

**Orthognathic surgery versus distraction osteogenesis in the management of cleft lip and palate : A Review**

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**Abstract**

In this article , all the literature dealing with the various aspects of the two treatment modalities : distraction and conventional orthognathic surgery in the management of cleft lip and palate was thoroughly reviewed. The literature showed that maxillary distraction in mild cases of retrusion proved to be superior in terms of providing long term stability. In cleft patients, those who underwent distraction showed less relapse rate compared to the conventional osteotomy patients . For mild to moderate cases , no significant difference was observed between the two modalities . This review article deals with the pros and cons of the two treatment modalities and also highlights the future outcomes.

**Keywords:** Orthognathic Surgery, Distraction Osteogenesis , Cleft Lip and Palate , Speech , Stability , Relapse , Impact on Quality of life , Complications, VRO, BSSO .

**Introduction**

The nature tends to align the dento-alveolar component when the maxilla and mandible grow disproportionately .They are then said to be in a state of compensation and the nature tries to restore harmony with the altered skeletal bases. The dental decompensation can be done by fixed orthodontic therapy and then a surgical intervention is planned.Two most commonly employed surgical options available in the literature are conventional orthognathic surgery and distraction osteogenesis.

**Distraction Osteogenesis** is defined as the formation of new bone and adjacent soft tissue after applying gradual and controlled traction to the bone fragment developed by surgical osteotomy. Tissues other than bone have been observed to form under tension stress which include mucosa, muscles, tendons, blood vessels and even peripheral nerves<sup>[1,2]</sup>.

**Orthognathic Surgery** may be defined as the art and science of diagnosis, treatment planning and execution of treatment by combining orthodontics and oral and maxillofacial surgery to correct the musculoskeletal, dento-osseous and soft tissue deformity of the jaws and the associated structures.

This article tries to elaborate the debate between orthognathic surgery and distraction osteogenesis while considering some important aspects related to the management of cleft patients.

This critical review for the management of cleft lip and palate focusses on the studies that report various aspects of two broad surgical treatment modalities i.e. distraction osteogenesis and conventional orthognathic surgery, for the correction of severe skeletal dysplasia associated with cleft patients. In this regard, apart from other literature work, 17 reviews of literature, 3 systematic reviews, 5 randomized controlled trials (RCTs) and 2 meta-analyses have been thoroughly reviewed and a collective gist of knowledge is presented here.

#### **Comparison In Terms of Stability Achieved**

The term STABILITY simply means deviation from the intended position. RELAPSE, on the other hand, means a tendency to return to the original position. It is a post operative movement either towards the pre-operative position or farther away from it. The mean relapse of a particular study and procedure may be zero, but there still may be a significant relapse in both directions for individual patients so that the overall relapse rate of zero

becomes non-significant. The Relapse rate following conventional orthognathic surgery was found to be more compared to distraction osteogenesis<sup>[3]</sup>. A review by Austin et al. (2015) reported a weak evidence that there was improved horizontal stability for internal maxillary distraction<sup>[4]</sup>.

A relapse rate of 5-80% has been reported in the literature in the patients with cleft palate having severe maxillary hypoplasia when the treatment modality chosen was conventional Le Fort 1 osteotomy<sup>[5,6,7]</sup>. Swennen et al. (2002) conducted a review and concluded that distraction osteogenesis was a better treatment modality in the cases which had a greater tendency of relapse such as the cleft cases<sup>[8]</sup>.

The need for bone grafting is omitted in distraction osteogenesis thereby reducing chances of local infection and bone resorption. Moreover, the relapse rate is reduced by the formation of mature lamellar bone at the distraction site between the two bony segments. The generation of mature lamellar bone at the distraction site was also confirmed histologically<sup>[9,10]</sup>

Saltaji et al. (2012) in a review of 10 studies comparing the stability of maxillary distraction osteogenesis and orthognathic surgery concluded that maxillary advancement by conventional LeFort 1 osteotomy in cleft lip and palate patients show a moderate relapse in horizontal plane and a high relapse in the vertical plane<sup>[11]</sup>. Conventional orthognathic surgery has been quite a popular treatment modality for the past 25 years although the relapse rate has been a constant problem for oral and maxillofacial surgeons. In a study conducted at the University of North Carolina (UNC), 20% of the cases who underwent maxillary advancement by conventional orthognathic surgery had relapse movement of 2-4 mm during the 1<sup>st</sup> post-operative year. After a follow up for 5 years, only 10% of the cases showed mild relapse

tendency<sup>[12]</sup>. Patient compliance with the distraction device poses as a risk factor responsible for relapse<sup>[13]</sup>.

Vertical Ramus Osteotomy, with or without fixation, and Bilateral Sagittal Split Osteotomy with rigid fixation, both, have been used for mandibular setbacks. Studies indicate that the two procedures manifest relapse in the opposite directions. VRO has been shown to have a relapse rate of 5-12% in the posterior direction with a mean of 9%. BSSO has been shown to have relapse in the anterior direction with the rate ranging between 10-62% with a mean of 22%<sup>[14,15]</sup>. VRO for setback is preferred by some over Sagittal split osteotomy because of lower neurosensory deficit<sup>[16]</sup>.

Bays et al, (2003), conducted a meta-analysis on mandibular setbacks by VRO and reported a mean relapse rate of 9%<sup>[17]</sup>. The literature is quite scant on stability after orthognathic surgery because only syndromic and severe cases require osteotomy at LeFort III level<sup>[16]</sup>.

The results are quite stable in the adults compared to children when the mandibular distraction is compared because of the inherent uncertainty observed in the pediatric population. Based on a study conducted by Louis et al. (1993), it was concluded that the relapse rate of orthognathic surgery becomes higher as the amount of maxillary advancement increases<sup>[18]</sup>. The palatal and the pharyngeal scarring remains a major limiting factor for the amount of maxillary advancement in such patients<sup>[16]</sup>. The maximum amount of maxillary advancement that can be achieved by conventional orthognathic surgery is about 10 mm<sup>[19]</sup>, whereas some others suggest that the maximum amount of advancement that can be achieved becomes limited due to scar contracture and is about 5 mm<sup>[20]</sup>.

Singh et al. (2012) in a study concluded that the maxilla showed a relapse of 30% 6 months post distraction<sup>[21]</sup>.

Cho and Kyung (2006) suggested that an over correction of about 20-30% was required to minimize relapse<sup>[22]</sup>.

Some researchers could not attain a significant conclusion in terms of relapse rate when comparing the two modalities<sup>[23]</sup>.

### **Impact of Orthognathic Surgery and Distraction Osteogenesis on The Quality of Life**

In the initial phases, distraction osteogenesis has a negative impact on the self esteem and confidence of the patients, but in the long run, it results in providing better life satisfaction as compared to conventional orthognathic surgery<sup>[24]</sup>. A limitation with conventional orthognathic surgery is that it can only be performed after the skeletal growth is complete whereas no such limitation occurs in case of distraction osteogenesis. This helps in improving the social stigma of the patients<sup>[25]</sup>.

Orthognathic Surgery has been sometimes shown to have a detrimental impact on the mental well-being of the patients such as conversion disorders and depression especially when Inter-Maxillary fixation techniques are employed<sup>[26,27]</sup>. 'Four Day Blues' is a well recognized and a common phenomenon associated with orthognathic surgery post-operatively<sup>[28]</sup>.

Satisfaction with Life Score (SWLS) was significantly higher in the DO group compared to the orthognathic surgery group. DO initially lowers the psychosocial moral and confidence of the patients but it produces more satisfaction as compared with the conventional orthognathic surgery. This can be attributed to the better stability imparted by DO as well as by the self-perceived contribution by the patients to the success of the treatment<sup>[24]</sup>.

A study by Andersen et al. (2012) aimed to evaluate and compare the patient satisfaction following DO and orthognathic surgery in 25 cleft lip and palate patients. They concluded that the patients who underwent distraction osteogenesis were less satisfied at follow up due to the increased duration of the treatment<sup>[29]</sup>.

### **Distraction Osteogenesis And Orthognathic Surgery In Terms Of Providing An Improved Esthetic Outcome**

Jena et al . ( 2011 ) reported an improved soft tissue profile , nasolabial angle after immediate , 6 months and 2 year follow up of maxillary distraction .According to their study , the forward advancement of the nasal tip and the nasal base was increased significantly and the length and thickness of upper lip was enhanced after various time intervals of maxillary distraction osteogenesis . They also reported that the changes remained stable at the end of 2 years follow up <sup>[30]</sup>.

Chua and Cheung et al .(2012 ) reported that distraction osteogenesis produces hard and soft tissue ratios that are more consistent and the amount of changes produced are also more with DO <sup>[31]</sup>. The soft tissue profile is better improved in terms of improved nasolabial angle and more prominence of the upper lip <sup>[32]</sup>.

### **Which Treatment Modality Has More Complications Following Surgical Intervention**

Lanigan et al .(1991 ) reported that false aneurysms and arteriovenous fistulas are amongst the rare complications of orthognathic surgery that commonly involve the internal maxillary artery .Embolization can be used to treat both the complications <sup>[33]</sup>.The ischemic complications that are more commonly associated with orthognathic surgery are not seen in distraction osteogenesis , but some mucosal infections can occur <sup>[23]</sup>.

Several studies indicate that the conventional orthognathic surgeries are quite safe to perform <sup>[34,35,36,37]</sup>.Panula et al .( 2001 ) reported only one serious complication of intra operative bleeding associated with conventional orthognathic surgery <sup>[36]</sup>.

Ayub et al . (2001 ) reported only 12 patients out of 821 developed early post operative complications following orthognathic surgery that required surgical intervention <sup>[38]</sup>.

Neurologic complications are also reported following orthognathic surgery and the effect on inferior alveolar nerve is more pronounced after mandibular surgeries <sup>[17]</sup>.Facial nerve palsy has also been reported in 9 out of 1747 patients who underwent BSSO and about 95 % of these osteotomies were setbacks <sup>[39]</sup>.Other complications associated with osteotomies are Frey's Syndrome <sup>[40]</sup> , bilateral hypoesthesia in the dermatome of mylohyoid nerve <sup>[41]</sup> , traumatic neuroma involving the inferior alveolar nerve <sup>[42]</sup> etc.

Baker et al.(1991 ) reported a brain abscess case who had undergone a LeFort 1 osteotomy <sup>[43]</sup> .An indirect complication of conventional orthognathic surgery is iliac abscess which occurred after the graft was harvested <sup>[44]</sup>.Ophthalmic complications may also occur such as lack of tears , damage to greater petrosal nerve , nasolacrimal duct damage and abducent nerve palsy <sup>[45]</sup>. Blindness after LeFort 1 osteotomy has also been reported <sup>[46]</sup>.

Condylar resorption to various degrees has also been reported in the literature but is quite an uncommon complication following orthognathic surgery . Borstlap et al .(2004 ) reported a 4 % resorption of the condyle following BSSO and fixation with two miniplates .They also stated that the patients with age less than 14 years were at a higher risk for the occurrence of condylar alterations including resorption . Highly suspicious risk factors for condylar changes include TM joint sounds and pain in the first few months post operatively <sup>[47]</sup>.

Bhaskaran et al .(2010 ) reported a case of CSF leakage from the floor of the left middle cranial fossa at the site of attachment of the pterygoid plates on the 3<sup>rd</sup> post operative day following 4 mm anterior and 5 mm posterior maxillary impaction .The cerebrospinal fluid leak stopped after 16 days by neurosurgical intervention with lumbar drain <sup>[48]</sup>.Other complications that have been reported include nasal mucosa perforation by fixation screws

leading to post operative nasal congestion and pain<sup>[49]</sup>. Formation of oro-nasal and oro -antral fistulas has also been reported<sup>[50]</sup>.

### **Distraction Osteogenesis or Conventional Orthognathic Surgery: Which Treatment Modality Has A Better Impact On Speech**

According to several authors , there is a potential for velopharyngeal insufficiency following maxillary advancement but no significant difference in the rate of occurrence with respect to DO and orthognathic surgery could be found<sup>[51]</sup>.

Ko et al . (1999) in a study evaluated the velopharyngeal anatomic changes on lateral cephalograms and speech evaluation was performed pre -operatively , immediately following distraction and then at 6 month intervals. The evaluation included assessment of air pressure flow , hypernasality and articulation .They concluded that the increase in the nasopharyngeal depth might compromise the velopharyngeal closure .The increase in velar angle was a compensatory mechanism considered to be a part of the Velopharyngeal closure .There was no adverse effect on the pre existing pharyngeal flap on maxillary distraction but it did not prevent post operative hypernasality<sup>[52]</sup>.

Guyette et al .(2001 ) evaluated 18 patients for 1 year and found that 16.7 % exhibited a significant increase in hypernasality whereas 75 % of the patients which had pre operative hyponasality showed better nasal resonance post operatively<sup>[53]</sup>.

Some authors advocate that maxillary advancement by orthognathic surgery lead to a rapid correction of dental articulation but at the same time caused velopharyngeal compromise that lead to an increase in velopharyngeal distance<sup>[54,55]</sup>.

Kumar et al. (2006 ) concluded that the cleft lip- cleft palate patients with severe maxillary deficiency , had 48

% less relapse in the group that underwent distraction osteogenesis compared to the conventional orthognathic surgery group<sup>[56]</sup>.

### **Treatment Modality In Terms Of Timing And Duration**

The time required for the completion of distraction osteogenesis is more compared to the conventional orthognathic surgery . The DO procedure is also more expensive<sup>[57]</sup>.The relapse in LeFort 1 osteotomy is not significant but the growth status must be assessed carefully .The growth of anterior maxilla is affected by LeFort 1 osteotomy but the vertical growth continues<sup>[58]</sup>.The DO can be performed at any age , irrespective of growth spurts or the cessation of growth whereas orthognathic surgery , on the other hand , should be performed only after the cessation of growth to avoid any complications.

### **Conclusion**

Generally, distraction osteogenesis has no extra advantage over conventional orthognathic surgery in prevention of velo-pharyngeal insufficiency and speech disturbance in moderate cleft maxillary advancement cases. But sufficient evidence exists that maxillary distraction in moderate or severe cases of maxillary retrusion offer long-term stability of hard and soft tissues as compared to conventional orthognathic surgery.

Significant maxillary advancement by distraction osteogenesis results in significant increases in posterior airway space. Distraction osteogenesis promotes correction of bone and soft tissues simultaneously. According to Precious (2005) "*distraction osteogenesis and conventional orthognathic surgery are not mutually exclusive*". A point that favors distraction is not necessarily an argument against orthognathic surgery. Both these treatment strategies are unique in themselves. we cannot replace distraction osteogenesis with

conventional orthognathic surgery and vice versa. Both these modalities of treatment are independent of each other.

Vertical maxillary excess cases and any maxillo-mandibular setback cases can be done by conventional orthognathic surgery only because there is no applicability of distraction osteogenesis in such cases. Distraction osteogenesis remains a powerful tool amongst the armamentarium of cleft lip and palate management team for the correction of mid-face retrusion. Both these treatment modalities can result in substantial improvement in various measures of facial esthetics.

The litmus test for these treatment strategies is the extent to which either can restore the normal development of one's pathological pattern of facial growth, yet this issue largely remains unsolved<sup>[58]</sup>.

## References

1. Fernandes FHC et al. Distraction Osteogenesis in Dentistry. *Int J Morphol* 2010;28(3):8743–8.
2. Cohen SR et al. Distraction osteogenesis of the human craniofacial skeleton: initial experience with new distraction system. *J Craniofac Surg* 1995;6(5):368–74.
3. Chua HDP et al. Cleft maxillary distraction versus orthognathic surgery--which one is more stable in 5 years? *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2010;109(6):803–14.
4. Austin SL et al. Distraction osteogenesis versus orthognathic surgery for the treatment of maxillary hypoplasia in cleft lip and palate patients: a systematic review. *Orthod Craniofac Res* 2015;18(2):96–108.
5. Houston WJ et al. Le Fort I maxillary osteotomies in cleft palate cases. Surgical changes and stability. *J Craniomaxillofac Surg* 1989;17(1):9–15.
6. Cheung LK et al. The 3-dimensional stability of maxillary osteotomies in cleft palate patients with residual alveolar clefts. *Br J Oral Maxillofac Surg* 1994;32(1):6–12.
7. Posnick JC, Dagens AP. Skeletal stability and relapse patterns after Le Fort I maxillary osteotomy fixed with miniplates: the unilateral cleft lip and palate deformity. *Plast Reconstr Surg* 1994;94(7):924–32
8. Swennen G et al. Cranio-facial distraction osteogenesis: a review of the literature. Part II: Experimental studies. *Int J Oral Maxillofac Surg* 2002;31(2):123–35
9. Rachmiel A et al. Characterization of midface maxillary membranous bone formation during distraction osteogenesis. *Plast Reconstr Surg* 2002;109(5):1611–20.
10. Rachmiel A et al. Midface membranous bone lengthening: A one-year histological and morphological follow-up of distraction osteogenesis. *Calcif Tissue Int* 1998;62(4):370–6.
11. Saltaji H et al. Maxillary advancement with conventional orthognathic surgery in patients with cleft lip and palate: is it a stable technique? *J Oral Maxillofac Surg* 2012;70(12):2859–66.
12. Proffit WR. *Contemporary Treatment of Dentofacial Deformity*. Mosby; 2003.
13. Serafin B et al. Stability of orthognathic surgery and distraction osteogenesis: options and alternatives. *Oral Maxillofac Surg Clin North Am* 2007;19(3):311–20.
14. Proffit WR et al. Stability after surgical-orthodontic correction of skeletal Class III malocclusion. Maxillary advancement. *Int J Adult Orthodon Orthognath Surg* 1991;6(2):71–80.
15. Mobarak KA et al. Long-term stability of mandibular setback surgery: a follow-up of 80 bilateral sagittal split osteotomy patients. *Int J Adult Orthodon Orthognath Surg* 2000;15(2):83–95

16. Schatz JP, Tsimas P. Cephalometric evaluation of surgical-orthodontic treatment of skeletal Class III malocclusion. *Int J Adult Orthodon Orthognath Surg* 1995;10(3):173–80.
17. Bays RA et al. Complications of orthognathic surgery. *Oral Maxillofac Surg Clin North Am* 2003;15(2):229–42.
18. Kim JH et al. Distraction osteogenesis and orthognathic surgery for a patient with unilateral cleft lip and palate. *Am J Orthod Dentofacial Orthop* 2015;147(3):381–93.
19. Louis PJ et al. Long-term skeletal stability after rigid fixation of Le Fort I osteotomies with advancements. *Int J Oral Maxillofac Surg* 1993;22(2):82–6.
20. Hoffman GR, Brennan PA. The skeletal stability of one-piece Le Fort 1 osteotomy to advance the maxilla; Part 1. Stability resulting from non-bone grafted rigid fixation. *Br J Oral Maxillofac Surg* 2004;42(3):221–5.
21. Singh SP et al. Treatment outcome and long-term stability of skeletal changes following maxillary distraction in adult subjects of cleft lip and palate. *Contemp Clin Dent* 2012;3(2):188–92.
22. Cho BC, Kyung HM. Distraction osteogenesis of the hypoplastic midface using a rigid external distraction system: the results of a one- to six-year follow-up. *Plast Reconstr Surg* 2006;118(5):1201–12.
23. Cheung LK, Chua HDP. A meta-analysis of cleft maxillary osteotomy and distraction osteogenesis. *Int J Oral Maxillofac Surg* 2006;35(1):14–24.
24. Chua HDP et al. The comparison of psychological adjustment of patients with cleft lip and palate after maxillary distraction osteogenesis and conventional orthognathic surgery. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2012;114(5 Suppl):S5–10.
25. Stewart TD, Sexton J. Depression: a possible complication of orthognathic surgery. *J Oral Maxillofac Surg* 1987;45(10):847–51.
26. De Sousa A. Psychological issues in oral and maxillofacial reconstructive surgery. *Br J Oral Maxillofac Surg* 2008;46(8):661–4.
27. Blinder D et al. Conversion disorder after maxillofacial trauma and surgery. *Int J Oral Maxillofac Surg* 1996;25(2):116–8.
28. Kiyak HA et al. The emotional impact of orthognathic surgery and conventional orthodontics. *Am J Orthod* 1985;88(3):224–34.
29. Andersen K et al. A Retrospective Study of Cleft lip and palate Patients' Satisfaction after Maxillary Distraction or Traditional Advancement of the Maxilla. *J Oral Maxillofac Res* 2012;3(2):e3.
30. Jena A et al. Long-term stability of soft-tissue changes following maxillary distraction osteogenesis in adult subjects of cleft lip and palate. *Asian Journal of Oral and Maxillofacial Surgery* 2011;5(4):1345
31. Chua HDP, Cheung LK. Soft tissue changes from maxillary distraction osteogenesis versus orthognathic surgery in patients with cleft lip and palate--a randomized controlled clinical trial. *J Oral Maxillofac Surg* 2012;70(7):1648–58.
32. Wen-Ching Ko E et al. Soft tissue profile changes after maxillary advancement with distraction osteogenesis by use of a rigid external distraction device: a 1-year follow-up. *J Oral Maxillofac Surg* 2000;58(9):959–70
33. Lanigan DT et al. Major vascular complications of orthognathic surgery: false aneurysms and arteriovenous fistulas following orthognathic surgery. *J Oral Maxillofac Surg* 1991;49(6):571–7.

34. Steel BJ, Cope MR. Unusual and rare complications of orthognathic surgery: a literature review. *J Oral Maxillofac Surg* 2012;70(7):1678–91.
35. Chow LK et al. Prevalence of postoperative complications after orthognathic surgery: a 15-year review. *J Oral Maxillofac Surg* 2007;65(5):984–92.
36. Panula K et al. Incidence of complications and problems related to orthognathic surgery: a review of 655 patients. *J Oral Maxillofac Surg* 2001;59(10):1128–1137
37. Kim SG, Park SS. Incidence of complications and problems related to orthognathic surgery. *J Oral Maxillofac Surg* 2007;65(12):2438–44.
38. Ayoub AF et al. Complications following orthognathic surgery that required early surgical intervention: fifteen years' experience. *Int J Adult Orthodon Orthognath Surg* 2001;16(2):138–44.
39. de Vries K et al. Facial palsy after sagittal split osteotomies. A survey of 1747 sagittal split osteotomies. *J Craniomaxillofac Surg* 1993;21(2):50–3.
40. Güerrissi J, Stoyanoff J. Atypical Frey syndrome as a complication of Obwegeser osteotomy. *J Craniofac Surg* 1998;9(6):543–7.
41. Guyot L et al. Alteration of chin sensibility due to damage of the cutaneous branch of the mylohyoid nerve during genioplasty. *J Oral Maxillofac Surg* 2002;60(11):1371–3.
42. Newhouse RF et al. Life-threatening hemorrhage from a Le Fort I osteotomy. *J Oral Maxillofac Surg* 1982;40(2):117–9.
43. Baker SB et al. Brain abscess as a complication of orthognathic surgery: diagnosis, management, and pathophysiology. *Plast Reconstr Surg* 1999;104(2):480–483.
44. De Riu G et al. Delayed iliac abscess as an unusual complication of an iliac bone graft in an orthognathic case. *Int J Oral Maxillofac Surg* 2008;37(12):1156–8.
45. Newlands C et al. Ocular palsy following Le Fort I osteotomy: a case report. *Int J Oral Maxillofac Surg* 2004;33(1):101–4.
46. Cruz AAV et al. Blindness after Le Fort I osteotomy: a possible complication associated with pterygomaxillary separation. *J Craniomaxillofac Surg* 2006;34(4):210–6.
47. Borstlap WA et al. Stabilisation of sagittal split advancement osteotomies with miniplates: a prospective, multicentre study with two-year follow-up. Part III--condylar remodelling and resorption. *Int J Oral Maxillofac Surg* 2004;33(7):649–55.
48. Bhaskaran AA et al. A complication of Le Fort I osteotomy. *Int J Oral Maxillofac Surg* 2010;39(3):292–4.
49. Levine MH, Super S. Unusual complication after Le Fort I osteotomy. *J Oral Maxillofac Surg* 2007;65(8):1672–3.
50. Deeb M el et al. Complications of orthognathic surgery. *Clin Plast Surg* 1989;16(4):825–40.
51. Chua HDP et al. Maxillary distraction versus orthognathic surgery in cleft lip and palate patients: effects on speech and velopharyngeal function. *Int J Oral Maxillofac Surg* 2010;39(7):633–40.
52. Ko EW et al. Velopharyngeal changes after maxillary advancement in cleft patients with distraction osteogenesis using a rigid external distraction device: a 1-year cephalometric follow-up. *J Craniofac Surg* 1999;10(4):312–22.
53. Guyette TW et al. Changes in speech following maxillary distraction osteogenesis. *Cleft Palate Craniofac J* 2001;38(3):199–205.



54. Maegawa J et al. Speech changes after maxillary advancement in 40 cleft lip and palate patients. *J Craniofac Surg* 1998;9(2):177–84.
55. Okazaki K et al. Speech and velopharyngeal function following maxillary advancement in patients with cleft lip and palate. *Ann Plast Surg* 1993;30(4):304–11.
56. Kumar A et al. Improved outcomes in cleft patients with severe maxillary deficiency after Le Fort I internal distraction. *Plast Reconstr Surg* 2006;117(5):1499–509
57. Precious DS. Treatment of retruded maxilla in cleft lip and palate--orthognathic surgery versus distraction osteogenesis: the case for orthognathic surgery. *J Oral Maxillofac Surg* 2007;65(4):758–61.
58. Wolford LM et al. Considerations for orthognathic surgery during growth, Part 1: Mandibular deformities. *American Journal of Orthodontics and Dentofacial Orthopedics* 2001;119(2):95–101.
59. Distraction osteogenesis versus conventional orthognathic surgery for cleft lip and palate management: a critical review. Ahmed R et al., *Int J Dent Health Sci* 2015; 2(4):911-932