British Journal of Oral and Maxillofacial Surgery (2001) **39**, 8–12

doi: 10.1054/bjom.2000.0480, available online at http://www.idealibrary.com on IDEAL

BRITISH
Journal of
Oral and
Maxillofacial
Surgery

TECHNICAL NOTE

Bone anchored intraoral device for transmandibular distraction

M. Y. Mommaerts

Division of Maxillo-Facial Surgery, General Hospital St. John, Bruges, Belgium

SUMMARY. **The Transmandibular Distractor (TMD) is an intraoral expansion device for symphyseal widening by callus distraction. Its advantages include limited surgical exposure, skeletal anchorage, and expansion along the arch segment together with proportional and differential widening in the frontal plane. © 2001 The British Association of Oral and Maxillofacial Surgeons**

In the clinical setting, anterior mandibular widening after vertical osteotomy has generally been achieved with tooth-borne devices.[1–6] It has been shown experimentally that the problems encountered are similar to those of tooth-borne maxillary expanders: tipping of teeth and segments, loosening of the device and more dental expansion in relation to skeletal widening.[7,8] The bone-borne Transpalatal Distractor (TPD™) solved these problems for the maxilla.[9] The aim of the present paper is to describe the rationale and use of the bone-borne Transmandibular Distractor (TMD™ – Surgitech NV, L. Bauwensstraat 20, 8200 Brugge, Belgium), an intraoral titanium mandibular expansion device.

REQUIREMENTS AND DESCRIPTION OF THE DEVICE

Osteodistraction along a curved bone that has two joints at each side of the midline and teeth at each side of the callus, and is functionally loaded (although restrained), demands a special distractor design.

In general, surgical exposure for placement and removal of distraction devices must respect the soft tissue envelope. The activation mechanism should preferably be extramucosal, both from a biological viewpoint and so that it is easily accessible for activation. This helps to control the distraction rate and is helpful in case of a mechanical problem. From a biological viewpoint, it is important not to interfere with callus formation and maturation. It should be possible to remove it without denuding of the newly formed bone. The material has to be soft tissue compatible in the presence of oral microbiological flora. The anchorage should be rigid and avoid teeth and nerves. All this is in the line of our philosophy about intraoral osteodistraction systems.[9,10] In particular, this symphyseal distraction device should permit expansion along an arched segment without the fear of instability of the fixation or translational condylar movements. It has to be a miniature model that does not interfere with tongue and lip movements. It also has to resist the juggling forces of opening and closing the mouth, speech, and mastication. Disproportional movements at the occlusal and mandibular base level should be avoidable and controllable.

TMD™ is made entirely of pure titanium grade 2. It consists of two vertical footplates for osteosynthesis, each provided by an off-set extension that pierces the mucosal incision (Fig. 1) The footplates are positioned close to the vertical osteotomy line. The osteotomy is generally done in the midline between the roots of the central incisors. We use a reciprocal disposable sawblade (Aesculap AG, Tuttlingen, Germany), a thin Lindemann burr (Komet AG, Lemgo, Germany) and an osteotome 1 cm wide in a fashion very similar to Van Sickels[4] and Guerrero.[5] The distance between the lateral borders of the footplates is also kept to a minimum so that the labial sulcus incision

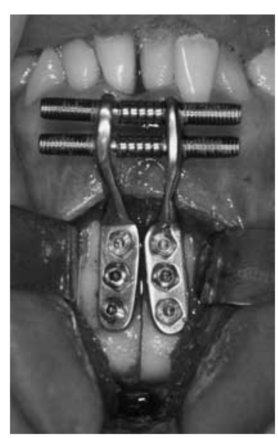

Fig. 1 The Transmandibular Distractor across a median symphyseal osteotomy. The exposure is limited and respects the mentalis muscles.

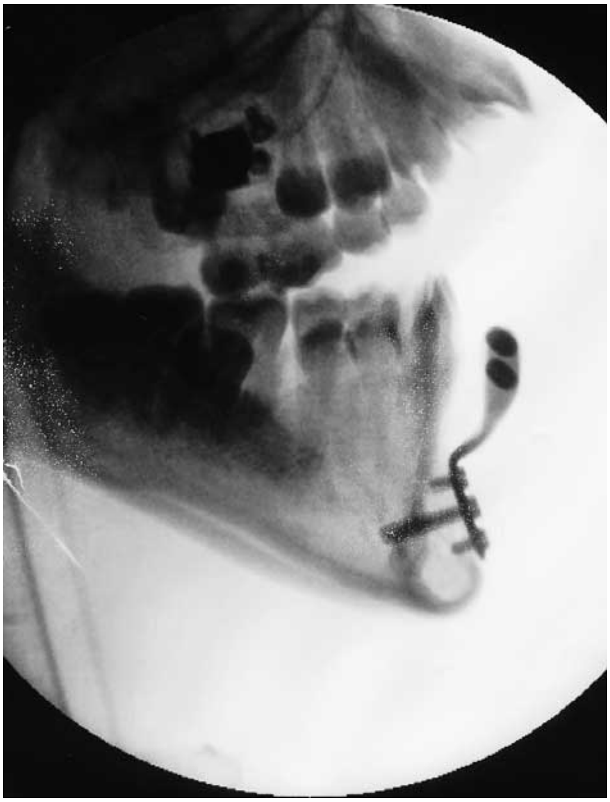

Fig. 2 Preoperative lateral radiograph of the patient in Figure 1, showing a Transpalatal Distractor in the maxilla and a Transmandibular Distractor in the mandible for dual expansion, a common indication. The length of the osteosynthesis screws is clearly visible, two monocortical (5 mm) and in the middle one bicortical (here 13 mm) for every footplate.

can be kept to 15 mm and the subperiosteal dissection can be made medial to the mentalis muscles. The extensions are connected by two threaded parallel distraction rods, the middle part of which is helical. The footplates are 1 mm thick in their lower three-quarters, to make them bendable and adaptable to the bony surface, and 1$\frac{1}{2}$mm thick in their upper quarter, to increase the rigidity of the system. The footplates are angled 10 in the axial plane, to facilitate adaptation. They are fixed with monocortical and bicortical screws made of titanium grade 5. Each footplate has three holes for osteosynthesis. We recommend that one bicortical screw is placed in the middle hole (Fig. 2). The lower monocortical screw is easier to handle when the distractor is removed, and the upper monocortical screw avoids the apical area and the dental branch of the inferior alveolar nerve. The extensions can be bent as well, but to a moderate degree.

It is important to check the position of the device in relation to the upper arch before bending it, particularly if the bite is deep. The distraction rods have an opposite thread running at each side. The device is activated with a screwdriver that can be inserted at either end of the rods (Fig. 3). Every full turn equals 1 mm expansion. Patients are advised to activate at a rate of 0.5 mm/day. Two rod lengths are available, one for 12 mm distraction, and the other for 20 mm. The helical middle part allows for bending of the distractor in the axial plane during expansion. The twin rods make a rigid connection in the frontal plane. Both rods are activated at the same rate and rhythm. However, should a disparity develop in the degree of widening at the upper and lower borders then activation of one rod only will set torque in the system and allow correction of the disparity.

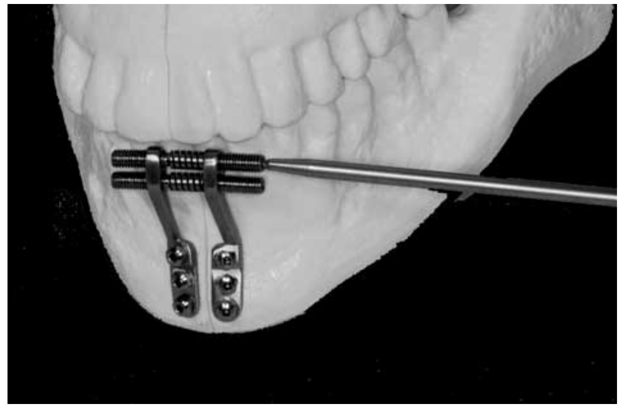

Fig. 3 The patient activates the distractor with a screwdriver-activator, which can be applied at both sides.

Orthodontic closure of the diastema is allowed after 1$\frac{1}{2}$ months of consolidation. The appliance is removed after two months, after calcifaction of the callus is radiographically confirmed.

DISCUSSION

The inviolability of the mandibular intercanine distance is one of the oldest dogmas in orthodontics, and continues to be reinforced by current research.[11] Whereas the upper apical base is examined routinely for hypoplasia, the lower apical base is not, because there are no viable treatment options. Osteotomy techniques to narrow or angulate the symphysis are known, but rarely used. Symphyseal widening without resorting to osteodistraction techniques is practically impossible. Immediate expansion would lead to a gingival laceration and exposure of the necessary bone graft and osteosynthesis plates. The advent of osteodistraction in the facial skeleton has enabled the dogma of not violating the intercanine width to be destroyed. Although long-term studies on stability are yet to be undertaken, it does not seem likely that the mineralized symphyseal regenerative tissue will collapse at a later stage. However, the effects of tertiary crowding in these expanded mandibles still have to be investigated.

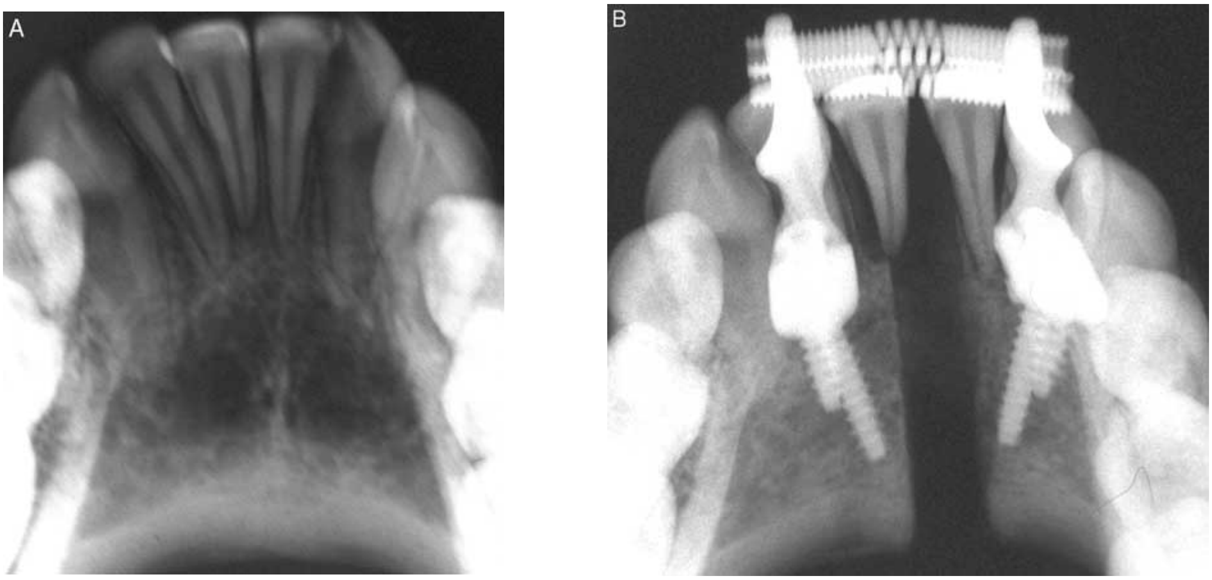

Fig. 4 (A) Occlusal radiograph of the symphyseal area, showing the close relationship of the apices of the central incisors. An osteotomy in the midline is possible, but complications such as root section or fracture, or devitalization can be expected. (B) Occlusal radiograph $1\frac{1}{2}$ months after distraction. All teeth were alive, despite their 'walking'. Notice early calcification areas in the callus.

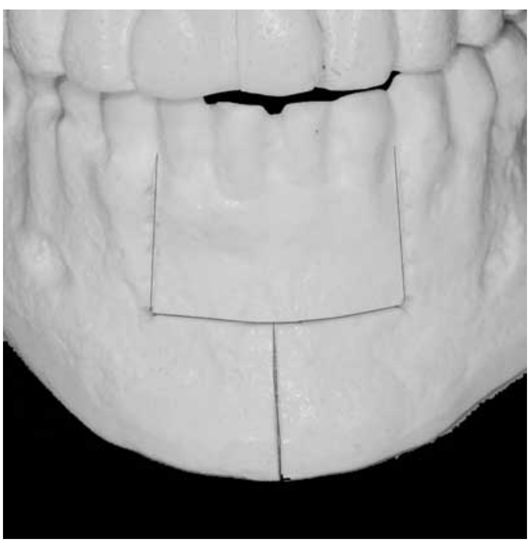

Fig. 5 An alternative osteotomy. Stabilization of the incisor segment by an orthodontic archwire is essential. In most cases, there is sufficient room for a vertical osteotomy between the lateral incisor and the canine. A prerequisite for this technique is a high symphysis.

We are currently focusing on different osteotomy designs (midline, between canine and lateral incisor, bilateral, with and without genioplasty,[5] on a technique to maintain a lamina dura at both sides of the osteotomy line, on the importance of the latency period for soft tissue healing, and on the importance of the 'walking teeth' phenomenon.[5] Losing an incisor, and creating an asymmetrical condition when bilateral premolar extraction would have led to a compensated but accepted symmetrical condition, might prove disastrous. We have been able to split the interdental bone precisely but not predictably with the current techniques (Fig. 4). A way to avoid a bunch of tapered incisor roots is to place the osteotomy between the canine and the lateral incisor (Fig. 5). It is obvious that an undesirable chin deflection will be the result, unless bilateral osteotomies are done that may or not may be connected at the midline at the mandibular border (P. Pinto, personal communication). The TMD™ is placed below the apices, which allows for a horizontal subapical osteotomy. Stabilisation of the frontal segment seems necessary and can be accomplished with an orthodontic archwire.

We maintain a latency period of 7 days to allow the soft tissues to overcome the initial inflammatory response to injury. An inadvertent gingival laceration combined with an osteotomy cut that exposes a root surface could otherwise lead to a breach in the periodontal system. The absence of a margin of alveolar bone adjacent to a contiguous tooth seems to prevent bone formation within the new tissue, when the appliance is activated to achieve an immediate 1 to 2-mm separation of the bony edges.[5,7,12] When the activation is commenced but after 1 week, the Sharpey's fibres are able to reattach, if they have been inadvertently stripped off the cementum,[13,14] and bone will form readily.[12]

Variable tipping and migration of non-banded teeth towards the distraction gap commonly occur after osteodistraction: the so-called 'walking teeth' phenomenon (Fig. 6).[7,12] The elastic traction of the trans-septal

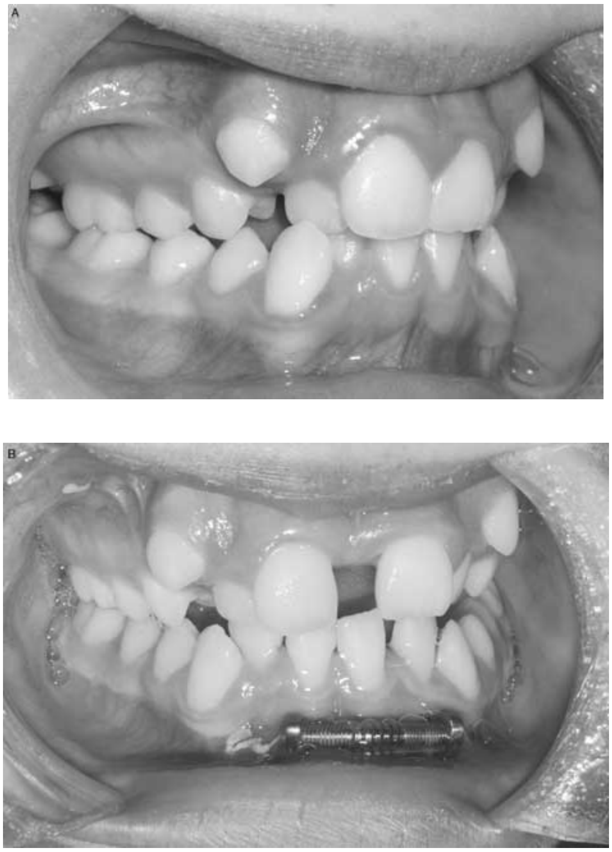

Fig. 6 (A) Preoperative 3/4 occlusal view of a patient with severe crowding and constriction of both jaws. Extraction of four premolars was avoided and the buccal corridors were corrected by transpalatal and transmandibular distraction. (B) Postdistraction view with the devices still in place. Notice the 'walking teeth' phenomenon in the mandible that occurs earlier and to a greater extent than in the maxilla.

fibres creates tension, which gradually transposes the incisors to the midline.[12] It is still not known if a tooth that is moving through non-mineralised regenerative tissue is prone to complications such as apical migration of the attached gingiva, loss of vitality, or increased vulnerability. Clinical and experimental experience has shown that this is not necessarily detrimental. Currently, we are looking for clinical differences between incisors that are allowed to move, and others that were splinted as bilateral segments by a split lingual retainer.

The use of tooth-borne distraction devices to widen the mandible in dogs and primates has resulted in canine tipping and incisal expansion being greater than apical expansion and skeletal expansion.[7,8] Proportional movements occurred when a bone-borne device was used in animals.[12] Because exposure is necessary for the osteotomy anyway, we see no advantages in seeking dental anchorage, except that removal does not need local anaesthesia.

Each 1 mm of midline widening theoretically results in 0.34 of rotation of each mandibular condyle.[16] These rotational changes may generate compressive forces at the anteromedial and posterolateral surfaces of the condyles, possibly leading to degenerative changes.[17] Widening of 10 mm would result in 1.7 of condylar rotation. The temporomandibular joint is used to rotational movements. The ipsilateral condyle rotates more than 4 with mean (SD) lateral movements of 12 (1) mm.[18] For years unilateral sagittal splits have been used to correct laterognathic mandibles without having a detrimental effect on temporomandibular joint function. We think that moderate symphyseal expansion will not cause clinical problems in the joint area. This is in contrast to moderate mandibular lengthening, when the distractor is placed parallel to the surface and no hinge mechanism is provided. Lateral condylar translation occurs at a ratio of 0.25 mm for every 1 mm of lengthening.[16] Lateral dislocation of the condyle commonly causes clinical problems.

REFERENCES

1. Guerrero C. Rapid mandibular expansion. Rev Venez Ortod 1990; 48: 1–2.
2. Guerrero C, Constati G. Transverse (horizontal) mandibular deficiency. In: Bell WH, ed. Modern practice in orthognathic and reconstructive surgery, Vol 3. Philadelphia: Saunders, 1992: 2383–2397.
3. Perrot DH, Berger R, Vargervik K, Kaban LB. Use of a skeletal distraction device to widen the mandible: A case report. J Oral Maxillofac Surg 1993; 51: 435–439.
4. Weil TS, Van Sickels JE, Payne CJ. Distraction osteogenesis for correction of transverse mandibular deficiency: A preliminary report. J Oral Maxillofac Surg 1997; 55: 953–960.
5. Guerrero CA, Bell WH, Contasti GI, Rodriguez AM. Mandibular widening by intraoral distraction osteogenesis. Br J Oral Maxillofac Surg 1997; 35: 383–392.
6. Kisnisci RS, Fowel SD, Epker BN. Distraction osteogenesis in Silver Russell syndrome to expand the mandible. Am J Orthod Dentofac Orthop 1999; 116: 25–30.
7. Bell WH, Harper RP, Gonzalez M, Cherkashin AM, Samchukov ML. Distraction osteogenesis to widen the mandible. Br J Oral Maxillofac Surg 1997; 35: 11–19.
8. Hollis BJ, Block MS, Gardiner D, Chang A. An experimental study of mandibular arch widening in the dog using distraction osteogenesis. J Oral Maxillofac Surg 1998; 56: 330–338.
9. Mommaerts MY. Transpalatal distraction as a method of maxillary expansion: Technical Note. Br J Oral Maxillofac Surg 1999; 37: 268–272.
10. Mommaerts MY, Jacobs W, De Jonghe N. Un système de distraction mandibulaire par ostéosynthèse dynamique: DM-SOD. Rev Stomatol Chir maxillofac 1998; 5: 223–230.
11. Wehrbein H, Bauer W, Diedrich P. Mandibular incisors, alveolar bone, and symphysis after orthodontic treatment. A retrospective study. Am J Orthod Dentofac Orthop 1996; 110: 239–246.
12. Bell WH, Gonzalez M, Samchukov ML, Guerrero CA. Intraoral widening and lengthening of the mandible in baboons by distraction osteogenesis. J Oral Maxillofac Surg 1999; 57: 548–562.
13. Pitaru S, Narayanan SA, Olson S *et al*. Specific cementum attachment protein enhances selectively the attachment and migration of periodontal cells to root surfaces. J Periodontal Res 1995; 30: 360–368.
14. Ivanovski S, Komaki M, Bartold PM, Narayanan AS. Periodontal-derived cells attach to cementum attachment protein via alpha 5 beta 1 integrin. J Periodontal Res 1999; 34: 154–159.

15. Kawato F. Changes of the periodontal vascular network, periodontal fiber and alveolar bone incident to tooth extrusion. Kanagawa Shigaku 1989; 24: 117–138.
16. Samchukov ML, Cope JB, Harper RP, Ross JD. Biomechanical considerations of mandibular widening by gradual distraction using a computer model. J Oral Maxillofac Surg 1998; 56: 51–59.
17. Harper RP, Bell WH, Hinton RJ, Browne R, Cherkashin AM, Samchukov ML. Reactive changes in the temporomandibular joint after mandibular midline osteodistraction. Br J Oral Maxillofac Surg 1997; 35: 20–25.
18. Hochstedler JL, Allen JD, Follmar MA. Temporomandibular joint range of motion: a ratio of interincisal opening to excursive movement in a healthy population. Cranio 1996; 14: 296–300.

The Author

Maurice Y. Mommaerts LDS, MD, DMD, FEBOMS
Consultant Maxillofacial Surgeon
AZ St. Jan, Ruddershove 10
8000 Brugge, Belgium
Tel: +32 50 45 22 60; Fax: +32 50 45 22 79
E-mail max.fac@azbrugge.be

Correspondence and requests for offprints to: Dr M. Mommaerts

Paper received 9 December 1999
Accepted 14 June 2000
Published online 4 December 2000