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Role of distraction osteogenesis in the cranio-maxillofacial deformities: A Review literature

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Abstract:

Background:

Distraction osteogenesis (DO) has become a well known useful procedure now-a-days in the field of oral and maxillofacial surgery, as we know initially this technique was used in the limbs, that is in the long bones but slowly thanks to its success in that area it potentiated the use of this procedure in the mandible, then gradually into the maxilla and now it has become a widely used procedure in the cranio- maxillofacial deformities. This review aims to provide an insight into the role of distraction osteogenesis in the cranio- maxillofacial deformities.

Conclusion:

The patients with cranio- maxillofacial deformities has more functional problems, poor aesthetics, muscular imbalance, improper oral hygiene, and sequelae of problems will follow it. So, distraction osteogenesis has become boon for those patients with such deformities. Distraction osteogenesis procedure has clinically showed that it is a versatile technique that it can performed with orthognathic surgery with proper planning and also supports the surgical treatment of tmj ankylosis by relaxing the airway obstruction caused by it. The worthiness of this procedure increases day by day in modern surgery and is definitely a key in oral and maxillofacial surgery.

Keywords: Cranio- maxillofacial, distraction, mid-face, mandible, airway obstruction..

1. INTRODUCTION:

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This review article staged to discuss the cranial distraction osteogenesis, mid face distraction osteogenesis, mandilbular distraction ostegenesis, distraction osteogenesis along with orthognathic surgeries.

2. DISCUSSION:

CRANIAL DISTRACTION OSTEOGENESIS:

Swennen, et al.[1] in his review described the experience of distraction osteogenesis (DO) in 96 patients with craniofacial syndrome. The patients were mainly with Apert, Crouzon, Pfeiffer syndrome, and cleft lip and palate. The technique was carried out predominantly in those patientsby performing Le Fort III osteotomies with monobloc distraction. Children with respiratory obstruction and exophthalmos under 4 years of age undergone distraction with internal distractors in 86.5% of cases.

Cranial distraction osteogenesis is also used in the treatment of craniosynostosis or craniodysostosis.[2,3] Wiberg, et al.[4] reported only minor complications and consisted of minor dural tears and superficial activation arm infections. The advantages were reduced blood loss, lower morbidity reducing dead space. Ko et al.[5] described the changes three dimensionally after fronto-facial distraction osteogenesis in five syndromic patients. After distraction there was increase of 11% in cranial volume. The changes were noted that the globe protrusion was reduced by 3.7mm and upper airway volume was increased by 85%. Komuro, et al.[6] described the four cases of sagittal synostosis treatment with a combination of distraction and other techniques and reported the advantage of shortening operating time and reducing the blood loss over total calvarial remodeling. The follow-up is done for an year and computed tomography (CT) scan also showed that there was a significant bone regeneration at the osteotomy sites.

Other advantages of distraction is that it prevents bone resorption and there will note be any need for surgical dissection. There are other few disadvantages is there as well when compared with traditional cranial vault remodeling by fronto-orbital repositioning. It is difficult to achieve three-dimensional movements with unidirectional distractors and a another procedure is required for the removal of the distraction devices.

The role of distraction osteogenesis in cases of craniosynostosis is uncertain without long-term and larger case series. But there is a large support for distraction osteogenesis of cranium along with midfacial advancement. For patients with raised intracranial pressure and chiari malformations posterior vault distraction technique proves to be very much beneficial and gaining more popularity now- a-days.[7]

MIDFACIAL DISTRACTION OSTEOGENESIS:

Cohen, et al. described mid-facial distraction for the first time, which provided great solutions for numerous problems surrounding the mid face regions improving the functions and esthetics providing a great balance.[8]

Syndromic craniosynostosis where the maxilla, nasal complex, and zygomatic body are hypoplastic and the orbits are shallow are the main indications for performing distraction in the midface regions. There are many functional problems that may include airway obstruction, exorbitism with corneal ulceration, and lid dislocation occurs due to midface deformities. 50% of

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the syndromic synostosis patients may have undiagnosed obstructive sleep apnoea and upper airway obstructions.[9]. Other functional problems like neurogenic, eye problems especially visual acquity problems can occur.

These kind of patients present with Class III skeletal malocclusion and there will be marked anterior open bite. The correction of malocclusion is delayed until skeletal maturity. Sometimes, the initial earlier correction of the mid-face hypoplasia by Le Fort III osteotomies have a significant impact on facial aesthetics and reduces, and sometimes overcorrects, the occlusal deformity thus aiding in the psychological development of the patient.[10]

The advantages as well as the disadvantages of the mid face distraction procedures as the monobloc or Le Fort III immediate repositioning have been reported extensively in the literature[11–15] with several reported advantages of distraction. The distraction procedure is versatile and will keep on updating itself to recent trends. The most significant advantage of this procedure is that it does not require bone grafting and there wont be any secondary donor site morbidity.[16] Holmes, et al. suggested a mean advancement of 18 mm at the Le Fort III level[17] and the other advantage will be the gradual expansion of the soft tissue envelope (histiogenesis) that is major reason for lower rates of relapse in distracted cases.[18]

The distraction as a monobloc segment provided reduction in the frontal dead space which was regularly reported in the traditional advancements. Whereas, here the incremental advancement is performed in which the cranium easily fits itself by catching up with the incremental space created, thus there wont be any room for the frontal dead space infections.[19]. The distraction techniques have been evolved drastically in which there is a shorter operating time, reduced hemorrhage, lesser period of hospital stay and cost feasible.

The mid face distraction has the same disadvantages as the distraction performed elsewhere in the body. As we all know the distraction procedures are give and take kind of a procedure for the clinician as well as to the patients. Patients compliance and patient's attender co-operation is also key for achieving the desired result because the attenders have to perform the activation of the distraction procedures. The mid-face distraction involves a one-piece segment, it will be difficult to perform separate level procedures such as a Le Fort I repositioning simultaneously.

Mid face distractors have come up with various designs and that provides application of necessary forces. The push and pull actions are provided by the internal and external devices respectively. The external devices comprises of the halo frame that is attached to the cranial vault;(e.g., rigid external distractor (RED) system, KLS Martin, Tuttlingen, Germany). Polley, et al. reported the greater advantages of the rigid external device in the distraction procedures of maxillary hypoplasia when compared to the conventional methods of distraction.[20]

External distraction provides a great advantage like modifying the vectors and forces during activation with great control. The external devices can be easily fixed as well as it can be easily removed. The rigid internal distractor involves the usage of cranial pin fixation and the wires to the facial skeleton with help of wide range of plates so that the adjustible multidirectional vectors can be achieved. Intraoral splints along with newer methods of internal fixation plates at the paranasal rims and infraorbital regions are also in use. The physical and psychosocial discomfort of the external halo device is the major disadvantage on the patient's perspective.

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There are bone-borne customized or standardized plates of internal distractors that are extendable along a unidirectional track for distraction. The internal distractors with resorbable plates are also available which can be used for distraction and it can be left in situ to dissolve after detachment of the activation arms. Cohen, et al. suggested its in Le Fort III cases.[21]. Burstein, et al. suggested single stage resorbable system, that did not require secondary surgery.[22] It was manufactured by the combination polymer (Lactosorb – Walter Lorenz Surgical, Jacksonville, FL). These resorbable plates are more bulky that reduces its brittle nature and it cannot be manipulated to adapt itself to the bone contours. Foreign body granulomas of the covering skin has been reported in some cases.[22] Off late the follow up studies on the use of internal resorbable distractors have been drastically reduced.

The bone-borne internal distractors are relatively smaller in size with better patient acceptance and function independently in the midface region when compared to the rigid external distractors that uses cemented splints. The need for second procedure to remove the distractors is the major disadvantage in these methods. However it should be customized otherwise there will be difficulty in achieving precise bilateral vectors to be parallel for symmetrical distraction. In addition to it the modification of vector will be difficult once the plates have been fixed.

Meling, et al. recently reported on 20 patients which were treated with mid-face distraction were compared among those 12 patients who had internal distraction and 8 patients with external distraction.[23] The monobloc advancement or Le Fort III advancement was surgical procedure performed on those patients and it was concluded that external devices required a shorter operating time when compared to internal devices and there was no difference in blood loss and other complications. However, the external device provided better 3-dimensional control of the vectors when compared to internal devices.

The metallic distractors that provide long term stability have recently started appearing in the literature. Le Fort III distraction is now considered to be comparatively a stable procedure. Nadjmi, et al. reported on 20 patients who had undergone mid-face distraction[24] with a follow-up period of 13-65 months. The stability has been assessd using lateral cephalometrics, they concluded that up to 5 years post-distraction, there was a significant long-term stability.

Lee, et al. reported on the stability by combining both methods like internal as well as external devices distraction in six patients with Crouzon syndrome.[25] and the consolidation period was upto 6 months. They evaluated the long-term stability with a mean follow-up of 4.5 years, and reported both occlusal stability and facial contour changes.

In another study 40 syndromic craniosynostosis patient undergone Le Fort III distraction with the Rigid external device distraction, 20 patients were followed for over 10 years post-distraction.[26] Follow-up CT scans showed better ossification at the osteotomy sites. They concluded the Class III malocclusions did not recur with further growth but mild exorbitism and maxillary hypoplasia reappeared to some degree.

Thus the mid face distraction has become the more valuable and stable procedure in treating growing children with airway problems and severe mid-face retrusion. The midface gradual distraction has provided great advantages when compared to the conventional methods of distraction.

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MANDIBLE DISTRACTION OSTEOGENESIS:

There is a lot of controversy revolving around the role of distraction osteogensis in the mangement of hemifacial microsomia and other associated conditions such as Goldenhar syndrome.[27]. There were vaiations in the protocols in which some centres confined to distraction in milder forms of mandibular deformity whereas others distract only the grossly hypoplastic structures.[28,29] Still there is no strong opinion for usage of distraction osteogenesis in mild to moderate mandibular deformities. Conventional orthognathic procedures were preferred in those patients.

In severe mandibular deformities like in Type IIB and III, the role of distraction osteogenesis remains controversial. This is due to the controversy surrounding the hemifacial microsomia that whether is it a progressive deformity or it is complex stationary deformity. A progressive pyriform rims and occlusal plane cant was demonstrated by Kaban, et al.,[30] whereas Polley, et al. reported that the patients which were not operated doesn't show progressive deformity and the contralateral side found to be matching with growth of the affected side [31]. The postpubertal growth of the mandible in some cases had complete absence of condylar growth centre and worsen condition progressively and has less ability to match the normal side, whereas in cases with a mild hypoplastic condyle/ramus unit, the mandible found to be growing more to scale.

The vertical lengthening of the ramus with the intention of stretching the soft tissue envelope and thus overcoming the relapse is the main objective for using distraction osteogenesis in hemifacial microsomia. In the absence of a well-developed condylar/ramus unit, distraction osteogenesis is difficult as the definitive posterior stop for the proximal component is lacking, with a tendency for the fragment to be displaced superiorly and posteriorly.[32]

Meazzini, et al. reported on a follow-up of 14 patients who were treated with distraction osteogenesis with mean age 5.9 years with an untreated sample of 8 patients.[33] Both groups were followed up until the growth completion period. The results of this study showed that the though the affected side was corrected with same ratio to that of the contralaeral normal side there was siginificant relapse noted in 16% of the patients in the first year and it was found to be progressive in nature. This study highlighted that early intervention with distraction osteogenesis doesn't maintain the correction during growth.

DISTRACTION OSTEOGENESIS AND TRADITIONAL ORTHOGNATHIC SURGERY:

Several studies have evaluated distraction osteogenesis and orthognathic surgery. Vos, et al. assessed stability of mandible after conventional bilateral sagittal split (BSSO) advancement and distraction techniques.[34] The mean advancement for both samples was 7 mm and there was found to be no difference in the stability after 1 year of follow-up between the DO and BSSO techniques. Follow up was done further for 4 years with the sample of patients was reported by Baas, et al.,[35] and he found that, in both the techniques there was no significant difference in the stability. Ow, et al.,[36] also confirmed the same results by comparing two techniques and reported that advancements of between 6 and 10 mm resulted in no differences in stability after 1 year of follow-up.

The emergence of distraction osteogenesis in the mid face and mandible was very strong and was once thought by the experts that it would replace the traditional orthognathic surgery [37] in the

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treatment of maxillofacial deformities but that was not the case. Distraction osteogenesis can be applied in syndromic craniosynostoses as a staged procedure along with orthognathic surgery in the management of skeletal discrepancies but there was no significant advantage when performed solely. So on certain conditions were distraction osteogenesis was performed along with orthognathic surgery provided good facial balance and occlusal correction.

3. CONCLUSIONS:

The patients with cranio- maxillofacial deformities has more functional problems, poor aesthetics, muscular imbalance, improper oral hygiene, and sequelae of problems will follow it. So, distraction osteogenesis has become boon for those patients with such deformities. Distraction osteogenesis procedure has clinically showed that it is a versatile technique that it can performed with orthognathic surgery with proper planning and also supports the surgical treatment of tmj ankylosis by relaxing the airway obstruction caused by it. The worthiness of this procedure increases day by day in modern surgery and is definitely a key in oral and maxillofacial surgery.

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