Non-compliant maxillary protraction by orthodontic micro-implants

ABSTRACT

Background Delaire-type facemask is still the appliance of choice for non surgical paediatric Class III treatment. However, it entails great aesthetical problems and is totally dependent on patient compliance. A new modified maxillary protractor was then designed: it is monomaxillary, fixed, implant-supported, aesthetically pleasing and it does not require patient compliance. The aims of this study were to evaluate the clinical use and analyse the effects of a new appliance called Fixed Maxillary Protractor. The device aims at obtaining a forward movement of the maxillary dento-alveolar component in non-compliant paediatric patients, when mandible retrusion cannot be pursued.

Case report A non-compliant patient aged 4 years 11 months with mild skeletal and predominant dento-alveolar Class III malocclusion with maxillary deficiency, anterior crossbite and complete deciduous dentition was treated for 10 months. The appliance, anchored by 2 micro-implants in the posterior palatal region, consisted of an acrylic plate, a lingual splint, 2 TMA springs that delivered a posterior-anterior force, 2 anterior security devices and 2 occlusal bite raising splints on the deciduous molars. The treatment yielded a slightly overcorrected Class I incisal relationship. Increase in SNA angle (2°) and a decrease in SNB angle (1°) resulted in an increase in ANB angle (3°). Increases in Wits appraisal of 4 mm and in overjet of 7 mm were obtained. A correction of the anterior crossbite the a posterior sliding of the mandible due to the crossbite correction were observed. An anticlockwise rotation of the maxilla and a mild increase in the anterior facial height were achieved: the treatment effects are similar to those obtained with the Delaire-type facemask, but the amount of postero-anterior correction is lower.

Discussion and conclusion The Fixed Maxillary Protractor is effective for the treatment of mild-moderate Class III malocclusion with maxillary deficiency in non-compliant paediatric patients.

Introduction

The majority of Class III malocclusions are due to maxillary deficiency [Ellis et al., 1984; Sue et al., 1987; Luchese et al., 2005]. When the malocclusion is not expected to require orthognathic surgery in adulthood, the treatment of choice in childhood is characterised by a first phase of rapid palatine expansion associated with maxillary protraction using a Delaire mask [Vaughn et al, 2005.; Baccetti et al., 2007; Arman et al., 2006; Devecioglu Kama et al., 2006; Jiang et al., 2005; Pangrazio-Kulbersh et al., 2007; Macdonald et al., 1999; Baccetti et al., 1998; Gallagher et al., 1998], and a second phase with fixed treatment. Most authors suggest to begin treatment during the initial mixed dentition or late deciduous phase [Franchi et al., 2004], or in any case as soon as possible, in order to obtain the best possible results, given the type and severity of the malocclusion. Godt et al. [2008] recommend to begin the treatment of Class III during the deciduous dentition phase. However, clinical evidence demonstrates the difficulty of obtaining good compliance: the younger the patients, the less likely they are to apply the mask for the required therapeutic intervals. The use of Temporary Anchorage Devices (TADs - micro-implants or miniscrews) in contemporary orthodontics has proven to be an excellent alternative to traditional orthodontic anchorage, especially in cases where compliance is neither constant nor assured, or when the aesthetic component is important to patients [Favero et al., 2002]. A previous study was carried out to improve some characteristics of the implants (i.e, volumetric porosity, modulus of elasticity, frictional modulus) [Luchese et al., 2001; Luchese et al., 2011a; Luchese et al., 2011b; Palmieri et al., 2011; Annunziata et al., 2008; Aversa et al., 2008; Sollazzo et al., 2011]. A new fixed monomaxillary device anchored on TADs was therefore designed for orthodontic and possibly orthopaedic maxillary protraction with no aesthetic impact, minimising the compliance bias.
Case report

Diagnosis and treatment plan

The patient treated was a 4 year 11 months Caucasian girl, affected by a moderate skeletal and predominant dentoalveolar Class III malocclusion, with an anterior crossbite with mandibular anterior slip. The child exhibited Class III intermaxillary basal and occlusal relationship; overjet −3 mm and overbite 6 mm (Fig. 1, 2, 3). The treatment goals were to obtain a dental, molar and incisal Class I relationship, with correction of the anterior crossbite, to stimulate the maximum skeletal change possible and obtain an improvement of the facial profile. Growth prediction analysis, according to Baccetti et al. [2004] predicted a borderline chance of successful treatment with an orthodontic protocol with rapid palatal expansion and a Delaire mask followed by a second phase with a multibracket fixed device. The patient and her parents, however, refused any type of orthodontic treatment that would have been externally visible. Moreover, further clinical and behavioural analyses suggested that the patient might not have granted adequate compliance during treatment. Another conventional therapeutic option was then proposed: an orthodontic-surgical treatment to be carried out in adulthood, after the achievement of full maturation of the facial bone structures. Even this treatment option was firmly refused. A fixed maxillary protraction device for orthodontic-orthopaedic treatment was therefore devised, designed and proposed using skeletal palatal anchorage through orthodontic micro-implants in alternative to the traditional Delaire’s inverse extra-oral traction: the Fixed Maxillary Protractor (Fig. 4, 5). This device is composed of a steel splint with anterior safety devices, a palatal acrylic button and two springs that exert a posteroanterior force.

The splint is designed to be positioned on the lingual slope of the upper arch, being virtually undetectable on the labial side. It is made of a 0.040 in. steel wire, bended so as to encircle the palatal margin and the cingulum of the front teeth and equipped with occlusal bases and occlusal rests for the first deciduous molars. In addition, at the level of deciduous molars, occlusal bite raising splints were applied in order to achieve the anchorage of the steel splint and occlusal release so as to limit any interferences with the desired dental movement. The second deciduous molars were banded and soldered to the splint. The Nance-type palatal button is made of acrylic resin; it is 3 mm thick, in median palatal position with sagittal, rather than lateral, extension, and it has two grooves in the distal area for the placement of the micro-implants. These holes were placed in the distal portion of the plate, where the bone of the palatine process of the maxilla is thinner, but at the same time more distant from the dentoalveolar and pre-maxillary complex, object of the desired orthodontic movement: a certain degree of skeletal protraction of the pre-maxilla could be possible before 7 years of age, that is to say before the pre-maxillary sutures completely disappear [DiMalta et al., 2002].

The micro-implants chosen were Orthodontic AbsoAnchor® in titanium alloy (Ti6Al4Va) for orthodontic anchorage, developed by Dentos Inc (Daegu, Korea) (8 × 1.5 mm) [Favero et al., 2008].

The two chosen springs, applied laterally to the button, are made of TMA (β-titanium-molybdenum) alloy, 0.036 in. in diameter, and are similar to those applied to the Hilgers pendulum, but with opposite vector [Favero e tal., 2003]: the force exerted by the pre-activated springs is about 300 g per side. Furthermore,
two anterior security systems were designed, passive under normal conditions, in order to prevent swallowing of the device should it detach or break accidentally. Biomechanical studies were previously conducted on simulators of this new device, using plaster models and a Typodont, and demonstrated the advancement of the maxilla and a slight counter-clockwise rotation of the maxillary plane [Favero L et al., 2005].

After being adequately informed on the nature of the therapy, on the effects of the proposed device and on the instructions for use, the parents gave their consent to this treatment option.

**Treatment progress**

The Fixed Maxillary Protractor was applied to the patient for a period of 10 months, and then radiological (OPT, TRx) and cephalometric examinations were performed (Fig. 6). Following evaluation of the results and the clinical evidence, the treatment was deemed concluded and the device was removed (T2). Three months later, a further radiographic and cephalometric assessment was performed (T3).

**Results and discussion**

Restoration of a normal occlusal intermaxillary relationship was demonstrated, and a slightly hyper-corrected incisal Class I relationship was obtained through normalisation of the inverse anterior bite. In addition, a clear improvement of the soft tissue appearance and of the facial profile was achieved (Fig. 7, 8, 9). Later on, the patient underwent a six-month check-up protocol, in order to verify the stability of the results in the mixed dentition period. After three years a complete clinical and radiographic assessment was performed (Table 1).

The cephalometric outcomes of the present case report show how the SNA angle shifted from the pre-
treatment value of 88° (T0) to 89° post-treatment (T1). Later on in the course of the treatment (T2), an additional advancement of one degree was induced (90°), with a final total increase of 2°. SNB, on the other hand, was slightly reduced, shifting from 87° to 86°. The ANB values thus changed from 1° pre-treatment to 4° post-treatment, expressing a significant improvement in the sagittal intermaxillary relationship. The backward movement of the mandible is closely related to the correction of the anterior slip present at T0. The ArGoMe, NGoMe and NSGn angle values, the Mx/Md intermaxillary angle and the angle between the mandible and the cranial base (S-N/Md), increased from T0 to T1 but then decreased from T1 to T2. This was due to the use of occlusal bite raising splints, which were removed at T1. The Wits value displayed a considerable improvement, shifting from −6 mm to −2 mm for a total amount of 4 mm. The dentoalveolar values that characterised the malocclusion were significantly modified: in particular the overjet, which increased by 7.5 mm and then returned to the range of normal values, achieving therefore the normalisation of the overbite. Even the changes of the Wits value, the gonioc angle, the overjet and the overbite are similar to the values reported in the literature for the Delaire’s mask. The values, however, are considerably lower when compared to the paediatric patients treated by Franchi et al. [2004]. The overall effects are similar to those reported in cases treated with the Delaire mask, even if to a lesser degree when compared to patients of the same age group. After active treatment was suspended, in the three-year check-up period, the previous open bite Class III growth pattern was again appreciated (Table I).

**Conclusion**

The FMP proved effective in the treatment of a non-compliant patient in deciduous dentition with Class III malocclusion without using inverse extra-oral traction. The effects obtained, mainly dentoalveolar, are lower than those achievable with a traditional Delaire’s mask, but similar in vector, as they both act in the posterior-anterior direction. The device, similar to the Hilgers pendulum but with opposite vector, exerts a continuous force that acts 24 hours every day, 7 days a week and is anchored to palatal micro-implants. It is designed...
to be applied in young non-compliant patients, with high aesthetic demands, in order to intercept and quickly correct Class III malocclusions; it aims to achieve advancement of the dentoalveolar component of the maxilla, since it cannot act as a distraction force on the maxillary-palatine sutures.

References