CLEFT PALATE IN CHILDREN AND ADOLESCENT: A STUDY OF ARCH EXPANSION.

By

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A Thesis

Submitted to the School of Dentistry

at

Universiti Sains Malaysia

In fulfilment of the requirements

For the degree of

Master of Science

In

Orthodontics

Department of Orthodontics

USM, Kelantan.

2004

بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ ﴿١﴾ خَلَقَ الْإِنسَانَ مِنْ عَلَقٍ ﴿٢﴾ اقْرَأْ وَرَبُّكَ
الْأَكْرَمُ ﴿٣﴾ الَّذِي عَلَّمَ بِالْقَلَمِ ﴿٤﴾ عَلَّمَ الْإِنسَانَ مَا لَمْ يَعْلَمْ ﴿٥﴾

سُورَةُ الْعَلَقِ

[96:1-5] Read! In the name of your Lord who created – Created the human from something which clings. Read! And your Lord is Most Bountiful - He who taught (the use of) the Pen, Taught the human that which he knew not.

Chapter 96: AL-ALAQ

Dedication

To my parents, whose love, support, eternal dedication and devotion to us inspire me and design my life.

To my brothers and sisters, Husam, Salah, Ahmad, Manal, Amneh, Maram, Muna, whose love and support made this possible.

To my in-law Dr. Reyad Al-Shalabi, and **my sweet nieces**, Rawan and Diana. Your smiles are all I need for encouragement.

THANK YOU!

Acknowledgment

Praise is to ALLAH, the Lord, the Almighty...

There are times when words are inadequate. I grant my grateful appreciation and thanks to all those who have contribute to this work.

My main supervisor **Dr. Ahmad Burhanuddin Abdullah**, for his unparalleled example, clinical skills and leadership that gave me a great foundation in orthodontics.

My co-supervisor **Prof. Dr. Abd. Rani Samsudin**, for his untiring dedication, guideness, and for his great knowledge of research, support, advice and leadership.

Dr. Nizam Abdullah for her time, efforts, help and contribution to my research.

Dr. Mohd Ayub Sadiq for his expert analytical and mathematical contributions to this project.

Dr. Rusdi Abdul Rahman for his assistance on this project.

Prof. Dr. Ahmad Sukari for his contribution and support.

My respect and thanks are due to all the staff at **Jalan Mahmoud Dental Clinic**, **Orthodontic Department**, especially **Puan Salina**, for their help and support.

Thanks and gratitude is also due to the head and staff of **Dental school, USM**, especially **Orthodontic department** for their support and homely environment.

I also extend my grateful appreciation and thanks to

My colleagues, classmates, fellow residents and friends, for their friendship and support, especially **Dr. Mohd Sarhan, Dr. Ayman, Dr. Saed Ba'nabilah, Dr. Rajan, Dr. Hamed, Dr. Rasheed, Dr. Fawaz, Dr. Naser, Dr. Saed Mohd, Arrifin, Dr. Siddique, Dr. Zain, Dr. Ali, Maulood, Rana, Tabitha, Ma'en, Monther, Yazan, Rebhi, Wisam, Zeyad, Sultan, Majed, Ali Sleet, Ra'fat, Dr. Iyad, Dr. Ayed, Mustafa, Moh'd Hamzeh, Dr. Silwadi, Nael Abu rub, Abu Afif, Dr. Dawabeh, Zaid, Abdullah, Rania, Abu Jaitem, Samer, Dr. Sanjay, Shahida, Nadia, Omar, Qawi, Abu Salim.**

To all named and unnamed helpers and friends, I again extend my thanks.

DR. NAJEEB ABU RUB

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Abbreviations	List of abbreviations
KCCCDC	Kelantan Combined Cleft Lip and Palate and Craniofacial Deformities Clinic.
C – C	Inter-canine's width.
C – C arch length	Inter-canine's arch length.
C- point	Cuspid point
CAPSP	Clefts of Anterior & Posterior Secondary Palate.
CASP	Clefts of Anterior Secondary Palate.
CL	Cleft lip alone.
CL/P	Cleft lip or/and palate.
CLP	Combined cleft lip and palate.
CLPP	Clefts of Lip and Primary Palate involvement.
CP	Cleft palate alone.
CP/L	Cleft palate with or without cleft lip.
CPP	Clefts of Primary Palate.
CPSP	Posterior Secondary Palate.
I – H	Palatal length.

I- point	Incisal point.
ICC	Intra-class Correlation Coefficient.
H-D	Palatal Depth or arch depth.
PLAL	Posterior left Arch Length.
PRAL	Posterior Right Arch Length.
PRS	Pierre Robin Sequence
PSOP	Pre-Surgical Orthopedic Plate
QH	Quad Helix
RME	Rapid Maxillary Expansion
SCC	Spearman Correlation Coefficients
SPSS	Statistical Package for the Social Sciences
T - T	Inter-tuberosities width, or palatal posterior arch width
T- point	Tuberosity point
TPA	Trans Palatal Arch
URA	Upper Removable Appliance with mid line jack screw
VPI	Velopharyngeal Insufficiency
UFA	Upper Fixed arch wire Appliances
D- point	The deepest palatal point where it coincides with T – T points
C - T	Posterior arch length

Abstract

Cleft palate in children and adolescent: A study of arch expansion

The use of palatal expansion appliances has been claimed to produce a light, continuous force, which is capable of expanding the maxilla and correcting dental arch width of cleft palate patients who have deficient maxilla. The aim of this study is to evaluate the palatal changes and the effects of expansion practice with different arch expansion appliances in patients with cleft palate with or without cleft lip (CP/L) that were treated at the Kelantan Combined Cleft lip & palate and Craniofacial Deformity Clinic (KCCCDC) at different stages of the long-term management and also to compare these changes among upper removable appliance with mid-line screw (URA), quadhelix (QH) and upper fixed appliance (UFA).

This is a retrospective record review study involving forty-nine oral clefts patients who underwent palatal expansion at KCCCDC, comprising of 12 patients had used Pre-Surgical Orthopedic Plate (PSOP), 11 patients used URA, 11 patients used QH, 3 patients used Rapid Maxillary Expansion (RME), and 12 patients used (UFA). All these had orthodontic study models taken prior to expansion and at the end of the retention period following expansion. These pre and post treatment study models were analyzed for changes in inter-tuberosities width, inter-canines width, palatal length, palatal depth, inter-canine arch length, posterior arch length; using fowler-sliding caliper measuring instrument (Fowler Ultra – Gold, USA). By analyzing pre and post treatment dental casts using SPSS statistical analysis version 11.0, differences in palatal changes in all expansion groups were evaluated

for statistical significance of the effect of expansion appliances using Two-related sample analysis and Wilcoxon signed ranks test. The correlation between age and palatal changes also tested for all expansion groups using Spearman rank correlation. And comparing the palatal changes and the effect of expansion produced between URA, QH, & UFA were evaluated for statistical significance using Kruskal Wallis test .

Results of this study suggest that all expansion appliances are clinically capable of expanding the maxilla. There is a significant increase in maxillary inter-tuberosity width following treatment with maxillary expansion appliances.

Age does not have influence in explaining the total amount of expansion in all the appliances except that in RME group, the inter-tuberosity width increase as age increase. And quite opposite; palatal depth in UFA group decreases as the age increase.

There is no significant difference in palatal change between URA, QH and UFA expansion appliances, except in inter-tuberosity width; there is significant difference between the groups and more increase in the URA group then QH and UFA.

In conclusion, this study shows that PSOP, URA, QH, RME and UFA are suitable for arch expansion in all ages of children and adolescent, except that RME produce more lateral expansion in adolescent and UFA produce more shallow palate in children.

Abstrak

Sumbing bibir dan lelangit dikalangan kanak-kanak dan remaja: Kajian tentang pengembangan rahang maksila.

Penggunaan alat untuk mengembangkan lelangit telah dikatakan berkesan dalam menghasilkan daya ringan yang berpanjangan untuk mengembangkan rahang maksila di kalangan pesakit-pesakit sumbing bibir dan lelangt yang mempunyai saiz maksila yang kecil. Tujuan kajian ini ialah untuk mengkaji kesan dari pengembangan saiz maksila dengan menggunakan beberapa jenis alat yang berbeza ke atas pesakit pesakit sumbing bibir dan lelangit yang dirawat di Klinik bersepadu sumbing bibir dan lelangit di Negeri Kelantan. Ianya juga bertujuan untuk membuat perbandingan perubahan yang dihasilkan dari sudut kepelbagaian alat-alat dan umur pesakit.

Kajian retrospektif ini melibatkan 49 pesakit sumbing bibir dan lelangit yang telah menjalani rawatan pengembangan rahang di Klinik Pergigian Kota Bharu. Dua belas orang pesakit telah menggunakan 'Pre-surgical orthopedic plate' (PSOP), 11 orang pesakit telah menggunalian aphar boleh tanggal 'Upper Removable Appliance' (URA), 11 orang pesakit telah menggunalian 'Quad Helix', 3 orang pesakit telah menggunalian 'Rapid Maxillary Expansion' (RME) dan 12 orang pesakit telah menggunalian 'Upper Fixed Appliance' (UFA). Model kajian ortodontik sebelum dan selepas rawatan dikaji dengan mengukur panjang lelangit, kedalaman lelangit, lebar antara gigi taring dan lebar antara tuberositi dengan menggunakan fowler sliding caliper untuk mengetahui perbezaan di antara waktu

sebelum dan selepas rawatan bagi setiap jenis alat yang digunakan. Kaitan di antara umur pesakit dan perbezaan hasil pengembangan yang dihasilkan oleh setiap alat juga dikaji.

Keputusan kajian ini menunjukkan bahawa semua alat pengembangan rahang yang digunakan berupaya untuk menghasilkan pengembangan rahang maksila yang diperlukan. Penambahan yang ketara dilihat pada lebar antara tuberositi.

Umur pesakit didapati tiada berkaitan dengan jumlah penambahan pengembangan kecuali dalam kumpulan yang menggunakan RME yang mana lebar antara tuberositinya bertambah bila umur bertambah. Disebaliknya, kedalaman rahang untuk kumpulan UFA berkurang bila umur bertambah.

Tiada perbezaan pada rahang didapati diantara penggunaan alat URA, QH dan UFA, kecuali pada lebar antara tuberositi yang telah didapati berbeza antara kumpulan. Penambahan yang ketara didapati pada kumpulan URA berbanding dengan QH dan UFA.

Sebagai kesimpulan, kajian ini menunjukkan bahawa alat-alat PSOP, URA, QH, RME dan UFA adalah sesuai digunakan untuk pengembangan rahang maksila untuk pesakit pada semua peringkat umur. Walaubagaimanapun alat RME didapati mengahasilkan pengembangan lateral yang lebih pada pesakit remaja dan alat UFA didapati menghasilkan lelangit yang cetek pada pesakit kanak-kanak.

Chapter One

Introduction

Chapter One

Introduction

1.1. Background

Cleft lip or/and palate (CL/P) in children has drawn the attention of many researchers to study this most frequent congenital oro-facial deformity, occurring approximately in 1:700 life births (Barden *et al.,* 1989). Cleft lip and palate is usually not a terminal illness unless it is associated with some syndrome having other systemic complications that could include cardiac, central nervous system, renal, and skeletal defects. These are associated with 10-20% of cleft palate cases which often require complicated management (Sphrintzen *et al.*, 1985).

The face is formed by fusion of a number of embryonic processes, which form around the primitive oral cavity (stomodeum). The palate is formed by the fusion of the maxillary shelves with each other (maxillary process) and with the frontonasal process. Failure of fusion of these processes results in clefts of the palate. Cleft lip is caused by inadequate proliferation and fusion of the maxillary process and medial nasal process. Cleft lip could occur either unilaterally or bilaterally with varying degree of severity. The condition is more prevalent in males and if it occurs unilaterally, it is usually on the left side (Young, 1998). From about the third month of pregnancy; it is usually possible to diagnose a cleft using high tech ultrasonic scanner.

The development of cleft lip was found to be of genetic mechanism different from that of cleft palate. The lip develops between the 5^{th} and 7^{th} week of intrauterine life while the

palate at about 9th week. The mechanism altering the former could interfere with the later, but the palate closure might also be affected independent of lip formation (Rani, 1997).

Oral clefts are believed to occur due to genetic and environmental factors. Recent studies have shown that the etiology of cleft lip and palate is an interaction of multi-factorial etiology; hence it cannot be attributed solely to either genetic or environmental factors. It is argued that unless the patient is genetically susceptible; the environmental factors may not by them selves cause clefts (Habel *et al.*, 1996).

A cleft lip or/and palate patient (CL/P) is afflicted by a number of problems, which could broadly be classified under dental deformities, aesthetics, speech and hearing, psychosocial, and systemic. The complexity of the problem requires that a team cooperate to ensure comprehensive care of the patient. This led to the concept of multidisciplinary cleft lip and palate team which include pediatricians, pedodontists, orthodontists, oral and maxillofacial surgeons, general dentists, plastic surgeons, prosthodontists, psychiatrists, ENT specialists, genetic counselors, speech therapists, social workers, and cleft supporting organizations.

Cleft lip and palate patients developed defective dental occlusion and midface concavity due to collapse and insufficient growth of the maxilla. The orthodontist's has played a great role in the correction of the dentoalveolar and maxillomandibular relationship by applying a combination or a solitary use of orthodontic and orthopedic forces. Orthodontists usually have to start this part of treatment early in the neonatal period and follow up as the child's growth eventually into the adulthood. By the end of the treatment, the middle and lower

third of the face have been assisted to develop both functionally and aesthetically. Even in severe oral cleft near normalcy can achieve.

Cleft palate cases often have narrow upper dental arch. As such attempts are made to correct the segmental displacement and expand the maxilla by means of rapid or slow palatal expansion, which will often open and identify an occult defect in the alveolar bone. For this reason, it is carried out before bone grafting procedures.

In mixed and permanent dentition, maxillary arch expansion appliances are widely incorporated to allow maxillary expansion in order to achieve proper dental alignment and correct maxillomandibular relationship. The most common rapid maxillary appliances used for expansion are Derichsweiler type, Hass type, Isaacson type, and Hyrax type. These appliances produce a skeletal as well as dentoalveolar expansion (Bhalajhi, 1998). While the most common slow maxillary appliances used for expansion are Jack screws, Coffin springs, and Quad helix. These appliances bring about a slow dentoalveolar expansion. When the slow maxillary appliances are used during the deciduous and early mixed dentition stage, skeletal mid-palatal splitting can be achieved. An apparently complex yet relatively simple procedure in orthodontics is maxillary arch expansion; its versatility is unique despite many controversies surrounding it. Desirable results could be achieved when used in appropriate situation, adequate time, cooperative patient and skilled clinician. The issue of arch expansion as part of management of cleft lip and palate patients will be the focus of this study.

1.2. Statement of the problem

The palatal expansion appliances is claimed to produce a light, continuous force which is capable of expanding the maxilla and correcting dental arch width of cleft palate patients who have deficient maxilla. The skeletal and dental effects of the palatal expansion appliances on the maxilla have not been reported in the practice of Kelantan Combined Cleft lip & palate and Craniofacial Deformity Clinic (KCCCDC). Hence, we carried this research to find an evidence based practice of which expander to be used or which expander was more efficient and also to evaluate the benefit of each expander.

1.3. Hypothesis

1. There are changes in maxillary inter-canine width, maxillary inter-tuberosity width, palatal length, palatal depth, inter-canine arch length and posterior arch length following treatment with maxillary expansion appliances in cleft palate with or without cleft lip patients (CP/L) at the KCCCDC.

2. There is correlation between age and palatal changes in following treatment with maxillary expansion appliances in CP/L patients.

3. There is difference in palatal changes between different expansions appliances used.

1.4. Objectives

1.4.1. General objectives

The purpose of this study is to investigate the epidemiology of oral clefts at the KCCCDC and the practice of arch expansion using various arch expansion appliances for management CP/L patients at KCCCDC.

1.4.2. Specific objective

To study and describe the palatal changes and the effects of expansion produced by various expansion appliances used in management of CP/L patients at KCCCDC.

To correlate between age and palatal changes following treatment with maxillary expansion appliances.

To compare the palatal changes and the effect of expansion produced between URA, QH and UFA expansions appliances.

1.5. Significance of the study

The results of this study will provide information on the skeletal and dental effects produced by various palatal expander appliances used in KCCCDC. This information will aid clinicians in selecting the appropriate appliance for maxillary expansion in CP/L patients.

1.6. Assumptions

It is assumed that all diagnostic materials utilized such as alginate impressions, and study models were taken and prepared in a consistent manner according to professional standards but there are still effects of errors such as impression distortion, dental cast trimming and polishing which may take place for all groups and not possible to be measured. It is also assumed that all rapid expansion appliances whether banded or bonded produce comparable amounts of lateral expansion to each other and that any differences are insignificant, this is also applicable to upper fixed appliances. Also, since multiple operators are involved in the placement of the expansion appliances, it is assumed that the appliances are inserted and activated in a consistent manner.

1.7. Delimitations

All patients used in this study are cleft palate patients with or without cleft lip, and require palatal expansion as part of their orthodontic treatment and range from infant to adolescent with no previous history of orthodontic expansion with pre and post dental casts available. All patients are free from any medical condition that could affect their normal growth and development.

Chapter Two

Literature Review

Chapter Two

Literature Review

2.1. Introduction

Clefts of the lip and palate usually affect the child's dental development. Teeth in the area of the cleft may be missing, and other teeth may be improperly positioned. Because problems with the dentition affect not only the child's appearance, but also his or her speech development and chewing ability, attention to the child's dental development is important. Vigilant prevention practices and regular visits to the pediatric dentist will help ensure the best dental outcome for the child. Most children with such conditions will require orthodontic treatment at various ages, even as early as four years. The orthodontist, in conjunction with the rest of the cleft palate team, will devise treatment plans for the best dental and jaws growth.

2.1.1. Definition

Cleft lip and palate are congenital abnormalities (present at birth) that affect the upper lip and the hard and soft palate of the mouth. Features range from a small notch in the lip to a complete fissure (groove) extending into the roof of the mouth and nose. These features may occur separately or together (Reviewed by Molmenti, 2002)

2.1.2. History

Hippocrates (400 BC) and Galen (150 AD) mentioned cleft lip, but not cleft palate in their writings. For centuries, perforations of the palate were considered to be secondary to syphilis, and cleft palate was not recognized as a congenital disorder until 1556, by Fanco. The first successful closure of a soft palate defect was reported in 1764 by LeMonnier, a French dentist. Dieffenbach performed the first closure of the hard palate in 1834. In the 1930's, Kilner and Wardill independently developed the "pushback" procedure (Stewart, 1991).

2.2. Epidemiology of oral clefts

Clefts involving lip and/or palate are the most common congenital deformities that occur at the time of birth. The incidence of the oral clefts has been the subject of many studies. These studies have shown that there are variations in the incidence among different races. The incidence of cleft deformities reported in many corners of the worlds varies from 0.79 to 3.62 per 1000 (Vanderas, 1987). Mean value of the studies conducted in the world among different races was 1:700 live births (Barden *et al.*, 1989).

The incidence of cleft deformities in Malaysia, reported by National Oral Health Survey of School Children, Ministry of Health (1997) is 1: 941. While incidence in Kelantan state in Malaysia shown that the ratio of cleft was 1:700 live births (Halim & Singh, 2000).

The mongoloid (Asian descent) has the highest incidence while the Negroid (Africans) has the least incidence; (1.00 per 1000 live births in Caucasians, 0.4 per 1000 live births in Negroid, and 2.1 per 1000 live births in mongoloids (Berryman, 1999).

Most of the epidemiological studies categorize oral clefts into cleft lip, cleft lip and palate, and cleft palate only. As shown in Fig. 2.1 combined cleft lip and palate (CLP) represents approximately 50% of incidents, cleft palate alone (CP) 30%, and cleft lip alone (CL) 20% (Young, 1998).

Clefts of the lip and combined lip and palate are twice as common in males. Isolated cleft palates are twice as common in females. This may be explained by the fact that the secondary palate closes one-week later in females (Young, 1998). The left side was affected twice as commonly as the right side with majority of cases being unilaterally.

The incidence of oral clefts is generally increasing. Studies in Denmark (Jensen *et al.*, 1988) have shown a rise from 1:667 to 1:529 between 1942 and 1981. A report from The European registration of congenital anomalies and twins showed an increase of 1.45/1000 to 1.57/1000 from 1980 to 1988 (EUROCAT, 1995). The increase in incidence is thought to be multifactorial. However there have been reports associated with older age maternal and/or paternal of oral clefts offspring (Slavkin, 1992).

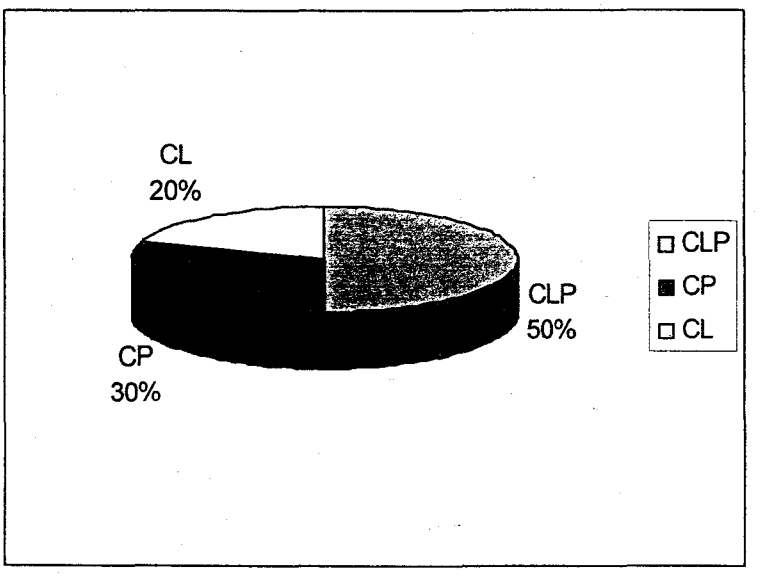


Fig. 2.1. Oral Cleft breaks down (Young, 1998)

2.3. Classification of oral clefts

Clefts of the lip and palate can vary considerably from one individual to the next. Some have both cleft lip and palate; some have only a cleft of the lip; others have only a cleft of the palate. Clefts may be unilateral or bilateral. Oral clefts are generally grouped on the basis of clefting of the lip or palate or both. Various authors have put many classifications for clefts.

2.3.1. Davis and Ritchie classification (1922)

It is based on location of the cleft in relation to the alveolar process (Table. 2.1.).

Table. 2.1. Davis and Ritchie classification.

Group 1 Pre alveolar clefts (Clefts of the lip)	**Group 2** Post alveolar clefts (Clefts of hard and soft palate extend up to the alveolar ridge).	**Group 3** Complete clefts, involving the palate, alveolar ridge, and lip.
Unilateral	Unilateral	Unilateral
Bilateral	Bilateral	Bilateral
Median	Median	Median

2.3.2. Veau's clssification (1931)

Veau has classified cleft lip and palate into four groups (Table 2.2).

Table. 2.2. Veau's classification.

Group	Description
1	Involving soft palate only.
2	Involving hard and soft palate, extending up to incisive foramen.
3	Complete unilateral clefts of soft palate, hard palate, lip and alveolar ridge.
4	Complete bilateral clefts affecting soft palate, hard palate, lip, alveolar ridge.

2.3.3. Classification by Fogh Andrsen (1942)

Fogh Andersen classified clefts into three groups: clefts of the lip, clefts of the palate and clefts of lip and palate (Table.2.3).

Table. 2. 3. Fogh Andersen classification.

Group 1 Clefts of the lip	**Group 2** Clefts of lip and palate.	**Group3** Clefts of palate, extending up to the incisive foramen.
Unilateral or Median	Unilateral	Unilateral or median
Bilateral	Bilateral	Bilateral

2.3.4. LAHSHAL classification

In 1987 Okrien had classified cleft lip and palate by paraphrase LAHSHAL, which is the anatomic areas, affected by clefts.

L: Lip. A: Alveolus. H: Hard palate. S: Soft palate. H: Hard palate. A: Alveolus. L: Lip. Areas involved in the clefts are denoted by specifically indicated alphabets standing for it for example: L - - S - - - / stands for clefts of right lip and soft palate

2.3.5. Schuchrdt and Pfeifer's symbolic classification (1966)

This classification makes use of a chart made up of a vertical block of three pairs of rectangles with an inverted triangle at the bottom (Fig. 2.2). These are representing clefts of lip, alveolus, hard palate, and soft palate respectively. Areas affected by clefts are shaded in the chart, the advantage of this classification is the simplicity but the disadvantage is the difficulty in writing or communication

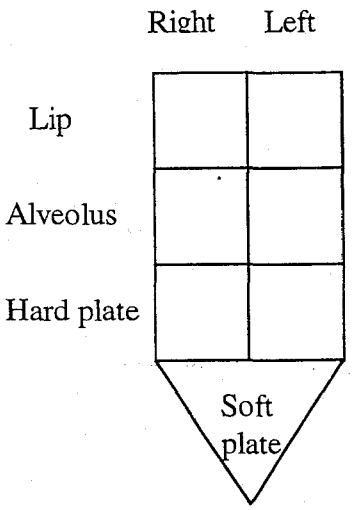


Fig. 2.2. Schuchrdt and Pfeifer's symbolic classification

2.3.6. Kernahan's stripped "Y" classification by Kernahan and Stark (1958)

This is another symbolic classification; a stripped "Y" having numbered blocks, which represent a specific area of the oral cavity (Fig. 2.3).

-Blocks 1 and 4 represent the lip.

-Blocks 2 and 5 represent the alveolus.

-Blocks 3 and 6 represent hard palate anterior to the incisive foramen.

-Blocks 7 and 8 represent hard palate posterior to incisive foramen.

-Blocks 9 represent the soft palate.

The boxes, which will be shaded, are the places where clefts have occurred.

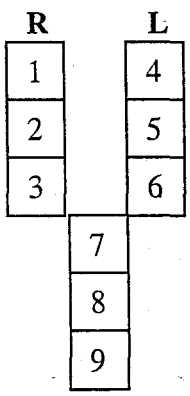


Fig .2.3. Kernahan's stripped "Y" classification

2.3.7. Classification given by International confederation for plastic and reconstructive surgery in 1968

International confederation for plastic and reconstructive surgery classified oral clefts into three groups: Clefts of anterior primary palate, Clefts of posterior palate and Clefts of anterior and posterior palate (Table. 2.4).

Table. 2.4. International confederation for plastic and reconstructive surgery classification.

Types	Area affected	sides
Group 1 Clefts of anterior primary palate.	Lip:	-Right side. -Left side. -Both.
	Alveolus:	-Right side. -Left side. -Both.
Group 2 Clefts of anterior and posterior palate.	Lip:	-Right side. -Left side. -Both.
	Alveolus:	-Right side. -Left side. -Both.
	Hard palate:	-Right side. -Left side. -Both.
Group 3 Clefts of posterior palate.	Hard palate:	-Right side. -Left side. -Both.
	Soft palate:	

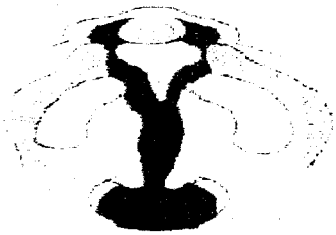
2.3.8. IOWA classification

IOWA has classified Cleft Lip and Palate into five groups as shown in Fig 2.4.

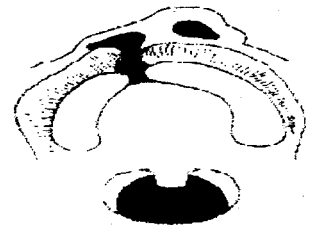
It should be noted here that all the classifications apply equally to unilateral and bilateral clefting.

Group I: Clefts of the lip only

Group 2: Clefts of the palate only (secondary palatal clefts)



Group 3: Clefts of the lip, alveolus and palate. (Complete cleft lip and palate)



Group 4: Clefts of lip and alveolus. (Primary cleft palate and lip).

Group V
This classification is defined as miscellaneous and includes clefts, which do not fit into any of the above categories.

Fig. 2.4. IOWA classification of Cleft Lip and Palate.

2.4. Embryology background

To manage a case of cleft lip or/and palate it is necessary to grasp the normal development of lip and palate. Normal embryological development of the oral cavity has been described by Sperber (1976).

The face is formed by the fusion of a number of embryonic processes that form around the primitive oral cavity or stomodeum. By the fourth week of intra uterine life, five branchial arches develop at the site of the future neck, which play a vital role in the human body development. The first branchial arch, called the mandibular arch, is responsible for the development of nasomaxillary complex.

The embryonic precursor of the face appears as a large frontal prominence that forms the upper boundary of the stomodeum (primitive oral cavity). The primary mouth is divided from the foregut by the buccopharyngeal membrane. On either side of the stomodeum is the developing mandibular arch, the dorsal end of which gives off a bud called (maxillary process), with the formation of the nasal pits. The frontonasal process gets divided into medial nasal process and two lateral nasal processes (Fig. 2.5).

2.4.1. Development of the primary palate

In the 5th and 6th week of intra uterine life, the maxillary process undergoes rapid growth. By the 6th and 7th week, the maxillary process merges with the medial and lateral nasal processes to form the intermaxillary segment (Fig. 2.6). This intermaxillary segment has a labial component, which form the philtrum of the upper lip, and a triangular palatal component, which include the four maxillary incisors and extends backward to the incisive foramen. The upper lip and the pre-maxilla is thus formed. Inadequate proliferation of the maxillary and medial nasal processes would cause cleft lip.

2.4.2. Development of the secondary palate

Secondary palate that makes up the rest of the palate forms both hard and soft palate; i.e. about 90% of the palate.

By the 6th week of intra uterine life the medial surface of the maxillary process gives off palatal shelves, which grow medially and downward, lateral to the tongue. Elevation of the palatal shelves begins in week 7th, and more.marked in the anterior region, adjacent to the primary palate. Elevation of shelves accompanies forward and lateral growth of the mandible. The forces prompting this elevation have been labeled "intrinsic shelf force".

The tongue plays a vital role in the initial prevention of palatal shelves union, thus the shelves grows vertically down.

By the 8th week of intra uterine life the tongue descends and palatal shelves become more horizontal and approximate. When the palatal shelves touch; the epithelium has thinned and degenerated, allowing mesenchyme from both sides to join in the mid line. Fusion is completed by the 10th week. Final closure by fusion occurs later in female than males.
Failure of fusion of the maxillary shelves with each other and with the frontonasal process results in cleft palate.

The soft palate is formed from secondary growth centers by successive merging rather than fusion. The mandibular process gives rise to the lower lip and jaw.

Defective fusion or incomplete fusion between various processes leads to different types of clefts. It should be noted that during normal development, primary palate has no cleft unlike the secondary palate development.

Many health workers have put forward theories and investigated the possible reasons for failure of the fusion process.

Fig. 2.5. Face of 5 week old embryo.

(Adapted from CLAPAI. Available at http://www.cleft.ie)

Fig. 2.6. Secondary Palate in 7 week old embryo.

(Adapted from CLAPAI. Available at http://www.cleft.ie)

2.5. Etiology of cleft palate

2.5.1. Introduction.

When researchers look at oral clefts, they begin to wonder whether the cleft represents a deficiency of tissue, displacement of what tissue are present and / or presence of division of tissue, resulting in an opening. Several studies have been undertaken on cleft youngsters. Cast studies and radiographic studies. It was ascertained that deficiency and /or displacement could be present (Coup & Subtelny, 1960).

Cleft lip is considered to arise from inadequate mesodermal proliferation of the maxillary process and medial nasal process. This causes a weakening and eventual breakdown of the epithelial bridge between these structures, thereby producing cleft. Another theory says that the epithelium covering the mesenchyme doesn't undergo apoptosis thus producing a physical barrier to fusion.

The theories put forward to explain Cleft palate include failure of adequate mandibular growth, which may inhibit elevation of the palatal shelves. Another is that the tongue become wedged and does not descend clear of the palatal shelves, thus physically obstructing them. It is generally considered that the most likely causes are either hypoplasia of the shelves or delay in timing of shelf elevation.

Cleft lip and palate either complete or incomplete is more common than either one in isolation. Cleft palate only is more common in females than males. It is proposed that this is caused by the later elevation of the palatal shelves in females, thus leaving open longer time period for a potential environmental insult. However, males over all are more likely to exhibit oral clefting.

The development of cleft lip was found to be of different genetic mechanism from that of cleft palate; since the lip develop between the 5^{th} - 8^{th} week of intra uterine life and the palate at 9^{th} – 10^{th} week, the mechanism altering the former could interfere with the later; but the palate closure might also be affected independent of the lip.

2.5.2. Factors contributed in Oral clefts

Oral clefts are believed to occur due to genetic and environmental factors.

2.5.2.1. Genetic factor

Three types of genetic risk groups are present. They are the syndromic group, which is most easily identified by examination, the familial group, and the isolated defect group, which is identified by history.