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Pellerin's craniofacial distractor: A boon in low-resource setting

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ABSTRACT

Aim: The aim is to show the use of a novel Pellerin's distractor in the correction of midfacial and mandibular deformities. **Materials and Methods:** A total of ten patients were included in the study. Among the ten patients, two presented with Apert syndrome, three with Crouzon syndrome (CS), three with hemifacial microsomia, one with temporomandibular joint ankylosis, and one presented with Pfeiffer syndrome. All cases were treated by the Pellerin's distractor. All patients were followed for a minimum of 1 year. **Results:** Two patients were lost to follow-up. All the remaining patients achieved satisfactory correction of their deformity. The average amount of advancement achieved was 37.5 mm (32–50 mm). No serious complications were seen in any patient. Pin tract scarring was the most common complication seen in six of the patients. **Conclusion:** The Pellerin distractor can be used in both the midface and the mandible for correction of the deformities. The device is constructed using easily available hardware that is also resusable. This makes it a cost effective alternative to the currently available distractor appliances, especially for a low-resource setting.

Key words: Apert syndrome, crouzon syndrome, distractor, distraction osteogenesis, hemifacial microsomia, temporomandibular joint ankylosis

INTRODUCTION

The application of distraction osteogenesis (DO) in craniofacial skeleton has been prevalent since the 1990s. It quickly adapted from the orthopedic field to the maxillofacial region for treating different craniofacial anomalies, for example, craniosynostosis, cleft lip and palate, hemifacial microsomia (HFM), midface hypoplasia, and transverse discrepancies.[1,2] There have been modifications and developments of the appliance suitable for this region.[3,4] Broadly, distractor appliances are either internal or external each having their own advantages and disadvantages. Although internal distractors are more inconspicuous, they are mostly unidirectional, have limited scope of the length of distraction and have no vector control.[5] The cost of these devices weighs heavily on the patient with a large proportion of them opting out of the treatment due to financial reasons.

We have devised a novel distractor that is versatile and can be used both for midfacial and mandibular distraction and is also low on cost and most suited for low-resource setting. The fundamentals of the design of the device are using parts regularly used in orthopedic and general surgeries. These parts have lower cost than those designed for craniofacial surgery since they are widely used. The device is reusable after proper autoclaving. It can be also used in a variety of craniofacial abnormalities that the craniofacial surgeon may encounter. We have therefore endeavored to construct this device for suitability and effectiveness when used in developing countries.

MATERIALS AND METHODS

Study design

This was a retrospective study undertaken from May 2010 to May 2015. The study was approved by the institutional review board and adhered to the

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declaration of Helsinki. We reviewed a total of ten previously diagnosed syndromic cases (six presenting with midfacial retrusion and four presenting with severe mandibular deficiency) that were operated using the Pellerin's craniofacial distractor. Among the ten patients, two patients presented with Apert syndrome (AS), three with Crouzon syndrome (CS), three with HFM, one with temporomandibular joint ankylosis (TMJA), and one presented with Pfeiffer's syndrome (PS). Those patients associated with AS, CS, or PS presented with midfacial retrusion with Class III skeletal malocclusion in association with other anomalies. The three cases with HM presented with severe deficiency of the mandibular body and ramus region on the left side contributing to facial asymmetry with midline shift to the left. The one case of TMJA associated facial asymmetry was associated with short ramus and body length. The study was ethically approved by the Richardsons Dental and Craniofacial Hospital's Ethical Committee.

Distractor design

The device is made from pins and screws used in the orthopedic practice. Screws and bolts which have to be replaced are standard ones and inexpensive, and the central part of the element is reusable almost indefinitely. The domino is the basic part of the device, and it could be combined to suit all situations (midface and mandible). Most of the time for unilateral mandibular distraction two dominos on a stainless steel threaded wire A4 standard (4 mm-bolt 7) is used. For bilateral mandibular distraction, the frame could be customized according to a CT scan. When the callus has to be bent (multiplanar distraction) it could be done by bending the threaded wire with pliers. For mandibular distraction, the implants are Kirschner wire 2 mm threaded tip (Stryker Cie.) designed for hand surgery. For midfacial distraction, the transfacial pin could be used or depending on the availability in your country either a Kirchner wire 2 mm or a guide wire 2.5 mm drill tip is stiffer (Stryker). The anterior attachment could be a domino or a cylinder [Figure 1].

Surgical treatment

All the cases were operated by a single craniofacial surgeon following an informed written consent. In patients presenting with AS, CS, or PF, a classical bi-coronal approach was utilized for affecting the Le fort III osteotomy cuts followed by the disjunction of the maxilla from the pterygoid plates from the intraoral site. The mobilization of the maxilla was then carried out using a pair of Rowe's maxillary disimpactions forceps. For the placement of the Pellerin's distractor device in these patients, the posterior support was derived from the use of U-shaped folded K wire screwed about 2 cm above the transverse root of the temporal zygomatic apophysis, symmetrically on both sides using a 8-hole titanium miniplates which itself was folded across the bony flap. The folding across the bone flap prevents the device from getting disengaged or subluxated during the period of active distraction. This was followed by vertically pulling the folded K wire through the skin so that it would lie immediately on top of it. The bicoronal incision was then closed. For the purpose of anterior support, a transfacial pin was inserted from one side to another under the orbital wall and above the developing permanent teeth germs. This maneuver was assisted by performing a three-dimensional reconstructed computed tomogram (CT) before surgery that allows for precise placement of the transfacial pin. The distractor was then screwed to these two supports.

Figure 1: The parts of Pellerin's distractor

In the mandible, the exterior markings of the contour of the mandible were carried out on the skin for assisting in the placement of K wire. This was followed by a crevicular incision with a vertical release in the mandibular body region, and a full thickness mucoperiosteal flap was reflected to affect the osteotomy. Two K wires on either side of the osteotomy were fixed followed by closure of the incision. The same distractor utilized for affecting the midfacial distraction was used for the purpose of mandibular distraction and was screwed to these K wires.

Distraction protocol

Following a latency period of 5 days, the distraction was initiated at the rate of 1.5 mm/day (two turns twice daily). Following the achievement of satisfactory distraction, the device was kept in place for a period corresponding to the time of active distraction for bony

consolidation. Radiographs in the form of digitalized orthopantomograms, lateral cephalograms as well as posteroanterior cephalograms were taken at regular intervals to monitor the bone formation. After the consolidation period, the device was easily removed in an outpatient setting. In cases of maxillary distraction, a short incision was placed posterior to the bicoronal incision to remove the miniplate and U-shaped K wire, whereas the transfacial pin was removed by pulling it out using pliers. In cases of mandibular distraction, the K wires screwed in the bone were removed using pliers.

All patients were followed up for up to 4 years (minimum follow up of at least 1 year) to assess the overall outcome of the procedure utilizing this distractor device.

RESULTS

Among the ten patients reviewed, complete set of records were available for eight patients, whereas two patients (one with AS and one with HM) were lost to follow-up. Among the remaining eight patients, four patients were males and four were females aged between 7 and 26 years (mean 8.43 years). In patients with AS, CS, or PS, satisfactory correction of the midfacial retrusion was achieved [Figures 2 and 3]. In the two patients with HM, mandibular asymmetry and midline shift to the left was seen to be desirably corrected as was in the case of TMJA [Figures 4 and 5]. The horizontal advancement achieved in all cases was in the range of 32–50 mm (mean 37.50 mm). The consolidation period in all patients was in the range of 28–42 days (mean 34 days). Satisfactory correction of class III to Class II malocclusion was observed in three patients (two with AS, one with CS) and to Class I malocclusion was observed in one patient (PS). Results were maintained even after the minimum 1 year follow-up.

With regard to complications, no serious or life-threatening complications were observed. Scarring in the region of entry of the transfacial pin in case of maxillary distraction or in case of K wires for mandibular distraction was the most common complication observed in six patients. The scarring was seen to become inconspicuous with increasing follow-up. In three patients, secondary revision of the scar was performed. Infection at the site of entry of transfacial pin or K wires was observed in four patients that was managed with local wound care and intravenous antibiotics. In two patients (two with CS and one with AS), anterior open bite was observed after 2 years of surgery that was corrected using a combination of orthodontics and orthognathic surgery. One patient with CS also developed secondary nose deformity that was corrected with rhinoplasty 3 years postsurgery. The asymmetric vector of distraction was observed in one patient (one with PS) that was successfully managed by callous molding. No instances of plate loosening or disengaging of the pins or plate were observed in the entire study population [Figure 6].

DISCUSSION

The use of DO in the management of craniofacial deformities has been evolving over the past 20 years, with initial experiments on the mandible, followed by the mid-face and subsequently, the cranium. The main indication emerging for DO of the midface is in cases of syndromic craniosynostosis where the maxilla, nasal complex, and zygomatic body are hypoplastic, and the orbits are shallow.[6] For the mandible, cases of HFM, Goldenhar syndrome and TMJA deformity are effectively treated by DO. The gold standard of treatment remains the multi-vector distractor.[7] However, most of these distractors are expensive and are specific for the region. The distractor device constructed by us, on the other hand, is universal in its application and is cost effective. The same appliance can be used for both mandibular and midface lengthening.

The results of the study are quite encouraging. The Pellerin's distractor represents an effective means of achieving satisfactory midfacial and mandibular advancement while at the same time avoiding serious

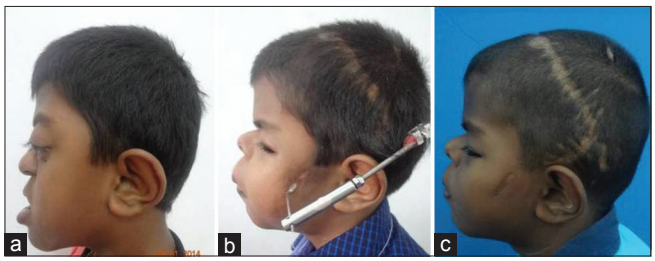

Figure 2: Patient of Apert syndrome. (a) Preoperative profile view showing severe midface retrusion and shallow orbits. (b) The Pellerin distractor *in situ*. (c) Two years follow-up shows correction of the midface and orbital deformity

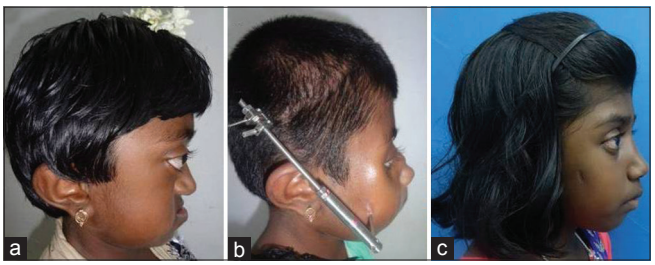

Figure 3: Patient of Crouzon's syndrome. (a) Preoperative profile view showing severe midface retrusion and shallow orbits. (b) The Pellerin distractor *in situ*. (c). Three years follow-up shows correction of the midface and orbital deformity

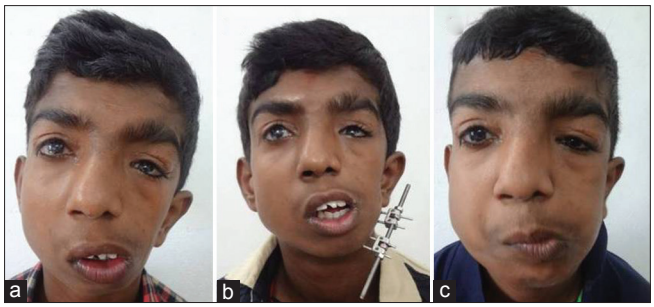

Figure 4: Patient of left Hemifacial macrosomia. (a) Preoperative view showing deviated chin to the left and short mandible of left side. (b) Pellerin distractor *in situ*. (c) 1 year follow-up shows satisfactory correction of asymmetry

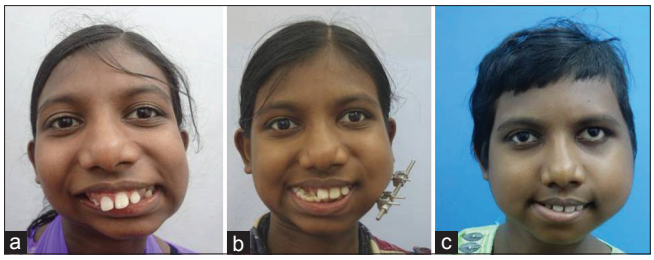

Figure 5: Patient of left temporomandibular joint ankylosis. (a) Preoperative view showing deviated face to the left. (b) Pellerin's distractor *in situ*. (c) One year follow-up shows correction of asymmetry

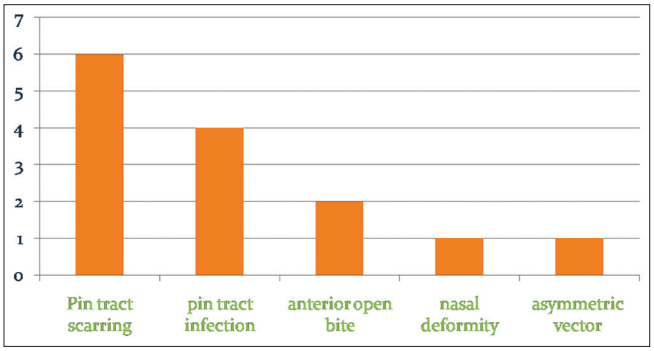

Figure 6: Bar graph showing the complications seen in our study

and life-threatening complications. Although we observed some complications, these are usually of minor consequence. The devices were reused between the patients, and the screws and bolts were readily available.

The greatest advantage of the distractor resides in the fact that it is cost effective and can be used both on midface and mandible and therefore is a feasible option for patients with financial constraints. Another major advantage is the fact that it is reusable, the distractor with its assemblage of transfacial pin and K wires can be sterilized and reused. Other advantages include adaptability (can be used for both the purpose of midfacial and mandibular distraction), easy to place and remove in the outpatient setting, allows for constant control of the distraction protocol and is less hindrance than a halo frame. Furthermore, the external nature of the device contributes to decrease infection as compared to intra-oral devices.

On the negative front, scarring on the face in the region of placement of the transfacial pin or K wires is an issue that might require revision procedures. The distractor does not allow for control of rotational vector. Furthermore, the external nature of the device can be socially handicapping for the patient.

CONCLUSION

This method of craniofacial DO using Pellerin's Distractor is an effective alternative to the other various commercially available expensive external or internal distraction devices currently available for midface or mandibular hypoplasia. It is an extremely versatile device that can be used for midface and mandible and also reduces the treatment cost for the patient and hence, more patients can be treated with no patient being denied treatment due to financial reasons. The parts of the device are easily available, is reusable and versatile in the regions it can be applied. This makes it a favorable device for craniofacial DO in developing countries where resources may still be limited.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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