Original Article

SUCCESS RATE OF MINISCREW ANCHORAGE FOR MINISCREW ANCHORED MAXILLARY PROTRACTION

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ABSTRACT

Different bone anchored maxillary protraction (BAMP) protocols were introduced in the last few years for the treatment of growing Class III. Mini-implant stability is the most critical point controlling the success of bone anchorage in orthodontics. To evaluate the success rate of miniscrew anchorage for bone anchored maxillary protraction. Twenty patients (11.4±1.3 years; range, 9.5-13.2 years) with maxillary hypoplasia without clefts or craniofacial anomalies were recruited in this study. All participants received a miniscrew supported hyrax expander (hybrid hyrax) that was activated by Alt-RAMEC protocol for 9 weeks. A miniscrew anchored mandibular bar was delivered for each case acting as attachment for full time Class III elastics (200 g). Maxillary protraction was ceased when achieving positive overjet. A total of 80 miniscrews (maxilla, 40; mandible, 40) were placed by the same operator. Miniscrew success rate was analyzed for insertion site and gender using Fisher's exact test at 5% level of significance. ResultMaxillary protraction was achieved in all cases within 12.2±2.1 months. There was no significant correlation ($p > 0.05$) between gender nor insertion site and miniscrew failure. Success rate was 97.5% for the palatal screws and 87.5%for the mandibular interradicular screws. Skeletal anchorage by miniscrews is effective for BAMP. Palatal miniscrews were more successful than mandibular interradicular screws, but the difference was not significant.

Key words: Class III, Maxillary protraction, Mini-implant, Success rate.

Introduction

Over many years, facemask therapy was used for the correction of maxillary hypoplasia in growing patients [1]. The protraction facemask was used with tooth-borne intraoral appliances which presented several disadvantages; dentoalveolar compensations, clockwise rotation of the mandible, anticlockwise for the maxilla, and non-compliance especially with an active lifestyle [2-6]. To overcome these side effects, different bone-anchored protraction protocols with class III elastics were introduced including; hybrid hyrax (HH) mentoplates combination and bone-anchored maxillary protraction (BAMP) using mini plates [7, 8]. The previously mentioned plates need to be placed by the surgeon under general anesthesia after flap elevation. The mini crew implants are easy to be placed by orthodontists under local anesthesia.

Several reports presented a modified BAMP replacing the mini plates with miniscrews, known as miniscrew anchored maxillary protraction (MAMP) [9-12]. These reports showed promising results, however, the success rate of miniscrews in MAMP had not been investigated yet. Therefore, this prospective study aimed to evaluate the success rate of miniscrew anchorage for MAMP in growing maxillary retrusion patients.

Materials and Methods

Twenty patients were recruited for this study from the postgraduate clinic of orthodontics, Faculty of Dentistry, Mansoura University, Egypt. The mean age of patients was 11.4±1.3 years (range, 9.5-13.2 years). Ten male (mean age, 11.6±1.3 years; range, 9.7-13.2 years) and 10 female patients (mean age, 11.2±1.2 years; range, 9.5-13 years) were included. The success rate was used as a parameter for sample size calculation by using the two proportions Z-test. Based on a previous study, the difference between the two proportions was determined as 27.8% [13]. The power analysis revealed that 33 mini-implants per group were needed to detect clinically meaningful differences between the groups at a power of 90% and a significance level of 0.05. The sample size was estimated by G*Power (Version 3.1.9.4; Kiel University, Germany). Accordingly, a total of 80 mini-implants (40 per group) which were inserted in 20 patients, were evaluated in the study.

The inclusion criteria were; growing Class III patients with maxillary hypoplasia erupted mandibular canines and no clefts or craniofacial anomalies. Written consents were signed by the parents before patient inclusion.

In the maxillary arch, 2 paramedian palatal miniscrews (8 mm length,1.8 mm diameter, 3M ESPE Dental Products, St. Paul, MN, USA) were inserted distal to the 3rd palatine rugae and 3 to 5 mm lateral to the mid palatine raphe according to the protocol described by Wilmes *et al.* **(Figure 1a)** [14, 15]. The O-caps were used over the screws acting as transfer caps

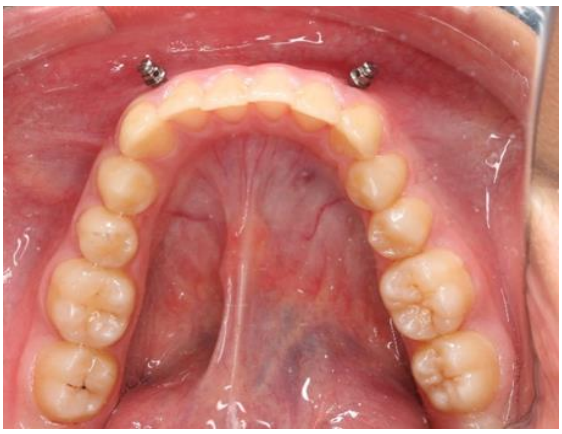
and attachments for the HH. A silicon impression was recorded for the upper arch with the caps in place. Then the HH was fabricated on the dental model and welded to the caps on the transfer analogs. Posterior bite blocks were added to the HH to avoid any occlusal interference during protraction. Buccal hooks on the molar bands were used as attachments for elastics. The HH was cemented 3 weeks after miniscrews insertion using a Blue band (SIA Orthodontic Manufacturer, Rocca d' Evandro, Italy) **(Figure 2)**. Nine weeks of alternate rapid maxillary expansions and constrictions (Alt-RAMEC), with an activation protocol of 2 quarter turns every 12 h, were initiated.

In the 7th week of Alt-RAMEC, 2 inter radicular screws (8 mm length, 1.5 mm diameter, 2mm transmucosal, Morelli, S.B, Brasil) were inserted at the mucogingival level between the mandibular canine and lateral incisor with 20-30 degrees to the occlusal plane apically **(Figure 1b)** [10]. The screws were transferred to the model using a silicon impression for the lower arch. A custom-made bar was fabricated to fit perfectly over the screws with 2 hooks above the screws for elastic attachment. The bar was cemented with the Blue band.

All the miniscrews were inserted by the same operator (AK) under local anesthetic. All patients were instructed to rinse with chlorhexidine HCL (125mg/100ml) mouth wash and after meals for 2 weeks. Paracetamol (500mg/12h) was prescribed for 2 days. Chlorhexidine gluconate (0.1%) containing toothpaste was used daily till the end of treatment.

After 2 weeks, intermaxillary class III elastics (Ortho Organizers, CA, USA) running from the maxillary hooks to the bar, were used on both sides for 24 hours a day **(Figure 3)**. The patients were instructed to change the elastics every 12 hours. The initial force was 100 g per side. It was increased to 200 g per side after one month and kept at that level till the end of treatment. The mean follow-up period was 12.2±2.1 months (range, 9-16 months).

a)



b)

Figure 1. a) Palatal paramedian mini-implants; b) Lower inter radicular mini-implants.

Figure 2. Hybrid hyrax expander, anchored on 2 paramedian palatal mini-implants.

Figure 3. Miniscrew anchored maxillary protraction, intermaxillary elastics running from hybrid hyrax to the miniscrew supported mandibular bar.

Statistical analysis

All statistical analyses were conducted using SPSS® for Windows version 23.0 (IBM Corp., Armonk, NY, USA). Kolmogorov- Smirnov (K-S) test was used to test the normal distribution of metrical parameters. The following parameters were analyzed concerning miniscrews success

rates: 1) insertion site; 2) patient gender. Comparisons between nominal variables were performed with Fisher's exact test for non-parametric data. Statistical significance was set at $p < 0.05$.

Results and Discussion

There was no significant correlation ($p > 0.05$) between gender nor insertion site and miniscrew failure **(Table 1)**. In this study, 80 miniscrews were inserted with excellent primary stability. Of these 80 screws, 1 maxillary and 5 mandibular screws failed. In 3 males and 2 females, 5 mandibular screws showed mobility after 3 to 4 months of loading. Four weeks later, these screws were reinserted in a lower position with more apical angulation.

After 9 weeks, a male patient complained of pain in the one palatal insertion site and the related screw became loose on appliance removal. It was reinserted 4 weeks later in a more lateral position.

Before appliance delivery, all patients complained about lower lip and tongue irritation after the screw insertion visit. This was solved by covering the head of the screw with soft wax.

The miniscrews provide an excellent skeletal anchorage with high patient acceptance. Different reports of miniscrews failure and success rates were published in the last few years [16-20]. However, only the effect of continuous loading on miniscrews stability was investigated. The force applied by intermaxillary elastics is not stable or continuous in time. The force changes in duration, direction, and magnitude because of different mandibular movements during chewing, swallowing, and speech.

Table 1. Success rate according to sex and insertion site.

Variable		Stable *n* (%)	Failed *n* (%)	***P value**
Sex (n=80)	Male (n=40)	36 (90%)	4 (10%)	0.675
	Female (n=40)	38 (95%)	2 (5%)	
Site (n=80)	Maxilla (n=40)	39 (97.5%)	1 (2.5%)	0.201
	Mandible (n=40)	35 (87.5%)	5 (12.5%)	

Fisher's exact test, $*P < 0.05$

To our knowledge, the success rate of miniscrews anchorage for maxillary protraction by hybrid hyrax-intermaxillary elastics combination in growing patients has not been investigated yet. A clinical trial on 48 screws, reported the miniscrew success rate with MAMP of 79.2% in the maxilla, which is different from the result of the current study (97.5%) [11]. This can be attributed to the difference in the insertion sites and the loading protocol. The authors used buccal inter radicular sites instead of palatal paramedian sites in our study. The success rate of the anterior palatal screws was reported higher (98.9%) than inter radicular screws (71.1%) [13]. The protraction forces were applied directly to the screws, unlike indirect loading through the hybrid hyrax in our protocol. The success rate in the mandible was similar to our results (87.5%). The reason may be due to the increased surface area of the two screws by the connecting bar [21].

Indirect loading was proven to have a higher success rate than direct use [22]. The mandibular screws were directly loaded by elastic forces in comparison with indirect loading in the maxilla. However, the palatal screws received a higher expansion force of Alt-RAMEC with higher success. Moderate loading forces were suggested for high success which was applied in the current study [23].

The success of the screw was affected by the screw length and diameter [20]. A drawback of our study is using different screw designs and diameters but not the length. The smaller diameter screws were chosen to accommodate the small inter radicular insertion site in the mandible. However, the 1.6 mm diameter screw is supposed to have a failure rate lower than the 1.8 mm screw [20]. Bicortical insertion of screws was recommended for higher stability, but it was not investigated in this study due to the equal length of screws.

The initial stability depends mainly on the mechanical retention of the miniscrews in the external cortical bone. Therefore, the thickness and density of this bone which is reduced in growing compared with adult patients, determine the screw's initial stability [24]. However, The density was not analyzed, but it probably contributed to the failure of the screws in our study.

All in all, careful observation of oral hygiene, gingival status, miniscrews mobility, and elastic forces are essential for successful treatment.

Conclusion

- Miniscrew anchorage is successful for bone-anchored maxillary protraction.
- The palatal paramedian miniscrews offered a higher survival rate of 97.5%.
- Splinting the 2 mandibular screws resulted in a success rate of 87.5%.

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Conflict of interest: None

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Ethics statement: The study protocol was approved by IRB (code no. A16260219).

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