Journal of Cranio-Maxillo-Facial Surgery 47 (2019) 1881–1886

Contents lists available at ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

Lag screw fixation of the premaxilla during bilateral cleft lip repair

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ARTICLE INFO

Article history:
Paper received 31 July 2019
Accepted 20 November 2019
Available online 28 November 2019

Keywords:
Bilateral cleft lip
Protrusion
Premaxilla
Vomer
Osteotomy
Fixation

ABSTRACT

In synchronous primary premaxillary setback and cleft lip repair for bilateral cases with severely protruding premaxilla, stabilization of the premaxilla is mostly achieved by gingivoperiosteoplasty. This kind of repair carries risk of impairment of blood supply to the premaxilla and/or prolabium, and at the same time it cannot ensure adequate stabilization of the premaxilla postoperatively. To overcome these problems, we have developed a unique technique of fixation of the premaxilla. In this paper, we discussing this technique, its advantages, and potential complications associated with it. From 2016, 10 patients aged 4–10 months, with bilateral cleft lip and palate with premaxillary protrusion (≥10 mm) underwent premaxillary setback and cheilorhinoplasty in the same stage. Instead of gingivoperiosteoplasty, a 'lag screw' fixation technique was used to stabilize the premaxilla. The follow-up period ranged between 5 and 32 months. In all the cases, we achieved adequate stabilization of the premaxilla. None of the patients had any issue related to the vascularity of the premaxilla or prolabium. There was no impairment in the eruption process of deciduous teeth in the premaxillary segment. Overall aesthetic outcomes of the lip and nose were acceptable. This technique of premaxillary fixation with lag screw gives us the liberty to perform primary cheilorhinoplasty along with premaxillary setback in the same stage, without risking the vascularity of premaxilla and prolabium. It ensures adequate stabilization of the premaxilla, but evaluation of regular growth of the midface and, if needed, corrective orthodontic and surgical treatment in the follow-up periods are advisable.

1. Introduction

Cases of bilateral complete cleft lip can be managed comfortably if the premaxilla is in favourable position; however, they become challenging if there is severe protrusion of premaxilla, and far more challenging if it is rotated as well. This abnormal position of the premaxilla is related to its attachment to the nasal septum via the septo-premaxillary ligament. The premaxilla is carried forward without any resistance from the upper lip at the same rate as that of the growing septum to which it is firmly attached. The premaxilla has only one restraining point, the vomero-premaxillary suture (VPS), the connection between the premaxilla and vomer (Latham, 1973; Delaire and Precious, 1986). Various appliances and techniques such as extraoral head caps, elastic straps, tapes, Burston plate, Latham appliance and naso alveolar moulding (NAM) have been proposed and used by the different authors to manage such premaxilla in a non-surgical way (Millard and Latham, 1990). We, at our centre, perform pre-surgical NAM routinely for managing such kinds of premaxillas; however, NAM cannot be a solution in all the patients for many reasons such as unfavourable age of the child, poor treatment compliance, parental reluctance or unproductive NAM. In such cases, there remain two options only: either repair the lip over the protruded premaxilla, or push the premaxilla back surgically to a favourable position first and then repair the lip over it. When the premaxillary protrusion is less than 10 mm, we choose the first option, but if it is 10 mm or more, we prefer to perform reduction osteotomy of the premaxilla and to set it back to facilitate lip closure (Fig. 1). The 'lip adhesion' technique can be used to repair such a type of bilateral lips; however, this requires two-stage surgery, it may disturb the anatomical landmarks, and there is the chance of wound dehiscence in cases of excessive protrusion. The lip repair over a markedly proclined premaxilla is usually disappointing because of difficult muscular approximation, and it may lead to distortion of the prolabium, widening of the inter-alar distance and stretching of scars, and at the same time it does not correct premaxillary posture and stabilize the dental arch. The premaxilla remains protruded, lingually rotated and vertically

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https://doi.org/10.1016/j.jcms.2019.11.015
1010-5182/

Fig. 1. Premaxillary protrusion of 13 mm with unilateral deviation and torsion.

elongated; moreover, the lateral maxillary segments collapse behind the premaxilla (Mulliken, 1985; Wallace, 1963; Bitter, 1992).

The use of primary premaxillary osteotomy and setback in early childhood have been criticised by many authors (Narayanan et al., 2006; Scott et al., 2007; Heidbuchel et al., 1993), but at the same time have been performed and advocated by others (Murthy, 2009; Fakih-Gomezet al., 2015; Vyas et al., 2016). There have been differences amongst advocates of this procedure in relation to placement of osteotomy cuts, anterior or posterior to the VPS. Few surgeons have performed reduction osteotomy anterior to the VPS (Fakih-Gomezet al., 2015; Vyas et al., 2016; Park and Kim, 2018), while others have recommended making the osteotomy incision posterior to the VPS (Murthy, 2009; Kobayashi et al., 2017; Almas et al., 2018). All 10 patients included in this study underwent 'anterior' osteotomy. After achieving premaxillary setback by any of the approaches, the main challenge is to stabilise the osteotomised premaxilla, which is mostly done by gingivoperiosteoplasty (GPP). We also performed GPP for the same purpose in our first 4 cases (not included in this study) of primary premaxillary setback. In those cases, we observed the patients to have some degree of mobility in the premaxilla even after complete healing of the osteotomy and GPP sites. This experience of ours with GPP motivated us to develop some other technique of stabilizing the premaxilla after performing osteotomy. Options such as wiring, splints or miniplates work well for the mixed dentition period, but not for the pre-dentition period. Therefore, for such age group patients, we started using a 'lag screw' technique for the fixation of the premaxillary segment. The aim of our study is to document the newly developed technique of fixation in cases of bilateral cleft lip and palate with having premaxillary protrusion, along with its advantages, limitations potential complications.

2. Case Report

This study includes cases treated between November 2016 and February 2019. The inclusion criteria consisted of child patient with complete bilateral cleft lip and palate with premaxillary protrusion of a minimum of 10 mm who could come for regular follow-up. The patient with systemic disease, and successful pre-surgical orthodontic treatment were excluded from the study. The series included 10 patients, aged 4–10 months, with mean age of 6.4 months. The following procedures were performed simultaneously: reductive osteotomy anterior to the VPS with premaxillary setback and primary cheilorhinoplasty. The follow up period consisted of 5–32 months. This clinical study was approved by the Integrity Ethics Committee. Written informed consent for the procedure was provided by parents of all the patients. All parents have given permission to use pictures of their child for publication purposes.

2.1. Surgical technique

Before discussing surgical technique, it is mandatory to understand the anatomical landmarks (Fig. 2). All the key points were marked, and the extent of protrusion was noted by measuring the distance between the posterior edge of premaxilla and the anterior edge of lateral segments. This dictates the size of the ostectomy and the extent of setback. A straight midline incision was made along the crest of the premaxillary stalk. No releasing incisions were given. This helps in reducing chances of damaging the blood supply from the nasal septum. While performing premaxillary osteotomy, it is important to secure the following two blood supplies: 1) that from the periosteum and mucosa of the nasal septum, and 2) that from the vestibular periosteum and soft tissue of the anterior premaxilla. The mucoperiosteal flaps were reflected gently on both sides of premaxillary stalk. Care was taken to limit the reflection of the flaps inferiorly up to bony premaxilla only and not to involve the mucoperiosteum of the septum. The VPS was identified and the ostectomy cuts were placed anterior to it (Fig. 3). The desired amount of bone was excised, and the premaxilla was set back to its new position. Some amount of the underdevelopment lies in the lateral maxillary segments from the embryonic period itself in these patients; therefore, while setting the osteotomised premaxilla back, care should be taken not to align it with the lateral segments because this may result in excessive retrusion of the midface during adolescence. Instead of being aligned, it should be stabilised in a place where its posterior edges just meet with the anterior edges of the lateral segments. For fixation of the premaxilla, we used a lag screw (2 mm in diameter x 20 mm in length). This screw has threads in the distal end and a smooth shank at the proximal end adjacent to the screw head. To achieve proper fixation, a 'guide'

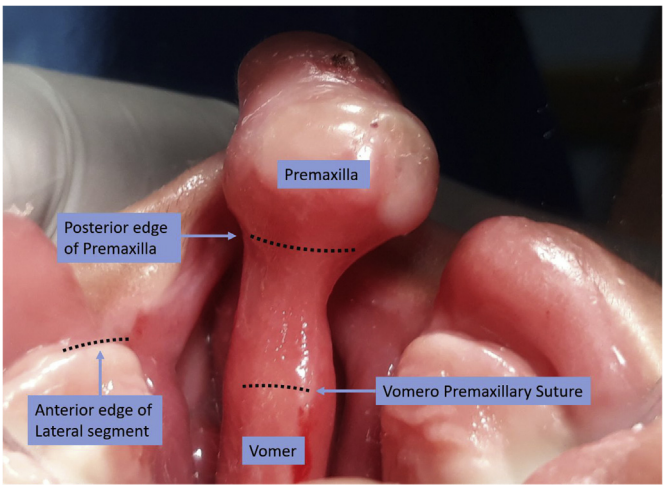

Fig. 2. Anatomical landmarks.

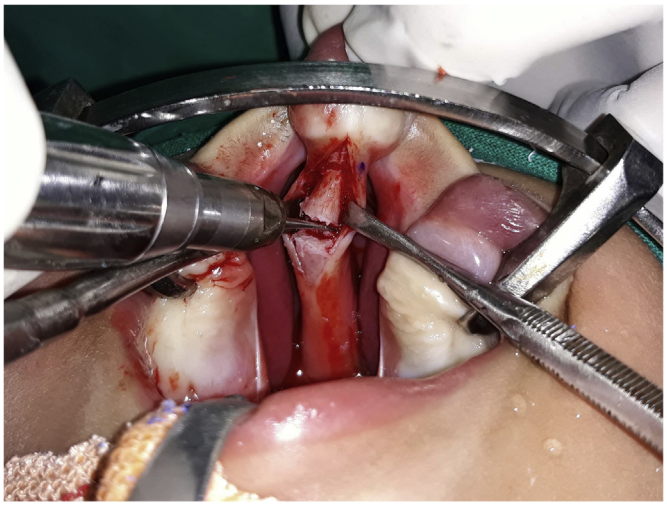

Fig. 3. Osteotomy cuts anterior to VPS.

Fig. 5. Tightening of the lag screw.

hole was drilled through the premaxillary segment, which should be at least as large as the thread diameter of the screw. The entry point of this hole was made in the vertical midline of the anterior surface of premaxilla, just above the vestibular fold (Fig. 4). This is followed by drilling the 'traction' hole at the most central point in the vomer. This traction hole should be smaller than the thread diameter of the screw. When the screw was tightened, the premaxillary segment was pushed towards the vomer by the screw head (Fig. 5). The tightening was done gently until both the raw surfaces met each other. By this method, this screw lies actively in the vomer and passively in the premaxillary segment while ensuring proper contact of the osteotomised surfaces (Fig. 6). Excessive tightening should be avoided, as it may cause pressure necrosis to the premaxilla and damage to the developing teeth. The surgical site was closed with 4-0 Vicryl (Fig. 7). Following this, primary cheilorhinoplasty was performed (Fig. 8). Screw removal was done during cleft palate repair, which was performed after 3–6 months of cleft lip repair (Fig. 9). The approximation of osteotomised segments, placement of the screw and change in the skeletal profile of the patient can be evaluated by low-radiation computed tomography (Fig. 10).

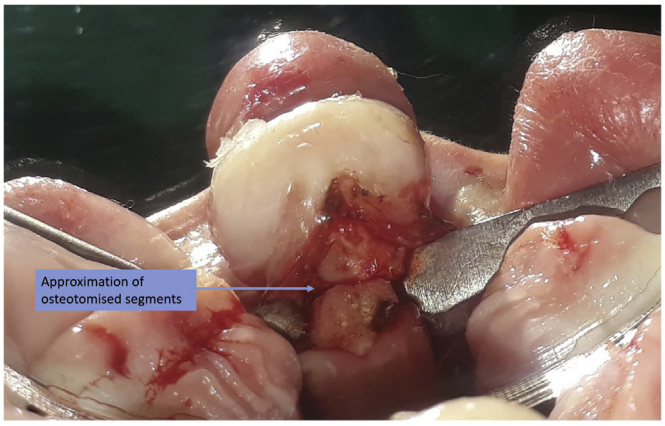

Fig. 6. Approximation of osteotomised segments.

The outcome of this technique was evaluated on the following five parameters by the two surgeons independently:

1. Vascularity of prolabium and premaxilla after 24 h of procedure: This was evaluated by assessing the colour of the prolabium and

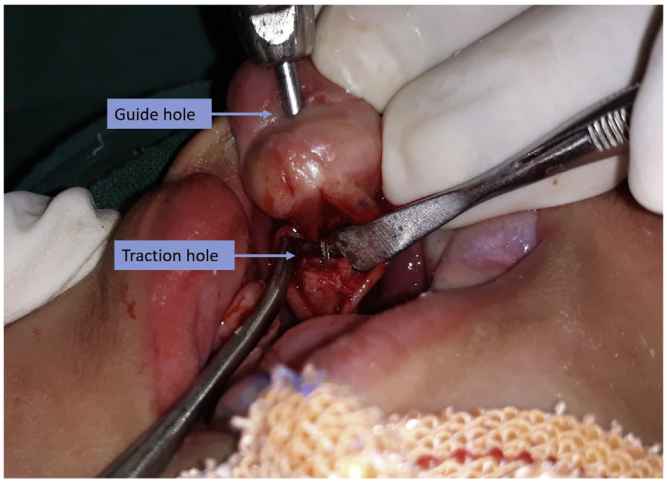

Fig. 4. Drilling of guide and traction holes.

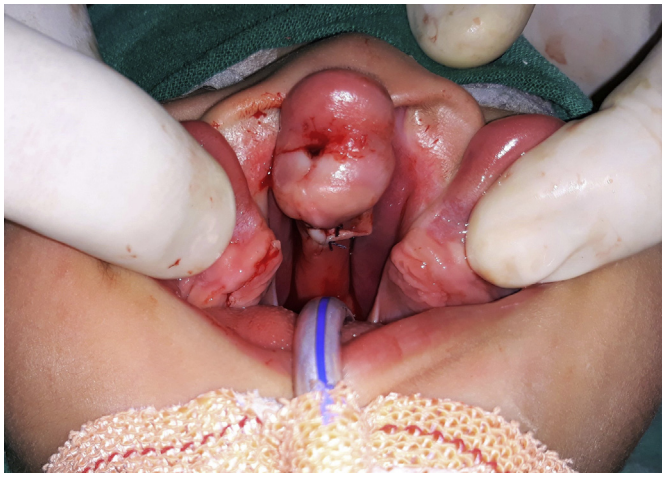

Fig. 7. Final setback and closure.

Fig. 8. Post cheilorhinoplasty.

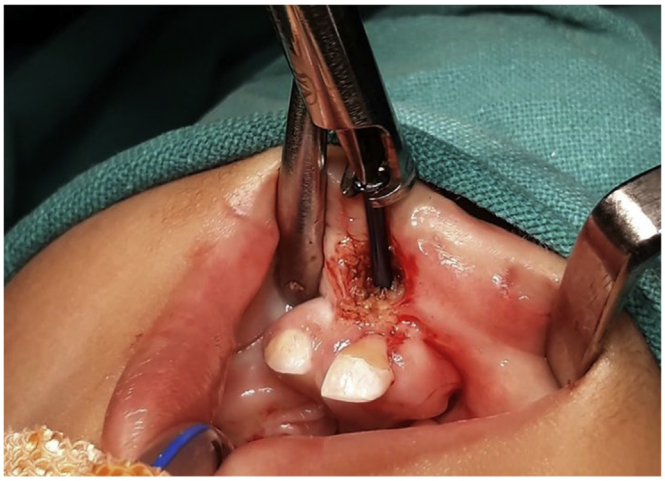

Fig. 9. Screw removal during palatoplasty.

premaxilla. A pink colour reflected good perfusion, a pale appearance implied an arterial inflow problem, and a blue color denoted venous insufficiency. The colour of prolabium and premaxilla was pink in all the patients. There was no sign of any ischemic injury in any of the cases.

2. Condition of operative sites after 14 days: All the surgical sites; sites of osteotomy and screw placement, suture line of lip and nose were evaluated for completion of primary healing. In all cases, all the wounds were healed primarily without having any infection or dehiscence except in one patient, who developed a small fistula on the floor of nostril on one side.
3. Aesthetic outcome of the lip and nose after 1 month: This was evaluated by assessing the following:
   a) Continuity of the muscle: This was restored in all cases, and there was no notching in the muscle in any of the patient.
   b) Reconstruction of philtrum, Cupid's bow, and tubercle: These anatomical landmarks were reconstructed symmetrically in all cases.
   c) Bilateral symmetry of nostrils, columellar height and projection of the tip of the nose: In all cases, we achieved symmetrical nostrils and noticeable height of the columella and projection of the tip of nose except in 4 patients. Of these 4 patients, 3 had unremarkable columellar height, and 1 had inconspicuous projection of the tip of the nose.
4. Status of eruption of deciduous teeth in the premaxillary segment at the age of 12 months: In all patients, both deciduous upper central incisors were found erupted, either completely or partially.
5. Position and stability of the premaxilla after removal of lag screw: After screw removal, which was done during palatoplasty, the premaxilla was completely stable in the same place where it was fixed, in all except 1 case. In that particular case, the premaxilla got rotated a little laterally along with the screw, but it was stable, with no mobility.

3. Discussion

Premaxillary ostectomy at an early age has always been a matter of discussion and controversy. The studies done by Vargervik (1983), Heidbuchel et al. (1993), Narayanan et al., (2006) and Scott et al. (2007) indicate that it affects maxillary growth, whereas observations made by Mulliken et al. (2003), Murthy (2009), Mulliken et al., (2009), Fakih-Gomezet al. (2015) and Vyas et al. (2016) suggest that it does not affect the normal growth pattern of the premaxilla. Friede and Pruzansky (1985) compared the long-term effects of premaxillary setback and concluded that surgical setback of the premaxilla, whether done

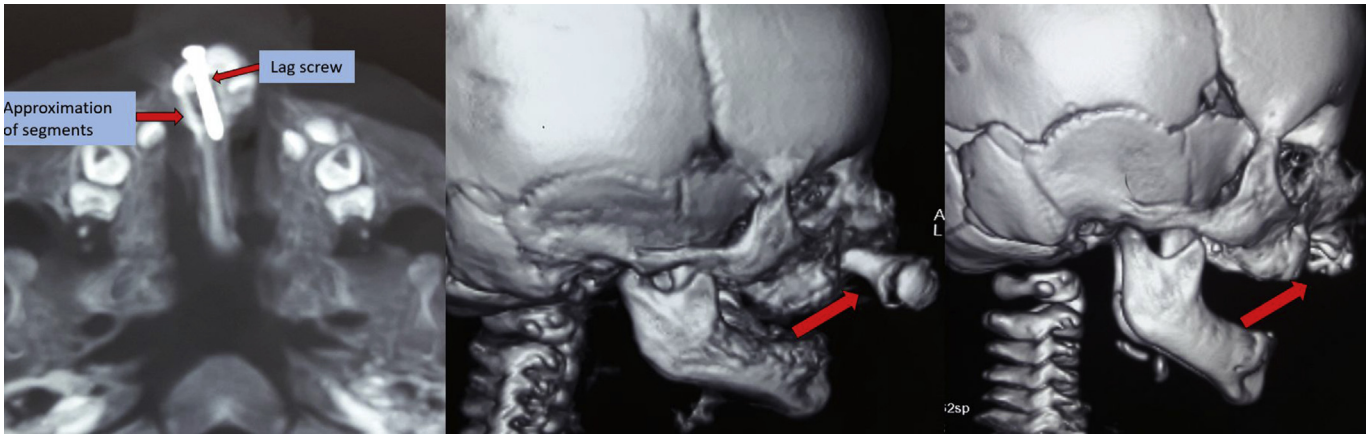

Fig. 10. Segments approximation,lag screw and change in skeletal profile.

in infancy or done later, caused a slightly concave profile (Friede and Pruzansky, 1985). Padwa et al. (1999), after conducting a long-term study on the effect of age at premaxillary osteotomy on facial growth, concluded that premaxillary osteotomy in childhood does not inhibit midfacial growth; therefore, there is no reason to wait until age of 10–12 years to properly position the premaxilla (Padwa et al., 1999). At the same time, the effect of primary palatoplasty on midface growth should not be forgotten. In practical terms, it is difficult to conclude whether it was primary setback of the premaxilla or primary palatoplasty that resulted in underdevelopment of the midface. We support the concept of early correction of premaxillary protrusion by NAM before lip repair, and, when NAM is not possible, by reduction osteotomy during lip repair. This early correction has many advantages, including the following:

1. Tensionless repair of the muscle; optimal aesthetic outcomes of lip and nose
2. Psychological benefits for the child and parents; better social acceptance for them
3. Reduction in formation of labial and anterior palatal fistulae
4. Better oral functions established at early age, such as mastication and speech

As required for most of the patients with bilateral complete cleft lip and palate, the patients undergoing primary premaxillary setback may require maxillary advancement appliances or procedures during mixed dentition period or adolescence. Lip repair at any age, with or without premaxillary setback, causes some inhibition of midfacial growth; as many as 40%–70% of teenagers with repaired bilateral cleft lip and palate will need maxillary advancement (Voshol et al., 2012; Heliovaara et al., 2013).

The osteotomy cuts can be placed anterior or posterior to the VPS. Cosman (1984), Fakih-Gomezet al. (2015), Vyas et al. (2016) and Park and Kim, 2018) performed anterior ostectomy, whereas Murthy (2009), Kobayashi et al. (2017) and (Almas et al., 2018) have preferred a posterior approach. Fernando et al. have argued that anterior osteotomy may potentially damage the septal cartilage, which is the key structure for midface growth; may risk the vascularity of the premaxilla; and may also limit the extent of concurrent rhinoplasty (Almas et al., 2018). Does posterior ostectomy have any advantage over anterior in relation to growth of the midface? It is an important aspect of discussion and deserves to be explored more in long-term studies. The septo-premaxillary ligament is the only attachment of the premaxilla to the nasal septum at the VPS. Traumatic or surgical disruptions of the anatomical relationship in this area can lead to septal deviation, and loss of cartilage can lead to a growth impediment in the nose and maxilla. At the same time, the residual gap between the cut segments of the vomer or cartilage, when cuts are made anterior to the VPS, affects midfacial growth proportionately (Verwoerd and Verwoerd-Verhoef, 2010). In our technique, while performing anterior ostectomy, we exercised all precautions so as not to damage the septal cartilage and, at the same time, ensured adequate approximation of the cut segments as well as their rigid fixation by the lag screw; by doing so, we minimised chances of growth suppression of the premaxilla. However, we still believe that long-term studies comparing anterior versus posterior ostectomy in relation to midface growth will be more conclusive.

For fixation of the osteotomised premaxilla in the pre-dentition or deciduous dentition period, GPP has been the procedure of choice. The role of GPP is not only to immobilize the premaxilla, but also to aid in alveolar bone formation (Kobayashi et al., 2017). However, this procedure has two disadvantages: 1) it does not provide rigid fixation, and some degree of mobility of the premaxilla can be expected postoperatively; and 2) it may impair the vascular supply of the premaxilla and/or prolabium when performed bilaterally along with premaxillary setback and primary cheilorhinoplasty. Fakih-Gomezet al. (2015) avoided primary nose correction in their patients because of increased risk of impairment of the already-compromised vascularity of the philtrum and premaxilla (Fakih-Gomezet al., 2015). Vyas et al. (2016) suggested two methods to reduce the chances of ischemic injury: the first is to perform GPP on one side only to secure the blood supply from other side of the nasal septum; and the second is to perform premaxillary osteotomy and GPP without cheiloplasty as a first stage to secure the blood supply from the mucosa and periosteum of the anterior premaxilla (Vyas et al., 2016). Park and Kim also expressed their concern as to whether the combined premaxillary setback and nasolabial repair causes deflective circulation to the premaxillary segment or the prolabial flap (Park and Kim, 2018). These potential complications of synchronous premaxillary setback and cheilorhinoplasty can be avoided by using our lag screw fixation technique instead of GPP for the fixation of premaxilla. It is easy for an experienced cleft surgeon to perform, gives rigid fixation to the premaxilla; it allows one to perform primary cheilorhinoplasty along with premaxillary setback without risking the vascularity of premaxilla and prolabium; and the screw can be removed easily during cleft palate repair.

The overall cosmetic results for all patients were satisfactory except for a few minor issues, which were not related to the lag screw placement. In none of our patients did we noticed any kind of interference from the screw to the eruption of deciduous teeth. The stability of the premaxilla should be checked only after removal of the screw. In all patients, the premaxilla was completely stable after screw removal. In one of our patients, the premaxilla was found to be rotated laterally along with the screw. This rotation occurred probably because of insufficient length of the screw and the pressure from the repaired lip. This can be avoided by choosing a screw of the appropriate length. The screw should be long enough to engage all of its threads inside the traction hole in the vomer.

This technique might be associated with a few potential complications. The major complication might be disturbance in growth, which can takes place in two situations. First, if the nasal septum is damaged by the surgical drill or screw, it might interfere with the vascularity of the premaxilla, and can potentially lead to premaxillary necrosis and growth retardation. This can be avoided by carefully placing the screw well within the premaxillary stalk and vomer, which are not the primary growth centre. Latham and Burdi argued that the nasal septum and septo-premaxillary ligament are primary drivers of central facial projection, whereas the VPS is a passive reactive site of ossification (Latham, 1970; Burdi, 1971). Second, if the screw is left for the longer duration (>6 months), it might suppress forward growth of the premaxilla; therefore, great care should be exercised to remove it within 6 months of the placement. Another complication can be injury to the developing teeth by the surgical drill while making the guide hole in inappropriate place. This can be avoided by drilling the hole in the vertical midline of the anterior surface of the premaxilla just above the vestibular fold; doing so ensures its placement in the non-dentate area.

There are some limitations of our technique. First of all, it should be performed by a surgeon who is experienced enough with cleft osteotomies; and second, it should be done for the patient who can come for the regular follow-up visit. The major limitation of our case series is the lack of long-term results in relation to the eruption of permanent teeth and midface growth.

4. Conclusion

After evaluating all the factors and our findings, we conclude that the presented technique might be an alternative to unavailable, unattainable, and unsuccessful presurgical orthodontic treatment. The value of this technique can only be evaluated after long-term follow-up.

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