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Surgically Assisted Rapid Palatal Expansion Using Piezosurgery – Case Report

Chirurgicznie wspomagane rozszerzenie szczęki z użyciem piezosurgery – opis przypadku

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A – research concept and design; **B** – collection and/or assembly of data; **C** – data analysis and interpretation; **D** – writing the article; **E** – critical revision of the article; **F** – final approval of article

Abstract

When planning orthodontic treatment in young adult patients with substantial maxillary stenosis, there are indications for combined surgical and orthodontic treatment. These are difficult patients for whom only orthodontic maxillary expansion would involve a risk of vestibular protrusion or extrusion of the posterior teeth, fenestration in bone lamella, inability to open palatal suture or a tendency to recurrences upon completion of the treatment.
The aim of surgically assisted rapid palatal expansion (SARPE) procedure is to overcome the bone resistance to the maxillary expansion device. Ultrasonic bone cutting techniques (piezosurgery), used so far with great success as they enable selective tissue cutting, appear to be particularly useful for those surgical procedures which involve a risk of damaging important anatomic structures.
Maxillary cortical osteotomy using a piezosurgical device was performed in a patient with substantial stenosis of upper dental arch within the bone base accompanied by bilateral cross bite. After nine months a significant maxillary expansion and no cross bite were observed.
Piezosurgery used for osteotomy in the maxillary lateral segment enabled microinvasive operation with minimal risk of damage to the maxillary sinusal mucosa (**Dent. Med. Probl. 2015, 52, 4, 499–504**).

Key words: piezosurgery, combined surgical and orthodontic treatment, cortical osteotomy, maxillary stenosis.

Słowa kluczowe: piezosurgery, leczenie zespołowe chirurgiczno-ortodontyczne, osteotomia kortykalna, zwężenie szczękowe.

When planning orthodontic treatment in young adult patients with substantial maxillary stenosis, there are indications for combined surgical and orthodontic treatment. These are difficult patients for whom only orthodontic maxillary expansion would involve a risk of vestibular protrusion or extrusion of the posterior teeth, fenestration in bone lamella, inability to open the palatal suture or there would be a recurrences upon completion of the treatment [1, 2].

Surgically assisted rapid palatal expansion procedure (SARPE) seems to be particularly useful in such cases, because it enables transverse maxillary expansion in patients with a mature skeleton or in immature patients where orthodontic treatment has been ineffective [1, 3].

SARPE was described for the first time by Kole in 1959 [1, 4], and has undergone many modifications since then. The areas of resistance have been classified as anterior support (piriform aper-

ture pillars), lateral support (zygomatic buttresses), posterior support (pterygoid junctions), and median support (midpalatal synostosed suture). Initial reports described the midpalatal suture as the area of greatest resistance to maxillary expansion [4–6]. However, later reports highlighted the zygomatic buttress and the pterygomaxillary junction as critical areas of resistance [7–9].

All of these are related to the maxillary corticotomy and the suppression of resistance in order to obtain an extension of the upper dental arch. The choice of the appropriate procedure is dependent on the age of the patient, dental condition and shape of the dental arch [1, 10]. Suppression of bone resistance is an important factor in the functioning of the maxillary expansion device. The device should always be stable, preferably cemented to the teeth before or during the surgery. The most common types are the Hyrax or Haas expander. It is only necessary to loosen the screw once or twice per day depending on the condition of the parodontal tissues [2, 11]. An additional advantage of SARPE is that it helps to increase the volume of the upper airways [3, 12], restrict orthodontic indications for extraction of teeth and improve hearing after the treatment [13]. Surgically assisted extension of upper dental arch is found to show a lower likelihood to recurrences compared to conventional treatment [1, 3].

However, the procedure is not free from risk. There may occur bleeding, pain or infection within the operated area. The literature reports a loss of epithelial attachment in the vicinity of central upper incisors, increased mobility of these teeth, gingival recession and ulceration in palatal tissues [1–3].

The aim of this study is to present a case of maxillary stenosis in an adult patient treated with surgically assisted rapid palatal expansion.

Case Report

Male patient T.L., aged 30 years and 7 months, presented for orthodontic treatment because of a remarkable upper dental arch stenosis and crowding of the upper incisors accompanied by palatal position of upper lateral incisor. He did not report any systemic diseases in the history.

Oral examination revealed skeletal class I, remarkable upper dental arch stenosis within the bone base and bilateral cross bite. Upper premolar and molar teeth protruded compensatorily towards the vestibule. Palatal width, measured next to gingiva within first molar teeth, was 27 mm. The symmetry line was shifted by 3 mm in occlusion and opening of dental arches. Canine Class I was visible on the right side and canine Class II on the left. Prolonged clinical crowns were present in both arches (Fig. 1–3). Pantomography showed an asymmetric position of the mandibular articular heads and horizontal losses in both maxillary alveolar ridge and mandibular alveolar portion (Fig. 4). It was decided that a combined orthodontic and surgical treatment should be applied in order to obtain maxillary lateral expansion using cortical osteotomy and fixed appliances to straighten both dental arches. Prior to the surgery the RPE device was cemented to the Hyrax screw on the maxillary first premolars and first molars (Fig. 5).

Fig. 1. Patient before treatment – dental arches in occlusion

Fig. 2. Patient before treatement – left side in occlusion

Fig. 3. Patient before treatment – right side in occlusion

Under block anesthesia (3% lignocainum hydrochloricum to both maxillary intraorbital foramens, to the incisive papilla, on the maxillary tubers and to the greater palatine foramens) to-

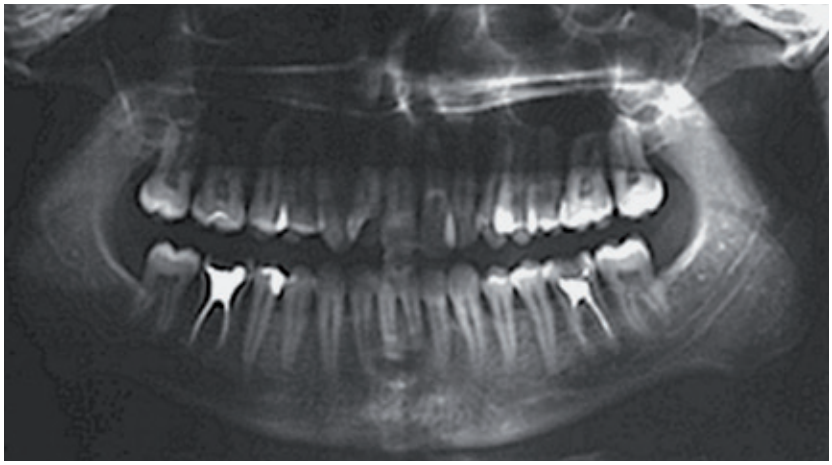

Fig. 4. Pantomogram of patient T.L. before treatment

Fig. 5. RPE device with Hyrax screw cemented on the maxillary first premolars and first molars

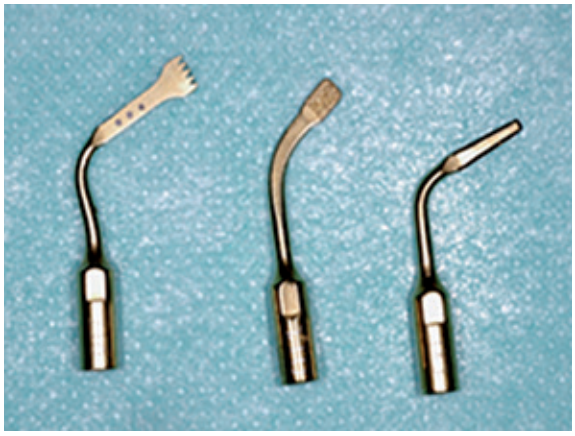

Fig. 6. The piezosurgery device end-pieces used for-maxillary cortical osteotomy

gether with infiltration within the oral vestibule, a horizontal incision was made across the mucosa and periosteum, above the mucogingival junction in the oral vestibule, between tooth regions 18 and 28. Then piezosurgery (Mectron®, name producer, country of origin) was used to cut the vestibular lamina dura, beginning from the distal surface of maxillary tuber on the right side to the lateral piriform aperture of the right side above tooth apices. The location of the bone cut was marked using the end-piece EH1 and an osteotomy was performed using the end-pieces QT7, depending on their bending angle to enable good access within the operation area. The bone was cut without damage to the maxillary sinusal mucosa in the lateral maxillary segments (Fig. 6, 7). The same procedure was repeated on the left side. A loop suture was used for closing. Upon completion of the surgery, the patient was given antibiotic amoxycillin with klawualan acid (Augumentin®) 1 g every 12 h, analgesics, non-steroid anti-inflammatory ketoprofen (Ketonal®), and cold compresses.

The patient was instructed to loosen the screw once per day for a period of 4 weeks. As the maxilla was expanding, the patient reported pain in

Fig. 7. Intra-operative view after cortical osteotomy on the right side

the upper central incisor on the right side. This, however, disappeared spontaneously after a few days. After 2 months the maxillary expansion device was replaced by an active palatine arch type Bi-helix. Six months after the beginning of the treatment a full fixed upper appliance was placed. Orthodontic locks according to Roth prescription were used in mixed slot.018''x.022'', together with

Fig. 8. Ninth month of the treatment – dental arches in occlusion

Fig. 9. Ninth month of the treatment – dental arches in occlusion, left side

Fig. 10. Ninth month of the treatment – dental arches in occlusion, right side

Fig. 11. Ninth month of the treatment – upper dental arch

a round.014" Sentalloy arch, and 3 months later a lower fixed appliance was placed using similar locks and round arch.014" Sentalloy arch.

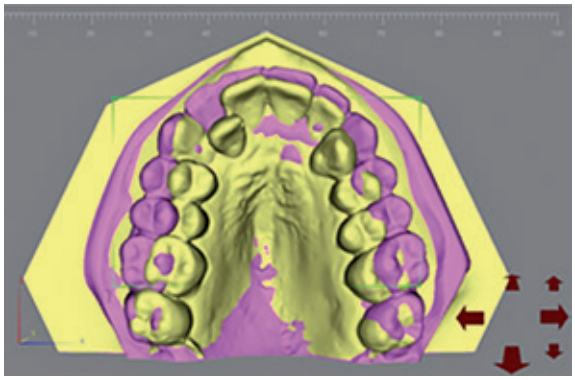

Fig. 12. Superimposition of digital models before and after treatment

Fig. 13. Patient after treatment – dental arches in occlusion

Fig. 14. Patient after treatment – right side in occlusion

Fig. 15. Patient after treatment – left side in occlusion

After 9 months of the treatment a significant expansion of the upper dental arch had been obtained. The width of the palate, measured next to the gingiva within the first molar teeth, was

33 mm. No cross bite was visible on either side (Fig. 8–11). The achieved expansion is illustrated by superimposing digital models before and after treatment (Fig. 12). The fixed appliances were removed after 19 months after the start of the treatment (Fig. 13–15). An upper and lower removable retention plate was used.

Discussion

On the basis of the review of the literature, it is apparent that there is no consensus about either the extent or the procedure for SARPE [1]. There are also no conclusive means to determine the areas of resistance to lateral maxillary expansion or ascertain an individualization of the surgical cuts. The extent of surgery ideally should depend on the areas of resistance with some individualization [1]. In literature (references) authors describe that the main obstacle in maxillary expansion device are zygomatic buttresses and pterygoid junctions. In the study described, the authors refrained from performing an incision along the palatal suture. The patient's age (30 years) qualified him for a palatal suture incision.

However, the positive effect of the treatment was possible by resigning from it and limiting the extent of the surgery. Due to this fact there is need for developing more accurate indications for using individual modification of the procedure in specific clinical cases.

Ultrasonic vibrations have been used in medicine for two decades to cut tissues, and as a routine for a few years in otolaryngology, neurosurgery and orthopedics [14]. Nowadays, ultrasonic vibrations are also commonly used in periodontology to remove dental deposits, in endodontics to process root canals, in maxillofacial surgery, in oral surgery and implantology for osteotomy, corticotomy or to collect blocks and bone chips in augmentation procedures [15]. Performance of piezoelectric devices is based on ultrasonic vibrations due to piezoelectric effect. In medicine the opposite piezoelectric effect is used to cause distortions in crystal walls through an external electric field [16]. The initial piezoelectric devices had quite a few disadvantages:

– they did not have sufficient power and therefore required much effort to make them effective,

– they generated a large amount of heat leading to tissues necrosis.

Modern piezoelectric bone cutting technique – piezosurgery was developed by Tomaso Vercellotti [14]. His investigations led the to the elimination of unfavourable parameters. The present technique has many advantages. The cutting end-piece can move horizontally or vertically to achieve high precision, clean cuts with no wrinkled edges. The range of frequency is different for soft tissues (above 50 kHz) and for hard tissues (25–29 kHz) to ensure selectivity [14]. As a result, no damages to important structures, such as vessels, nerves or mucosa, were caused during cutting. Low invasiveness of the method decreases bleeding, thus obtaining a clean operation area and better visibility of the operated tissues. The risk of developing tissue necrosis is also low due to a cooling system with physiological saline solution [17]. Piezosurgery achieves a better postoperative bone healing process due to the increased amount of morphogenetic proteins BMP-4 and TGF-β2. Moreover, it ensures better control of the inflammatory processes through releasing specific cytokines [14]. The surgeon needs to apply less effort than in the case of rotational milles or oscillatory saws driven by micromotors. If oscillatory saws are used, it is necessary to counter macrovibrations and, therefore, good control of the cutting depth seems hardly possible [17]. As an osteotomy in the maxillary lateral segment involves the risk of damaging maxillary sinusal mucosa, the most important advantage of the piezoelectric device was for our operation selectivity in cutting the tissues. The probability of such intraoperative complications will be to a great extent restricted if an ultrasonic bone cutting technique is used. In our case this technique allowed for the performance of a safe and effective maxillary corticotomy followed by orthodontic treatment.

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