Journal of Cranio-Maxillo-Facial Surgery 45 (2017) 540–546

Contents lists available at ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

Comparison of two preoperative protocols for mandibular symphyseal distraction osteogenesis to reduce the risk of tooth damage

Heinz Winsauer [a], Oliver Ploder [b, *], Katharina Juengling [c], Andre Walter [d], Andreas Kolk [c]

[a] Dental School, University of Graz, Austria
[b] Department of Oral and Maxillofacial Surgery, Academic Teaching Hospital, Feldkirch, Austria
[c] Department of Oral- and Cranio-Maxillofacial Surgery, Klinikum rechts der Isar, Technische Universität München, Munich, Germany
[d] Department of Orthodontics and Dentofacial Orthopaedics, School of Dentistry, Universitat Internacional de Catalunya, Barcelona, Spain

ARTICLE INFO

Article history:
Paper received 16 May 2016
Accepted 22 December 2016
Available online 30 December 2016

Keywords:
Mandibular symphyseal distraction osteogenesis
Tooth-borne appliance
Relapse
Complication
Tooth damage

ABSTRACT

Two techniques to separate the lower incisors prior to mandibular symphyseal distraction osteogenesis (MSDO) were evaluated with respect to avoiding tooth damage.

Methods: Fifty patients (20.2 ± 7.0 years) requiring MSDO were treated with a tooth-borne appliance by utilizing two preoperative protocols to separate the central incisors: i) brackets and a V-bent wire with an open coil spring (two-step; TS; n = 24) and ii) a wire attached from the appliance to the central incisors with subsequent dento-alveolar expansion prior to surgery (one-step; OS; n = 26). The distance between the lower incisors was measured preoperatively on radiographs and measurements at the cast models were performed. Complications and radiographs were analyzed.

Results: The mean distance (±SD) between the lower central incisors for OS and TS prior to surgery was 3.44 ± 1.05 and 3.18 ± 1.13 mm, respectively. The mean expansion for OS and TS was 4.3 ± 2.9 and 4.3 ± 2.7 mm at the dental level and 3.8 ± 3.2 and 4.0 ± 2.1 mm at the bone level, respectively. Four patients undergoing the TS and one patient undergoing the OS showed transient dental complications.

Conclusion: Pre-surgical dento-alveolar expansion by utilizing a one-step technique to separate the lower central incisors reduces the risk of permanent tooth damage and weakens the mandibular bone in the midline.

1. Introduction

Transverse mandibular deficiency is a common problem in orthodontic patients. The clinical signs of mandibular transverse deficiency are a decrease in mandibular arch length, a narrow intercanine width, a crowding of the lower anterior teeth, a flattened anterior arch morphology, an increased overbite and a posterior buccal crossbite (Del Santo et al., 2000; Chung and Tae, 2007). In younger patients, transverse mandibular deficiency can be corrected by orthodontic expansion, lip bumpers, Schwarz devices, or functional appliances resulting in stable results (Bell et al., 1997). In adults, treatment options depend on the amount of arch discrepancy, the location of crowding and the general treatment plan for orthodontic correction, the possibility of dento-alveolar compensation and aesthetic considerations (Conley and Legan, 2003). Correction of crowding attributable to arch width discrepancy can be achieved by interproximal reduction of tooth mass (stripping of teeth), extraction of teeth (mostly premolars), orthodontic dental compensation or surgical correction by expanding the mandibular midline by the means of distraction osteogenesis. The first transversal mandibular expansion by a parasymphyseal osteotomy using a tooth-borne appliance was described by Rosenthal (1951) and symphyseal osteotomy with a subsequent distraction protocol has gained in popularity after the publication by Guerrero et al. (1997). Since then, mandibular symphyseal distraction osteogenesis (MSDO) has revolutionized the treatment of lower arch discrepancies and has gained in popularity (Guerrero et al., 2000). MSDO can be achieved by using tooth-borne, bone-borne or hybrid appliances subsequent to the osteotomy of the mandibular midline (Guerrero et al., 2000; Bell et al., 1997; Alkan et al., 2007; Boccaccio et al., 2008; Raoul et al., 2009). The disadvantages of bone-borne

* Corresponding author. Department of Oral and Maxillofacial Surgery, Academic Teaching Hospital, Carinagasse 47, A-6800 Feldkirch, Austria. Fax: +43 5522 303 7552.
E-mail address: oliver.ploder@lkhf.at (O. Ploder).

http://dx.doi.org/10.1016/j.jcms.2016.12.022
1010-5182/

devices are the extended duration of surgery, costs and the need of second operation to remove the appliance (Conley and Legan, 2003). Tooth-borne appliances allow orthodontists better control during the distraction process and show adequate symmetric expansion and stability (Boccaccio et al., 2008; Ploder et al., 2009). However, in cases of a midline osteotomy, since crowding is an indication for MSDO, the space between the incisor apices is limited and osteotomy can cause gingival, periodontal or dental problems (von Bremen et al., 2008). With regard to tooth injury, 3% of the patients presented irreversible damage in a retrospective study (von Bremen et al., 2008). The minimum distance between the teeth for interdental osteotomy to be safely performed without damaging periodontal tissue and devitalizing teeth is proposed to be between 3 and 5 mm (Dorfman and Turvey, 1979). To reduce the risk of permanent tooth damage and to induce new bone formation in the distraction gap, any root exposure must be prevented at both osteotomy sites (Bell et al., 1997). This can be achieved by creating sufficient space between the lower central incisors with pre-surgical orthodontic treatment and/or by using proper techniques to separate the mandibular bone between the teeth. A simple technique to increase the space between these teeth is to diverge the roots by using a short-segmented wire and an open coil spring between two angled brackets (Winsauer et al., 2011). After sufficient separation of these incisors, surgery for MSDO is performed after fixation of the tooth-borne appliance (two-step technique, TS). Following the use of this technique, gingival recessions were observed because of collision of the central incisors with the lateral incisors during lateral displacement (Ploder et al., 2009). Thus, the separation of the lower incisors by more than 2 mm might take several months and lengthen the overall treatment time. Therefore, a more advantageous technique has been established whereby the central lower incisors are connected via segmented wire arms to the tooth-borne expansion device. Dento-alveolar expansion of both dental arch halves with subsequent separation of central incisors is started prior to surgery (one-step, OS).

The aim of this consecutive study was to evaluate these preoperative protocols (OS vs. TS) for the separation of the central lower incisors prior to MSDO, with respect to feasibility, complications and relapse rates.

2. Patients and methods

Ethical approval for the present investigation was obtained from the local Ethics Committee (approval number EK-2-2014/0016) and individual written consent was obtained from all subjects.

Between 2008 and 2015, 50 consecutive subjects (16 males, 32.0%; 34 females, 68.0%) with a mean age of 20.2 ± 7.0 years (range: 12–38 years) with transverse mandibular deficiency and significant dental crowding (>3 mm) with mixed dentition (n = 10) and complete permanent dentition (n = 40) were included in this consecutive study. In all patients, measurements of the arch length were performed and, depending on the location of the crowding and the general orthodontic treatment plan, mandibular widening by means of MSDO was indicated. Mean arch discrepancy for all patients was 6.1 ± 1.9 mm. Descriptive data of both preoperative protocols are displayed in Table 1. Thirty patients received an expansion of the upper jaw with surgically assisted maxillary expansion.

2.1. MSDO hinge expander

In all patients, a tooth-borne expander, namely the MSDO hinge expander, was used for mandibular expansion (Winsauer et al., 2011). This appliance consists of a lingually placed expansion screw and two acrylic splints, covering up to five teeth on each side.

Table 1
Descriptive patient data and the time needed for separation of the lower central incisors prior to surgery.

	One-step technique (n = 26)	Two-step technique (n = 24)
Age (years)	20.2 ± 6.4	20.3 ± 7.8
Sex (female, male)	18 f, 8 m	16 f, 8 m
Arch discrepancy (mm)	6.4 ± 2.1	5.7 ± 1.7
Mixed dentition (n)	7	3
Permanent dentition (n)	19	21
Time for separation of lower central incisors (days)	105 ± 38[a]	193 ± 118[a]

Data are presented as means ± standard deviation (SD).
[a] Significant difference at level P = 0.001.

The conventional 1.5-mm diameter retention arms are ribbon-like but are reduced in diameter down to 0.7 mm in a 3-mm-long section adjacent to the expansion screw. These arms act as a hinge axis with sufficient stability against the tipping of the buccal teeth and reduce the risk of the alteration of the intercondylar distance. The splint-type appliances (Orthocryl®, Dentaurum, Ispringen, Germany) were cemented with Ketac Cem® (3M Espe, Neuss, Germany) and additionally fixed underneath the dental contact points with two piston spring screws (Dentaurum, Ispringen, Germany) on each side (cemented and screw-fixed appliance) (Fig. 1).

2.2. Preoperative protocols (one-step and two-step technique)

Preoperatively, two protocols were used to increase the distance between the central lower incisors. Between 2008 and 2011, the ***two-step technique*** (TS) was used in 24 consecutive patients. With this technique, brackets were first placed at the central lower incisors in an angled position by using Light Bond (Reliance Ortho Prod. Inc, Itasca, IL) to support an elastic Nitinol 0.017′ × 0.025′ wire and an open coil spring to create a bodily diastema. After sufficient separation of the lower incisors (>2 mm), the MSDO hinge appliance was fixated a few days before surgery. The central incisors move against blocking lateral incisors and canines and, thus, the time to create a diastema can take several months (Fig. 1). Because of the unpredictable treatment time, the protocol and the expansion device were modified and a ***one-step technique*** (OS) was used in 26 consecutive patients from 2011 to 2014. First, the tooth-borne MSDO hinge appliance was attached to the lower buccal teeth including the canine as described. The appliance was additionally connected directly to the central lower incisors via segmented wire arms each containing an up-righting loop at their mesial ends (Fig. 2). After fixation of the appliance, the expansion screw was activated by 0.2 mm every third day. Under these conditions, the lateral incisors remain unattached and can move out of the way if the roots of the central incisor shift laterally. The same appliance serves to expand the dento-alveolar arch halves and thereafter distracts the mandible halves; it is called the one-step protocol. Surgery was performed after achieving sufficient space between the central lower incisors (>2 mm).

2.3. Surgery

The surgical procedure was accomplished under i.v. sedation with remifentanil hydrochloride (0.2–0.5 μg/kg) and propofol (8–12 mg/kg). After the application of local anaesthesia, a 10-mm vertical incision was made in the midline of the mandible. The mucoperiosteum was elevated and a midsymphyseal osteotomy was carried out by using the piezoelectric system (Synthes Inc., Oberdorf, Switzerland) with a 0.6-mm diamond cutting tip in