Journal of Orthodontics, Vol. 41, 2014, S47–S53

The Hybrid Hyrax Distalizer, a new all-in-one appliance for rapid palatal expansion, early class III treatment and upper molar distalization

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Growing class III patients with maxillary deficiency may be treated with a maxillary protraction facemask. Because the force generated by this appliance is applied to the teeth, the inevitable mesial migration of the dentition can result in anterior crowding, incisor proclination and a possible need for subsequent extraction therapy. The Hybrid Hyrax appliance, anchored on mini-implants in the anterior palate, can be used to overcome these side-effects during the facemask therapy. In some class III cases, there is also a need for subsequent distalization after the orthopaedic treatment. In this paper, clinical application of the Hybrid Hyrax Distalizer is described, facilitating both orthopaedic advancement of the maxilla and simultaneous orthodontic distalization of the maxillary molars.

Key words: Class III malocclusion, protraction facemask, hybrid hyrax, rapid maxillary expansion, mini-implant anchorage

Received 2 April 2014; accepted 30 May 2014

Introduction

A class III relationship may be caused by a retrognathic maxilla, a prognathic mandible or both (Litton *et al.*, 1970; Proffit *et al.*, 1998). Growing patients with a maxillary deficiency may be treated with a maxillary protraction device, namely the facemask. However, because the force is applied to the teeth, the inevitable mesial migration of the dentition can result in anterior crowding, incisor proclination and the possible need for a subsequent extraction therapy (Williams *et al.*, 1997). Furthermore, the desired positive skeletal effect of this approach can often turn out to be less than expected (Williams *et al.*, 1997; Ngan *et al.*, 1998). To overcome these problems, different kinds of anchorage reinforcement have been used to transfer the force directly to the maxillary bone by utlizing: ankylosed teeth (Kokich *et al.*, 1985), dental implants (Henry, 1999) and surgical mini-plates (Kircelli and Pektas, 2008; De Clerck *et al.*, 2010; Kaya *et al.*, 2011; Sar *et al.*, 2011). To minimize surgical invasiveness, Wilmes and colleagues introduced the Hybrid Hyrax (Wilmes *et al.*, 2008; Wilmes and Drescher, 2008; Wilmes *et al.*, 2009; Ludwig *et al.*, 2010; Wilmes *et al.*, 2010; Wilmes *et al.*, 2011), which uses two mini-implants in the anterior palate to provide sagittal skeletal anchorage and avoid mesial migration of the maxillary dentition (Wilmes *et al.*, 2010; Nienkemper *et al.*, 2013). These mini-implants serve as an anterior skeletal anchorage unit, whilst deciduous or permanent molars are used as posterior dental anchorage (hybrid anchorage). It is recommended that these mini-implants are used with abutments to obtain a stable coupling between them and the wires of the Hybrid Hyrax expansion appliance.

To increase advancement of the maxilla, facemask therapy is often combined with rapid palatal expansion (RPE) (Baccetti *et al.*, 1998), because stimulation of the midfacial sutures can be expected. Even though there is a controversy in the literature about the effectiveness of this approach, a number of authors recommend the combination of RPE and facemask to enhance maxillary advancement (Jager *et al.*, 2001). In some class III cases there may be a need for subsequent molar distalization after the orthopaedic treatment. Using a headgear for upper molar distalization may result in an unwanted orthopaedic maxillary growth inhibition. Additionally, there may be an instinctive problem associated with

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DOI 10.1179/1465313314Y.0000000107

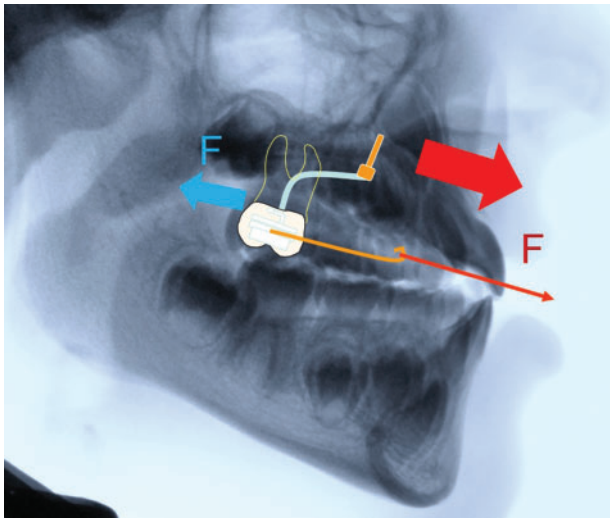


Figure 1 Principal features of the Hybrid Hyrax Distalizer appliance: orthopaedic protraction of the maxilla and orthodontic distalization of the molars

compliance with headgear wear. Consequently, it seems reasonable to utilize the mini-implants that were used for the RPE and sagittal anchorage for the facemask (Hybrid Hyrax) for the molar distalization phase. This multi-purpose appliance is called the 'Hybrid Hyrax Distalizer' and is used for the following three purposes: (1) to prevent side-effects (tipping, periodontal damage, loosening) associated with the premolars and deciduous molars when expanding the maxilla (Wilmes *et al.*, 2010); (2) to avoid mesial migration of the upper molars when using a facemask (Nienkemper *et al.*, 2013); and (3) to distalize the upper molars without anchorage loss and a need for additional patient compliance.

In summary, orthopaedic advancement of the maxilla and the simultaneous orthodontic distalization of the upper molars is feasible with the Hybrid Hyrax Distalizer (Figure 1) as demonstrated by the following case report. This also describes the clinical procedures involved with the technique.

Case report

A 10-year-old boy presented with a severe class III malocclusion primarily associated with maxillary retrognathia (SNA= 81.8°, SNB=81.6°, ANB=0.1° Wits= −5.2 mm) and with no centric relation-centric occlusion discrepancy. Due to early loss of the deciduous molars, the upper first molars were mesially displaced and there was a lack of space for the premolars (Figure 2a-c). The treatment plan involved interceptive class III treatment with maxillary facemask protraction followed by upper molar distalization. To avoid dental side effects and to facilitate distalization, a Hybrid Hyrax Distalizer was prescribed.

Mini-implant insertion and impression

Under local anaesthesia, two mini-implants with removable abutments (2 × 9 mm, Benefit system, PSM, Tuttlingen, Germany) (Figure 3) were inserted with a contra-angle screwdriver next to the mid-palatal suture and near to the third palatal rugae (Figure 4). In such young patients, pre-drilling is not necessary due to their low bone density. At the same appointment bands were fitted to the upper first molars. A silicon impression was then taken after application of transfer caps.

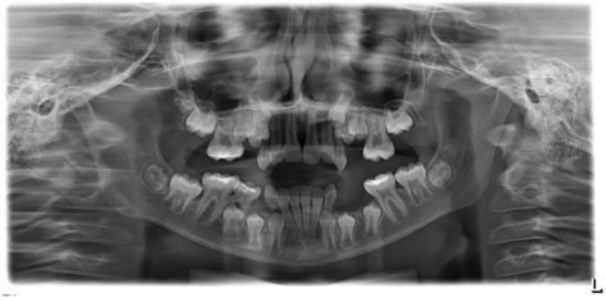
Laboratory process

Laboratory analogues were placed on the transfer caps, the bands were positioned in the impression and a plaster model made. Afterwards, two standard abutments (see Figure 3) were screwed on top of the laboratory analogues. A transverse palatal expansion screw (Hyrax, Dentaurum, Germany) and two distalization screws (Variety SP, Dentaurum, Germany) were connected by welding anteriorly onto the two abutments and posteriorly onto the molar bands. For application

Table 1 Difference between pre- and post-treatment lateral cephalometric parameters measured

Lateral cephalometric parameters	Pre-treatment	Post-treatment	Change
SNA angle (°)	81.8	86.4	4.6
SNB angle (°)	81.6	81.7	−0.1
ANB angle (°)	0.1	4.7	4.6
Wits (mm)	−5.2	1.7	6.9
ML–NL (°)	21.1	26.7	5.6
U1–NL (°)	124.7	104.1	−20
U1–L1 (°)	128.5	143.6	−15.1
L1–ML (°)	85.8	85	−0.8

Key: SNA, angle between Sella-Nasion-A point; SNB, angle between Sella-Nasion-B point; ANB, difference SNA-SNB; Wits, measure of sagittal jaw discrepancy at occlusal leve; ML, mandibular plane; NL, palatal plane; U1, upper incisor long axis; L1, lower incisor long axis.



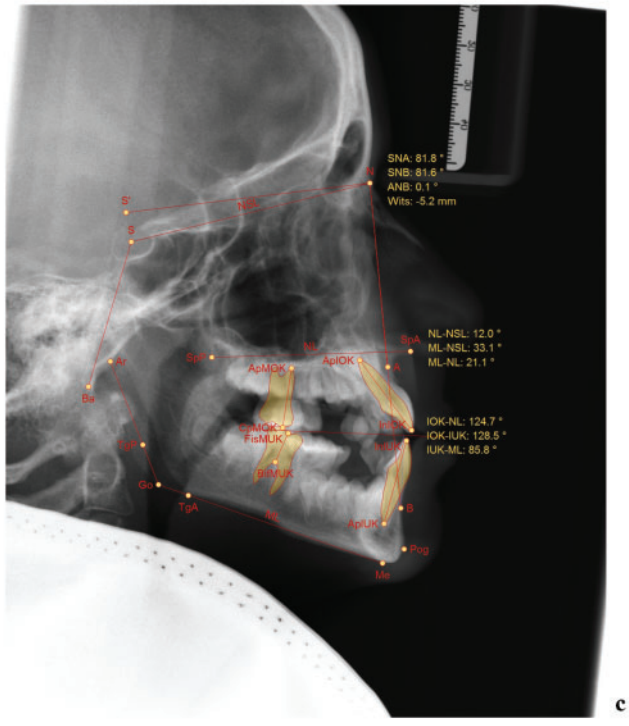


Figure 2 (a) 10-year-old male patient with a severe Class III malocclusion, early loss of the deciduous molars, and associated potential premolar crowding. (b) Pre-treatment orthopantomogram. (c) Pre-treatment lateral cephalogram showing a severe Class III (Wits=−5.2 mm)

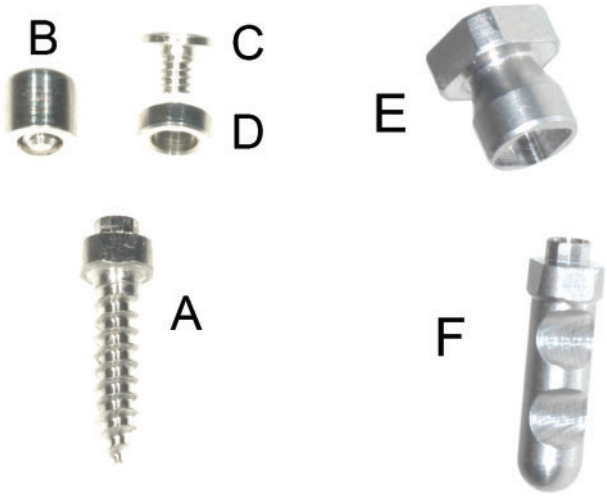


Figure 3 Components for the anterior skeletal anchorage units of the Hybrid Hyrax Distalizer: A. Benefit mini-implant. B. Standard abutment. C. Fixation screw. D. Hyrax Ring. E. Impression cap. F. Laboratory analogue

of orthopaedic protraction forces, 1.2 mm stainless steel sectional wires, with hooks near the canine region, were welded on the buccal side of the molar bands.

Intraoral installation and activation protocol of the appliance

After a provisional fitting on the maxillary molars, the Hybrid Hyrax Distalizer was fixed on the mini-implants followed by the final seating on the molars. While screwing the abutment screws, the Hybrid Hyrax was gently pressed onto the mini-implants to facilitate the fixation. The use of light curing cement (e.g. Band-Lok, Reliance Orthodontic Products, Itasca, IL, USA) is recommended for the molar bands to allow enough time to fully fit the appliance (see Figure 4). The sagittal split screw was activated for expansion immediately after insertion of the appliance and twice daily, resulting in a 0.8 mm daily activation.

A 400 g bilateral protraction force was applied by elastics connected to the facemask. After six months of facemask treatment and establishment of a sufficient overjet (Figure 5), molar distalization phase was started (see Figure 4c, d). The patient was instructed to activate the distalization screws weekly (approximately 0.2 mm per week). After 5 months, the molars had distalized by 3–4 mm (Figure 4d). During this distalization phase the patient continued to wear the facemask.

This interceptive treatment for orthopaedic class III correction and orthodontic upper molar distalization was completed after 14 months (Figure 6). The SNA angle was improved from 81.8 to 86.4° (4.6° difference), SNB was essentially unchanged from 81.6 to 81.7° (−0.1° difference), and the Wits appraisal improved from −5.2 to 1.7 mm (6.9 mm change). Additionally, enough space was gained for eruption of the canines (see Table 1).

Discussion

Mini-implant insertion and stability

The anterior palate is the preferred insertion region for mini-implants because of its good bone quality and relatively low rate of problems during insertion and usage. The thin attached mucosa is ideal for mini-implants and there is almost no risk of root damage. Recently published studies have reported a very high success rate associated with mini-implant placement in the palate, of an order of 98% (Karagkiolidou *et al.*, 2013). If the patient is afraid of a syringe anaesthetic, then topical application of an appropriate mucosal anaesthetic is also possible. The Hybrid Hyrax/Hybrid Hyrax Distalizer should be installed as soon as possible after insertion of the mini-implants to avoid problems arising from any untoward jiggling effects from the tongue.

Fitting

For easy installation of the appliance, parallelism of the two mini-implants is advisable, but not a prerequisite, since the appliance can still be fitted when the two mini-implants are inserted at slightly different angles. Using the standard abutments of the Benefit system, installation of the appliance appears simple since the fixation screws are integrated into the abutments and hence cannot get lost. However, this places high demands on precision at both the impression and Hybrid Hyrax fabrication stages. If the Hybrid Rings are used instead of the abutments, then precision problems can be detected and more easily corrected. The Hybrid Rings are secured with small fixation screws (see Figure 3).

Facemask versus miniplates

A facemask has been used as extraoral anchorage for the protraction force. If patients prefer a completely intraoral approach then mandibular anchorage can be achieved using either a single midline 'mentoplate' (Wilmes *et al.*, 2011) or two Bollard mini-plates (De Clerck *et al.*, 2010) can be used instead of the facemask. However, this would be associated with a much more invasive procedure when compared with inserting the mini-implants.

Effectiveness and stability

The improvement in the Wits value was very substantial in the present case (6.9 mm) and higher than the previously reported average of 4.1 mm using the

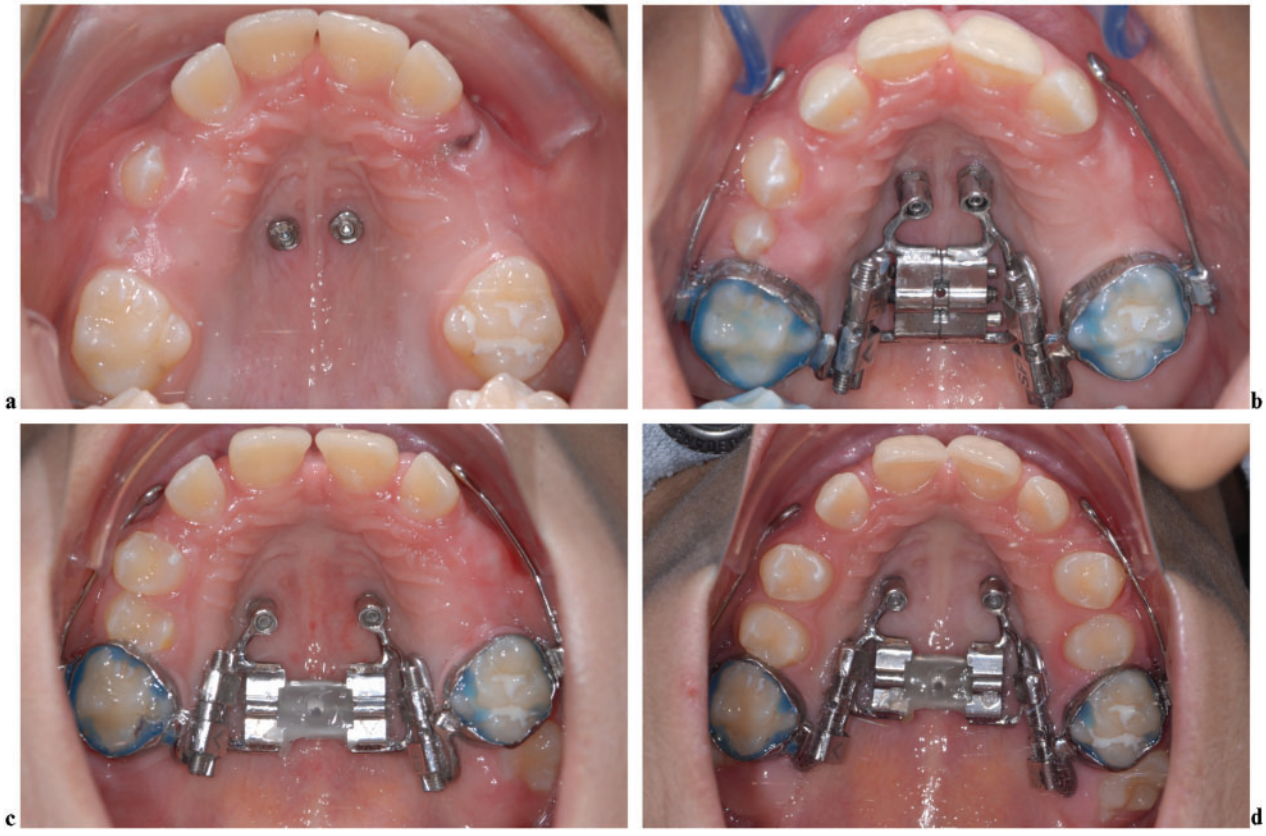


Figure 4 (a) Two mini-implants inserted near the third palatal rugae. (b) After installation of the Hybrid Hyrax Distalizer. (c) After three months of rapid palatal expansion and facemask application. (d) After five months of distalization

Hybrid Hyrax and facemask (Nienkemper *et al.*, 2013). In the present case, the change in Wits was primarily due to the forward movement of the maxilla with a change in SNA angle from 81.8 to 86.4° and no change in the mandibular sagittal position. At completion of this treatment, the upper and lower incisor angulation was near ideal, suggesting no anchorage loss was evident after the orthodontic distalization procedure.

Figure 5 Establishment of a normal overjet after 6 months of facemask treatment. In the lower arch, a lingual arch was inserted to maintain space

For severe class III cases Liou's Alt-RAMEC (Liou, 2005) protocol (of alternating expansion and constriction) seems promising. The midface suture stimulation as a result of the Alt-RAMEC protocol may be maintained over a longer lasting period with the aim of achieving greater maxillary skeletal protraction compared to a single expansion period. Due to the skeletal anchorage provided by the mini-implants in the anterior palate (Hybrid Hyrax), expansion and constriction forces are primarily skeletally borne (Ludwig *et al.*, 2013) and the risk of periodontal damage is very low (Wilmes *et al.*, 2014). Further research has to been done to evaluate the anticipated advantage of the Alt-RAMEC protocol.

A recent randomized clinical trial by Mandall and coworkers (Mandall *et al.*, 2012) with 3 years of follow-up, has shown that on average 70% of children treated with a protraction facemask retain favourable changes in their maxillary and mandibular bases, which suggests that such changes can be stable, at least in the medium

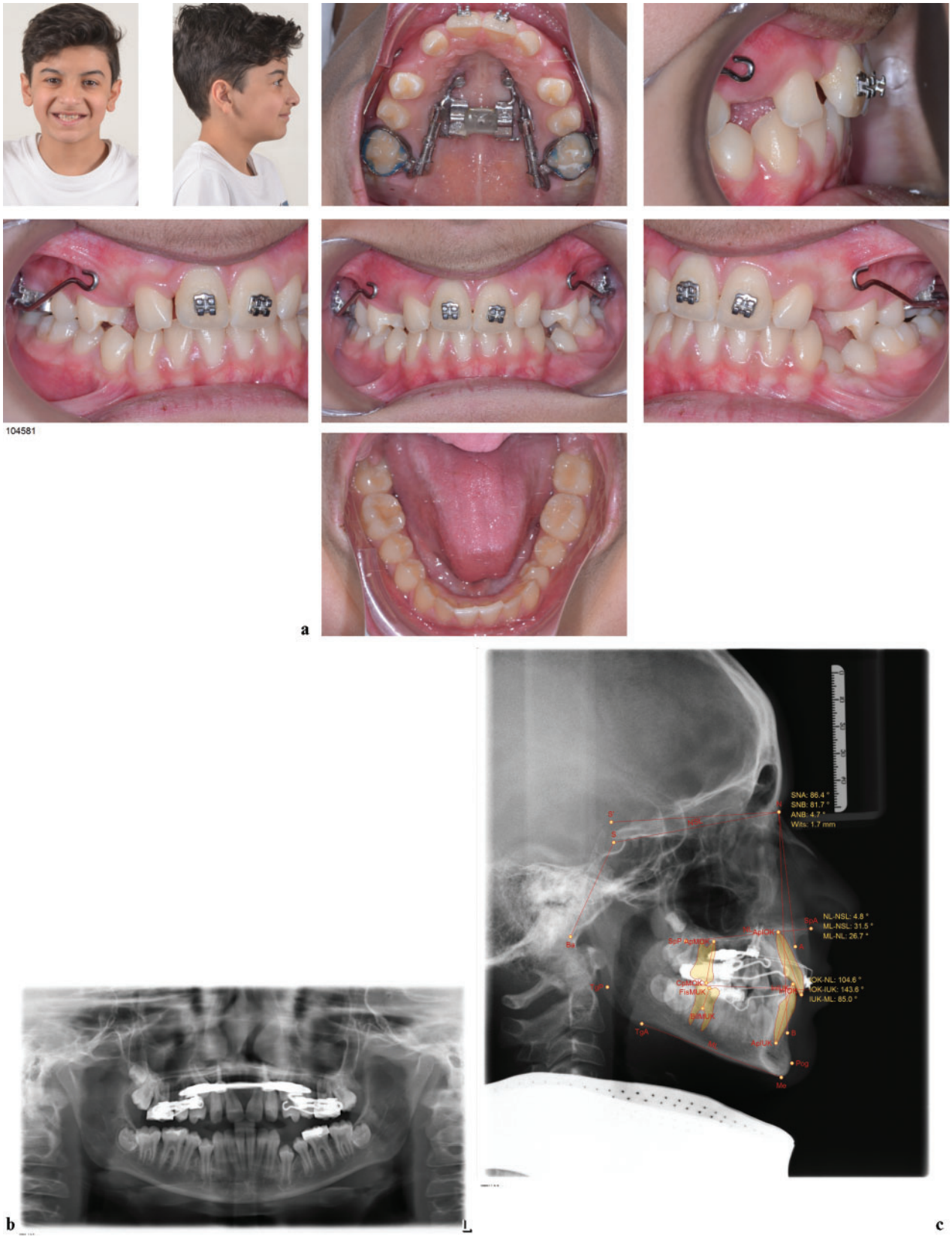


Figure 6 (a) Post-treatment photographs. (b) Post-treatment orthopantomogram. (c) Post-treatment lateral cephalogram

term. Further studies are required to assess the long term stability of the Hybrid Hyrax Distalizer used with a facemask as suggested in this case report.

Conclusions

In summary, the Hybrid Hyrax Distalizer facilitates simultaneous orthopaedic maxillary protraction and orthodontic upper molar distalization. This appliance has the following advantages over a conventional approach for young patients with a class III malocclusion requiring orthopaedic maxillary protraction and orthodontic upper molar distalization:

- the sagittal forces are transferred to the maxillary bone and there are no dental side effects in terms of mesial migration of the teeth;
- the transverse forces are applied anteriorly to the mini-implants; hence there is no risk of periodontal damage on the premolar and deciduous molar teeth;
- upper molars can be distalized with the same appliance with a minimal need for compliance;
- low surgical invasiveness;
- an anaesthetic treatment with no need for brackets or other fixed appliances and some cases may possibly be treated later with aligner therapy.

Disclaimer statements

Contributors No statement made.

Funding None.

Conflicts of interest Dr Benedict Wilmes is the inventor of the Benefit mini-implants.

Ethics approval None.

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