensus on the relative superiority of pilot drilling vs. self-tapping TAD designs. The group believed, however, that drilling with "controlled RPM" was essential. A recommendation was made to use slow speeds (800-1,500 rpm) and low pressure against the bone. A discussion ensued on whether water-spray cooling was necessary, since the water does not reach the tip of the drill and the drill is relatively small. Regardless, it was felt that good surgical technique should be followed. One suggestion was to pre-cool the instruments before surgery.

Placement of TADs can be accomplished with:

1. Finger pressure and a screwdriver or thimble.
2. An adjustable torque wrench.
3. An electric handpiece with rotational and torque limits.

No particular preference was expressed for any of these methods. Although the amount of torque required to place a TAD has not been established, the group favored allowing a safety margin for the particular device being used. For example, if studies showed that a particular device fails at 25N of torquing force, a maximum of 20N should be used during placement to avoid breakage.

The group agreed that panoramic and/or periapical radiographs were acceptable for positional planning, although three-dimensional imaging would be ideal. The accuracy of two-dimensional radiographs could be improved by using wires or other markers. Although TADs should be placed perpendicular to the bone surface, this is not always possible, especially in areas of difficult access. Deviation of 10° from the perpendicular was considered acceptable, but deviation of 20° or more was not. The apical third of a tooth was favored for placement, because the roots are more tapered in this area and the alveolar bone thickness is greater. A post-operative radiograph was not generally considered necessary, particularly because two-dimensional images cannot show the true perspective and position of a device. Furthermore, surgical complications such as drilling into a dental root can be felt by the operator during placement, since the density of the root is much different from that of bone.

There was considerable discussion on whether orthodontists, oral surgeons, or general dentists should place TADs. It was agreed that the orthodontist is in by far the best position to

understand the case, the biomechanics, and the optimal placement sites. Another benefit would be a reduction in the number of appointments required. TAD placement fees reported by the group ranged from no additional patient cost (with the service included in the overall treatment fee) to around $200. The cost of a TAD to the orthodontist ranges from about $30-60. Orthodontists with experience in TAD placement indicated that it was a five-to-15-minute procedure, including the administration of anesthesia.

It was acknowledged that many orthodontists in North America are reluctant to place TADs because it involves a local anesthetic and a minor surgical procedure. It was also recognized, however, that TAD placement is a relatively straightforward technique within the overall spectrum of dental procedures. In addition, the AAO's practice insurance has now been modified to provide coverage for TAD placement. An oral surgeon could be better prepared to remove a TAD if it broke during placement, but placement by an oral surgeon or other specialist could add prohibitive costs for the patient, ranging from $200 for a simple TAD to $1,000 for other designs. Although some general dentists are currently placing TADs, it was generally agreed that they are the least qualified to do so, particularly if they have no additional training in orthodontics and oral surgery.

Force Application

Participants with TAD experience indicated that the devices should be loaded immediately or after six weeks, but that the worst time to load them was at two weeks. In any case, the group believed that initial stabilization of the TAD was essential to its success. It was noted that palatally placed TADs may fail if the patient's tongue continually jiggles the device during healing. The group questioned whether an optimal time of initial loading could be correlated with the quality of bone, and called for histological studies on this topic and on the bone's response to the effects of biomechanical forces over time.

The importance of appropriately designed connecting archwires was emphasized. It was observed that direct occlusal forces would lead to TAD failure, and that shear forces should also be avoided. The biomechanical design and lines of action of the forces placed on the implant should be well planned. For example, intrusion of incisors with anterior TADs could also produce undesirable incisor proclination; in this situation, the TADs could be placed posteriorly to supplement traditional anchorage, and conventional archwire biomechanics could be used to intrude the incisors.

Coil springs were preferred over elastomeric C-chains because of the nature of their force delivery. A recommendation was made that the attachment loops on the ends of coil springs be redesigned to allow easier placement over the heads of TADs.

Failures and Complications

Early reports on the success of TADs ranged from 60-85%, although some researchers included all failures during the development and prototyping of various designs and refinement of their procedures. Recent reports, using the latest TAD designs and placement techniques, have shown dramatically higher success rates. Still, it was noted that TADs seem to be more successful in the maxilla than in the mandible and in adults than in children.

The major complications discussed were breakage and damage to adjacent tooth roots. It seems that recent designs and proper placement techniques have made device breakage a problem of the past. If a TAD does break, the group recommended removing it with a root-tip plier and leaving deeply embedded fragments in place. Minor root damage can heal with little consequence. It was noted, however, that in the relatively few reports on this topic, the teeth were not moved subsequent to the root damage, and that additional movement could exacerbate the situation. Another possible complication would be the movement of a tooth into a TAD, but this has not yet been reported in the literature.

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U.S. Acceptance

It seems that fear of litigation is one of the major barriers to acceptance of TADs by U.S. orthodontists, even though there has been no known litigation in this area to date. The group felt it was important to educate American orthodontists, without oversimplifying the procedure and its risks, because they may be unnecessarily eliminating a viable treatment modality for some patients. One suggestion was to provide typodonts for training orthodontists on the placement of TADs, with potential placement sites marked according to the optimal thickness of cortical bone. The group also believed it was important for professional orthodontic organizations to develop consensus statements on the use of TADs.

Commentary

In response to the above report and to the JCO Editor's Corner by Dr. Robert Keim ("Answering the Questions About Miniscrews," January 2005), I agree that the locomotive of skeletal anchorage is moving toward mainstream orthodontics faster than many would care to admit. The advantages are obvious, undeniable, and exciting. Where I disagree with a number of orthodontists is on who should place the devices.

It seems to be in the character of many of our colleagues to completely shun any technique that is even the slightest bit invasive. Some orthodontists proclaim with pride to their patients that there are "no needles in this office", which may be more a reflection on those orthodontists than words of comfort to their patients. We need to remember that we are *all* dentists, and there is no reason to feel that placing temporary anchorage devices (TADs) is an act of betrayal of our specialty.

These devices do not require flap elevation, bone recontouring, emergence profiles, or any other procedures that another specialist may be better qualified to execute. What *is* required is a specific understanding of the mechanics and anchorage requirements needed for the case—an understanding that is unique to orthodontics.

With the advent of drill-free miniscrews and the availability of Oraqix, a new periodontal topical anesthetic providing profound local anesthesia without an injection (Editor's Corner, JCO, December 2004), the list of required equipment for most TAD cases is reduced to a screwdriver. Removal is usually done without anesthetic of any kind. The procedure couldn't be simpler, safer, or quicker. After a couple of miniscrew placements, any orthodontist will have the procedure down to just a few minutes.

I am currently contributing to a chapter on TAD complications for a skeletal anchorage textbook. Frankly, the potential complications I am describing are not only minimal, but primarily theoretical, because I have yet to find any serious complications reported in the literature.

I applaud the AAO for adding miniscrew placement to its liability insurance coverage without any fanfare or comment to the orthodontists carrying the policies. It seems to me that the profession of orthodontics had better grab hold of this adjunctive procedure, one that is unique to our specialty, and take ownership of it. If we don't, it then becomes our responsibility to continuously update our surgical colleagues on the latest techniques, screw types, anchorage requirements, mechanics, and so on. Better we should place the implants ourselves.

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