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Role of Orthodontist in Cleft Palate/Craniofacial Team

A Project Submitted to

The College of Dentistry, University of Baghdad, Department of Orthodontics in Partial Fulfillment for the Bachelor of Dental Surgery

By

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Certification of the Supervisor

I certify that this project entitled "**The role of orthodontist in Cleft Palate/Craniofacial Team"** was prepared by the fifth-year student **Sana Haider Bahaa** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor degree in Dentistry.

Supervisor's name: Ihsan Sadiq Mohammed

Date: May, 2023

Dedication

I would Like to dedicate this work to my

Father and Mother

I know that all word can not

Describe your support, your endless love

Thank you for every pray, every tear

and every effort you do for me.

Acknowledgment

First and foremost, praises and thanks to **Allah** Almighty for giving me all these blessing, to be able to studying and working for myself.

I would like to extend my deepest respect and gratitude to the Dean of College of Dentistry, University of Baghdad, **Prof. Dr. Raghad Al-Hashimi.**

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List of abbreviation

Title	Meaning
Fig.	Figure
ENT	Ear-nose-throat
PNAM	Presurgical nasoalveolar molding
GPP	Gingivoperiosteoplasty
RED	Rigid external distraction

Introduction

Cleft lip and palate are one of the most common congenital anomalies of craniofacial region **(Tolarova and Cervenka, 1998)**.

Everyday some 700 children with cleft lip and/or cleft palate are born in the world, which means that a baby with such a cleft is born every 2 minutes**(Samuel *et al*.,2014)** .

Cleft lip and palate is most prevalent among Asians, least in Africans, and in Caucasians its prevalence is intermediate and hence incidence varies according to geographic location, ethnicity, gender, and socioeconomic status (**Cooper ., 2000)**.

Cleft lip and/or palate problems may or may not be severe in a young child, but they tend to worsen as the individual grows older. Although cleft lip and palate is a single anomaly it causes a range of functional as well as aesthetic problems which consist of a very severe impact on several systems and functions that include facial growth, dentition, speech, hearing and genetic aspects because of the complex mode of inheritance. It also causes social and psychological problems that have a lasting impact on the children and parents **(Cooper *et al*., 2000)**.

Although inheritance may play a role, cleft lip and palate is not considered a single gene disease but of a multifactorial origin/ etiology with potential contributing factors, including chemical exposures, radiation, maternal hypoxia, teratogenic drugs, nutritional deficiencies especially folic acid, physical obstruction and genetic influences **(Samuel *et al*.,2014)**.

Moreover, Orofacial Clefts can occur as syndromic or non-syndromic cleft with the latter accounting for the majority of cases (70% of CL/P cases and 50% of CP cases) **(Dixon *et al*., 2011)**.

Therapeutic management of cleft lip and palate is a long and complex procedure demanding the cooperation of experts from different scientific fields. The level of cooperation and the ethos of our noble profession calls for organization of experts at a single center, where treatment planning and implementation will be performed. The staff of competent cleft management center should include the following professionals: radiologist, anaesthesiologist, geneticist, plastic surgeon, maxillofacial surgeon, social worker, speech therapist, neurologist, neurosurgeon, nursing staff, orthodontist, paediatrician, paedodontist, prosthodontist, psychiatrist, psychologist and an ear-nose-throat (ENT) specialist **(Philips and Warren, 2018)**.

Over the years, the role of orthodontist has been multiple, because of its synergism with other treatment needs of the patient, The orthodontist can participate during all stages of care of cleft patient: In early stages with pre surgical maxillary orthopaedics; during the intermediate stages by aligning the maxillary segments and dentition and preparation for secondary alveolar bone grafting; during the final stages by obtaining ideal dental relation and preparing the dentition for prosthetic rehabilitation or orthognathic surgery**(Eichenauer et al., 2018).**

The Aim of the study:

Aim of the study is to identify the roles of orthodontists in the management of cleft lip and palate patient.

Chapter One

1.1 Cleft lip and palate

1.1.1 Definition

Cleft lip and palate is one of the most common malformation affect craniofacial region. They are a three dimensional anomaly affecting the skeletal

and soft tissue and causing changes in the growth and function in the affected area **(Berkowitz, 2013)**.

Most commonly presented as cleft lip with or without cleft palate or isolated cleft, Cleft lip and palate is a separate congenital deformities but may occur in association syndrome such as van der Woude's syndrome **(Smith *et al*., 2016)**.

They can be subdivided into:

-Non-syndromic.

- Syndromic which is occur in combination with developmental and physical deformities **(Martyn and Andrew, 2016)**.

1.1.2 Cleft lip

Cleft lip occurs due to failure of union between the maxillary processes with medial nasal process. It is maybe unilateral or bilateral, symmetrical or asymmetrical, may involve the alveolar process. **(Bishara, 2001)**.

Depending on the extension of the defect cleft lip can have different types:

1- Complete cleft lip: It is extended from the vermilion border to the floor of nose. In these cases, the affected people will appear from the profile view they have protruded premaxilla. In complex cases the cleft lip will affect the alveolar process and is not necessary to be part of it.

2- Incomplete cleft lip: has two categories

A- Minimal defects involving only the vermilion border as in **(Fig.1)**.

B-large defect involves the muscle of the nose and all layers of the bridge except muscular layer. Depended on the width and extension of the cleft the alar of the nose is deviated to the affected side while the tip of the nose is deviated to unaffected side **(Berkowitz, 2013)**.

Fig.1: Unilateral cleft lip **(Martyn and Andrew, 2016).**

1.1.3 Cleft palate

Cleft palate occur due to failure of union of the lateral palatine shelves with each other, with nasal septum or with primary palate **(Bishara, 2001)**.

The cleft may affect the soft and hard palate together **(Fig.2)** or soft palate alone **(Fig.3)** but never affect the hard palate alone **(Berkowitz, 2013)**.

Sometimes it appears as a simple defect in the submucosa that disrupted the continuity of musculature in the palate area or more complicated that bifid the uvula and affected both the primary and secondary palate **(Martyn and Andrew, 2010)**.

Fig2: Unilateral cleft involve both hard and soft palate **(Martyn and Andrew, 2016).**

Fig.3: Unilateral cleft involve the soft palate only **(Martyn and Andrew, 2016).**

One of the most widely accepted classification of the palatal defect is introduced by Victor Veau in 1931 **(Alonso and Raposo-Amaral, 2018)**:

Group 1: Cleft of soft palate only

Group 2: Cleft of hard and soft palate up to incisive foramen, involve secondary palate only.

Group 3: Completely unilateral cleft in the midline and deviating to the affected side which extended from the incisive foramen to the uvula and in some cases reach the alveolus in the region of future position of lateral incisor.

Group 4: Complete bilateral cleft, two clefts extended from uvula to the incisive foramen and involve the alveolus.

1.1.4 Cleft lip and palate:

Cleft lip and palate is a defect in the part that separate the oral cavity from the nasal cavity so it will result in direct communication between them, it is may be unilateral **(Fig.4)** or bilateral **(Fig.5)**, complete or incomplete. **(Alonso and Raposo-Amaral, 2018).**

In unilateral cleft lip and palate there is a various degree of the palatal shelves separation and the palatal segment will be more deviated to the affected side. In the bilateral according to the equality in the defect it is may be symmetrical or asymmetrical **(Berkowitz, 2013)**.

Fig.4: Unilateral cleft lip and palate **(Martyn and Andrew, 2016).**

Fig.5: Bilateral cleft lip and palate **(Martyn and Andrew, 2016).**

1.2 Embryology

There are many structures in the head and neck developed from pharyngeal apparatus so it is important to know the normal condition to differentiate it from abnormal, their development start at 4 week in embryonic period due to the migration of natural cell to the head and neck **(Moore and Persaud, 2019)**.

It consist from bilateral pairs of arches, clefts, grooves and membranes, each one of these structures numbered serially as I,II,III,IV and there is V,VI arches but unwell developed in the human. The arches are separated incompletely from outer surface by pouches and the part between them is called pharyngeal membrane **(Bishara, 2001)**.

Each part of pharyngeal apparatus is responsible for the formation of number of nerves, bones, cartilages and muscles and now we will talk about them:

- The pharyngeal arches:

  1- The first pair of arches are responsible for the formation of fifth cranial nerve (trigeminal nerve), maxillary and mandibular process, Meckel's cartilage, and muscles of mastication, anterior digastric muscle, tensor veli palatini, tensor tympani and part of maxillary artery.

  2- The second pair of arches are responsible for the formation of the seventh cranial nerve (facial nerve), the superior body and lesser horn of hyoid bone, styloid process, stylohyoid ligaments, Reichert's cartilage, muscles of the facial expression, posterior belly of digastric muscle and stapedial and hyoid arteries.

3- The third pair of arches are responsible for the formation of the ninth cranial nerve (glossopharyngeal), the inferior body and great horn of hyoid bone, stylopharyngeal muscle and part of carotid system.

4- The fourth and sixth arches are responsible for the formation of the tenth cranial nerve (vagus nerve), laryngeal cartilages, muscles of the pharynx and larynx **(Bishara, 2001)**

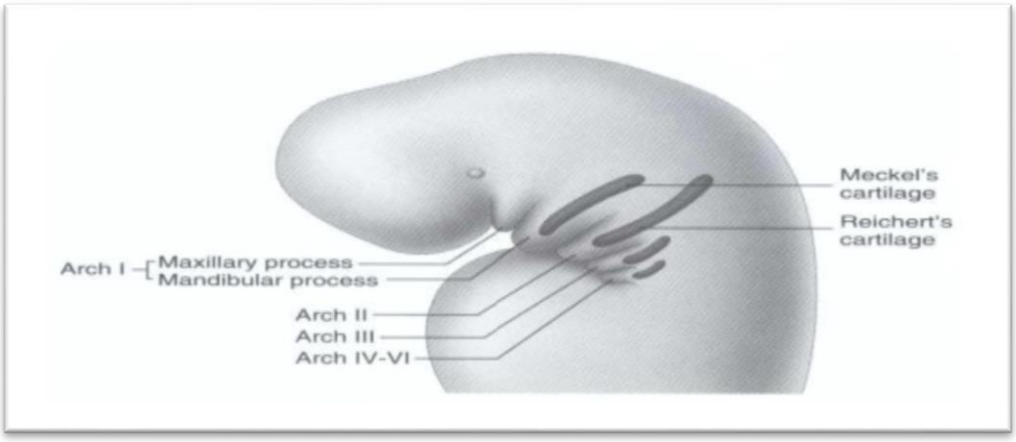

Fig.6: The pharyngeal arch apparatus **(Bishara, 2001).**

The development of the face starts in the 4 week during the embryonic period and continues to 8 week so in the end of this period the face will take the primary human form, this starts by union of both mandibular prominences in midline to form the chin and lower lip **(Moore *et al*., 2019)**.

Followed by formation of nasal placodes by inferior portion of the frontonasal prominence and the mesenchymal tissue in the peripheries of these placodes will differentiated to form the lateral and medial nasal prominences the later one has a horse-shoe shape while the remains part in the middle of these placodes will form the nasal pits and these will give rise to nasal cavities and nostrils, the medial nasal process will be approximated with each other and in the same time the maxillary

prominence become larger due to differentiation of mesenchymal tissue and then they will meet with each other in the midline and form the intermaxillary segment and the middle part of it will give rise to the philtrum of upper lip during the 6 and 7 week , also the premaxilla will be formed during the same period and the lateral nasal processes give rise to ala of the nose **(Jiang *et al*., 2006)**.

The development of the palate starts in the 6 week in the embryological life and continues to 12 week, the end of the 6 week to the beginning of 9 week is the most critical period during the development of the palate. The palate consists of two parts primary and secondary, the primary palate which lies in front to the incisive foramen so it is also called premaxilla and it is triangular shape while the secondary palate lies behind the incisive foramen, the later one results from the fusion of paired of lateral palatal shelves (results from the union of bilateral medial projection of maxillary process in midline and they are oriented in a vertical direction that allow the face to elongated) and these shelves will join with each other in the midline when the tongue move downward and become smaller, the remnant of these shelves will present as medial palatine raphe after their rotation and orient themselves in the horizontal direction **(Neville *et al*., 2016)** .

This disruption occurs when the palatal shelves start their rotation until the closure of uvula, sometimes the bone is not affected only the muscles of the palate will be affected (soft palate) and this is will appear as submucosal cleft, if the defect occurs in the premaxilla this will present in the form of cleft lip with or without involve of the alveolus while if it occurs posterior to the incisive foramen that mean affect the secondary palate it will lead to formation of cleft palate **(Bishara, 2001).**

1.3 Etiology

The etiology of cleft lip and palate is multifactorial, both genetic and environmental factors play an important role each one alone or in combination in the development of clefts **(Michael, 2011)**.

The studies showed that the maternal family history increase the incidences of cleft lip and palate **(Figueiredo *et al*., 2015)**.

There are environmental factors related to the mother during pregnancy such as maternal age, uses of tobacco, alcohol consumption, taking drugs, smoking and drinking contaminated water, also there are others such as the child weight, gender, nutrition and geographic area **(Jamilian *et al*., 2017)**.

The studies show the incidences of clefts will increase about 10 times when the mother use antiepileptic drugs and the phenytoin is considered the most dangerous one, also if the mother have suffered from folic acid deficiency during pregnancy the chance that the child has clefts will increase **(Neville *et al*., 2016)**.

Most cases are caused by a combination of genetic and environmental factors as the inherited gene from mother or father transmitted to the baby during the first weeks of pregnancy with the effect of environment will lead to increase the possibility of anomalies development **(Setó-Salvia and Stanier, 2014)**.

1.4 Role of the orthodontist

Timing and sequencing of orthodontic care may be divided into four distinct developmental periods.

These periods are defined by age and dental development and should be considered as time frames in which to accomplish specific objectives.

Such sequencing avoids the common tendency to allow an early phase of treatment intervention to extend through infancy, childhood, adolescence, and into adulthood. With the understanding that children born with cleft lip and/or palate should be treated by an interdisciplinary team approach, **(Fig.7)**.

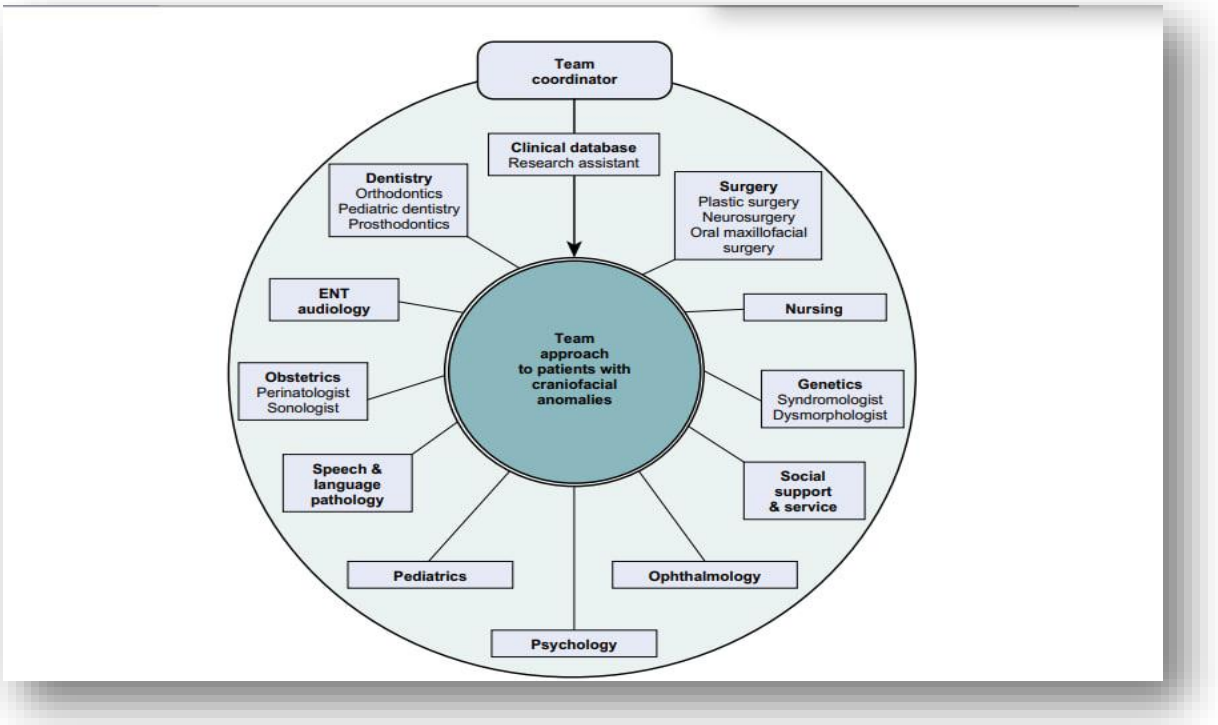

Fig.7: Members in the team approach to patients with craniofacial anomalies **(Graber, 2017).**

The primary goals of treatment are: **(Alzain *et al*., 2017)**.

1. Normal esthetic appearance of lip and nose

2. Normal speech, hearing and feeding

3. Nasal airway patency

4. Intact primary and secondary palate

5. Class I occlusion

6. Normal psychosocial development.

1.5 Orthodontic management of cleft lip and palate

Orthodontic treatment may be performed at different stages of the patient's development, depending on the particular problem. Patients presenting with a cleft lip only or a soft palate cleft may never require orthodontic treatment. Treatment of a syndromic patient has to be done in consultation with different specialities. Patients with unilateral or bilateral cleft lip, alveolus and palate may require orthodontic treatment during the following four different stages: **(Alzain *et al*., 2017).**

1. Neonate and infant

2. Orthodontic-orthopedic treatment during the primary dentition.

3. Orthodontic treatment during the mixed dentition.

4. Orthodontic treatment alone or in conjunction with orthognathic surgery in the permanent dentition

1.5.1 Neonate and infant

Infant orthopedics/ presurgical orthopedic intervention is performed on the maxillary arch of a newborn before the surgical repair of the lip. It was introduced in the 1950s and may be used in patients with bilateral or unilateral cleft lip, alveolus, and palate. The rationale behind this method involves orthopedic realignment of the "collapsed" segments using various mechanisms ranging from simple passive appliances to more active orthopedic appliances to extraorally activated pin-retained appliances. Neonatal maxillary orthopedics aims at securing a good maxillary arch form in acceptable relationship with the mandible and to restore normal oral function. **(Chong and Wong, 2010).**

1.5.1.1 Specific types of infant orthopedics

A. Kernahan Rosenstein Procedure

The Rosenstein appliance is a passive plate that is inserted prior to lip surgery. Then, the lip is closed and the arch segments are molded until they are in butt alignment, after which the segments are stabilized by a small subperiosteal onlay rib graft. The plate is retained for 6–8 weeks postgraft, and the palate is usually closed at or before 12 months of age**,** In complete bilateral cleft lip and palate, the appliance covers the lateral segments, holding them in position while an extraoral elastic band and later on the restored lip molds the premaxilla backwards**.(Rosenstein and Dado, 2005).**

B. Latham-Millard Pinned Appliance

In the Millard-Latham method of neonatal maxillary orthopedics, forces are applied using a pinned palatal appliance to manipulate mechanically the maxillary segments into close approximation, followed by alveoloperiosteoplasty and lip adhesion. The treatment was based on the concept of facial growth hypothesis, and was ultimately used by Millard in treatment of complete unilateral and bilateral clefts. The aim of the procedure is ‘to carry the interrupted embryonic process to normal completion’ by maxillary alignment, stabilization of the alignment along with tunneling of the alveolar cleft with periosteum, and reconstruction of the nasal floor to support the alar base. **(Bitter, 1992).**

C. Zurich approach

During early 1970s early maxillary orthopedic treatment was essential in Zurich, while surgical intervention was postponed in order to minimize subsequent growth disturbance, create optimal conditions for the maxillary segments to

develop to their entire growth potential, maintain or improve arch form, and to control effects of surgical lip closure. The appliance used is a passive plate of compound soft and hard acrylic resin, and it is worn 24 hours a day for about 16 to 18months, till the soft palate is closed surgically. The hard palate is closed after 5 years of age. During the course of treatment, the lip is closed at about 6 months of age. **(Sailer and Haers, 2003).**

D. Nasoalveolar Molding

The benefits of PNAM (Presurgical Nasoalveolar Molding) **(Bokhari *et al.*2014)** are:

(a) Improve long term nasal esthetics.

(b) Reduce number of nasal surgical procedures.

(c) Reduce need for secondary bone grafts if gingivoperiosteoplasty (GPP) is applicable,

(d) Effective retraction of the protruded premaxilla, and lengthening of the deficient columella, along with producing a limited maxillary growth disturbance.

The first goal of PNAM in bilateral cases is to move the premaxillary segment posteriorly and medially, while preparing the lateral alveolar clefts to come in contact with the premaxilla. The posterior lateral palatal shelves are molded to the appropriate width to accept the premaxilla. The premaxilla is retracted and derotated as necessary using the molding plate in conjunction with external tape and elastics. In addition, another important point is the elongation of the columella. **(Grayson *et al*., 2002)**.

In PNAM, nasal stents are added to the alveolar molding plate. The molding plate itself is mainly used to approximate the alveolar segments and retract the

protruding premaxilla in Complete Bilateral Cleft Lip and Palate in order to reduce the nasal deformity to a degree that enables the start of more precise nasal molding with stents. **(Maull *et al*., 1999). (Fig. 8)**

Fig.8: Typical nasoalveolar molding appliance. **(Shetty *et al*., 2016)**

Retention of the appliance in the mouth is secured by tapes on the cheeks, which engage the intraoral plate with orthodontic rubber bands.

The appliance is adjusted every 1–2 weeks in 1 mm increments by removing hard acrylic resin, and adding soft acrylic resin. Once the maxillary alveolar segment gap is less than 6 mm, a nasal stent can be added to the appliance using acrylic resin placed on 0.036 inch-thick wire. The stent is positioned 3–4 mm into the nostril, just below the soft tissue triangle of the nose. The size and shape of the stent is adjusted by adding soft acrylic to help create a "tissue expander" effect on the length of the cleft-side columella, as well as to reposition the malpositioned lower lateral cartilage. **(Liao *et al*., 2012).**

Presurgical orthopedic has remained controversial with different methodologies and approaches differing in efficacy and efficiency so the assessments on the effects of different combinations of cleft surgery and orthopedics methods are still needed.

1.5.2 Primary dentition

At 2 to 3 years of age, the establishment of the primary dentition permits classification of the type of developing malocclusion.

This determination may be part of the diagnostic regimen in which the contribution of the skeletal and dental components may be identified. The facial soft tissues may mask the underlying skeletal deficiency of the midface in young children **(Fig. 9)**. The dentition often reflects the skeletal relationship, especially if the dentoalveolar component (axial inclination of the teeth) has not compensated for any skeletal discrepancies. **(Proffit *et al*., 2013)**.

Dental compensation for maxillary skeletal deficiency may result in retroclination of mandibular incisors with proclination of the maxillary incisors to mask the anteroposterior discrepancy, although in children with repaired orofacial clefts, the scar tissue following lip repair may constrain the maxillary incisor axial inclination

Fig. 9: A, Frontal view of a 7-year-old boy with repaired unilateral left cleft lip and palate. B, Profile view showing mild bimaxillary retrusion. C, Lateral skull radiograph in early mixed dentition. **(Graber, 2017)**

Because the primary incisors tend to be more upright than their successors, an anterior crossbite may be unilateral or bilateral with or without a functional shift of the mandible. This shift occurs when the child closes the teeth together. To eliminate mandibular shifts, orthodontic treatment may be indicated to remove the interfering contact by tooth movement. This process may involve the maxillary incisors if an anterior crossbite exists or expansion of the posterior segments to eliminate a posterior crossbite **(Fig. 10, A to D)**.

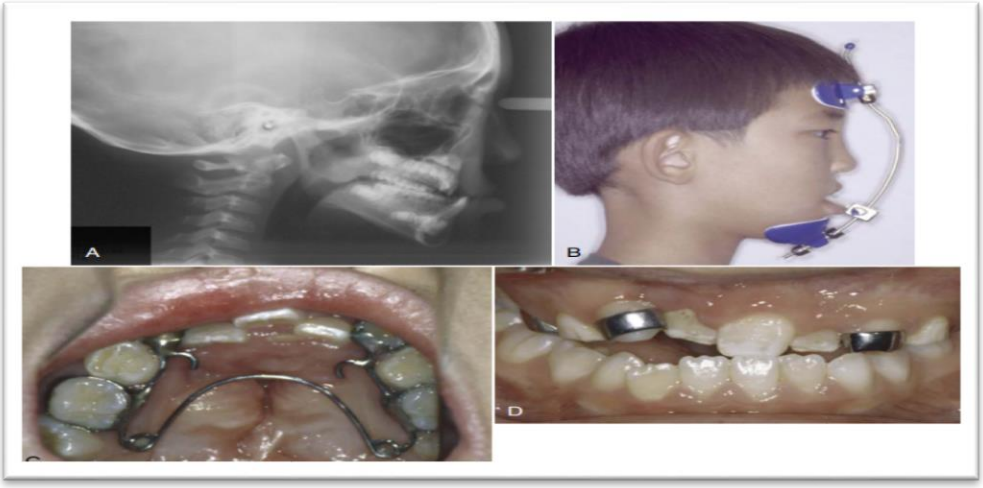

Fig.10: Eight-year-old boy with repaired unilateral right complete cleft lip and palate with sagittal and transverse maxillary deficiency. A, Lateral skull radiograph. Note the 7-mm reverse overjet. B, Protraction face mask with elastics attached to palatal hooks on expander. C, Palatal expander with bands cemented on the maxillary second primary molars and canines with palatal hooks to attach the protraction face mask. D, Lateral and anterior crossbites improving with palatal expansion and maxillary and dental protraction. **(Lidral and Vig, 2002)**

If the dental crossbite relationship is a continuing problem once the dentition is established, it may be a reflection of the underlying skeletal discrepancy for which growth modification and redirection may be indicated with a protraction face mask **(Fig.10, B)**. In cases of bilateral cleft lip and palate, severe

constriction of maxillary posterior segments often is associated with bilateral crossbite and protrusion/extrusion of the premaxillary segment. **(Proffit *et al*., 2013).**

The orthodontist should consider many factors in determining when to initiate orthodontic treatment during the primary dentition stage. These factors include the ability of the child to cooperate, the severity of the malocclusion, timing of secondary bone grafts, and the need for future orthodontic treatment in the early mixed or permanent dentitions. Contemporary opinion recognizes a need for orthodontic treatment in the early mixed and permanent dentitions. **(Cohen and Vig, 2017)**.

However, no strong evidence supports a benefit from routinely treating dental malocclusions in the primary dentition, suggesting that orthodontic treatment may be best delayed until it can be combined with other treatment goals and thus shorten the overall duration of treatment. **(Proffit *et al*., 2013)**

Severe skeletal discrepancies in the primary dentition are a more complex problem. Modification or redirection of growth has been advocated, and the use of functional or orthopedic appliances, including the forward protraction face mask, has been reported to have some success. More commonly, the “apparent correction” is achieved by a transient change in the position of the teeth only, so that with subsequent growth, **(Rygh and Tindlund, 1996)**.

1.5.3 Mixed dentition

The mixed dentition stage starts at approximately 6 years of age with the eruption of the first permanent molars and incisors. Further growth of the

craniofacial complex often accentuates a previously mild skeletal discrepancy. Patient evaluation includes an appraisal of the soft tissue condition (ie, presence or absence of oronasal communication); the skeletal aspects of malocclusion in all three planes of space; and dental problems, such as missing/malformed teeth, malpositioned/rotated incisors, anterior and/ or posterior crossbites. **(Proffit *et al*., 2018).**

Cleft lip and palate patients often develop maxillary retrusion after cleft repair. The purpose of treatment in mixed dentition stage should be to achieve a favourable occlusion with positive overjet and overbite which can be achieved by means of anterior orthopedic traction (protraction) **(Tindlund and Rygh, 1993)**.

Alveolar (secondary) bone grafting

By definition secondary or delayed alveolar bone grafting is performed after primary lip repair. The age at which the bone graft is placed defines whether it is early secondary bone grafting (2 to 5 years), intermediate or secondary bone grafting (6 to 15 years), or late secondary bone grafting (adolescence to adulthood).**(Graber,2017)**.

Intermediate or secondary alveolar bone grafting (6 to 15 years of age).

The success of this intervention requires collaborative treatment planning between the orthodontist, surgeon, and other team members. Secondary alveolar bone grafting offers five main benefits: **(Vig, 1992)**. **(Fig.11)**.

1. Provision of bone support for unerupted teeth and those teeth adjacent to the cleft.

2. Closure of oronasal fistulae. By using a three-layered closure technique.

3. Support and elevation of the alar base on the cleft side.

4. Construction of a continuous arch form and alveolar ridge.

5. Achieve stabilization and some repositioning of the premaxilla in those patients with a bilateral cleft.

Fig.11: Patient with a repaired unilateral cleft of the lip and palate of the left side. **(Mitchell, 2013).**

1.5.4 Permanent Dentition Stage:

Once the permanent dentition has been established, but before further orthodontic treatment is planned the patient should be assessed as to the likely need for orthognathic surgery to correct mid-face retrusion. The degree of maxillary retrognathia, the magnitude and effect of any future growth, and the patient's wishes should all be taken into consideration, however, it has been shown that around 25 per cent of cleft lip and palate patients treated to a standardized protocol require orthognathic surgery. **(Mitchell, 2013).**

This is because scar tissue from the original primary repair restricts growth of the maxilla. If surgical correction is indicated, this should be deferred until the

growth rate has slowed to adult levels (and be preceded by pre-surgical orthodontic alignment). **(Mitchell, 2013).**

Ward and coworkers Ward found that children with clefts reported lower social-emotional well-being compared with noncleft children, This effect was greater in adolescents 15 to 18 years of age than in younger children, pointing to the challenges that adolescents with clefts encounter with peer interactions. During adolescence, involution of the adenoidal lymphoid tissue occurs, often with impairment of speech from the resulting hypernasality, With a decline in cosmetic appearance and speech communication, many patients have a special need for early intervention by the surgeons, orthodontists, speech therapists, and psychologists. **(Firestone *et al*., 2013).**

1.5.4.1 Growth consideration

Patients with unilateral complete clefts of the lip and palate typically become more maxillary deficient and mandibular prognathic in their appearance, because of sagittal maxillary deficiency. **(Semb, 1991).**

However, vertical maxillary deficiency may also accentuate the class III tendency, resulting in overclosure of the mandible to achieve occlusion of the teeth. Alternatively, a class III skeletal relationship can be camouflaged by increasing the vertical dimension to rotate the mandible down and back. Since facial growth is the result of the interaction of genetic and environmental factors, continued growth in early adulthood may enhance or detract from treatment results obtained during childhood and adolescence. These dynamic properties of the face make the management of facial growth both challenging and rewarding **(Semb, 1991)**.

1.5.4.2 Skeletal-Facial Considerations

In general, a patient with an oral cleft may show a wide spectrum of orthodontic problems with the cleft palate-related anomalies superimposed on them. It is common that the maxilla exhibits deficiency in all three dimensions, i.e., anteroposteriorly, transversely, and vertically. Posterior crossbites are common even in cases that exhibit only an isolated cleft palate (not extending into the alveolus). Anterior crossbites are also commonly observed at this stage of development, often despite attempts to correct these problems at the mixed dentition phase of treatment. **(Kim *et al*., 2015).**

1.5.4.3 Dental considerations

Dental problems faced by the orthodontist include the following:

1. Absence of teeth adjacent to the cleft, most often the permanent lateral incisors.

2. High incidence of missing teeth in other regions, especially missing bicuspids.

3. Malformed teeth.

4. Supernumerary teeth.

5. Ectopically positioned teeth.

6. Lack of osseous support for some teeth compromising the possibility to move these teeth to the desired positions.

7. Accentuated curve of Spee in the maxilla, the mandible, or both.

8. Collapsed arch form.

9. Poor oral hygiene, caries, periodontal disease.

Orthodontic concepts and techniques used in the treatment of the permanent dentition of cleft palate patients are no different from those applied in the treatment of noncleft patients. **(Kim *et al*., 2015)**.

There are certain unique characteristics, however, that the orthodontist needs to be aware of in the management of the cleft palate patient.

1.5.4.4 Soft tissue considerations

Isolated palatal clefts not extending into the alveolar bone and lip may not affect facial esthetics to any significant degree. In general, lip contour and thickness in these patients appear normal. On occasion, a slight maxillary hypoplasia may occur, presumably as a result of an extensively scarred palate. Presence of a complete unilateral or bilateral cleft palate, however, may be associated with potentially severe maxillary growth deficiency, manifesting itself with straight or concave facial profile, sagittal deficiency of the maxilla, a thin upper lip, protrusive lower lip, and a deformed nasal tip with inadequate horizontal projection. **(Harada *et al*., 2001)**.

1.6 Treatment timing considerations

The timing and sequencing of orthodontic treatment require close communication with the team. Deciding to delay surgical orthodontic treatment until growth is stabilized may be sound judgment but not always in the patient's best interest, especially when psychosocial development is affected**. (Proffit *et al*., 2018).**

In some instances, skeletal surgery may be indicated before growth is completed, knowing that a further procedure may be necessary should the patient

outgrow the correction. As a general rule, skeletal surgery, orthodontic intervention, and final prosthetic rehabilitation should be completed before soft tissue revision or rhinoplasty is instituted. The outcome of soft tissue surgical procedures when combined with surgical orthognathic movement of the maxilla and mandible is unpredictable**. (Kumar *et al*., 2006).**

1.7 Distraction Osteogenesis

Correction of severe maxillary hypoplasia solely by advancing the maxilla may be possible, with the advent of distraction osteogenesis, such correction would be accomplished by expansion of the scar tissue at the same time distraction osteogenesis is performed. Briefly, rigid external distraction (RED) involves cementation of an intraoral tooth-borne splint in the maxilla with hooks extending extraorally for traction, The appliance is usually fabricated and delivered by the orthodontist.**(Graber, 2017).**

This tooth-borne method of attachment to the maxilla may place the teeth at risk of periodontal damage. Bone-borne methods of attachment reduce such risk and include miniscrews placed bilaterally in the alveolar ridges to guide the skeletal movements, or preadapted miniplates fixated to the anterior surface of the maxilla beside the piriform aperture for traction **(Minami *et al*., 2007)**. **(Fig.12)**.

A complete LeFort I osteotomy is performed, and a RED device is placed intraoperatively. The vector of the anterior force can be adjusted for each patient during the course of distraction, which is done at home by patients turning the activation screw at a rate of 1 mm per day. Following advancement, the RED device is maintained for 2 to 3weeks for bone consolidation. This is followed by a retention period during which the patient wears a protraction face mask.

Internal distractors, which typically are bone-borne, have also been used in patients with cleft maxillas, The distractor rod penetrates into the oral cavity, thus activation of the system is possible via an intraoral approach. After the desired advancement is achieved, the turning arms are removed and the submucosal components stay in place. **(Kumar *et al*., 2006).**

This method has the added benefit of allowing for long consolidation periods (3months). The benefit of distraction osteogenesis in a hypoplastic maxilla with scar tissue and a compromised blood supply lies in a more gentle skeletal advancement with corticotomy cuts without downfracture of the maxilla. The orthodontist may monitor for hypernasal speech that could occur with advancement of the maxilla. Because the nasomaxillary complex is advanced slowly, at a millimeter per day, speech may be evaluated at intervals as the advancement proceeds and adaptation of the velopharyngeal mechanism occurs. Again, the treatment benefits need to be weighed against the burden of care and considered in the context of the scientific evidence of the probability of achieving quantifiable outcomes of success and failure**. (Graber, 2017).**

Fig.12: 21-year-old male with repaired cleft lip and palate on the right side undergoing comprehensive orthodontic treatment. **(Graber, 2017).**

Fig.13: Same patient illustrated in Figure12. A, Cephalometric radiogram before distraction. SNA angle=62degrees (severe maxillary retrusion); SNB angle=81degrees (normal mandibular position); ANB angle=−19degrees (severe maxilla-mandibular discrepancy). B, to avoid excessive dental movement often associated with tooth borne anchorage, 2-mm plates are adapted along the osteotomy and anchored to the maxilla with a minimum of six screws on each side. Wires extending from the anterior hole of the plate exit via percutaneous punctures adjacent to the ala bilaterally.

This allows for skeletal anchorage and a more controlled vector of distraction. In this figure, the plates are shown adapted to a stereolithic model for illustrative purposes. Adaptation is easily accomplished during surgery and a model is not generally required. The wire extensions connect to the adjustable screw system in the vertical bar of the RED. **(Graber, 2017)**

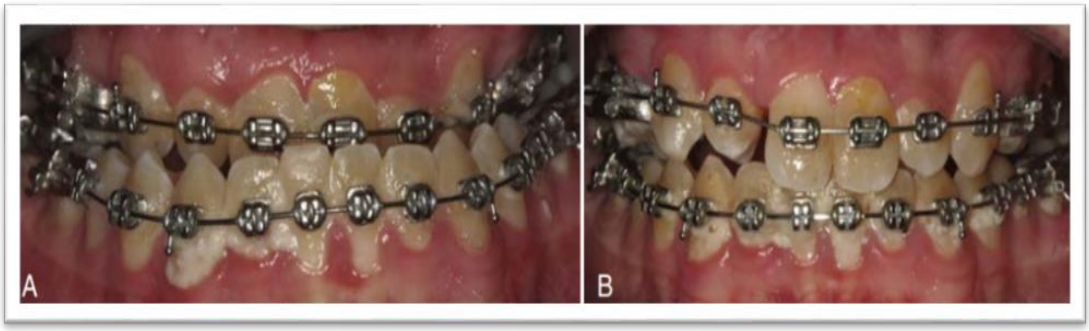

Fig. 14: Same patient illustrated in Figures 12 and 13. A, Frontal intraoral view prior to distraction. Overjet is −10mm. Overbite is nearly 50%. B, Frontal intraoral view after distraction. Overjet is 2mm. Positive overbite has been maintained. **(Graber, 2017)**

Chapter Two

2.1 Discussion

The orthodontist's role in the cleft palate team requires close collaboration with the other team members. The rationale of timing and sequencing of orthodontic treatment have been discussed in four periods of development:

(1) Neonatal or infant maxillary orthopedics.

(2) Orthodontic considerations in the primary dentition.

(3) Mixed dentition to include presurgical considerations before an alveolar bone graft is placed.

(4) Final treatment in the permanent dentition with orthodontics only or combined with orthognathic surgery.

The latter period combines an orthodontic and surgical approach to the correction of dental and skeletal components of malocclusion and facilitation of any necessary prosthodontic treatment. Speech considerations and the communicative skills of the patient with a cleft are important aspects in planning orthognathic surgery for these patients. Subsequent nose and lip revisions for cosmetic improvement also must not be underestimated in the enhancement of the final, soft-tissue, facial aesthetic result following correction of the skeletal and dental discrepancies.

Provided that the team members plan the timing and sequencing of appropriate treatment modalities in a closely coordinated, problem-oriented approach, patients with clefts should have optimal functional and aesthetic results. Outcome measures for reporting the results of surgical interventions require the choice of valid and reliable measures to be identified and implemented

The ultimate outcome for team-based care is to have a fully rehabilitated patient who is satisfied with the treatment outcomes in terms of speech, occlusion, facial and dental aesthetics, and function. The patient should continue to receive conventional dental and medical routine evaluations similar to any adult to maintain optimal oral health.

Chapter Three

3.1 Conclusions

1. Cleft lip and palate involve a multitudinous factors required to be considered while treatment planning and execution.

2. The orthodontist's management of cleft lip and palate consider four stages which include:

A. Neonatal or infant.

B. Primary dentition.

C. Mixed dentition.

D. Permanent dentition with orthodontics only or combined with orthognathic surgery.

3.2 suggestions

For future studies we suggest:

- Orthodontic treatment of unilateral cleft lip and palate associated with maxillary canine/premolar transposition.
- Retention protocol following post-orthodontic treatment in cleft palate patients
- Psychology and Counseling: Patients with cleft lip and palate may experience emotional and psychological challenges related to their condition. Healthcare professionals who work with these patients should have knowledge of psychology and counseling techniques, as well as experience working with patients who have experienced physical and emotional trauma.

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