ORTHODONTIC MANAGEMENT OF CLEFT LIP AND PALATE

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- Clefts involving the lip and palate are the most commonly seen congenital deformities that occur at the time of birth.
- They are not life threatening unless associated with other syndromes that have systemic complication.Cleft of the lip and palate can occur individually or together in various combinations.
- Clefting of the primary palate or secondary palate lead to a series of distortions in dentofacial development.
- The effected individual requires a series of prolonged treatment by an multidisciplinary team.
- At present there are well organized cleft palate teams in most part of the world, so treatment can be coordinated among team members from the very beginning.

The team involves

- Pedodontist
- Pediatrician
- Speech Therapist
- E.N.T surgeon
- Orthodontist
- Oral surgeon
- Genetic scientist
- Social worker
- Prosthodontist
- Plastic surgeon
- Psychiatrist

Epidemiology :

In Caucasians 1 case is seen in every 1000 individuals.

In India 1.7 cases are seen in every 1000 individuals.

In India - CL+CP-1.25/1000

CP 0.46/1000

Sex Ratio:

Incidence of cleft lip and palate is more in males than females.

Incidence of cleft palate alone is more in females than males.

Laterality of the lesion:

In case of unilateral clefts ,left side more frequently involved than the right side

Risk Factors

•If both the parents are unaffected, if they have an affected child, their next offspring has a risk of :CL and CP-4% CP-2%
•If the parents are unaffected, if they have affected children next offspring has a risk of : CL and CP -9% and CP of 1%.
•If both parents are affected a probability of offspring developing the anomaly is 60%.

Etiological factors

They can be broadly classified into-
•Genetics
•Teratogents
•Nutritional factors

Genetics

Monogenetic inheritance(Charbora&Harovitz1974)

50% of syndrome associated with cleft lip and cleft palate is due to gene disorder.There is equal distribution among autosomal dominant and recessive disorders.

Example-Vander Woudes Syndrome

-X Linked submucous clefts.

Polygenic inheritance (Roger Ladda)

several genes with relatively small effect act in the presence of triggering environmental factor to express the abnormality

Multifactorial/Threshold model(Melnick 1972)

occurrence of a anomaly depends on the additive effect of several minor abnormal genes and environmental factors .Accumulation of all these factors is tolerated by the fetus upto a certain threshold point beyond which there is the risk of malformation.

Chromosomal Anomalies

chromosomal abnormalities account for 18% of the clefts associated syndromes

Example-Trisomy-D

This may be due to-deletion,duplication,inversion and translocation

Inheritance of CL and CP in twins-

Monozygotic twins-40% chance CL and CP

Dizygotic twins -5% chance CL and CP.

Teratogens

These act by the process of mutations

Examples include-

Phenytoin

Alcohol

Thalidomide

Aminopterin

Trimethadoine

Corticosteorids.

Nutritional deficiencies(Johnston 1975)

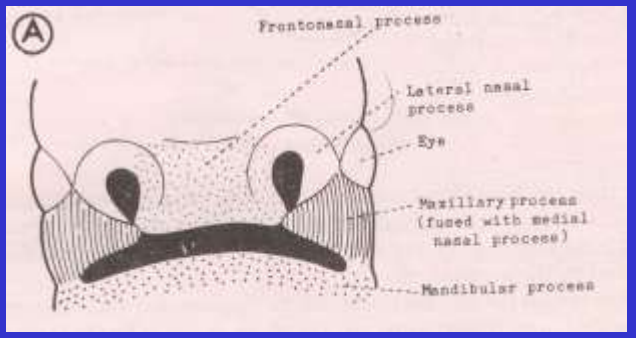
Deficiency of riboflavin and reduced levels of folic acid are considered as etiological factors.

Also role of blood groups ie. blood group AB and O show significantly increase frequency with CL and CP patients.

Embryological background in Cleft

Cleft of primary palate and lip

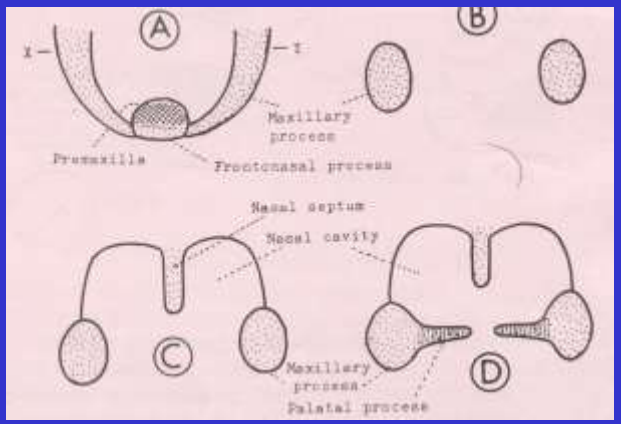
Appearance of the nasal placodes on the either side of the globular process is seen around 28th day .Median and the lateral nasal process develop around the nasal placodes around the 33rd day. Primary palate forms by the fusion of the medial nasal and the lateral nasal process at the bottom of the nasal pit. Later the maxillary process fuses with the frontal medial and the lateral nasal processes. Failure of this process results in the cleft of the primary palate.



Isolated Cleft Palate

This is seen due to the failure of the palatine shelves to make contact due to the insufficient growth of the shelves and interference with the shelf elevation.

Insufficient growth of the palatal shelves due to any tendency to mesenchymal deficiency



OTHER CAUSES

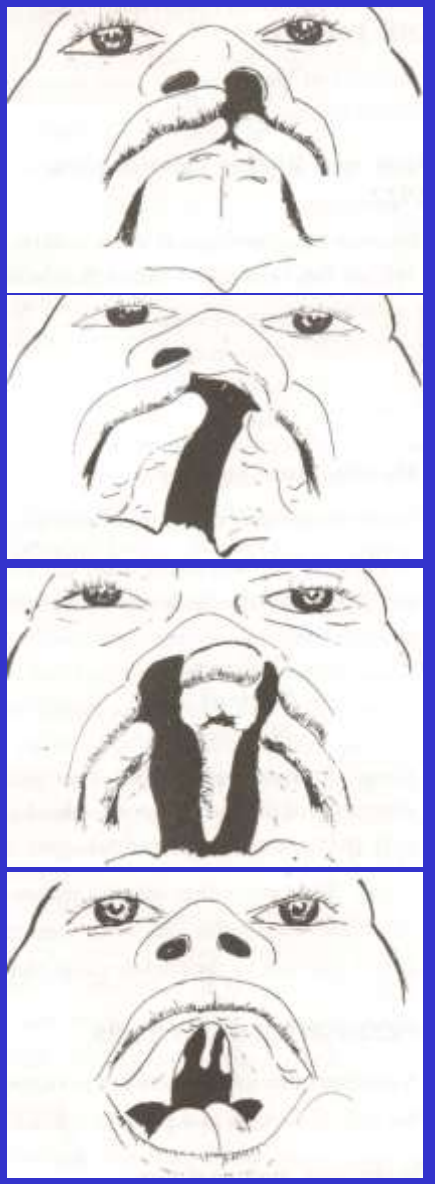
- Failure of the tongue withdrawal.
- Loss of amniotic fluid.
- Distortion or the malpositoning of the facial processes due to excessive or prolonged compression of face against the head.
- Rupture of the palatal plates- small epithelial islands trapped along the line of closure.
- Failure of the epithelial fusion despite the contact of the processes
- Cleft palate in Klipper Feil syndrome may result secondarily due to anomalous development of occipito cervical musculature.
- Leakage of CSF into surrounding tissue of vertebral column may decrease musculoskeletal development in the occipito cervical region.
- Palatal shelves maintained in the vertical postion too long during development

CLASSIFICATION OF CLEFT LIP AND PALATE

Davis and Ritchies –1922

Based on the location of the cleft relative to the alveolar process

1. Group I –Prealveolar clefts –unilateral
   - bilateral
2. Group II -Post alveolar clefts
3. Group III – clefts of both primary and secondary palate



Veaus - 1931

A) Cleft lip

Class I-unilateral and bilateral cleft of the Vermillion border not extending into the lip.

Class II-unilateral and bilateral notching of Vermillion with cleft extending into the lip, but not including the floor of the nose.

Class III- unilateral and bilateral cleft of vermilions border, involving lip and extending into the floor of the nose.

Class IV-any bilateral cleft of the lip whether incomplete or complete.

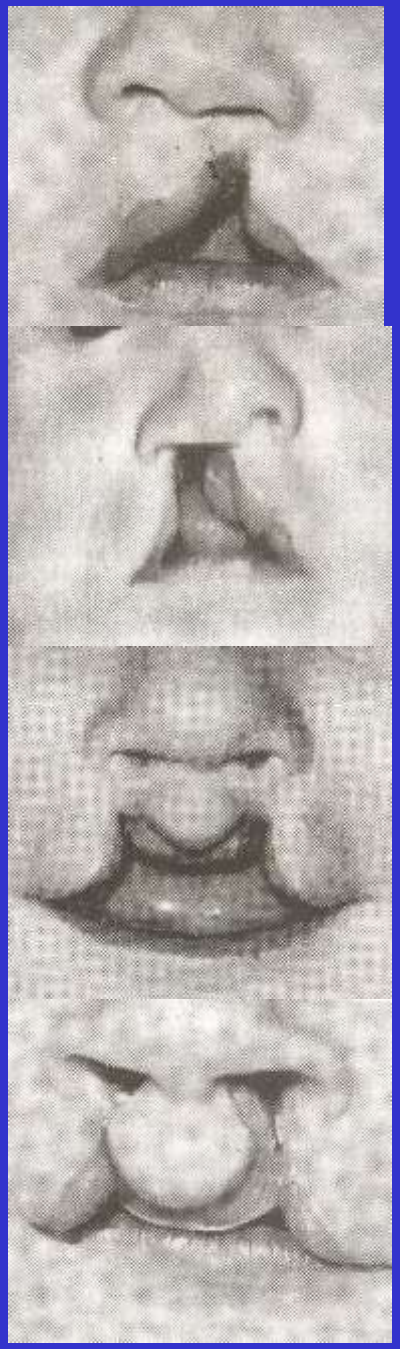
B) Cleft palate

Class I- cleft involving only soft palate

Class II- cleft involving hard and soft palate extending no further than the incisive foramen

Class III- complete unilateral or bilateral cleft extending from uvula to incisive foramen then deviating to one side

Class IV- complete bilateral cleft similar to class III with two clefts extending forward from the incisive foramen into the alveolus



Andersons classification- 1946

- Hare lip cleft
- Hare lip cleft associated with cleft palate.
- Isolated cleft palate

Kernahan and Starks Classification -1958

- Cleft of primary palate.
- Cleft of secondary palate
- Cleft involving both primary and secondary palate.

Spinas Classification -1974

Group I- preincisive foramen cleft
Group II-transincisive foramen cleft.
Group III- post incisive foramen cleft.
Group IV- rare facial clefts.

LAHSHAL Classification

L-lip

A-Alveolus

H-Hard palate

S-Soft palate

H-Hard palate

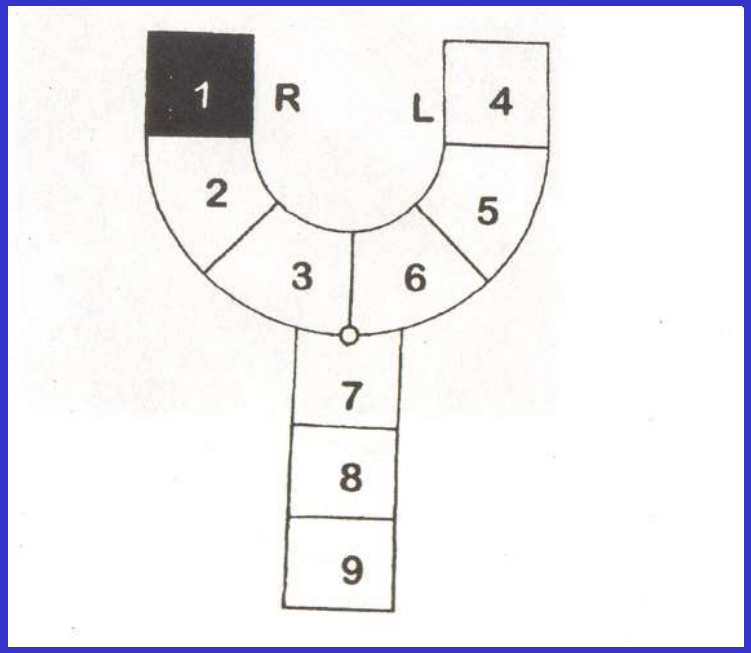
A-Alveolus

L-Lip

kernahans striped Y logo classification.

The classification uses a stripped 'Y' having numbered blocks. Each block represents a specific area of the oral cavity.

Block1 *and* 4 - Lip
Block2 *and* 5 - Alveolus
Block 3 *and* 6. - Hard palate anterior to the incisive foramen
Block 7 *and* 8- Hard palate posterior to incisive foramen
Block 9 - Soft palate



TREATMENT SEQUENCE IN CLEFT LIP AND PALATE PATIENTS

Pre surgical Orthopedics	1-4 weeks	Repositioning palatal segment facilitates lip repair done less frequently now
Lip closure	8 to 12 weeks	May be preceded by preliminary lip adhesion as an alternative to presurgical orthopedics
Palate closure	18 to 24 months	Closing only the soft palate initially an alternative, but one stage closure of the hard and soft palate is the usual procedure
Speech therapy	6 to 11 years	Articulation errors often develop as child tries to compensate for cleft
Early orthodontics	7 to 8 years	Usually incisor alignment and maxillary transverse expansion
Alveolar grafting	6 to 10 years	Needed before permanent canines erupt; timing determined by stage and sequence of dental development

Comprehensive orthodontics	11 to 14 years	Class III elastics often very helpful
Pharyngeal flap surgery	9 to 19 years	Only if required to overcome nasal air leakage during speech sometimes needed after loss of lymphoid tissue in the nasopharynx at adolescence or following maxillary advancement
Orthognathic surgery	17 to 19 years	Maxillary advancement, perhaps combined with mandibular set-back; not done until growth completed except in rare instances of severe psychosocial impact; needed infrequently
Fixed prosthodontics	17 to 19 years	Replacement of missing lateral incisors: comprehensive treatment only after growth completed

Philadelphia Centre for research in Child growth-Wilton Krogman(1947-71)

Divided into EIGHT STAGES

First stage-Prenatal phase-

Complete history of gestation and maternal health taken. This is accompanied by counseling of the parents. All this is carried out by the Genetisist and other Social workers.

Second stage – at birth

At this stage pediatrician discusses the condition with the parents.Surgeon advises about the operative plan and the dental specialists appraises the arch relationships.

Third stage – birth to 1 year

Pediatrican –advises about the feeding etc.

Surgeon- carries out the lip closure (rule of 10)

Dental specialist-secures the models and radiographs etc.

Speech therapist- discusses about the insufficiency and incompetence of the pharyngeal seal.

Fourth stage -1-2yrs

Pediatrican-takes care of the health and nutrition. Surgeon carries out the closure of the hard palate 1:2 soft palate1:6

Speech therapist-monitors the vocabulary and option of a prosthetic replacement ENT-monitors the ear condition.

Fifth stage-2-6yrs

Role of Orthodontist –arch relations

- Crossbites
- Developing malocclusion.

Sixth stage -6-12yrs

Surgical corrections-secondary closure /repair of palate, lip and the nose.

Seventh stage-12-18 yrs

Surgical follow up on the lip and nose corrections orthodontic treatment is continued

Eighth stages- 18 yrs onwards.

Regular follow up of the patient ,this can be done by a general practitioner

Cleft Lip and Palate Patients Management in OSLO-Norway
Lise and Ramstand 1948

- No preoperative orthopedics.
- Closure of Cleft lip in infancy
  millard procedure -3 months

The primary closure of lip and nasal floor in a combined cleft lip and palate leaves the posterior defect like an isolated palate and then repair later.Closure of the alveolar cleft region by a one layer flap during primary lip repair.

- Closure of the remaining isolated cleft –Von Langenbeck -18 months.
- Secondary operations 18-30 yrs of age.

Basic range of suggested times for orthodontic intervention

Fishman

Pre dental treatment-1-18 months of age.

Deciduous dentition 3-6 yrs of age-full eruption of primary dentition.

Early mixed dentition 7-9 yrs- after or during the eruption of permanent maxillary incisors.

Late mixed and early permanent dentition 9 ½ yrs onwards.

Proffit

Infancy-before the initial surgical repair of the lips.

During late primary and early mixed dentition.

Late mixed and early permanent dentition.

Late teens (after completion of facial growth in conjunction with orthognathic surgery)

DENTOFACIAL FINDINGS IN CLEFT LIP AND PALATE

Bishara and Jacobson AJO 1985 studied the dental and cephalometric parameters of 30 unoperated unilateral cleft lip and alveolus, unilateral cleft lip and palate, and bilateral cleft lip and palate. The ages ranged from 7 to 50 years. Fifty parameters were measured on the cephalograms and the dental casts.

Cephalometric parameters

- The major significant cephalometric finding in the comparisons between the three cleft groups was that the UCLP and BCLP subjects had a relatively steeper mandibular plane associated with a relatively shorter posterior face height and a relatively longer anterior face height.
- When UCLA. persons were compared with isolated clefts of the palate, the latter had retrusion of the maxilla and mandible but the maxillomandibular relationship remains normal due to the backward rotation of the mandible.
- Persons with bilateral cleft lip and palate showed varying degree of protrusion of the premaxilla

Dental arch parameters

- The maxillary intercanine width in the BCLP was smaller than in either the UCLA or the UCLP subjects.
- In the maxillary arch, the anterior part of the noncleft segment has a tendency to be rotated forward when viewed occlusally; hence, the increased overjet. On the other hand, the cleft segment has a tendency to rotate slightly medially; hence, the tendency for the canines to be edge-to-edge and sometimes in crossbite.
- When viewed labially, the teeth on either side of the cleft have a tendency to roll superiorly, resulting in these teeth being in infraocclusion with a localized openbite tendency

Omar da Silva Filho 1998 AJO studied the dental casts of the maxillary dental arch of 31 adults with unoperated complete BCLP, enrolled at the hospital

Arch width measurements included: intercanine (C to C), inter-first premolar (1° PM to 1° PM), inter-second premolar (2° PM to 2° PM) and inter-first molar (1° M to 1° M) distances. These distances were obtained from the cusp tip of one tooth to the corresponding tooth on the opposite side. Measurements of the sagittal length of the upper dental arch were calculated as the perpendicular distance from the most anterior point of the incisal surface of the central incisor to a line tangent to the distal aspects of the first permanent molars.

The results indicate that all arch dimensions larger in noncleft males than females. This gender differences were not present in cleft patients.

Comparisons between the males and females with and without clefts indicate that the groups with clefts have narrower arch width and longer arch length than the corresponding noncleft groups.

Cleft group presented a longer arch because of the separation of the premaxilla and the premaxillary anterior projection. The arch was constricted posteriorly

da Silva, Normando, and Capelozza AJO 1993 studied total of 229 adult white patients with cleft lip or palate using cephalometric radiographs to determine the mandibular structure and spatial position. A group of 65 subjects with normal occlusion and without cleft lip or palate was used as a control group. All groups were matched according to sex. When compared, the cleft groups and the normal group showed that the mandibular structure was significantly different. The mandible in the cleft groups displayed shorter mandibular ramus and body length, without difference between the cleft types. Mandibular position relative to cranial base was similar in the cleft groups with involvement of the palate and differed from group with cleft lip and alveolus and in the subjects without cleft. Palatal clefts induce a significant downward and backward rotation of the mandible associated with a more obtuse gonial angle

Nakasima and Ichinose 1983 AJO studied the craniofascial structure of parents of 251 children with cleft lip and/or palate. Three groups were created: cleft lip and palate (CLP), 180; cleft lip (CL), 45; cleft palate (CP), 26. The control group included 110 males and 110 females,

- Head length (HL) and anteroposterior length of the maxilla (Ptm'-Ans) were significantly shorter in parents of CLP children than in the controls.
- Upper anterior facial height (N-Ans) and upper posterior facial height (U-Pns) were significantly shorter, but both lower anterior facial height (Ans-M) and lower posterior facial height (Ar-Go) were significantly greater in parents of CLP children.
- The cranial base angle (saddle angle) was obtuse in parents of CLP children.
- Y-axis angle and ramus angle were significantly smaller in parents of CLP children, indicating a more open-rotated mandible in these parents as compared to control subjects.
- Interorbital width (OW), bizygomaticofrontal suture (FW), nasal width (NW), and bigonial width (GW) were significantly larger in parents of CLP children than in the controls.

Thus, larger horizontal dimensions and shorter vertical dimensions of the upper face in these parents seem to indicate a genetically determined morphology predisposing to the production of the cleft lip and/or palate anomaly

Ranta AJO 1986 reviewed the association of cleft type and dental abnormalities in number, size, shape, timing of formation, and eruption .

Lateral incisor in the cleft area

The tooth germ of the permanent lateral incisor is more susceptible to injury than the lateral incisor of the deciduous dentition. The incidence of supernumerary lateral incisors is greatest in cases of cleft lip only and decreases as the extent of the cleft increases.

Supernumery in the deciduous dentition is most common than the permanent dentition

No difference was found regarding in the cleft and non cleft side in unilateral case.

Woolf, Woolf, and Broadbent investigated the parents and siblings of patients with cleft lip and/or palate for an anomaly of the lateral incisor. They concluded that an incisor anomaly is not a microform of cleft lip or palate.

Mills and associates also concluded that minor oral and facial defects occurred as frequently in noncleft families as in cleft families.

Theories put forward regarding the absence of lateral incisors are.

- The cleft may produce a lengthening of the precanine section of the oral epithelium and thus an extension of the dental lamina— thereby introducing the possibility of the formation of an extra tooth.
- Epithelial remnants from the dental lamina may develop into teeth instead of being resorbed
- The tooth bud is situated across the nasopalatal sulcus; the cleft causes division of the bud of the lateral incisor

Hypodontia outside the cleft alveolus

Hypodontia involves the second premolars and lateral incisor out side the cleft. Hypodontia is seen in areas that are away from the cleft. More teeth are congenitally missing from the upper than from the lower jaw. The prevalence of hypodontia increases strongly with the severity of cleft.

The most frequently missing teeth are (1) the upper second premolars (2) the lower second premolars and (3) the upper lateral incisors

Formation and eruption of the permanent teeth are delayed approximately by 6 months

The surgical corrections of the cleft appeared not to affect the time of tooth formation because the delay was similar in both jaws.

The premolars and canines on the cleft side of the upper jaw will erupt later than the corresponding teeth on the noncleft side of the upper jaw.

The literature contains no notes on the timing of formation and eruption of the deciduous teeth in children with clefts.

An increase in the prevalence of asymmetrically developing contralateral teeth has been demonstrated in children with oral cleft.

Dental problems

The presence of the cleft is associated with division, displacement and deficiency of oral tissue. Cleft lip and palate patients can have one or more of the following features

- Congenitally missing teeth(most commonly the upper laterals
- Presence of natal or neonatal teeth
- Presence of supernumerary teeth
- Ectopically erupting teeth
- Anomalies of tooth morphology
- Enamel hypoplasia
- Microdontia
- Fused teeth
- Aberrations in crown shape Macrodontia
- Mobile and early shedding of teeth due to poor periodontal support
- Posterior and anterior cross bite
- Protruding premaxilla
- Deep bite
- Spacing and crowding

PRE SURGICAL INFANT ORTHOPEDICS

•The aims of presurgical treatment are not the same for unilateral and bilateral clefts because of the different segment displacement that occurs. In the unilateral, complete cleft of the lip and palate, the greater and lesser segments tend to rotate away from each other about axes in the tuberosity regions or the lesser segment can be rotated inwards towards the cleft.

• Huddart (1969) stated that the arch width posteriorly is greater than normal because the absence of functioning tensor palate muscles leaves the pterygoid muscles unopposed and this has been confirmed by a number of workers including.

•Shaw (1978) who carried out a cephalometric study on cleft infants who had titanium implants placed into the maxillary segments soon after birth. The center line deviates to the intact side because of a combination of muscle action, tongue activity and unrestrained growth of the nasal septum

In the bilateral complete cleft of lip and palate. there is often considerable prominence of the premaxilla because of the forward growth of the nasal septum and failure of muscle control. As a result, the two lateral segments are rotated inwards towards the deft. If the cleft is incomplete' on one side or a Simonarts band still persists, significant rotation of the premaxilla can occur.

APPLIANCES

Active and passive appliance are used along with lip straping. It is important that the initial appliance is fitted-within seven days of birth otherwise, acceptance may prove to be a problem.

Normally an impression is taken within 24 hours of birth using either alginate or heavy body rubber base material in a stock cleft impression tray.Care must be done to avoid respiratory embarrassment .A working model is made in stone .An active appliance is designed according to the segment movements that is required

Appliance incorporating coffin spring with extra oral wing as means to retain are used. Hodgkins suggested a technique in which the models are sectioned and repositioned prior to placement of the appliance which uses vacuum formed material with soft plastic liner ,a dental floss is attached.It is extremely important that the appliance is fitted within 7 days otherwise acceptance is a problem. Elastoplast can be used to apply lip strapping and to anteriorly rotate the segments in a unilateral cleft or to apply pressure to the premaxillary segment. However Pruzansky claims that use of lip strapping inhibits the growth of the maxillae and lead to cross bite

Presurgical orthopedics treatment – Is it necessary ?

Presurgical orthopedics was first described by Kerr McNeil(1954, 1964) in Glasgow and he followed observations in older cleft children where the residual palatal fistula reduced in size after he fitted a special obturator with stimulation pads. He then applied the same principles to the treatment of new - born infants with cleft palate and discovered that similar narrowing of the cleft occured. Great controversy was aroused at this time because of the implied claim that presurgical orthopaedic treatment would "close" the hard palate cleft by promoting soft tissue and possibly hard tissue continuity

Proponents of presurgical orthopedics Lubit 1976 AJO proposes the following claims

•The cleft reduces in size which simplifies the primary surgery and by implication, affects the quality of the repair.

•Partial obduration of the cleft helps in feeding

Cleft interferes with childs normal nursing , for him to suckle the nose must be sealed of from the mouth creating a negative pressure in the oral cavity, failure in this lead to the milk running out of the nose. In order to over come the procedure “ gravity feeding ” is advised. This method is ineffcient and time consuming. An orthopedic appliance restores the normal anatomy of the palate and helps in suckling .

•Tongue behaviour is modified which may lead to improved speech in the long term

Orthopedic appliance prevent the tongue from entering the nasal cavity . This restores the normal functional matrix by separating the oral cavity from the nasal cavity. In cleft the tongue raises it self into the cleft area this position fails to stimulate the normal growth of the maxilla

•Decrease in the number of ear infection

In cleft child the tensor veli palatini muscle ends in the Eustachian tube rather than continuing on to the anterior part of the soft palate . This interferes with the normal opening and closing of the Eustachian tube causing leading to inadequate drainage and ventilation . As a result two- third of the patients heve hearing loss and they are three to four time more prone to cold than normal children . An orthopedic appliance prevents milk and mucous from entering the Eustachian tube and prevents hear loss

- Expansion of the collapsed maxillary segment

small number of children with cleft palate are born with collapsed maxillary segment. This collapse may be due to abnormal fetal pressure like the pressing of an arm or shoulder against the cheek or a decrease in amniotic fluid. In these case if the lip is restored only the oropharyngeal ring of muscle holds the segments in the collapsed state preventing normal growth. Expanding the maxillae during the deciduous dentition state can thin out the lip and compromise esthetics. The best way to treat is to expand the maxillae with orthopedic appliance prior to lip closure.

- Constriction of the expanded anterior part of the maxillae

In some case the segments are expanded and the oropharyngeal muscle then allows for unrestricted lateral and posterior and superior rotation of th segments. Closure of the lip is difficult under these conditions. Even if the maxillary segment has moved mesially the premaxillary segment sticks out leading to poor esthetics , with the eruption of the incisors the situation is aggravated .Orthopedic segment can rotate the in a medial and inferior direction and recon tour the greater segment

- **Repositioning the premaxillary segment**

In bilateral cases the oropharnygeal musculare is split in two places allowing free movement of the premaxillary segment. Often the premaxillary segment is rotated superiorly and anteriorly and the maxillary segment is rotated medially. The forward position of the premaxilla allows the lower lip to fall behind the premaxilla , retruding the mandible and allowing the over development of the premaxilla and creating excessive over bite. Presurgical orthopedics help in the correction of the premaxilla

- **Support is given to parents at a difficult time**

Opponents of presurgical orthopedics put forth the following claims

- Cleft always reduces in size without presurgical treatment
- The cleft invariably reduces in size following primary surgery.
- Good surgical technique makes presurgical treatment unnecessary.
- All cleft babies can be fed satisfactorily without obturation of the palatal cleft
- Growth of the maxilla can be inhibited by the use of lip strapping and there is a greater incidence of cross bite.

Very little scientific evidence is available to support or refute most of these claims and counter- claims.
There is an increasing body of opinion which suggests that presurgical orthopaedic treatment is unnecessary.
Shaw 1978 and Fish 1972 suggest that in unilateral clefts the greater and the lesser segments rotate towards each other towards an axes in the tuberosity region reducing the seize of the cleft.
Huddart 1972 attributes the reduction in the cleft width to the limitation of the lateral separation of the growing segment. There is also some evidence which suggest that the inclination of the palatal shelves change once the influence of the tongue is removed and this also plays a part in narrowing the cleft.
Robertson ,Shaw and Volp 1977 suggest that in bilateral cleft the prominence of the premaxilla appears to be reduced by growth restrain and this allows the remaining face to catch up .

Hotz 1969 Hotz and Gnoinski 1976 of the Zurich universitiy is a firm proponent of presurgical orthopedic treatment and the technique they describe differs from most of the others.
Treatment starts in the first week of life and continues for 16-18 months during which three plates are required . Hard palate repair is delayed until 4-5 years the which it claimed lead to improved maxillary development. The plate is a passive appliance and constructed by progressively grinding on the gingival aspect every 3- 8 weeks , this provides space for the developing maxillary segment . There are no extraoral wings and it has a posterior extension that obturates the soft palate

LIP CLOSURE

It is technically possible to close the lip during the first and second day (some surgeons do this by choice).This has some psychologic advantage to the mother

However majority of the surgeons prefer to delay the operation until the criteria of rule of 10s are satisfied.

-10 week of age
-10 pounds of weight
-10 gms of Hb
-10,000 WBC(mass).

Most commonly used surgical procedure are-

-Tennison Randall triangular flap
-Millard Rotational advancement operation
-Skoog procedure
-Rose Thompson straight line repair

Long term Effects of lip Repair on occlusion

1 Excessive pressure on the teeth and the alveolar process as a result teeth are pushed palatally resulting cross bite. The tongue is forced out due the lack of space.

2 If the surgery result in short upper lip the it result in proclination of the premaxillary segment. Protrusion of the lower lip result as compensation of short upper lip , leading to increase mentalis activity.

3 Extensive undermining of the soft tissue result in abnormal frenal attachment.Low attachment of the fibrous tissue interferes with the eruption of the teeth leading to open bite

SECONDARY PALATE CLOSURE

Some surgeons prefer to repair the cleft with a vomer flap at the same time as the lip repair.
However most popular time of the cleft repair is around 18-24 months ie. prior to the development of the speech, while the other do it at the age of 5-7 yrs.
Technique usually followed is-
-Von Langenbeck procedure.
-Veau Wardill Kilner lengthing procedure.
-Skoogs method.

Post Surgical Growth and Development

Surgical variables affecting post surgical growth

- Timing of surgery.
- Type of surgery.
- Number of operation.
- The surgeon.

Post surgical growth of the maxilla

Effects on the palate-

Scar tissue which contracts during healing creates a constricting force on the maxilla.This constricting effect is more severe in the anterior region as severe collapse occurs in this region. Palatal repair result in the lowering of the soft tissue vault due to contraction of scar tissue

Maxillary tuberosity area appears to be area of problem. During surgical repair of the palate-

- Hamulus is fractured.
- Dissection is done in the area to release tension on the soft palate remnants.
- Mucoperiosteum is raised, displaced medially.
- Dissection is done to reorient tensor palate

As a result a continuous scar tissue forms which joins the maxilla palatine bones, ptergoid plates thus inhibiting separation of these bones thereby creating condition called Maxillary Ankylosis

Growth of Maxilla in width

There are two factors which are responsible for reduction of the maxillary arch width.

• Dental eruption pattern –

In cases of surgically repaired cleft teeth are united as cross palate mucosa has a scar This results in the contracting effect of the scar in the palate that pulls the teeth medially.

• Anteroposterior relation of maxilla to mandible

As the surgically treated maxilla is retruded maxillary arch becomes narrower from posterior to the anterior region, this results in a progressively retarded growth which increases with age resulting in a buccal crossbite

EARLY ORTHODONTICS TREATMENT

In patients malocclusion in the primary dentition is relatively rare. Mostly the problem is a posterior cross bite related to insufficient width of developing maxilla. Correction of cross bite at this stage is worth the effort is debatable deferring treatment until the eruption of permanent first molar and incisors is the better option.

During this period the goal of treatment are to correct the incisor rotation and to correct the anterior cross bite . In case of posterior cross bite the arch is expanded with help of bonded fixed appliance or removable appliance.

Prior to alveolar bone grafting most patients benefit from arch expansion . A quad helix is the appliance of choice for differentially expanding the upper arch and correcting the cross bite.This appliance allows differential expansion to be carried out and is activated approximately 1 cm before being cemented. Since the cleft lack bony continuity the cross bite is corrected rapidly and the appliance need to be removed and a reactivated after 2 months .Arndt appliance incorporating a nickel-titanium palatal expander Abdoney 1995 JCO has the added advantage of correcting molar rotations

Modified Hyrax expansion can be used in bucally placed premolars and molars.Helices incorporated into the design delivers a uprights and align the teeth following cementation.Radlanski 1989 JCO

Rapid palatal expansion in cleft patient Capelozzo filho JCO 1994

In normal patients the opening of the midpalatal suture is evidenced by the appearance of a diastema between the central incisors. In cleft patients, however, the separation occurs in the suture between the maxilla and the premaxilla, with no osseous gain. As in normal individuals, the pattern of expansion is triangular, with a greater opening in the anterior region.

The expansion appliance produces orthopedic movement that separates the maxillary bones and, to a lesser degree, tips the buccal teeth.

Because the palatal suture is missing, the buccal dental segments must first be leveled and aligned to allow better retention of the expansion appliance.

The upper first molars and premolars (or first deciduous molars) are banded, and the second premolars are usually bonded. A sequence of segmental wires up to .021"×.025" stainless steel is used

Once the posterior teeth are aligned, the archwires are removed and alginate impressions are taken. The expansion appliance is constructed of .045" wire, and a jackscrew is selected according to the amount of expansion needed. For optimum hygiene and patient comfort, the acrylic is trimmed 5mm from the gingival margins and away from the palatal rugae. The acrylic does not extend posteriorly beyond the proximal half of the second molars

To insure proper fit, the appliance is almost always constructed on the day of delivery. A 0.021x 0.025 inch segmental wire is incorporated in the buccal segment. Once the fit has been checked, the appliance is cemented and the archwires are replaced.

A piece of floss is tied to the expansion key to avoid accidental aspiration, and the patient is instructed in activating the expansion screw. The appliance is first activated with four quarter-turns (1mm) 24 hours after placement. For the next four days, the screw is activated two quarter-turns in the morning and two quarter-turns in the evening.After this activation is reduced to one -quater turn in the morning and evening

The average activation period is from one to two weeks, depending on the degree of maxillary constriction and the resistance of the patient's maxillofacial structures.

.A 2-3mm overcorrection at the molars is recommended to counteract a relapse that has been reported to reach 30-50%, or even 75% at the canines. If the screw extends to its maximum width and additional expansion is still needed, the screw can be deactivated and replaced without removing the appliance from the mouth

Once the desired expansion is obtained, the screw is immobilized by painting acrylic over it with a fine brush. The appliance is kept in place for three months of retention, which further reduces the possibility of relapse. The expander is then removed, and impressions are taken. A removable palatal plate, without clasps that might interfere with any remaining orthodontic movement or with proper tongue position, is worn as a retainer until the end of treatment.

Rapid maxillary expansion in cleft lip and palate patients produces a favorable anterior repositioning of the maxilla in relation to the mandible and to craniofacial structures. The more anterior position helps compensate for the short midface that these patients often display, as well as correcting any transverse maxillomandibular discrepancy.

Retention of both posterior expansion and incisor alignment is important. Posterior cross bite tends to recur even if the expansion is maintained due to the normal mandibular growth and deficient maxillary growth .

ALVEOLAR BONE GRAFTING

Primary bone grafting was very popular in the 1950s and was carried out in a number of centers.At the age of 3 months a split rib graft was placed in the cleft alveolus at the primary repair and was often combined with a programme of pre surgical orthopedics treatment.Pruzansky (1964) showed that mid –face growth was adversely affected by this procedure and similar findings was confirmed by Fried and Johanson(1974 ,1982) Ross(1987). However Childrens Hospital in Chicago has been using primary bone grafting for the past 25 years(Rosenstien1982 &1985). The lip is repaired initially at 6-8 weeks and the split rib graft is placed a few weeks later .

Despite the lapse of almost 50 years, with ample opportunity to evaluate the consequences of primary bone grafting, the controversy continues; the procedure is still performed in a few centers in the United States and Europe.

Periosteoplasty was introduced as an alternative to primary bone grafting. The advantage of this "boneless bone graft" was that continuity of the maxillary segments was established by local periosteal flaps with the intention of promoting bone formation in the cleft site. After completion of this procedure in infants, bone formation was reported in the cleft with no apparent adverse effects on facial growth. However, perioplasty is not accepted widely, although the results have been reasonably successful.

SECONDARY BONE GRAFTING

It was first described in the German literature by Lexur(1908) and Drachter (1914). It was subsequently popularized by Axhausen(1956) and further developed and refined as a surgical technique by Boyne and Sands (1976) in the U.S.A

By definition. secondary or delayed alveolar bow grafting is performed after primary lip repair.

Early Secondary Bone Grafting (2-5 *Years of Age)*

This typically is performed during the primary dentition period (age range, 2-5 years).Advocates of this procedure suggest good bony support at the time of the eruption of lateral incisor.This procedure restrict the growth of the maxilla

Intermediate or Secondary Bone Grafting (6-15 *Years of Age)*

Contemporary opinion is that this is the optimal time for alveolar bone grafting. Bone is provided for the eruption of the permanent canine into the cleft site; this has the added advantage of including alveolar bone. with the eruptive process. Minimal interference in midfacial growth and development can be expected.

Late secondary grafting (adolescent to late adulthood)

The need for a graft material to allow eruption of teeth through the graft into the dental arch is lost, and replacement of missing teeth by implants is a consideration

ADVANTAGE

- If a bone graft is placed before the eruption of the permanent canine. the canine is encouraged to erupt into the graft and may avoid the need to prosthetically replace a missing lateral incisor. Alternatively. a lateral incisor or rudimentary but useful fissural tooth may be encouraged to erupt in the cleft region.
- The placement of a bone graft assists with the closure of any residual oronasal fistulae.
- Periodontal bone support for thelateral aspect of the central incisor is improved and the alveoiar ridge is restored.
- In bilateral cleft the mobile premaxilla is stabilized
- It is said that additional support is provided for the nasal floor which will improve nasal symmetry to some extent.
- It helps to eliminate the mucosal recesses

The possible complications are

- The permanent canine tends to erupt palatlly and may need to be surgically exposed
- Lateral root resorption affecting teeth adjacent to the cleft has been
- There may be complete loss of the bone graft
- In the days of surgery the donor site has been the site of morbidity

The problem of the cleft alveolar arch

If the alveolar cleft is left untreated, the sequelae of growth and tooth eruption in this condition are the following:

a. an oronasal' fistula, with leakage of saliva and ingested into the nose, and a variable effect on speech

b. eruption of teeth into the cleft, with unavoidably poor oral hygiene and lead to frequent loss of such teeth

c. Transverse collapse of the minor dentoalveolar segment, leading to crowding and misalignment of the erupted teeth in the minor segment, and undesirable compensatory effects in the lower arch

d. loss of alar support for the nose, strongly contributing to the typical secondary cleft nose deformity

e. bilateral cases, a loose premaxillary segment occurs; with increased risk of loss of lateral incisors

There are three controversy regarding alveolar bone grafting

- Timing of the surgery for placing the alveolar bone graft
-
- The type of bone graft and the selection of the donor site
-
- Timing of orthodontic expansion ---before or after surgery

An important goal of bone grafting the cleft maxilla and palate is preservation of the permanent dentition without periodontal defects and without the need for prosthetic rehabilitation. In meeting this goal, it is critical to place the graft at an appropriate time. Ideally, the graft should be placed when the root development is of permanent canine is one- third to one half completion. In some cases the eruption of the central or lateral incisors is in question time of the grafting is reduced to (4-6) years.

Grafting should be done based on the prognosis of the tooth adjacent to the graft area.Periodontal defect can occur if tooth erupts into un-repaired cleft. Therefore, the timing of this procedure is best determined by stage of dental development, not by age. When a bone graft is placed into cleft sites after the eruption of the permanent dentition_there is an increased risk of damaging the roots of adjacent teeth and initiating external resorption.

The need for orthodontic or orthopedic expansion before bone grafting continues to be an area of controversy.

Advocates of expanding before bone grafting says that once the graft is placed and matures, the palatal suture is fused, and resistance to expansion increases. Expanding the arch before bone grafting facilitates surgery by creating more space for placement of the graft and also increases the size of the cleft defect.

Opponents say slow expansion initiated 6 weeks after graft placement has the potential of stimulating immature bone, which may enhance bone graft survival. Expansion before bone grafting will requires more soft tissue dissection to achieve adequate closure and lead to more scar formation..

The dilemma of the timing of arch expansion and the decision to expand must be made on the merits of each case

Current opinion favors bone grafting when patients are, 8 to 11 years old, with presurgical orthodontic treatment to correct the transverse discrepancy

Type of Grafting Material

Just as the timing of secondary alveolar bone grafting is controversial. so are the type of graft material and the donor site. Several types of bone grafting materials are currently used, although autogenous bone is considered the most effective. Allogeneic bone is used in some centers, but there are some contraindications to the use of this type of bone. Alloplastic materials prevent eruption of teeth and therefore are not used in children.

autogenous cancellous bone is the preferred and most successful grafting material.

iliac crest

The ilium has been recognized as the preferred donor site for harvesting large amounts of cancellous bone, even in young children. Difficulty associated with walking after discharge from hospital has been reported.However, this still remains the primary source of bone. from both the orthodontist's perspective and the perspective of many surgeons. If the orthodontist has corrected the transverse maxillary discrepancy preoperatively there is typically an increase in the size of the cleft to be grafted. This also may increase the size of an existing oral-nasal fistula,. Soft tissue closure with excessive undermining at the time of alveolar bone grafting to cover the widened cleft site may compromise the grafted unilateral or bilateral alveolar clefts. For this reason, placing the cancellous bone graft before orthodontic expansionis preferred in selected cases. This is done when the patient is 6 or 7 years of age, to provide support for the erupting lateral incisor. Expansion is then institued after 1 month

Cranial Bone

Calvarial bone dust has been used by neurosurgeons for reconstruction of skull defects but its application as a donor site for alveolar cleft grafts was not popularized until the 1980s. Cranial bone provides a convenient source of donor cancellous bone and there is also less pain during the postsurgical recovery period. There is a potentially higher risk and possible morbidity because of the close proximity to the brain. There is also more cortical bone in relation to cancellous bone in cranial bone grafts than in those harvested from the ilium. The orthodontist therefore may find that small spicules dehiscence during movement of the teeth into the grafted site.

Mandibular Symphysis

Controversy concerning the use of endochondral versus intramembranous bone has become an issue in choosing the donor site for cancellous bone. An alternative site from which to harvest membrane bone is the mandibular symphysis. Intraoral access to the donor site avoids scarring and morbidity postoperatively. However, the amount of bone that is available depends on the timing of the bone graft and the age of the patient. When early secondary bone grafting is contemplated, the surgeon must avoid the unerupted mandibular canine, and the bone available to harvest may be limited. The proximity of the mandibular incisor roots and of the mental nerve also entails potential risks when symphyseal cancellous bone is harvested from the mandible

Allogeneic Bone Grafts

This reduces a secondary surgical site and also reduces post surgical morbidity. However, the ability of allogeneic bone to produce results comparable with those produced by autogenous bone is still equivocal. Allogeneic bone grafts rely on osteoinduction for new bone formation, revascularization of the graft is slower and less responsive than when autogenous cancellous bone is used. Allogenic bone grafts therefore provide a scaffold from which new bone develops from subperiosteal and endosteal sources.As a result the timing of orthodontic treatment is delayed for 3 months versus 1 month for autogenous graft

The disadvantage of allogenetic are

- Transmission of diseases
- Infection at the recipient site due to contamination of the speciment
- Host incompatibility and rejection of the graft

Use of Fresh Autogenous Particulate Cancellous Bone

They contain osteogenic cells ,this advantages because most cleft cases have impaired vascularity due to previous surgery

Particulate cancellous bone responds most favorably to the odontogenic demands of this part of the maxilla and palate.

The ilium is the most commonly used site because of the predictable quantities of cancellous bone, the ease of procurement, the concealed scar, and little morbidity.

Turvey et al 1984 AJO reported the results of delayed bone-grafting procedures in a group of 24patients. The need for a prosthesis was eliminated in 12patients, and 8of the remaining twelve patients required only a three-unit bridge. In 17patients, the graft was placed prior to canine eruption, and in 16of these patients, the canine erupted passively into the arch The canines erupted into the arch .Periapical radiographs of the bone-graft sites indicated bone of normal radiographic appearance with trabeculation indistinguishable from the surrounding bone in areas

Orthodontic findings indicated better root paralleling when teeth erupted into the graft than when they were moved through the graft by orthodontic appliance therapy. The canines were noted to erupt rapidly through the graft following surgery.

7 of the 9 patients with bilateral clefts demonstrated minimal mobility of their premaxillas following bone grafting. Stabilizing the premaxilla provided suitable abutments for placing prosthesis. The study showed that the timing of graft should be based on the dental age rather than the chronological age an graft should be placed when 1\3 to 2\3 of the canine root is formed.The age of 8 to 10 years is the usual time for surgery.

COMPREHENSIVE ORTHODONTIC TREATMENT

Cleft patients have either a missing or peg shapedlateral incisors . In case of missing lateral a decision has to be made whether to close the lateral space by substituting the canine or maintain the space for prosthetic replacement . In the case of the former the posterior segment is brought into classII relationship or compensatory extraction is done in the mandibular arch in the case of the latter classII relationship is maintained as well as a non extraction approach.

The situation becomes complex when the patient has an underlining jaw discrepancy such as
class III malocclusion. If the growth deficiency is mild it can be alleviated by orthodontic treatment , in severe case orthognathic surgery is done at the end of the growth period. A surgically treated lip is less adaptable to proclination of the upper incisors.

Normal growth of maxilla is restricted by the soft tissue tension leading to class III relationship .In patients with vertical and anteroposterior deficiency the orthodontist can use class III elastics. The side effect of Class III elastics elongation of the upper molars which can lead to down ward and backward rotation of the mandible which is desirable in those patients with short lower anterior facial height. Elastics are for worn for long period of time to achieve this correction

A mild mid facial retrusion with an anterior dental cross bite can be successfully treated by orthopedic force. In some instance the treament begins in the primary dentition and this depends on the type of cross bite as well as the cooperation of the patient..
Delaire face mask is used in cases of mild maxillary hypolasia and when there is no maxillary ankylosis, in well motivated and co-operative patients and in cases where true mandibular prognathism and not maxillary hypolasia is the cause of class III.

Orton & Noar JCO 1992.Facemask wear produces a combination of forward translation of the posterior teeth and tipping of the upper and lower anterior segments,forward movement of the maxilla, and restriction of mandibular development, and backward hinging, results in significant occlusal and facial improvement.The facemask can also be used to support intraoral anchorage or to move teeth mesially for space consolidation prior to prosthetic replacement.Elastics are attached to a removable appliance allows the anterior force to be distributed not only to the dentition, but to the maxilla.The elastic hooks must be carefully placed, depending on the individual patient. The hooks should be as far forward as possible to prevent undue maxillary rotation. If there is a deep anterior crossbite, buccal bite blocks can be used to allow the upper incisors to move forward freely. Elastics generate a force 400 grams and is worn 14 hours per day. The overjet and molar relationships should be carefully monitored at monthly intervals. At six months, a lateral cephalogram should be taken to assess progress. Particular attention must be paid to the upper and lower anterior segments; if the chin pad is poorly trimmed or the palatal wires of the removable appliance are improperly placed, the upper anterior teeth can be excessively proclined and the lower anterior teeth retroclined.

VELOPHARYNGEAL INCOMPETENCE

Velopharyngeal sphincter is an anatomic and functional entity. It is formed by the levator veli palatini muscle and the superior constrictor muscle of the pharynx and separates the oropharynx from the nasopharynx during speech so that speech is produced the way we know it. Closure of the sphincter results from tension in the soft palate (or velum) and its elevation towards the posterior pharyngeal wall, assisted by movement of the posterior and lateral pharyngeal walls towards the velum. The relative contribution of each muscle group to this closure varies from individual to another and the presence of adenoids or a Passavant ridge may help to close the sphincter

As the person prepares to speak the velum is partially raised and held at the ready position before speech begins, it then moves to the closed position as phonation starts. The ability to close the sphincter completely is essential for compression of air behind the point of constriction so that the explosives(p,t,k) and the fricatives (f,th,s) can be released with sufficient strength.

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The surgical options include
Palatal lengthening procedures – Wardill- Kilner push back
Augmentation of the posterior pharyngeal wall using Teflon injection or insertion of
silastic pillows
Pharyngeal flap procedures or pharyngoplasty

Long and McNamara AJO 1985 conducted a longitudinal study 34 patients cleft lip and palate patients. Seventeen of these (9 with cleft palate only, 8 with unilateral cleft lip and palate) underwent pharyngeal flap surgery between the ages of 5 and 7 years. The other seventeen patients did not undergo pharyngeal flap surgery and served as a control group for this study

The mean age at which pharyngeal flap surgery was performed in this group was 6.2 years.The growth data used in this study were taken from standardized lateral cephalometric radiographs. The following conclusions were derived

mandibular growth direction become more vertical in the surgical group following pharyngeal flap surgery.

Facial axis angle became acute and Frankfort-mandibular plane more obtuse

Flap group demonstrated a more rapid increase in LAFH postsurgically as compared to the controls.

Mandibular retrognathia worsened following surgery

ORTHOGNATHIC SURGERY

Despite the recent advances in primary surgical techniques about 5% to 10% have severe jaw discrpency that require orthognathic surgery. The scar tissue generated by the primary lip and palate surgical procedure impedes the normal downward and forward growth of the maxilla.As a result disproportionate growth of the lower jaw takes place particularly in a forward direction in the absence of normal vertical growth of the maxilla.

All cleft patients with secondary skeletal deformities are seen in a combined orthdontic surgery clinic.Following information is obtained which helps in orthodontic diagnosis

- Medical history
- Previous surgical history
- Reference models
- Radiograph
- Photographs
- Serial height measurement

The aims of presurgical orthodontic treatment are as follows

- To improve arch alignment with the extraction of teeth, if necessary, for the relief of crowding
- The adjustment of maxillary arch width to enable a satisfactory occlusion to be obtained at the time of surgery.
- Decompensation of the maxillary and mandibular incisors to enable the optimum surgical movements to be achieved.
- The correction of the maxillary center line, if necessary.
- The redistribution of space if the prosthetic replacement of teeth

The adjustment of maxillary arch width.

In the repaired unilateral cleft, some arch expansion is generally needed and this can be achieved with a quad helix appliance. In bilateral cleft the posterior arch width is increased and in this situation, a contraction quad helix is the appliance of choice. This is constructed in a conventional way but the palatal arms are omitted and replaced with buccal arms which will initially move the premolars palatally as well. The quad helix appliance is ideal for this purpose as it can be adjusted differentially, has a long range of action and can produce changes in the segment

Decompensation of lower incisior

In a severe class III malocclusion there is marked compensatory retroclination of the mandibular incisors together with some proclination of the maxillary incisors which may disguise the skeletal discrepancy, to some extent. The lower incisor retroclination especially may produce arch irregularity which can be falsely interpreted as crowding. In such cases the decision to extract the lower premolars are not done until it is certain that orthognathic surgery is not required

Correction of the maxillary mid line

Very often the maxillary incisors tip towards the cleft with loss of centre line. An extraction may need to be considered in the non-cleft quadrant if correction of the maxillary centre line is one of the treatment aims.

Redistribution of space prior to the prosthetic replacement of teeth

In cases where bone grafting has not been carried out or the closure of the space is recommended a prosthesis is constructed in the lateral incisor region. Osseo intergrated implants is another choice

Surgical treatment plan

Most common procedure is Maxillary advancement(Le Fort I) , with mandibular set back but isolated mandibular set back is rarely indicated. In case where nasomaxillary hypolasia is present then Le Fort II is done

Jina Linton 1998 AJO

The study consisted of 29 patients with unilateral cleft lip and palate and 25 noncleft Class III Korean patients; all had crossbites of all four incisors. The group with unilateral cleft lip and palate was divided into two subgroups on the basis of the method of their anterior crossbite resolution; (Cleft-NS) cleft non-surgical and(Cleft-Surg) cleft surgical. The noncleft Class III group was divided into two subgroups; (CI III-NS)and (CI III-Surg). The aims of this study were : (1) to delineate diagnostic measures in borderline surgical cases of unilateral cleft lip and palate, (2) to verify the significance of negative overjet as a measure of anteroposterior discrepancy, and (3) to compare these diagnostic measures with those of borderline surgical cases of noncleft Class III malocclusions.

The group with unilateral cleft lip and palate showed smaller SNA and SNB angles than the noncleft Class III group, but the ANB angles and the amount of anterior crossbites showed no statistical differences. When the Cleft-NS and the Cleft-Surg groups were compared, the ANB angle and the Wits measurements were significantly different. When the CI III-NS and CI III-Surg groups were compared, the SNB, ANB, L1GoGn, Wits, and the crossbite showed significant differences. For borderline surgical Class III unilateral cleft lip and palate cases, ANB angle, Wits appraisal, and ABGoGn angle were critical diagnostic parameters. On the other hand, the magnitude of anterior crossbite, the negative overjet, was shown not to be a significant measure of anteroposterior discrepancy

DISTRACTION USING RIGID EXTERNAL DISTRACTION(RED)Figueroa and Polley AJO 1999

Effective technique in treating cleft associated maxillary hypoplasia.The appliance consist of a splint made with 0.045 or 0.050 inch stainless steel rigid orthodontic wire. The splint has a labial and palatal wire bend close to the maxillary teeth.Transpalatal bar is added to increase the stability. Connecting wires between palatal and labial passes through the gingival embrasure in the canine and lateral incisors. A wire is soldered on the labial aspect of the intra oral splint . The upper portion of the wire is used for intraoral traction and the lower portion for extra oral traction. The extra oral traction apply the traction through the center of resistance of the maxilla.Expansion procedure is done either before or after distraction inorder to control the vector of force. The distraction was performed by turning the screw at the rate of 1 mm per day and it is completed in 2 to 3 weeks . Once the distraction appliance is removed positive traction is done by means of protraction face mask .

Cephalometric measurement showed SNA angle increased 7.7º ANB by 8.6º, skeletal convexcity by 17.2º ANS moved 7.1 and A point moved 8.3 mm