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RESEARCH ARTICLE

MAXILLARY EXPANSION IN CLEFT LIP AND PALATE CASES- A REVIEW

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Corresponding Author*Dr. Sumita Jain****Abstract**

Transverse deficiencies are one of the major concern for cleft lip and palate cases and expansion of the maxilla is used to correct skeletal and dental transverse discrepancies between the maxilla and mandible. These discrepancies are corrected through a combination of skeletal expansion (separation of the maxillary mid-palatal suture) and dental expansion (lateral tipping of the maxillary posterior teeth). Various expansion modalities have been enlisted over the long period of time in literature. This review records various different appliances enlisted for expansion in cleft cases and various protocols to be used. Majority for transverse discrepancy problems improve with the use of expansion procedures, hence are of prime importance.

*Copy Right, IJAR, 2015, All rights reserved***INTRODUCTION**

Clefts of the lip and palate are the most common craniofacial birth defect and the second most common congenital abnormality, with a birth prevalence ranging from 1 in 500 to 1 in 2000, depending on the population (Marazita et al, 2004). The clefting of lip and/or palate occurs at such a strategic place in the oro-facial region and at such a crucial time (before birth) that it becomes a complex congenital and it warrants the sequential treatment strategies for desired treatment outcome. The etiology of these cleft defects is multi-factorial, either due to genetic predisposition or environmental conditions viz retinoic acid deficiencies, etc. These cleft deformities can be either associated with any syndromes (30% cleft cases) or may be non-syndromic (70% of cleft cases) (Martyn, 2004). These may occur either as unilateral defects or as bilateral defects, which may present themselves as complete, extending to soft palate or incomplete defect of lip or alveolus alone, or may only include some part of hard or soft palate.

CLEFT PROBLEM-

The cleft deformities are often associated with myriad of craniofacial skeletal and dental problems. The altered "form" in cleft cases is associated with altered function which further aggravates the deformity. According to an epidemiologic study by da Silva et al, 2007; approximately 21% of children have some form of transverse skeletal discrepancy involving the dental arches. The cause of maxillary constriction has been shown to be environmental, genetic, or multifactorial (Proffit WR, 2004). In order to address the problem of transverse discrepancy, most of cleft cases require expansion. The expansion procedures are performed during mixed dentition,

or early adolescence, since mid-palatal and other circum-maxillary sutures are still patent. These expansion procedures are the basic treatment modalities for cleft cases, be it be unilateral or bilateral.

RATIONALE FOR EXPANSION IN CLEFT CASES:

The basic need for expansion comprises of: alignment for collapsed arches, correction of cross-bites to the correctable extent, to expand the arch and align in order to prepare them for ABG (alveolar bone growth), to improve the airway dimensions following expansion, and facilitate nasal expansion, prepare them to aid in maxillary protraction, because rapid palatal expansion in cleft patients disarticulates circum-maxillary sutures, and protraction of maxilla could be easier to correct the antero-posterior deficiency, to improve tongue placement, facilitating speech development and early rehabilitation of facial appearance and dental functions, achieved due to expansion is of psychological benefit.

BIOMECHANICAL BASIS OF RAPID MAXILLARY EXPANSION:

Bell R.A., 1981, summed up the mechanics of rapid maxillary expansion simply when he reported, "If the applied transverse forces are of sufficient magnitude to overcome the bio-elastic strength of the sutural elements, orthopedic separation of the maxillary segments can occur." This is the basis of rapid maxillary expansion. The mid-palatal suture becomes more inter-digitated with age and therefore heavier forces are needed to overcome the partially interlocked suture in older adolescents and adults (Hansen L. et al, 2007). This serves the reason for the expansion procedure to be carried out during mixed dentition period (8-10 years of age). These forces decay rapidly following activation, but the rate of decay decreases within several minutes (Pfaff W. 1905). Active expansion usually takes place for 2-3 weeks followed by 3-6 months of the appliance being left in place as the suture reorganizes.

According to Isaacson, the main resistance to rapid maxillary expansion is not just the mid-palatal suture but the other maxillary articulations (Pfaff W. 1905), especially the zygomatic and sphenoid bone.

EXPANSION APPLIANCES:

The reasoning behind rapid maxillary expansion is that the orthopedic forces exerted by the expansion appliance can, up to a certain age, open the mid-palatal suture and widen the palate. Although it has been documented that expansion appliances in some form or another have been used since the 1860s, regular use of the appliance did not become popular until Haas introduced his expansion appliance in the 1950s. The Haas expander consists of a metal framework with an expansion screw in the palatal vault, bands on the first molars and premolars, an acrylic pad on the palatal tissue and buccal soldered bars as well to maximize anchorage and promote suture opening (Ghoneima A et al; 2011) [Figure 1].

An alternative to the Haas appliance is the hygienic or Hyrax expander developed by Biederman. This appliance was developed in response to the soft tissue irritation often seen with the Haas appliance (Harzer W, 2004). The Hygienic appliance consists of four orthodontic bands placed on the maxillary first molars and premolars with an expansion screw in the middle of the palate and a .040" buccal wire connecting the molar to the premolar bands on the buccal side of the teeth [Figure 2]. Like the Haas appliance, activation is two turns per day and a retention period of 3 months. According to Biederman, the main advantages of the hygienic appliance are patient comfort, easier hygiene, and prevention of lesions to the palatal mucosa.

More recently, expansion appliances have been developed that use mini-screw implants to secure the expansion screw directly to the palate [Figure 3], reducing the forces being placed directly on the teeth. Obviously this form of RPE, has been developed in an effort to maximize skeletal expansion and minimize dental tipping. Palatal distractors have been developed as an alternative to tooth-borne expansion appliances as well (Ghoneima A. et al, 2011; Garrett BJ. Et al, 2008; Krebs A., 1958; Verstraaten J, 2010). Cortese developed an appliance consisting of four 8 mm mini-screw implants that secure 2 titanium miniplates and a titanium jackscrew to the palate (Geran RG et al, 2006). Likewise, Lagrevère used a bone-anchored maxillary expander that consisted of an expansion screw and 2 stainless steel onplants secured to the palate by 2 mini-screw implants (Haas AJ., 1980). Likewise, hybrid appliances utilizing mini-screw implants and tooth-borne RME have been developed as well (Haas AJ, 1965; 1970). Another breakthrough was development of new type of slow palatal expansion appliance (Arndt WV, 1993) which utilizes the super-elastic and shape memory phenomenon of nickel titanium wires instead of the conventional stainless steel wires [Figure 4]. The effects of the appliance are a result of the shape memory and temperature transition characteristics of nickel titanium.

Apart from these conventional methods, most recently Eric Lio proposed a Fan type expander with a protocol of Alternate Rapid Maxillary expansion and constriction (AltRAMEC), for the growth of a hypoplastic

maxilla not only for the growing patients with cleft lip and palate, but also for those without cleft (Liou, E. J., 2005 a, b, c) [Figure 5].

TYPES OF EXPANSION:

Expansion procedures can be classified either as Rapid Maxillary Expansion (RME) or Slow Maxillary Expansion (SME). Various different protocols are given for both the two modalities.

Rapid Maxillary Expansion:

Rapid maxillary expansion (RME) appliances can be designed in many ways. However, they have certain features in common. These include a midline expansion screw (jackscrew) or spring that is attached to the teeth by means of acrylic or soldered wires. The appliance is bonded or banded to the anchor teeth. The appliance is usually activated on a daily basis by having the patient turn the active part of the screw or spring a prescribed amount. RME appliances are generally activated 0.2 to 0.5 mm per day with active expansion time usually less than a month.

Skeletal and Dental Changes after RME:

Literature has many studies enlisted on rapid maxillary expansion. These changes can be summarized as follows:

Skeletally in the sagittal plane, following expansion there was a forward movement of the maxilla in most reports with a tendency for the maxilla to be repositioned downwards as well (Haas AJ., 1961; Wertz RA., 1970; Davis WM. Et al, 1969; Krebs A., 1961). In the transverse plane, the two halves of the maxilla would separate in a triangular pattern with the apex located near fronto-maxillary suture and the base located in the alveolar region (Haas AJ., 1961; Wertz RA., 1970; Krebs A., 1961). Also reported was an increase in nasal cavity width ((Haas AJ., 1961; Krebs A., 1961; Thorne NAH, 1956). From an occlusal view, the maxillary mid-palatal suture also opened triangularly with more separation occurring anteriorly than posteriorly (Krebs A., 1958; Sandikcioglu M. et al, 1997; Debanne EF., 1958) with the ratio of anterior to posterior expansion being 3 to 2 and sometimes 2 to 1 (Wertz RA, 1970).

Dentally following expansion, the effects were opposite those seen with the mid-palatal suture with a greater increase occurring posteriorly in maxillary inter-molar width than anteriorly in inter-canine width (da Silva et al, 2007; Davis WM. Et al 1969). In comparing the amount of skeletal expansion to dental expansion, ratios ranged from 0.40 - 0.58 (da Silva et al, 2007; Thorne NAH., 1956; Timms RJ., 1980; Ladner PT. et al, 1995) indicating that of the total amount of expansion approximately half was dental and half was skeletal.

Slow Maxillary Expansion:

The majority of slow expansion appliances consist of a fixed palatal arch wire that is banded to the anchor teeth. The most traditionally used slow expansion appliances include the "W" arch, porter arch and quad-helix. Rates of expansion generally occur at approximately 0.5 to 1.0 mm per week producing forces from several ounces to 2 pounds. Advocates of slow expansion have questioned the need of such large rapid forces as those that are employed in RME. They believe that there is more physiologic adjustment to sutural separation producing greater stability and less relapse potential when using slower expansion (Chaconas SJ. et al 1982; Derichsweiler H. et al, 1953; Eric Liou, 2009). It was hypothesized that slow expansion because of the constant low-grade forces generated would maximize dental movement (tipping) and minimize skeletal movement (sutural separation).

Skeletal and Dental Changes after SME:

The dental and skeletal effects of slow maxillary expansion of the reviewed literature, in the sagittal plane the only observed skeletal change was an increase in the mandibular plane angle (Frank SW, 1982). Skeletally in the transverse plane, there was a triangular separation of the two maxillary halves with the greatest opening occurring inferiorly as reported in a study on primates (Cotton LA, 1978). Most human studies did demonstrate an opening of the mid-palatal suture (Bell RA. et al, 1961; Hicks EP., 1978; Ladner PT. et al, 1995; Sandikcioglu M. et al, 1997), however, radiographic evidence of sutural separation was variable with ranges from 50 - 80 percent of patients (Harberson VA. Et al, 1978; Sandikcioglu M. et al, 1997). Also an increase in nasal cavity width was reported (Cotton LA., 1978). In comparing the proportion of skeletal expansion to total expansion, ratios were found to range from 0.16 - 0.64 (Cotton LA, 1978; Frank SW. et all, 1982;Ladner PT. et al, 1995;Sandikcioglu M. et al, 1997) with a median ratio of 0.34, indicating slightly less skeletal change than rapid expansion procedures.

Dentally, there were significant increases in maxillary inter-molar and inter-canine widths with the inter-molar increases being less than the incisor and inter-canine increases (Bell RA. et al, 1981; Frank SW. et all, 1982; Sandikcioglu M. et al, 1997). Facial tipping of the maxillary molars was observed during the first 2 weeks of

expansion (Lima AC. et al, 2004) with no significant changes in molar inclination found following fixed orthodontic appliance therapy (Ekstrom C. et al, 1977).

PROTOCOL OF EXPANSION IN CLEFT:

RME exerts a force of around 120N, the same force which is normal for non-cleft cases may be detrimental in cleft cases, as there is non-existence of mid-palatal suture, the resistance offered by mid-palatal suture is much less or negligible. Also Hyrax and Hass type of expanders causes equal expansion in anterior and posterior region, which may not be desirable in bilateral cleft cases, since most often the molars are in buccal cross-bite and expansion of this type may further aggravate the problem. Therefore, quad helix type of an appliance [Figure 4] or W –appliance or fan shaped appliances as suggested by Eric Liou, 2009 and other advocators. These are slower expanders since they exert mild force of around 2N. A cleft cases do not require higher magnitude of forces, these appliances which are otherwise slow expanders bring about skeletal expansion in these cases, without causing undesired tissue reactions and allow physiologic adjustments and reconstitution of the sutural elements over a period of about 30 days (Ekstrom C, 1977; Story E., 1973). Also, these appliances have fan type of expansion, i.e more anterior and less posterior expansion, which is desirable in bilateral cleft cases.

LONG TERM STABILITY and RELAPSE:

Although the possibility of adolescent upper arch expansion with an RPE appliance is not questioned, the amount of long-term expansion effect is of prime concern. Arch width measurements were made directly on dental casts obtained at three time intervals: before treatment, after treatment, and after retention. Patients had been out of retention for approximately 8-10 years at a mean age of 30 years. Their findings suggested good stability for upper inter-canine and upper/lower inter-molar widths (Moussa R. et al, 1995).

McNamara et al. 2003 conducted a similar study and they included an untreated control group that was matched in age, sex distribution, and duration of observation to compare dental arch changes. In the short term, after RPE and fixed appliance therapy, the treated group presented with significant changes in arch dimensions when compared to the control group. During the post-retention period, some relapse was noted compared to the initial gain in arch dimension. However, when comparing the overall changes of the treated group to those of the untreated group, the conclusion was that the treatment did provide an overall gain in arch dimension that was greater than the control.

One of the most current and controlled studies on mandibular arch response and stability following RPE (Lima et al, 2004) looked at the dental casts of 30 patients obtained longitudinally at four assessment stages spanning approximately 12.5 years. Results of the study showed that mandibular inter-molar arch width increased significantly after rapid expansion. The increase was followed by a slight decrease of the occlusal value, however, the lingual value was maintained. Inter-canine width (occlusal value) remained stable throughout all assessment stages. Overall, there was remarkable stability in inter-molar width (lingual value) and inter-canine width (occlusal value), indicating that the increase in mandibular arch width dimension was in response to RPE and was maintained until adulthood.

CONCLUSION:

Expansion procedures provide promising treatment modalities for transverse deficiencies in cleft patients. Acquaintance with these interceptive procedures helps the clinician to understand better the final therapeutic effects and the way the expansion appliance actually acts on the basal bones and sutures of the craniofacial system.

LIST OF FIGURES:

Figure 1: Hass Expander (adopted)



Figure 2: Hyrax Expander (adopted)



Figure 3: Bone borne expander (adopted)



Figure 4: Nickel Titanium expander (adopted)



Figure 5: Fan expander (adopted)



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