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Absolute Anchorage in Orthodontics: Direct and Indirect Implant-Assisted Modalities

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Many of the conventional means for enhancing orthodontic anchorage are less than ideal, because they either rely on structures that are themselves potentially mobile (teeth), or they rely too heavily on patient compliance or dexterity (wearing headgear or elastics). Furthermore, many anchorage devices, such as lip bumpers and Nance appliances, are cumbersome, uncomfortable, inconvenient, and unhygienic.

Osseointegrated implants circumvent many of these shortcomings, although their use in orthodontics is still in its infancy. As orthodontists begin to appreciate the efficiency of implant-supported appliances, their mechanotherapeutic approaches may undergo profound transformation.

Numerous studies have been conducted on the efficacy of implant-assisted anchorage, both in animals[1-7] and in humans.[8-18] Force levels generated by orthodontic appliances and applied to implants have also been investigated.[11-13] The main conclusion to be gleaned from such studies is, as Roberts states: "within physiologic limits, rigid endosseous implants provide excellent orthodontic and orthopedic anchorage".[13]

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Direct vs. Indirect Anchorage

There are two basic means by which osseointegrated implants may be used for orthodontic anchorage. Direct anchorage utilizes forces from the actual implant, as when a dental implant takes the place of a missing tooth and eventually supports a dental restoration (Fig. 1).

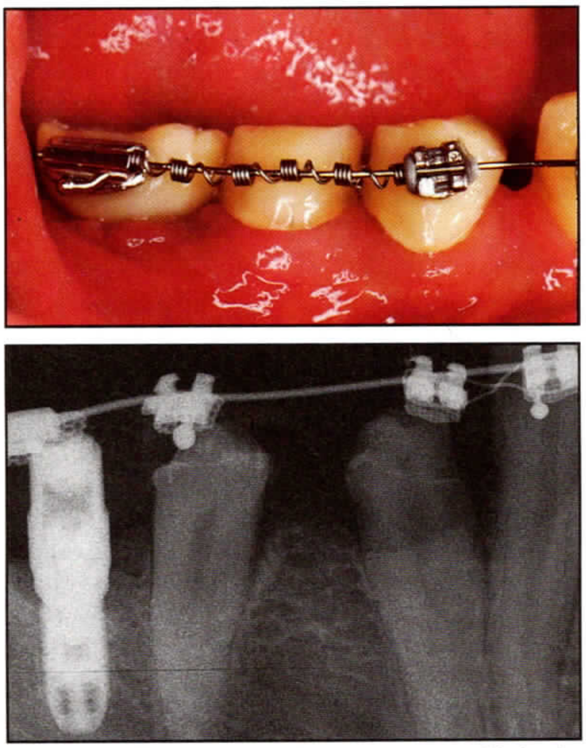

Fig. 1 Typical direct anchorage system. Molar is an implant-supported provisional restoration, and bicuspids are also provisional restorations. Implant functioned equally well as anchor against both pressure and tension stimuli.

The restoration or tooth placed over the fixture is used to secure the orthodontic band or bonded attachment. This technique, which is now common in restorative dentistry, can be used with either a provisional or a permanent restoration. Devices such as the Straumann bonding base* are available to customize the implant top for orthodontic appliances.

Indirect anchorage, on the other hand, uses the implant to stabilize specific dental units, to which clinical forces are then applied. Such an implant—usually a midpalatal fixture attached to a transpalatal arch—is placed solely for orthodontic purposes and is generally removed once its anchorage duties have been fulfilled.[19] It is this type of implant that is presently undergoing rapid research and development and promises to significantly alter the design and function of orthodontic appliances.

Presently, there are at least two indirect implants available in the United States: a device first described by Block and Hoffman and known as the "OnPlant",**[20] and another called the "OrthoImplant".* Both have received approval by the FDA for usage in adults; approval for adolescents will likely be forthcoming, pending research findings on the maturation of the palatal sutures. While there are significant differences between the two fixtures in their design and placement, they are similar in function once integrated and loaded.

OnPlant

The OnPlant, which resembles a button, is a relatively flat, disc-shaped fixture available in diameters of 8mm and 10mm. It has a textured, hydroxyapatite-coated surface for integration with the palatal bone (Fig. 2). Surgical placement involves making an incision in the palatal mucosa outward from the midline (Fig. 3). The tissue is tunneled under, in full-thickness fashion, past the midline to the eventual implantation site. The OnPlant is then slipped under the soft tissue and brought into position, and the incision is sutured.

*Straumann USA, Reservoir Place, 1601 Trapelo Road, Waltham, MA 02154.

**NobelBioCare USA Inc., 22895 E. Park Drive, Yorba Linda, CA 92887.

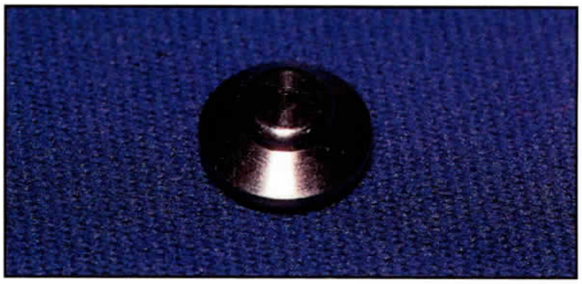

Fig. 2 OnPlant (soft-tissue side up).

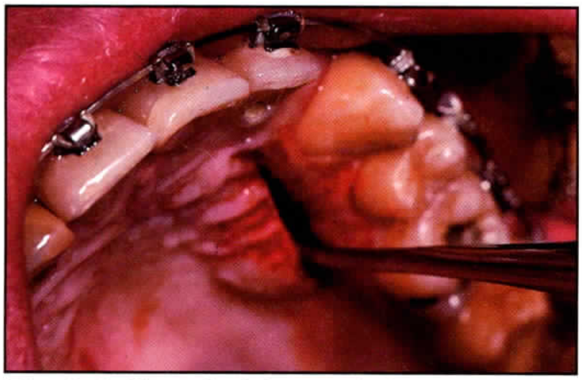

Fig. 3 OnPlant incision and tissue elevation toward midline.

A vacuformed stent is worn for 10 days to place pressure on the OnPlant. This step is crucial to the device's integration, which takes at least four months. Once integration has been achieved, an open-tray impression is taken by exposing the OnPlant, removing its cover screw, and securing an impression coping (Fig. 4). A simulated implant is used to pour the working cast.

A transpalatal arch is attached to the OnPlant and bonded or banded to the teeth on both sides of the arch. When the OnPlant is no longer needed for anchorage, it is explanted by soft-tissue exposure and de-integrated with a carefully aimed chisel.

The OnPlant is a relatively easy device to

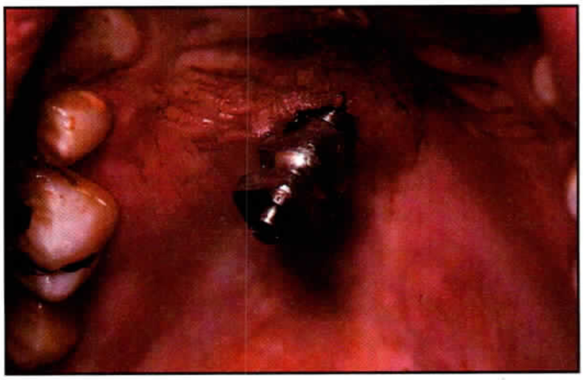

Fig. 4 Stage II of OnPlant procedure, with fixture exposed and impression coping screwed in and ready for open-tray impression.

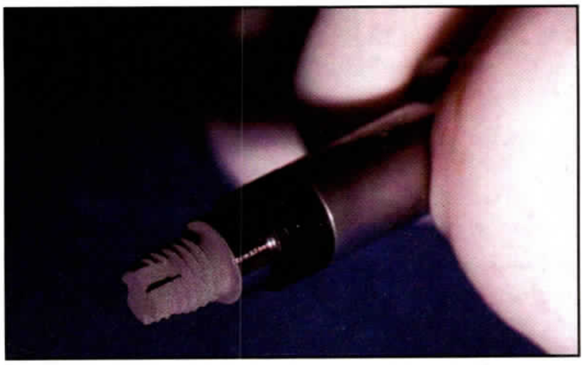

Fig. 5 OrthoImplant and carrier. SLA surface provides increased surface contact with bone for rapid integration.

place, secure, and remove. However, it should be noted that this is not an endosseous implant; since it lies superficial to the bone, it should be considered a subperiosteal implant.

OrthoImplant

The OrthoImplant, a true endosseous implant, is an SLA (sandblasted and acid-etched) screw fixture (Fig. 5) that is inserted into a carefully created osteotomy site in the midpalatal region. First, an appropriate location must be identified. Next, a soft-tissue trephine is used to remove a small core of palatal mucosa (Fig. 6). A round bur then scores the hard palate, followed by a spade adapted to the exact dimensions and proportions of the OrthoImplant. The depth of the osteotomy is either 4mm or 6mm; the outer diameter of the thread is 3.3mm (Fig. 7). The OrthoImplant is screwed into the osteotomy, and a cover screw or cap is placed to control soft-tissue overgrowth (Fig. 8). No suturing is neces-

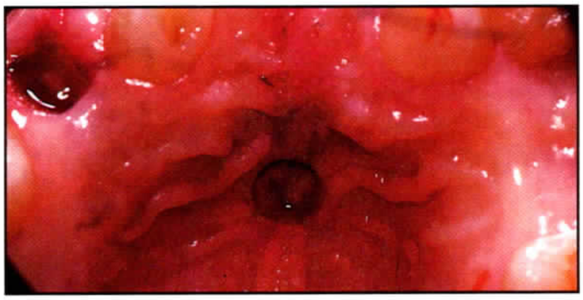

Fig. 6 Midline soft-tissue punch of implant site. No incision is made.

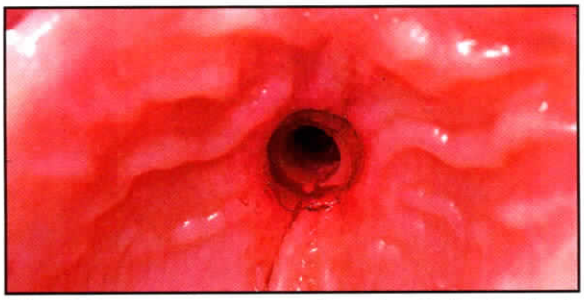

Fig. 7 Osteotomy preparation for OrthoImplant. Floor of site can be probed to verify that palatal bone has not been perforated.

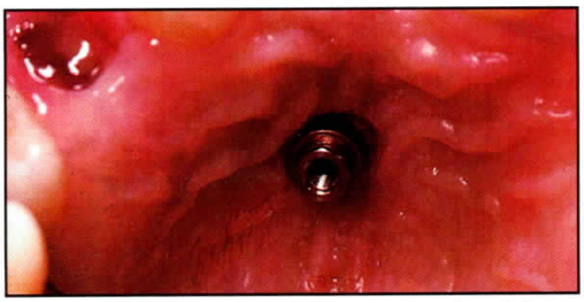

Fig. 8 OrthoImplant screwed in by hand and tightened with wrench. No sutures are needed.

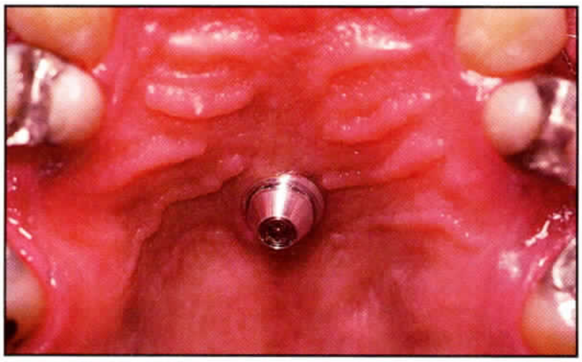

Fig. 9 Impression cap screwed into OrthoImplant, ready for conventional alginate impression. Cap is then unscrewed and placed in impression for pouring and fabrication of working cast.

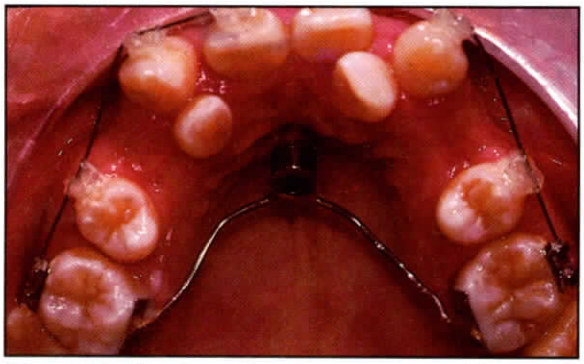

Fig. 10 Indirect anchorage system, with transpalatal bar soldered to sleeve of osseointegrated midpalatal implant and bonded to palatal surfaces of molars for absolute anchorage.

Fig. 11 OrthoImplant shown on lateral cephalogram.

sary, since a tissue punch was used instead of an incision.

After integration has been achieved (in about three months), loading may proceed, although an impression may be taken prior to full integration. An impression coping is fastened to the OrthoImplant, which greatly facilitates the process and eliminates the need for an open-tray technique (Fig. 9).

A transpalatal arch is fastened to the fixture and the desired teeth (Fig. 10). Once the OrthoImplant has accomplished its purpose, it is explanted with a trephine. Healing is usually uneventful.

The OrthoImplant has the advantages of simple placement and utilization. In addition, because it is a true endosseous implant, its integration may be far more predictable than that of the subperiosteal OnPlant.

Clinical Applications

To date, Dr. Celenza has placed three of each of these indirect implants. Only the OrthoImplant system has proceeded to the stage of loading. Two of the OnPlants did not integrate, and one was lost in the impression process. One OrthoImplant was lost to patient parafunction, but was replaced shortly thereafter and is now loaded. Several clinical observations are worth noting.

Monitoring of the healing of these implants can be troublesome; a lateral cephalogram lacks the detail needed to assess integration and bone health (Fig. 11). The OnPlant, being a submerged fixture, is impossible to evaluate during Stage I healing, and it is disconcerting to both clinician and patient to discover a non-integrated fixture at the Stage II uncovering, particularly after waiting the prescribed four months. Short of an exfoliation or blatant failure, there is no clinical way to monitor the progress of integration.

The OrthoImplant, on the other hand, is not submerged, and this has proven to have both advantages and disadvantages. Although the implant can be tested for mobility, the patient must be careful not to exert pressure with the tongue or to traumatize the implant site, as this can have a deleterious effect on integration. The initial healing abutments first recommended by the manufacturer were too large and intrusive for that reason. The clinician may prefer that the implant be left with only the abutment screw to protect its threads, even if this means that some soft-tissue overgrowth will need to be cleared at Stage II. It has also been suggested that a surgical stent be employed to cover and protect the fixture for the first few weeks. The OrthoImplant can be loaded sooner than the OnPlant; its SLA surface has shown successful integration in alveolar bone in as few as six weeks,[7,14,15,21-23] although a 10-week period is currently prescribed.

The OnPlant impression procedure can be technique-sensitive, especially if the operator is unfamiliar with open-tray pickups. The impression coping used in the OnPlant system can exert leverage on the implant if care is not exercised; one of our OnPlants was de-integrated in this way. The OrthoImplant simplifies the whole process by using an impression coping that does not require an open tray. Successful impressions can be consistently obtained with a conventional technique using alginate and disposable trays.

The need for accuracy in the impression is greatly reduced if a bonded transpalatal arch is used, rather than the banded appliance advocated by the manufacturers. This type of arch can easily be adjusted at the chair if better approximation to the tooth surfaces is needed. A light-cured bonding technique, utilizing a syringe to flow the resin between the bases and the etched tooth surfaces, makes the operation predictable and controllable.

Once the arch is secured, the orthodontic appliance can be activated with confidence that the anchorage system is secure and durable. A multitude of treatment variations are possible. For example, a molar-implant-molar transpalatal arch can accomplish anterior retraction by allowing en masse movement of the active segment (Fig. 12). Posterior protraction or distalization can be attained with a more anteriorly bonded transpalatal arch (Fig. 13). Multiple arch designs can even be used in the same case by debonding, unscrewing, and replacing the appliances as desired during treatment.

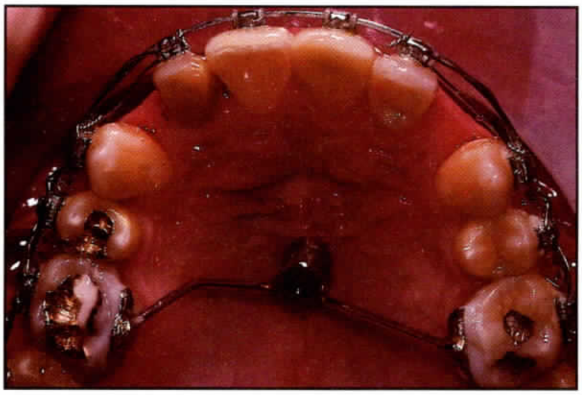

Fig. 12 Indirect anchorage system for en masse retraction of incisors.

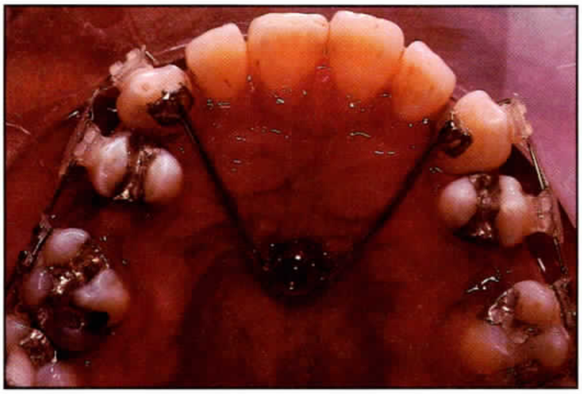

Fig. 13 Indirect anchorage system for posterior protraction. Note that transpalatal arch is attached from OrthoImplant to palatal surfaces of cuspids.

Conclusion

Orthodontists stand to benefit significantly from the inclusion of implants in their armamentarium. With anchorage preservation no longer an issue, orthodontic mechanotherapy can be greatly simplified. Maneuvers as intricate as tipbacks, stopped arches, cinched arches, and common ties will become superfluous. This, in turn, will reduce the need for archwire changes and decrease chairtime dramatically. Perhaps more important, anchorage-enhancing devices such as headgears, lip bumpers, and Nance buttons may be rendered obsolete, thus reducing the dependence on patient compliance.

With the use of implants such as the ones described in this article, treatment outcomes will be far more predictable. Therapies previously thought out of the realm of possibility may become easily attainable. The concept of "absolute anchorage" can now be effectively explored and employed.

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