TURKISH REPUBLIC OF NORTHERN CYPRUS

NEAR EAST UNIVERSITY FACULTY OF DENTISTRY

GRADUATE SCHOOL OF HEALTH SCIENCES

A MULTICENTER RETROSPECTIVE 3D STUDY OF CLEFT LIP AND PALATE CASTS TO EVALUATE DENTAL SHAPE, SIZE AND ANOMALIES IN ERUPTION AROUND THE CLEFT AREA BEFORE FIXED ORTHODONTIC TREATMENT

AKRAM IDRYS

PhD THESIS

DEPARTMENT OF ORTHODONTICS

Supervisors:

Assist. Prof. Dr. Beste KAMİLOĞLU

Prof. Dr. Ayşe Tuba ALTUĞ

2020 NICOSIA

TURKISH REPUBLIC OF NORTHERN CYPRUS
NEAR EAST UNIVERSITY FACULTY OF DENTISTRY
GRADUATE SCHOOL OF HEALTH SCIENCES

A MULTICENTER RETROSPECTIVE 3D STUDY OF CLEFT LIP AND PALATE CASTS TO EVALUATE DENTAL SHAPE, SIZE AND ANOMALIES IN ERUPTION AROUND THE CLEFT AREA BEFORE FIXED ORTHODONTIC TREATMENT

AKRAM IDRYS

PhD THESIS

DEPARTMENT OF ORTHODONTICS

Supervisors:
Assist. Prof. Dr. Beste KAMİLOĞLU
Prof. Dr. Ayşe Tuba ALTUĞ

2020 NICOSIA

TEZ ONAYI

YDÜ Sağlık Bilimleri Enstitüsü Müdürlüğüne;

Bu çalışma jürimiz tarafından Ortodonti Programında Doktora Tezi olarak kabul edilmiştir.

Jüri Başkanı: Prof. Dr. Ayşe Tuba ALTUĞ
Ankara Üniversitesi, Diş Hekimliği Fakültesi

Danışman: Yard. Doç. Dr. Beste KAMİLOĞLU
Yakın Doğu Üniversitesi, Diş Hekimliği Fakültesi

Üye: Prof. Dr. M. Okan AKÇAM
Ankara Üniversitesi, Diş Hekimliği Fakültesi

Üye: Doç. Dr. Ulaş Öz
Yakın Doğu Üniversitesi, Diş Hekimliği Fakültesi

Üye: Yard. Doç. Dr. Levent VAHDETTİN
Yakın Doğu Üniversitesi, Diş Hekimliği Fakültesi

ONAY:

Bu tez, Yakın Doğu Üniversitesi Lisansüstü Eğitim – Öğretim ve Sınav Yönetmeliği'nin ilgili maddeleri uyarınca yukarıdaki jüri üyeleri tarafından uygun görülmüş ve Enstitü Yönetim Kurulu kararıyla kabul edilmiştir.

Prof. Dr. K. Hüsnü Can BAŞER
Sağlık Bilimleri Enstitü Müdürü

NEAR EAST UNIVERSITY GRADUATE SCHOOL OF HEALTH SCIENCES, NICOSIA 2020

Signed Plagiarism Form

Student's Name & Surname: Akram IDRYS

Student's Number:

Programme: Department of Orthodontics

□ Master's without Thesis □ Master's with Thesis ● Doctorate

I hereby declare that I have fully cited and referenced all material that are not original to this work as required by these rules and conduct. I also declare that any violation of the academic rules and the ethical conduct concerned will be regarded as plagiarism and will lead to disciplinary investigation which may result in expulsion from the university and which will also require other legal proceedings.

....

(Signature)

ACKNOWLEDGEMENTS

Foremost, I would like to express my sincere gratitude to my advisors Assiss. Prof. Dr. Beste Kamiloğlu and Prof. Ayşe Tuba Altuğ for the continuous support of my doctoral study and research, for their patience, motivation, enthusiasm, and immense knowledge. Their guidance helped me in all the time researching and writing this thesis.

My sincere thanks also goes to Prof. Okan Akçam for his immense help by allowing me to use his own Dental Intraoral Scanner which was one main part of my research. I would like to thank Associate. Prof. Dr. Ulaş Öz and Assiss. Prof. Dr. Levent Vahdettin for their help, guidance, and sharing their knowledge with me through my time in the Department of Orthodontics.

I would like to thank our faculty dean Prof. Mutahhar Ulusoy for his guidance and support.
I thank my fellow colleagues and friends from the Department of Orthodontics, Near East University who helped me and shared the good and bad times with me.

I thank all my friends and the whole team from Department of Orthodontics, Ankara university for their amazing help and warm welcoming.

Last but not the least, I would like to thank my family: my parents Sameer Idris and Zainab Ayoub, and my sisters for their support and unconditional love throughout my life.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CLP	: Cleft Lip and/or Palate
BCLP	: Bilateral Cleft Lip and/or Palate
UCLP	: Unilateral Cleft Lip and/or Palate
URCLP	: Unilateral Right Cleft Lip and/or Palate
ULCLP	: Unilateral Left Cleft Lip and/or Palate
RCLP	: Right Cleft Lip and/or Palate
LCLP	: Left Cleft Lip and/or Palate
MD	: Mesial-Distal Dimension
LL	: Labial-Lingual Dimension
OG	: Occlusal-Gingival Dimension
NAM	: Naso-Alveolar Molding
PNAM	: Presurgical Naso-Alveolar Molding
WHO	: World Health Organization
TRNC	: Turkish Republic of Northern Cyprus

A Multicenter Retrospective 3D Study of Cleft Lip and Palate Casts to Evaluate Dental Shape, Size and Anomalies in Eruption Around the Cleft Area Before Fixed Orthodontic Treatment

Name of the student: Akram IDRYS
Supervisors: Assist. Prof. Dr. Beste KAMİLOĞLU
Prof. Dr. Ayşe Tuba ALTUĞ
Department: Department of Orthodontics

ABSTRACT

Objective: The aim of this study was to evaluate tooth crown size in patients with cleft lip and palate (CLP) with Right cleft lip and palate (RCLP) and Left cleft lip and palate (LCLP) subtypes and compare them between each other and between class I control group.

Material and methods: A total of 110 patients, 55 patients' records with CLP (28 male, 27 female) and the same number of 55 patients' records with class I (27 male, 28 female) as control group has been included. All plaster models were scanned with dental scanner (3Shape TRIOS® 3 intraoral scanner) and then analyzed using digital program to measure tooth size.

Results: When comparing right and left side of LCLP group mesio-distal (MD) and labio-lingual (LL) dimensions of the centrals have the significant difference, were the largest dimensions were the right centrals ($p<0,05$). When comparing right and left side of RCLP group labio-lingual (LL) dimensions of the canines have the significant difference, where the largest dimensions were the right canines ($p<0,05$). In class I group there were no significant differences between right and left sides. A significant mean difference in Centrals MD, Centrals LL and Canines LL ($p<0,05$) between all groups when comparing the right sides and left sides alone, where class I group has the largest mean between all groups.

Conclusion: Cleft lip and palate patients noticed to have significant dental anomalies that affect the number, shape, and size of the teeth. These anomalies can impair

function and affect the psychology of the patients. And therefore, a dental analysis focusing on restoring the aesthetics as much as function should be considered when treating these patients.

Keywords: Cleft lip and/or palate, Dental anomalies, Dental shape, Dental size, 3D scanning in orthodontics

Sabit Ortodontik Tedavi Öncesi Yarık Alanı Etrafındaki Erüpsiyonda Diş Şeklini, Büyüklüğünü ve Anomalilerini Değerlendirmek İçin Yarık Dudak ve Damak Kalıplarının Çok Merkezli Retrospektif 3 Boyutlu Çalışması

Öğrencinin adı: Akram IDRYS

Danışmanlar: Assist. Prof. Dr. Beste KAMİLOĞLU

Prof. Dr. Ayşe Tuba ALTUĞ

Bölüm: Ortodonti Anabilim Dalı

ÖZ

Amaç: Bu çalışma, dudak ve damak yarıklı (CLP) hastalarda, yarığın alt tipleri olan sağ yarık dudak ve damak (RCLP) ile sol yarık dudak ve damak (LCLP) olgularında diş kron büyüklüklerini değerlendirmek ve karşılaştırmak amacıyla yapılmıştır.

Gereç ve yöntem: Araştırmaya dahil edilen toplam hasta sayısı 110 olup, 55 dudak-damak yarıklı hastanın (28 erkek, 27 kadın) kaydı ve aynı sayıda 55 Sınıf I kontrol grubu hasta (27 erkek, 28 kadın) kaydı araştırma kapsamına dahil edilmiştir. Tüm alçı modeller dental tarayıcı (3Shape TRIOS® 3 intraoral tarayıcı) ile taranmıştır. Sonrasında ise dijital ortamda diş boyutu ölçüm ve analizleri gerçekleştirilmiştir.

Bulgular: LCLP grubunun sağ ve sol tarafları karşılaştırıldığında dişlerin mezio-distal (MD) ve labio-lingual (LL) boyutları arasında anlamlı fark bulunmuştur. En büyük boyut farkı sağ tarafta ölçülmüştür ($p < 0,05$). RCLP grubunun sağ ve sol tarafları karşılaştırıldığında, kanin dişlerin labio-lingual (LL) boyutları, sağ tarafta istatistiksel olarak anlamlı derecede daha fazla bulunmuştur ($p < 0,05$). Sınıf I grubunda sağ ve sol taraflar arasında anlamlı fark tespit edilmemiştir. Sadece sağ taraf ve sol taraf karşılaştırılırken, tüm gruplar arasında Santral mezio-distal(MD), Santral labio-lingual(LL) ve Kanin labio-lingual(LL)'de anlamlı ortalama fark bulunmuştur ($p < 0,05$). Burada Sınıf I grubu tüm gruplar arasında en büyük ortalamaya sahip gruptur.

Sonuç: Yarık dudak ve damak hastalarında dişlerin sayısını, şeklini ve boyutunu etkileyen önemli diş anomalileri olduğu fark edilmiştir. Bu anomaliler tüm fonksiyonları bozabilmekte ve hastaların psikolojisini olumsuz etkileyebilmektedir.

Bu nedenle, bu hastaları tedavi ederken fonksiyon kadar estetiğe de odaklanan bir tedavi yaklaşımı düşünülmelidir.

Anahtar Kelimeler: Diş anomalileri, Diş boyutu, Diş şekli, Ortodontide 3D tarama, Yarık dudak ve / veya damak.

1. INTRODUCTION

Orofacial clefts, which include cleft lip, cleft palate, and cleft lip and palate, resembling a range of disorders affecting the lips and oral cavity of which the causes remain largely unknown (Fig. 1). Effects on speech, hearing, appearance, and psychology can lead to long-lasting adverse outcomes for health and social integration. Affected children have higher morbidity and mortality throughout life than do unaffected individuals where they need multidisciplinary care — nursing, plastic surgery, maxillofacial surgery, speech therapy, audiology, psychology, genetics, orthodontics, and dentistry —from birth until adulthood to manage the condition (Christensen, Juel, Herskind, & Murray, 2004) (Ngai, Martin, Tonks, Wyldes, & Kilby, 2005).

Around the 6th week of embryogenesis, the medial nasal processes fuse with one another and with the maxillary processes on each side leads to the formation of the upper lip and the primary palate. The paired palatal shelves, which initially grow vertically down the sides of the developing tongue rise to a horizontal position above the tongue and come into contact and fuse to form the secondary palate, which happens around the 8th week of embryogenesis. Then the secondary palate fuses with the primary palate and the nasal septum. These fusion processes are complete by the 10th week of embryogenesis. Any disturbance during these periods can disrupt the development processes resulting in clefts of the lip or/and palate (Mitchell, 2007).

With improved ultrasound screening the management of this condition starts prenatally by early detection which allows the parents to be counseled and prepared for the arrival of the child. Since a child with CLP will have difficulty sucking milk suitable bottles are now available for babies with clefts. Most of cleft lip and palate treatment centers use acrylic plates (feeding plates) designed to help to feed the baby. Lip repair surgery usually is done by the age of 3 months. At 9 months, hard and soft palate repair is undertaken to separate the nasal cavity from the oral cavity and to facilitate normal velopharyngeal function and closure for comprehensible speech. Before the time of permanent upper canines eruption at 9-10 years old an alveolar bone grafting surgery carried out to provide an intact arch to allow canine eruption (Mitchell, 2007).

Comprehensive diagnosis and treatment planning are essential in a successful orthodontic practice. Model analysis plays a vital role in diagnosis and subsequent treatment planning. A space analysis, or an evaluation of crowding, is an important factor to be considered for orthodontic diagnosis and treatment planning. An evaluation of crowding is necessary when considering extraction therapy. Space analysis is traditionally performed by contrasting the mesiodistal sizes of teeth in the dental arch (tooth mass) with the size of the parabolic curve that is described by a line over the denture bases from the mesial aspect of the right first molar to the mesial aspect of the left first molar. The line is drawn over the contact points of the posterior teeth, the tips of the canines, and the incisal edges of the central and lateral incisors. This curve is defined as arch length, or available space. Traditionally, diagnostic measurements have been obtained from plaster dental casts. Another method of diagnostically measuring orthodontic study models is digital models. From the digitized models, the orthodontist can make routine measurements and obtain various analyses. 3-dimensional (3D) virtual models are currently available and used to calculate many diagnostic measurements. More orthodontists are using digital dental models for diagnostic records and assessment of patients' orthodontic conditions. This trend will probably accelerate and become more common as digital models alleviate or solve many problems and difficulties associated with storage, retrieval, reproduction, communication, and breakage of conventional plaster casts. (Leifert, Leifert, Efstratiadis, & Cangialosi, 2009).

Since CLP patients deal with a considerable physiological and psychological impairment during a long period of their lives and since the physiological damage to their upper palate, upper arch and/or upper lip is considerably large, this study aiming to test the theory that CLP would not just affect the surrounding tissues of the maxillary teeth but also the teeth would be affected. To do that we collected digital models of CLP patients' casts and comparing them with normal patients' casts.

2. GENERAL INFORMATION

2.1 Development of Cleft Lip and/or Palate

Development of the lip and palate entails a complex series of events that require close coordination of programs for cell migration, growth, differentiation, and apoptosis. Neural crest cells, which delaminate from the neural folds, contribute to and migrate through mesenchymal tissue into the developing craniofacial region where, by the 4th week of human embryonic development, they participate in formation of the frontonasal prominence, the paired maxillary processes, and the paired mandibular processes, which surround the primitive oral cavity. Formation of the nasal placodes (ectodermal thickenings) by the end of the 4th week of embryogenesis divides the lower portion of the frontonasal prominence into paired medial and lateral nasal processes. By the end of the 6th week of development, merging of the medial nasal processes with one another and with the maxillary processes on each side leads to formation of the upper lip and the primary palate. Immediately before completion of these processes, the lateral nasal process has a peak of cell division that renders it susceptible to teratogenic insults, and any disturbance in growth at this critical time can lead to failure of the closure mechanism. The first sign of overt development of the secondary palate happens during the 6th week of embryogenesis with outgrowth from the maxillary processes of paired palatal shelves, which initially grow vertically down the sides of the developing tongue. During the 7th week of development, the palatal shelves rise to a horizontal position above the tongue and come into contact and fuse to form a midline epithelial seam, which subsequently degenerates to allow mesenchymal continuity across the palate. The palatal mesenchyme then differentiates into bony and muscular elements that correlate with the position of the hard and soft palate, respectively. In addition to fusing in the midline, the secondary palate fuses with the primary palate and the nasal septum. These fusion processes are complete by the 10th week of embryogenesis; development of the mammalian secondary palate thereby divides the oronasal space into separate oral and nasal cavities, allowing mastication and respiration to take place simultaneously. Since the lip and primary palate have distinct developmental origins from the secondary palate, clefts of these areas can be subdivided into cleft lip with or without cleft palate and isolated cleft palate in which the lip is not affected (Fig. 1). This subdivision is validated by the finding that, under most circumstances, cleft lip with or without cleft palate and isolated cleft palate do not segregate in the same family. Integration of findings of human genetic studies (including positional cloning strategies, parametric-based genetic linkage analysis, non-parametric affected sib-pair approaches, chromosomal analysis, and candidate gene-based association studies) with data of experimental embryological techniques in model organisms has increased our knowledge of both the fundamental mechanisms driving normal facial morphogenesis and how these are disturbed in cleft lip with or without cleft palate and isolated cleft palate.

2.2 Environment role in cleft lip and/or palate development

Epidemiological and experimental data suggest that environmental risk factors might be important in cleft lip and palate, and maternal exposure to tobacco smoke, alcohol, poor nutrition, viral infection, medicinal drugs, and teratogens in the workplace and at home in early pregnancy have all been investigated.

2.2.1 Substance misuse during pregnancy

Maternal smoking during pregnancy has been linked consistently with increased risk of both cleft lip with or without cleft palate and isolated cleft palate, with a population-attributable risk as high as 20%. This association might be underestimated because passive exposure to smoke has not been assessed in most studies. Maternal alcohol use is a well-known cause of fetal alcohol syndrome; however, the role of alcohol in isolated orofacial clefts is less certain, with positive associations reported in some studies.

2.2.2 Nutritional deficiencies

Findings of observational studies suggest a role for maternal nutrition in orofacial clefts, even though assessments of dietary intake or biochemical measures of nutritional status are challenging and generally are not available in many impoverished populations with the highest rates of orofacial clefts. Zinc is important in fetal development, and deficiency of this nutrient causes isolated cleft palate and other malformations in animals. Mothers of children with cleft lip, cleft lip and palate, or cleft palate alone in the Netherlands had lower concentrations of zinc in erythrocytes than did mothers of children without clefts, and similar differences were noted between children with and without these defects. In the Philippines, zinc deficiency is widespread, and high maternal amounts of zinc in plasma were associated with low risk of orofacial clefts with a dose-response relation. Folate deficiency causes clefts in animals, and folate antagonists are associated with increased risk of orofacial clefts in people. The role of dietary or supplemental intake of folic acid in human cleft disorders is uncertain. In North America, where fortification of grains with folic acid has been mandatory since the late 1990s, some evidence suggests a decline in prevalence at birth of cleft lip with or without cleft palate, but this outcome has not been recorded in Australia, where fortification was voluntary. For all clefts combined, a decrease was seen in the USA, but not in Canada or Chile. Findings of case-control studies of multivitamin supplements containing folic acid, maternal dietary folate intake, and red cell and plasma folate are inconsistent. Other nutrients that could play a part in development of orofacial clefts include riboflavin and vitamin A. Fetal exposure to retinoid drugs can result in severe craniofacial anomalies, but the relevance of this finding to dietary exposure to vitamin A is uncertain.

2.3 Genetics and disorders involvement

Cleft lip with or without cleft palate is listed as a feature of more than 200 specific genetic syndromes, and isolated cleft palate is recorded as a component of more than 400 such disorders. The proportion of orofacial clefts associated with specific syndromes is between 5% and 7%. If specific genetic disorders are excluded, the recurrence risk to siblings is greater than that predicted by familial aggregation of environmental risk factors. Concordance rates for cleft lip, cleft lip and palate, and cleft palate alone are higher in monozygotic twin pairs than in dizygotic pairs. The familial clustering and concordance recorded in twins with cleft lip with or without cleft palate and isolated cleft palate is specific for each defect, and therefore the anomalies are thought to have heterogeneous causes.

In a study in North Cyprus done on 27 babies born in a period of 10 years with cleft lip and/or palate (Kamiloğlu, 2019) showed that 21 of these babies have syndromes. Most of these babies (15 male and 6 female) were males.

2.4 Global initiative to manage cleft lip and/or palate

Services and treatment protocols for management of children with cleft lip and palate can differ remarkably within and between developed countries. In Europe, a networking initiative funded by the European Union in the late 1990s reached consensus on a set of recommendations for cleft care delivery, which were subsequently adopted by WHO. However, findings of a network survey indicated that these guidelines were seldom matched in practice. The absence of a sound evidence base for selection of treatment protocols was shown by a striking diversity of practices across Europe for surgical care of just one cleft subtype—unilateral complete cleft of lip, alveolus, and palate. Of 201 teams doing primary surgical repair for this defect type, 194 different protocols were being practiced. Even though 86 (43%) groups closed the lip at the first operation and the hard and soft palate together at the second, 17 possible sequences of operation to close the cleft were being used. One operation was needed to completely close the cleft in ten protocols (5%), two were needed in 144 (71%), three operations were used in 43 (22%), and four were needed in four protocols (2%). Around half used presurgical orthopedic techniques with mostly passive plates and some teams also used a plate to assist with feeding. These uncertainties in treatment indicate the paucity of published randomized trials of cleft care. Such studies present particular challenges for planning and recruitment in comparison of surgical techniques, because trial protocols must take account of the surgical learning curve. So far, only a brief systematic review of cleft care has been published, as has a systematic review of prevalence of dental caries in children with clefts. Reliability of prenatal ultrasonographic diagnosis has been increasing, although sensitivity is still low, particularly for cleft palate. The rate of termination of pregnancy because of presence of a cleft varies between countries, but it remains generally low. Genetic testing in the future could enhance sensitivity and specificity of prenatal diagnosis for syndromic and non-syndromic orofacial clefts. Service organization, inequality of care, and treatment uncertainty are widespread issues, and scarce resources put basic surgical treatment beyond the reach of thousands of children in developing countries. Accordingly, WHO have highlighted the need for effective international collaboration on strategies to enhance clinical care, through interaction of regional cooperatives such as the Eurocran project. Several research priorities were noted by WHO, including: surgical repair of different orofacial cleft subtypes; surgical methods for correction of velopharyngeal insufficiency; methods for management of perioperative pain, swelling, and infection; and nursing. Clinical trials of these issues would need to include sufficient numbers of patients to be of adequate power. Other multidisciplinary studies of cleft care might include: use of prophylactic ventilation tubes (grommets) for middle-ear disease; presurgical orthopedic techniques; methods to achieve optimum feeding before and after surgery; and different approaches to speech therapy. In developing countries, trials need to address affordable surgical, anesthetic, and nursing care.

For rare interventions, prospective registries should be established to accelerate collaborative monitoring and critical appraisal, equivalent to phase I trials. Relevant topics would be craniosynostosis surgery, ear reconstruction, distraction osteogenesis for hemifacial macrosomia and other skeletal variations, midface surgery in craniofacial dysostosis, and correction of hypertelorism. Another urgent issue is the need to create collaborative groups (or to enhance networking of existing groups) to develop and standardize outcome measures. Work on psychological and quality-of-life measures and economic outcomes is needed especially urgently. Collaboration between clinicians and laboratory-based scientists is also essential, not only to describe phenotype much more sensitively than has been done hitherto but also to augment knowledge translation from bench to bedside. Such collaboration has not yet happened in the description and ascertainment of the importance of microforms. Other solutions, incorporating various amounts of charitable and non-governmental support, include high-volume indigenous centers of excellence, contracts between non-governmental organizations and local hospitals, and volunteer short-term surgical missions. WHO recommends promotion of dialogue between different non-governmental organizations to develop agreed codes of practice and adopt the most appropriate forms of aid for local circumstances, with emphasis on support that favors original long-term solutions.

2.5 Prevention and management of the disorder

Identification of modifiable risk factors for oral clefts is the first step towards primary prevention. Such preventive efforts might entail manipulation of maternal lifestyle, improved diet, use of multivitamin and mineral supplements, avoidance of certain drugs and medicines, and general awareness of social, occupational, and residential risk factors. The proportion of clefts attributable to maternal smoking in populations with a high prevalence of smoking in women of reproductive age was estimated at 22%. However, the link with smoking was not even mentioned in international reports on smoking and health. Tobacco use is rapidly increasing in women of reproductive age in many countries because they are targeted actively by tobacco marketing campaigns. Pictures of children's faces have been used to establish some of the world's largest medical charity organizations devoted to surgical repair of orofacial clefts. A similar approach might prove effective in public health campaigns to reduce tobacco use by women. Multivitamin and mineral supplements are associated consistently with reduced risk of cleft lip, cleft lip and palate, and cleft palate alone. However, adverse effects of long-term use of supplements containing antioxidant vitamins have been reported; therefore, clarification of the specific nutrients and minerals that account for this apparent inverse association is important (Mossey, 2009).

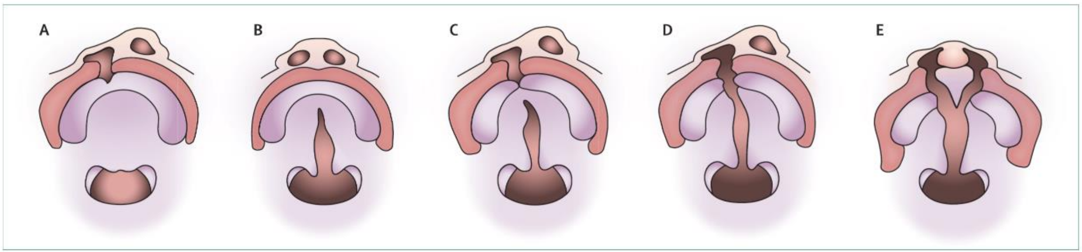


Figure 1: Non-syndromic orofacial clefts

(A) Cleft lip and alveolus. (B) Cleft palate. (C) Incomplete unilateral cleft lip and palate. (D) Complete unilateral cleft lip and palate. (E) Complete bilateral cleft lip and palate.

2.6 Concept of nasal molding

In the treatment of cleft lip nasal deformity, the correction of nose continues to be the greatest challenge. In patients with unilateral cleft lip and/or palate, the nasolabial defect influences the physical appearance of the child. Hence it is recommended to perform nasal molding prior to primary lip repair. Considering that nose is an important component of facial esthetics, correction of nasal symmetry and nasolabial fold is an important objective of nasoalveolar molding (Fig. 2) (Fig. 3). According to Millard (1984) clefting is due to disturbance of embryogenesis and proper closure of all involved structures should be achieved as soon as possible to favor normal growth of the face. Several approaches have been used in order to reduce the nasal asymmetry early in life using surgery alone or in conjunction with other approaches. Matsuo et al designed a nasal stent for the correction of the nasal deformity. However a drawback of this stent was that it required an intact nostril floor. In the cases without nasal floor, Matsuo performed primary lip adhesion to make stenting possible. Another modification as suggested by Grayson was addition of nasal stent in the alveolar molding plate. This did not require the presence of intact nasal floor and as the stent was added to the plate, controlled force could be exerted. Modified extra oral nasal molding appliance was suggested by Doruk et al (2005). The advantage of this appliance was that there was no need for nasal impressions and same appliance could be used for different patients after sterilization.

Kamiloğlu, used feeding and alveolar molding appliance. A soft denture liner was added in the area that required molding, and selective grinding of the hard acrylic was done where movement was expected. The second stage occurred when in unilateral clefts the intraalveolar gap had been reduced to 5–6 mm and in bilateral clefts the premaxilla and prolabium were located mostly on the alveolar ridge. The PNAM targets the nasal cartilage molding by incorporating a nasal stent component. The acrylic at the active tip of the nasal stent was covered with a thin layer of soft denture lining material to help prevent tissue irritation. An extraoral retentive button was fabricated with a ~40° downward angle. Betafix Surgical Hypoallergenic Flexible Tape, 2.5 × 5 cm, and orthodontic elastics were used for retentive taping. Postinsertion instructions were given to the parents regarding the wear and hygiene of both the feeding appliance and the PNAM (Fig. 5). The parents were asked to disinfect the appliance daily by cleaning it first with a toothbrush, soaking it in lukewarm water containing one quarter of an effervescent Steradent denture-cleansing tablet for 2 min, and later washing the appliance with drinking water. The nasal stent was kept out of the disinfecting solution because of the soft acrylic at the tip of the stent. The parents were asked to bring the cleft lip and palate babies in for weekly follow-up (Kamiloğlu, 2014).

Another study with case report of a 1-week-old male infant with a bilateral cleft lip and palate examined and treated by surgeon and orthodontist in Ankara University. Where they used nasoalevoelar molding before surgery (Fig. 4). The baby's nutrition was managed through a feeding tube. He was diagnosed by right incomplete, left complete cleft lip, and complete cleft palate deformity. At 2 weeks after birth, a conventional molding plate was fabricated on the maxillary cast obtained by an elastomeric impression material. This molding plate was secured in the infant's oral cavity by surgical tapes passing through the buttons. Initially, the molding plate was modified at weekly intervals to gradually approximate the premaxilla and alveolar segments and to reduce the sites of the intraoral cleft gaps. When the alveolar gap was reduced to <5 mm, the nasal stents were added to the labial flanges molding plate. The nasal stents were prepared from a stainless steel wire. The sections of the stents that were inserted inside the nostrils were covered with soft acrylic resin to not irritate the infant's nasal tissues. The weekly activations of the stents are performed by adding a soft acrylic resin. The nasal stents support the nasal tip and create soft tissue expanding forces that are directed to the columella and nasal lining. In addition, they provide support and give shape to the nasal tip and alar cartilages in the neonatal period while the cartilages are still flexible. When there is enough tissue at the columella region, the stents are connected with a bridge made of soft acrylic resin. This bridge and the lip bands also help elongate the columella. After a 2-month 3-week period of presurgical orthopedic treatment, the infant was ready for primary lip and nose repair (Altuğ, 2017).

Various studies have been conducted to assess the nasal changes after presurgical nasoalveolar molding. Studies performed by evaluating the casts after nasoalveolar molding revealed that this therapy significantly improved the nasal symmetry. Columella deviation, length and width were also significantly improved (Spengler et al 2006). Similar results were obtained by Pai et al who performed the evaluation based on the photographs of the patient. However some amount of relapse of the nostril width, height and angle of columella were observed at 1 year of age. Study conducted by Maull et al (1999) to determine changes in three dimensional shape of the nose after nasoalveolar molding also showed improved symmetry of the nose. However, early primary rhinoplasty procedures initially yielded good results, but return of original deformity soon followed. This was due to the inherent dysmorphology of the nasal cartilages and due to the contractures after surgical repair. Hence to prevent this post-surgical nasal stents have been recommended. Koken nasal splints which are commercially available can be used to prevent post-surgical relapse. Modification of this splint has been suggested by Cobley et al (2000) which could allow the stent to be removed and cleaned to maintain hygiene and also maintain the airway patent.

However very young patients have difficulty in tolerating such devices in which cases nasal splints can be recommended at the age of 4 or 5years when the child is more cooperative. One such appliance is dynamic nasal splint suggested by Cenzi R and Guarda, This splint acts by applying gradual orthopedic action. This splint consists of an expansion screw which is to be worn for 40 – 60 days for 15-18hours/day. Later the appliance is kept inactive without activating for a period of 3-4months. This is generally recommended after 4-5yrs of age when the patient is cooperative and accepts the nasal splint. The presurgical alveolar molding protocol for cleft patients has been described by Grayson et al (1993). In this protocol a conventional intra oral molding plate is fabricated after making the intra oral impressions. The molding plate is modified at weekly intervals. The modification is done by 0.5 – 1mm increments. The appliance is selectively grinded in the areas were movement is expected at the same time soft denture liner is added in the region which require molding. This is similar to Zurich type of molding device described by Hotz (1969). The soft denture liner applies pressure on the alveolar ridge. The effectiveness is enhanced by lip taping. The lip taping produces controlled orthopedic force which helps the molding plate to guide the alveolar segments in position. Various studies have been conducted to evaluate the effect of nasoalveolar molding. Study conducted by Ezzat et al has shown statistically significant reduction in the intersegmental distance in the cleft gap. At the same time it was found that the arch was not collapsed as there was an increase in maxillary arch width. Bongaarts et al, reported Infant orthopedics does not have any influence on the maxillary arch dimensions. Study conducted by Spengler et al on bilateral cleft lip and palate patients has shown that there significant improvement in the nasal symmetry. It was also found that nasoalveolar molding forces the protruded premaxillary segment into alignment with dentoalveolar segments, thereby improving the shape of the arch. Three dimensional analysis of effect of alveolar molding was done by Baek et al (2006). The results of the study suggested that the cleft gap was significantly reduced. It was also found that alveolar molding took place mainly in the anterior alveolar segment and growth occurred mainly in the posterior alveolar segment.

The timing of repair of the defect also plays an essential role. As described by Matsuo, the earlier the intervention is initiated the better are the results. A study was conducted by Shetty V to evaluate the effect of nasoalveolar molding at different ages. The results of the study indicated that favorable outcome was obtained when the treatment was initiated within 1 month of life however positive outcome was also achieved when the treatment was initiated within 5 months of life but to a lesser extent. Although all studies evaluating the effect of nasoalveolar molding have shown significant improvement in the result, but the drawbacks of these studies are that they are performed on a smaller population group and they lack a control group the subjects who do not undergo alveolar molding. Also long term effects of nasolaveolar molding have not been evaluated. Hence further studies are required to conform the long term effects of nasoalveolar molding.

2.6.1 Complications of Pre Surgical Naso-Alveolar Molding

Pre surgical nasoalveolar molding is most effective with full time wear. However, full time wear can be associated with certain complications like ulceration, tissue irritation and fungal infections and bleeding. Soft tissue ulcerations can be due to excessive activation or due to pressure from the molding plate. These ulcerations heal with the selective trimming of the molding plate. Improper maintenance of the hygiene with the full time wear of molding plate can also result in fungal infection. This can be treated by Nystatin or Amphotericin. However the Nasoalveolar molding therapy should continue during the treatment phase. Another common complaint with nasoalveolar molding is rash like area of erythema and chafing on the zygomatic process areas due to extraoral taping. These are generally self-limiting. The best way to prevent these rashes is to wet the tape thoroughly before removal of the same.

Excessive pressure on the nasal cartilage can result in mega nostril. This occurs due to excessive increase in the circumference of the nostril due to improper stent positioning or nasal over contouring. Controversies exists over the correction to compensate for the relapse. One group suggests slight orthopedic over correction of the alar dome (Singh et al 2005) while other group suggested vertical surgical nasal overcorrection (Liou et al 2004). However application of over activation should be avoided which may be seen clinically as external bruising or petechiae in the area of insult.

Hard tissues complications associated with nasoalveolar molding include excessive rotation of the lesser segment to meet the greater segment in a perpendicular manner, resulting in asymmetric T shaped configuration. Hence proper care should be taken to modify and monitor the segment movement. Another hard tissue complication involves eruption of the teeth. This could be due to the pressure exerted on the gingival tissues by the molding appliance. Modification of the appliance can be done to allow for favorable eruption of the teeth (Murthy et al., 2013).

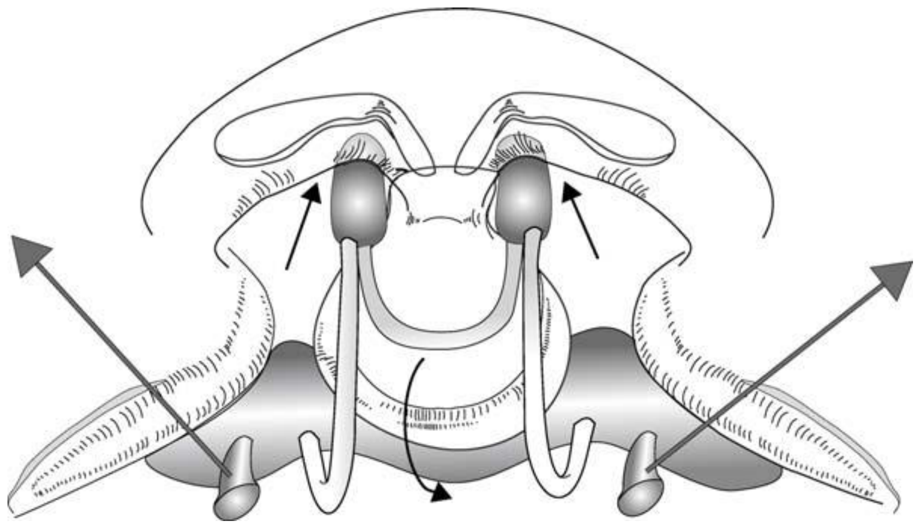


Figure 2: Nasoalveolar moulding (Penfold et al., 2011).

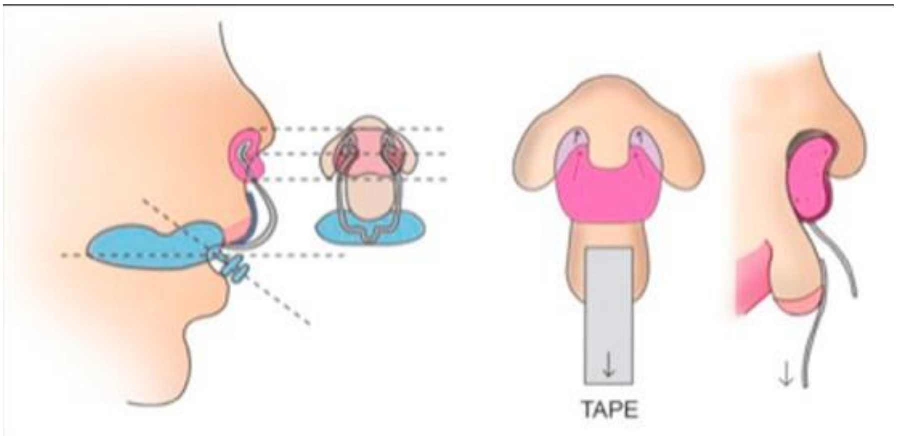


Figure 3: Showing the design of the nasal stent and the position of the nasal stent in the nostril (Shetye, 2017).

Figure 4: Showing Nasal stent incorporated in the nasoaleveolar molding (Altuğ, 2017).

Figure. 5: Showing the Initial, progress, and postoperative photographs using (PNAM**) (**Kamiloglu, 2014)**.**

2.7 Timing and staging of repair and use of presurgical orthopedics

Presurgical orthopedics and staged methods of repair have been advocated to address two main problems in the repair of BCLP. The first problem is how to achieve complete reconstruction of the muscles across a severe cleft with a protuberant premaxilla. The second is how to lengthen the columella; this will be discussed in the context of correction of the nasal deformity (Penfold et al., 2011).

2.8 Presurgical orthopedics

Presurgical orthopedics has been used since the 1950s to reposition the segments of the maxilla. Techniques have ranged from relatively non-invasive passive plates with external strapping to more invasive techniques such as Latham’s pinned premaxillary retractive device. The main objective of traditional presurgical orthopedics in the repair of BCLP is to retro-position the premaxilla and enable a tension-free repair of the lip. Although there is no doubt that it facilitates the repair and is still widely used, there is no evidence that it improves outcome. Over the last decade its role has been extended to address the problem of the deformed nasal tip using various forms of devices for nasoalveolar molding about which evidence on effectiveness is now accumulating (Penfold et al., 2011).

2.9 Staging of primary surgery

Two-stage repairs of the lip involve either an initial bilateral lip adhesion where repair of the muscles is usually completed at the second stage, or a one-side-first approach (RANDALL, 1965). Bilateral lip adhesion acts as a form of presurgical orthopedics and helps to control the protrusive premaxilla, which enables a later definitive repair. This inevitably delays any attempt at synchronous repair of the lip and nose, and there is no evidence that it improves long-term outcome. However, it is recognized that in very wide clefts it may not be technically possible to repair the muscles completely. In this situation an incomplete repair similar to that advocated by Delaire is more robust and effective than a formal lip adhesion, and can be achieved using a wide subperiosteal release even in the most severe cases (Delaire, 1991). The repair can then be completed as a secondary procedure 8–10 months later. A one-side-first method also precludes synchronous repair of the lip and nose but it does facilitate staged closure of the alveolar clefts with vomer flaps. At the second stage repair of the remaining unilateral cleft can be difficult if the premaxilla has rotated to the repaired side.

2.9.1 Reconstruction of the philtrum and midline vermilion

The midline vermilion can be reconstructed from the prolabial vermilion or from lateral vermilion flaps, or a combination of both. In a Manchester-type repair the prolabial vermilion is incorporated into the lip repair, which avoids scarring along the junction of the skin and vermilion (Manchester, 1965). This method, however, results in a midline segment of vermilion that looks abnormal. The prolabial vermilion is quite different to normal vermilion as it lacks a white roll and has no mucous glands. In the original Manchester repair the muscles were not reconstructed across the prolabium. This resulted in a functionless central lip segment that was associated with a “whistle deformity”, and it accentuated the difference between the medial and lateral vermilion. If muscle reconstruction across the prolabium is good, then the issue about whether to preserve the midline vermilion or use lateral vermilion flaps is probably less critical. This is particularly true when the width of the prolabium is thinned to the extent advocated by some authors, notably Mulliken (Mulliken, 2004). There may be some merit in conserving a small triangle of prolabial vermilion in cases where there is little white roll in the lateral segment as described by Brusati et al. An overstretched and wide philtrum is a common problem after the repair of BCLP, but a reduction in the width of the prolabium can compensate for postoperative stretching. Mulliken et al. whose method of repair is facilitated by presurgical orthopaedics, recommend that the distance between the peaks of Cupid’s bow should be 3.5–4 mm, decreasing to 2mm at the columellar labial junction (Mulliken, Wu, & Padwa, 2003). This would be difficult to achieve in wide clefts without presurgical orthopedics, even with good muscle reconstruction, and in this situation the adjustment to the prolabial width may have to be adequate with satisfactory skin closure. A simple modification of Millard’s shield design16 that incorporates the landmarks already described is used by the author and shown in (Fig. 6). The final point to consider when designing the prolabial flap is what to do with the wet prolabial mucosa. It can be used to augment the premaxillary lining of the fornix; the anterior sulcus wall is then reconstructed entirely with mucosal flaps that are advanced from the lateral segments of the cleft. This helps to produce a deep sulcus, but accentuates the tightness of the lip closure. An alternative approach is to incorporate the wet prolabial mucosa in the anterior sulcus wall, but its base should be carefully trimmed to avoid a mucosal bulge.

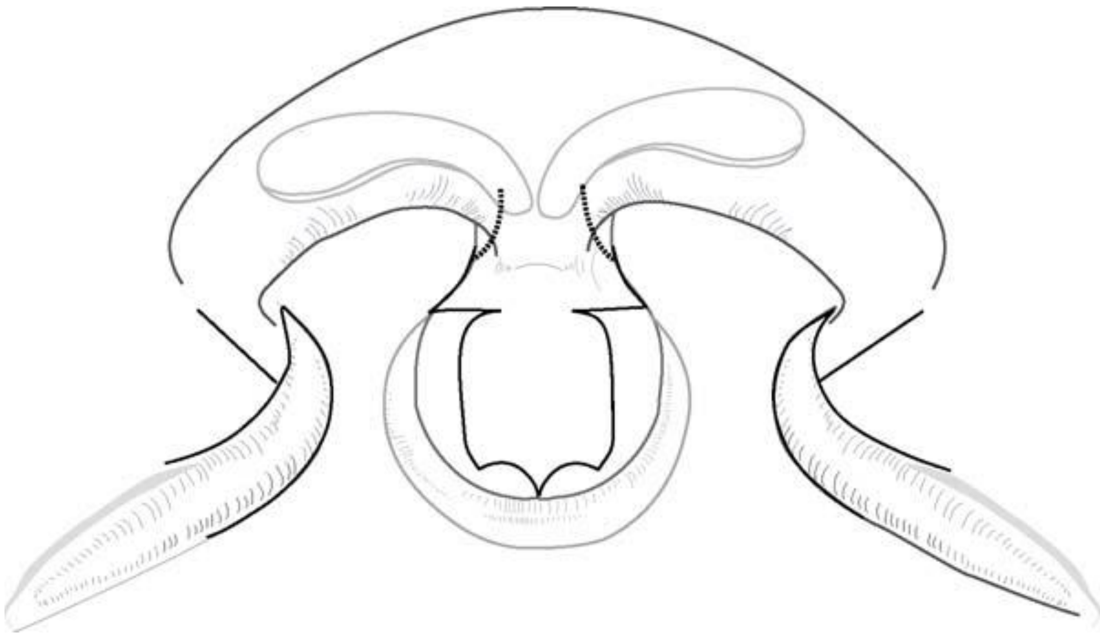


Figure 6: A simple incision design. Broken line = incision through membranous septum (Penfold et al., 2011).

2.9.2 Reconstruction of the nasolabial muscles

Muscle from the lateral elements should be advanced medially to reconstruct the nasolabial muscle rings as there is no muscle in the prolabium. There is little agreement about the best method of reconstruction partly because there is a lack of consensus about the normal anatomy of the nasolabial muscles, and partly because complete restoration of normal muscular anatomy at the time of primary repair in the severe bilateral cleft may be unrealistic (Fig. 7). Many authors advocate reconstruction of the superior oblique component (external bands) of the orbicularis oris muscle either to the anterior nasal spine, or to the base of the nasal septum, which restores continuity of the middle muscle ring (Kamdar, 2008)(Mulliken, Wu, & Padwa, 2003)(Talmant, 2000).

The boundary between the skin of the lip and skin of the nose in the lateral element marks the boundary between the underlying transverse nasalis muscle and the external bands of orbicularis oris, and facilitates their dissection (Fig. 8). Delaire emphasised the importance of reconstructing the upper nasolabial muscle ring by suturing the transverse nasalis muscle to the anterior nasal spine (Delaire, 1978). Talmant thinks that this method lifts the nasal sill too high, and advocates a lower origin for nasalis on to the periosteum of the lateral aspect of the premaxilla just below the fornix (Talmant, & Lumineau, 2004). Even if one is sceptical about the benefit of reconstruction of the transverse nasalis muscle, Delaire's method produces a functional lip that can pout, and will lengthen over time (Markus, & Delaire, 1993)(Precious, 2009).

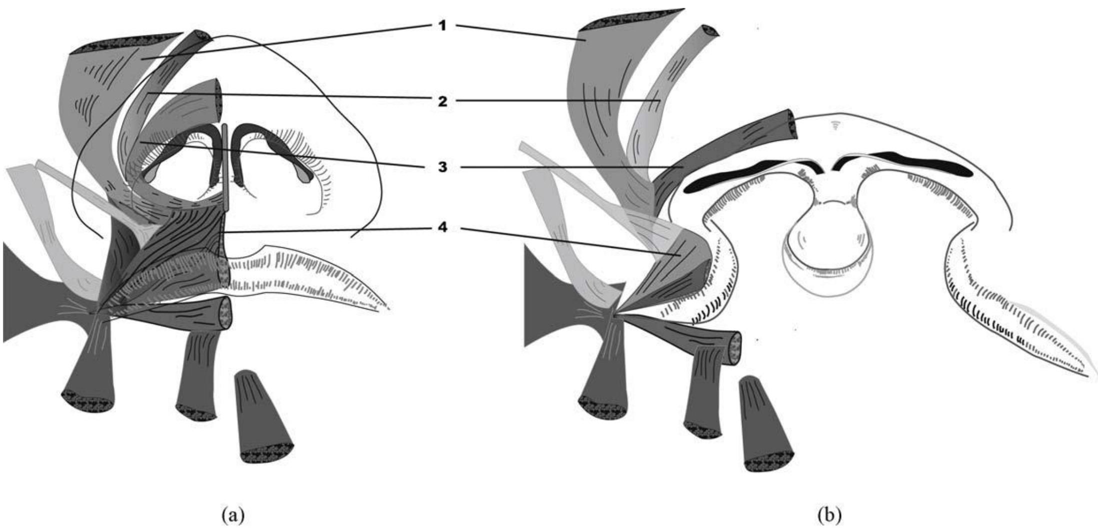


Figure 7: Anatomy of nasolabial muscle (a = normal; b = bilateral cleft lip); muscles: 1 = levator labii superioris; 2 = levator labii superioris alaeque nasi; 3 = transverse nasalis; 4 = external bands of orbicularis oris and levator labii superioris. (Penfold et al., 2011).

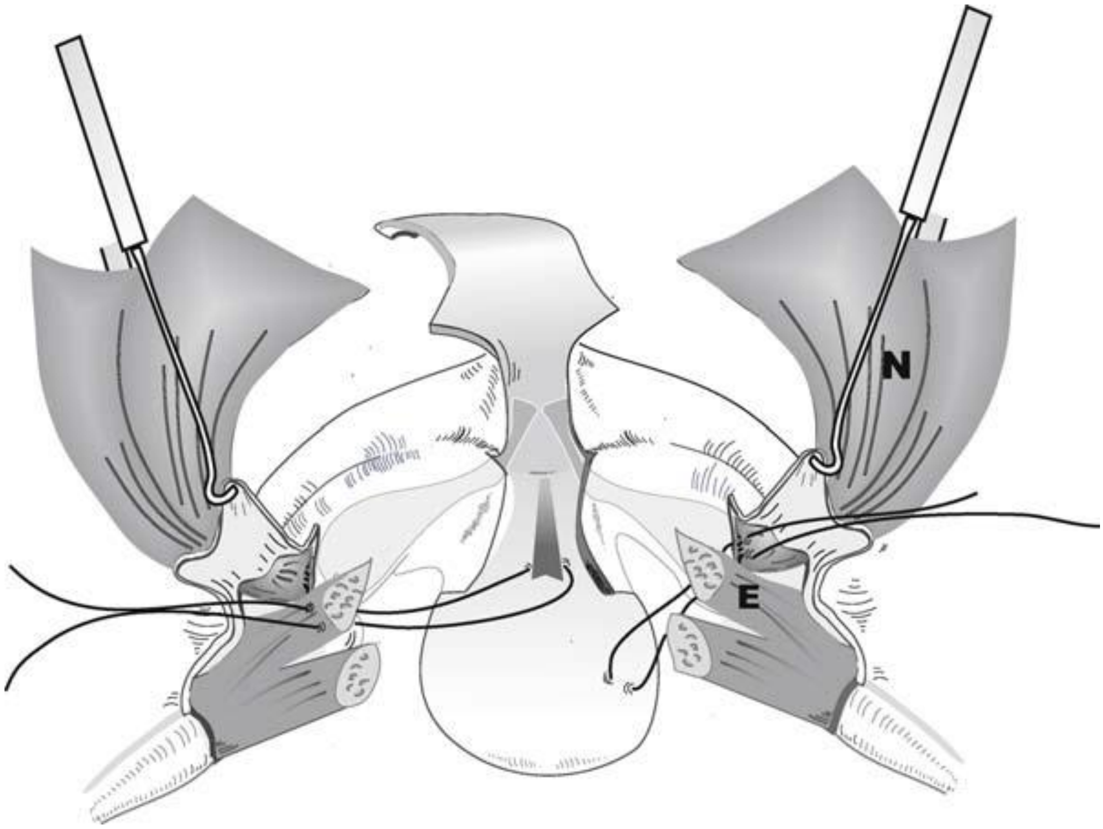


Figure 8: Nasolabial muscle repair (Talmant's modification of Delaire's method). (E = external bands of orbicularis oris and levator labii superioris muscles; N= transverse nasalis muscle). (Penfold et al., 2011).

2.9.3 Correction of the nasal deformity

The short columella is seldom fully corrected by functional surgery alone, and techniques have been devised to import skin from the prolabium or nasal sill into the columella to provide length. Examples include the elevation of forked flaps from the sides of the prolabium as described by Millard, and the nasal sill advancement flaps described by Cronin (Millard, 1971)(Cronin, 1958). The disadvantage is that they produce unsightly scars under the columella, and unnatural, overtly large external nares, the latter being a consequence of ignoring the real nature of the deformity of the alar cartilage. The domes of the alar cartilages are grossly flattened but the cartilage itself is seldom hypoplastic. Increased length of the lateral crus is at the expense of the medial crus, the effect of which is to drag the columella "into the nose". Recognition of the true nature of the deformity of the nasal tip has inspired a different approach to lengthening of the columella; it should be possible to retrieve the columella from the nasal tip and achieve a more anatomically balanced result with less scarring. Technical constraints inevitably impose an element of compromise between the demands of both columellar length and lip height. Ideally, the junction of the columella and lip should be established at a point midway between the prolabial mucocutaneous junction and the planned superior internal angle of the nostril. This anticipates a spontaneous increase in lip height, and complements retrieval of the columella from inside the nose.

Primary surgical reshaping of the alar cartilages in BCLP has been advocated by a number of surgeons (Mulliken, 1992)(Broadbent, & Woolf, 1984)(McComb, 1990)(Ward, & SA, 1999)(Trott, & Mohan, (1993). Access to the alar cartilages was initially achieved by external approaches through the flattened nasal tip, but dissatisfaction with long-term results led to more conservative approaches through intranasal incisions that resulted in less visible scarring. The reshaped lower alar cartilages can be supported by direct suturing or long-term nasal splints (Fig. 9). Although early results of primary cleft rhinoplasty have been encouraging, those of long-term studies still counsel a degree of caution, particularly about the extent and site of access incisions to the nasal tip. Three main themes can now be distilled from the wide variety of techniques advocated for primary correction of the alar cartilage. The first is a conservative technique with no extra incisions. The alar cartilages are approached medially from the prolabium by tunnelling under the columella and laterally from the alar bases. This can be combined with a limited amount of subperichondrial nasal septal dissection to allow for the repositioning of the medial crura. The second, the retrograde technique (posterior to medial crura) uses an extended prolabial incision up through the membranous septum. The alar cartilage is then accessed through a retrograde approach. The advantage of this method is that the prolabial blood supply is well maintained, and the medial crura can be repositioned superiorly to support the lengthened columella. The disadvantage is that access to the alar dome is difficult, and direct visualization of the alar cartilages is seldom possible. Cutting et al. emphasized the importance of dissecting out the fibroadipose tissue between the alar domes to allow for apposition of the cartilages (Fig. 10) (Cutting, Grayson, Brecht, Santiago, Wood, & Kwon, 1998). He combined a retrograde approach with intranasal rim incisions in those cases where nasoalveolar molding had not been completed. This provides good access to the alar dome for direct suturing without compromise of the prolabial blood supply. The third is an anterograde technique (anterior to medial crura) where the prolabial incision is continued subcutaneously up the lateral aspect of the columella superficial to the alar cartilages, together with a separate intranasal rim incision. Mulliken achieved improved postoperative columellar length using this method, but the nasolabial angle, columellar and interalar widthwas greater than normal (Kohout, Aljaro, Farkas, & Mulliken, 1998). Trott and Mohan extended the columellar incision into the intranasal rim incision (Trott, & Mohan, (1993). This allows direct access to the medial and lateral crura as in a conventional open rhinoplasty, but compromises the prolabial blood supply. There is no doubt that primary rhinoplasty with reshaping of the alar cartilage and direct suturing can produce satisfactory early results, but they are not always predictable. An open approach to the alar cartilage allows for nasal reshaping and may contribute to better and more predictable outcomes, but concern about the long-term effect of such radical primary nasal surgery still remains.

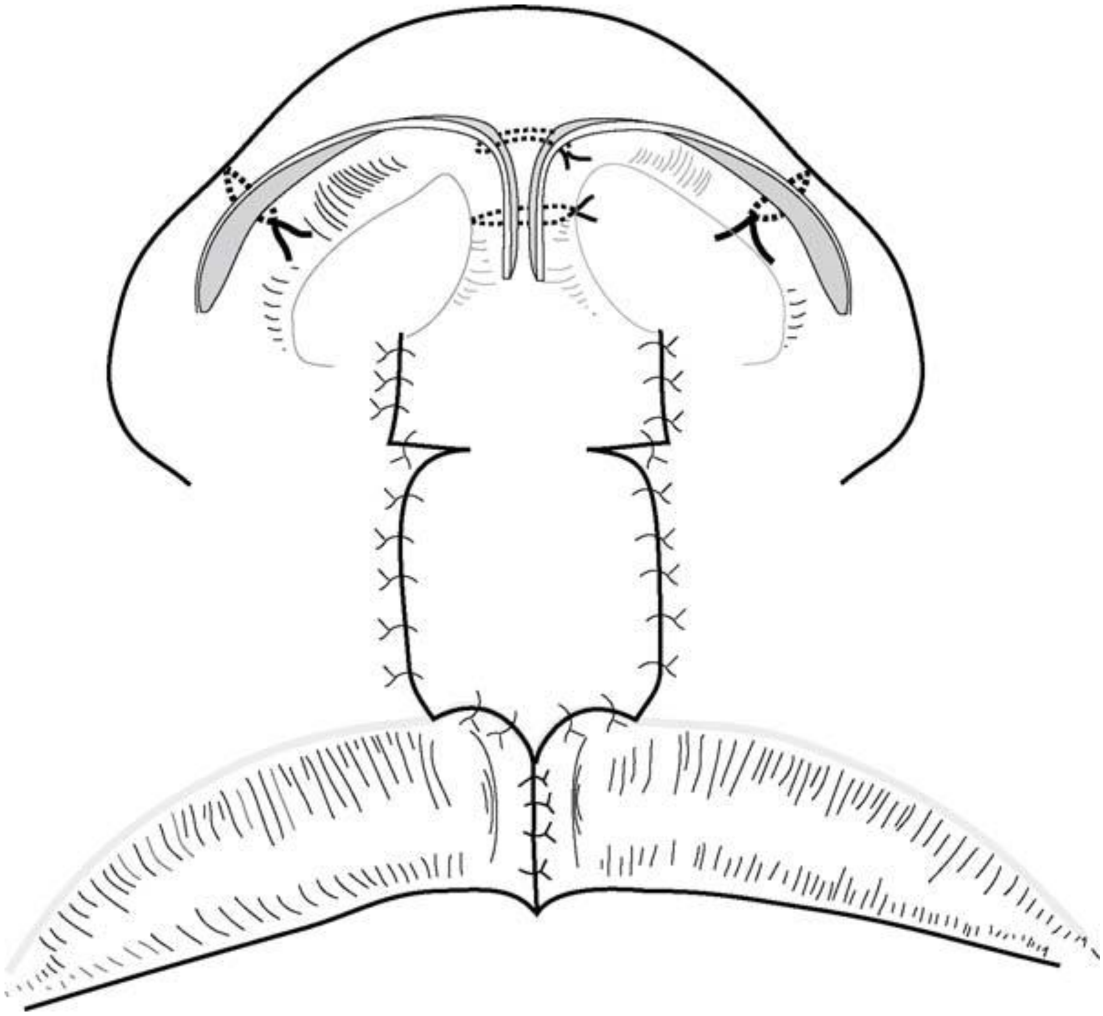


Figure 9: Dome support sutures (Penfold et al., 2011).

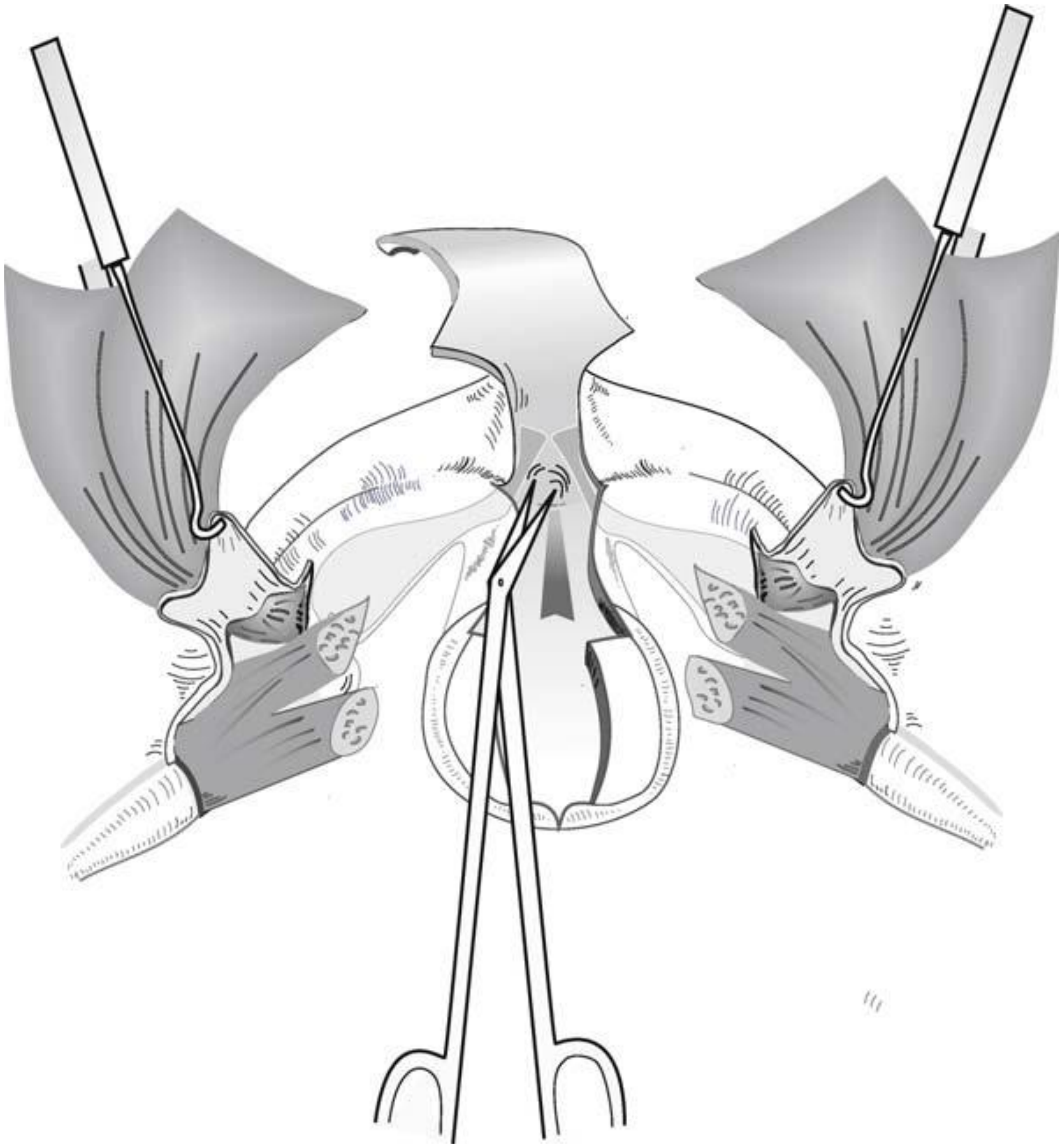


Figure 10: Retrograde approach to the nasal tip. Incision through the membranous septum extends posteriorly to the junction of the upper lateral cartilage and septum. Scissors are pointing into interdomal fat. (Penfold et al., 2011).

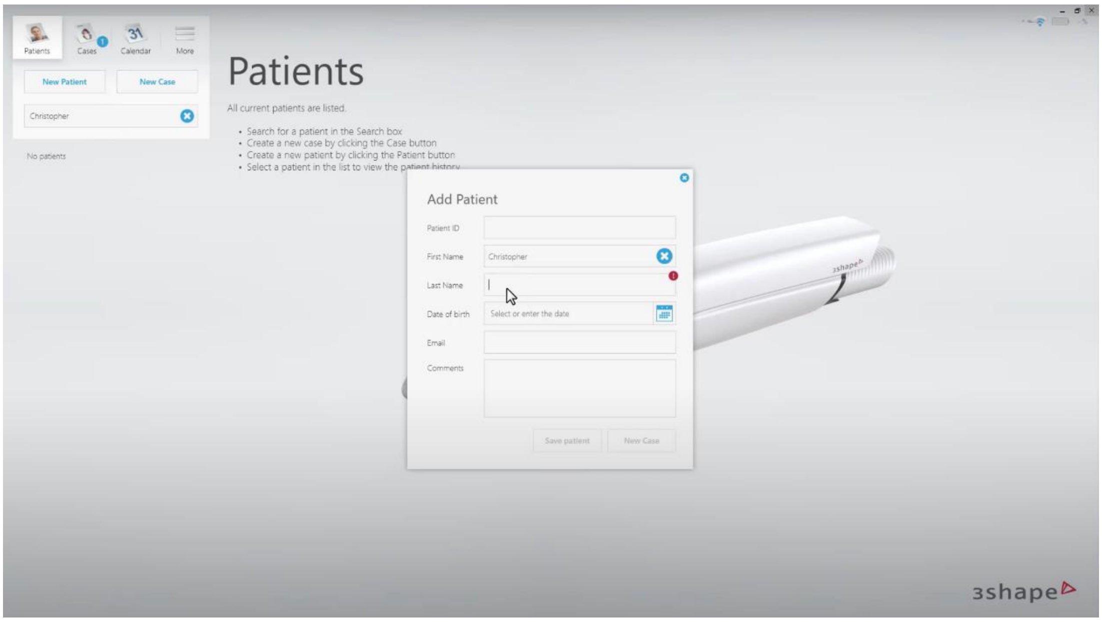
3. MATERIALS AND METHODS

We examined the pretreatment orthodontic digital dental casts of 110 patients, divided into 3 groups: group 1, ULCLP (41 subjects; 21 male, 20 female; mean age, 17.5 years); group 2, URCLP (14 subjects; 7 male, 7 female; mean age, 16.9 years); and group 3 (control) Class I (55 subjects; 27 male, 28 female; mean age, 15.6 years). The control group included those with Class I occlusion, proper overjet and overbite, well-aligned dental arches, normal dentoskeletal pattern, and harmonious profile, with minor or no crowding.

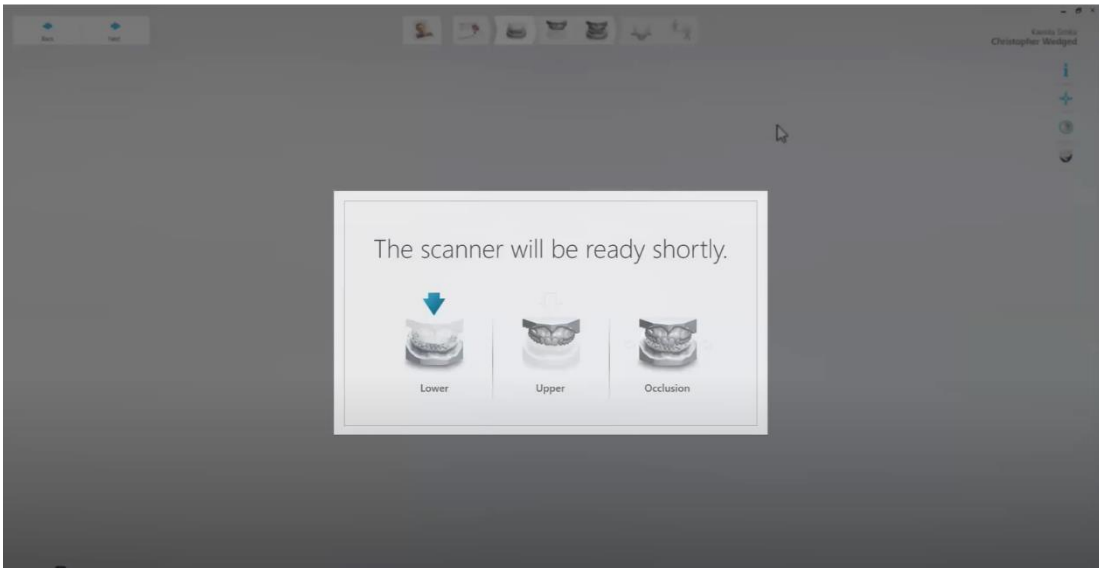
All patients were adolescents in the permanent dentition stage. All plaster casts of CLP patients were selected from the archives of the Department of Orthodontics at Faculty of Dentistry, Ankara University in Turkey. Plaster casts of (Class I) patients were selected from the archives of the Department of Orthodontics at Near East University in TRNC. Only Caucasian patients with good-quality dental casts were included. Casts with large restorations or crowns were excluded from the study.

All plaster casts were scanned using Intra-Oral scanner (3Shape TRIOS® 3 intraoral scanner) (Fig. 11). Measurements were done by using a digital software (3Shape Ortho Viewer. Ink) (Fig. 12) according to the method of Hunter and Priest, as follows: MD, the longest distance between the anatomic mesial to the distal contact point; LL (diameter), measured the longest distance between the Labial and lingual surface of the tooth perpendicular to the MD axis of the tooth (Fig. 13, Fig. 14). The same examiner (A.I.) made all the measurements to eliminate interexaminer variability.

Figure 11: 3D dental scanner (3Shape, Trios 3) that has been used in this study

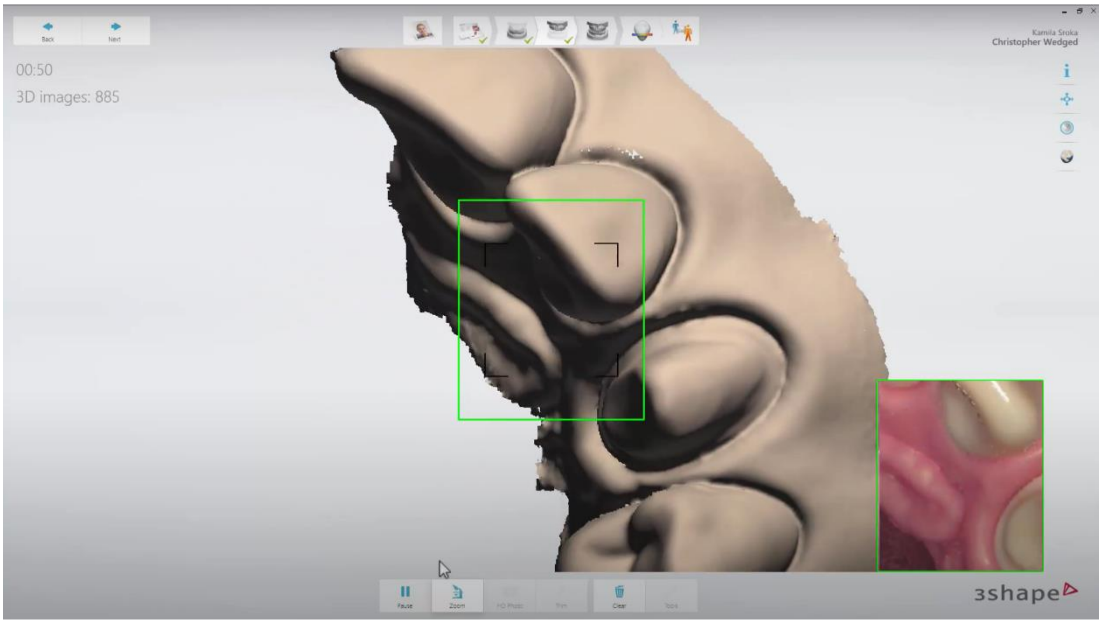


a



b

Figure 12: Digital software (3Shape Ortho Viewer) that have been used to scan the plaster casts and save them as STL files. A: starting a new scan by adding patients' information. B: choosing which dental arch to be scanned.



c

Figure 12: Digital software (3Shape Ortho Viewer) that have been used to scan the plaster casts and save them as STL files. A: starting a new scan by adding patients' information. B: choosing which dental arch to be scanned. C: scanning the dental arch.

3.1 Statistical Analysis

Statistical analyses were performed using SPSS software version 25. Descriptive analyses were presented using means, standard deviations, median, minimum, and maximum values for continuous data. The variables investigated using Kolmogorov-Smirnov test to determine whether or not they are normally distributed. Homogeneity of the variances between the groups was tested by Leneve's test. Since the variables were normally distributed, two independent samples t-test was used to compare the affected and not affected groups. Since the variables are not normally distributed, Mann-Whitney U test was used to compare these groups. Since the variables are normally distributed and variances are homogeneous, ANOVA test was used to compare three groups' means, if the variances, not homogenous Welch ANOVA was used to compare three group's men. Tukey or Dunnett's T3 test which is appropriate was performed the test the significance of pairwise differences. Since the variables are not normally distributed, a Kruskal-Wallis test was conducted to compare the medians of three groups. Mann-Whitney U test was performed to test the significance of pairwise differences using Bonferroni correction adjust for multiple comparisons. A 5% type-I error level was used to infer a statistical significance.

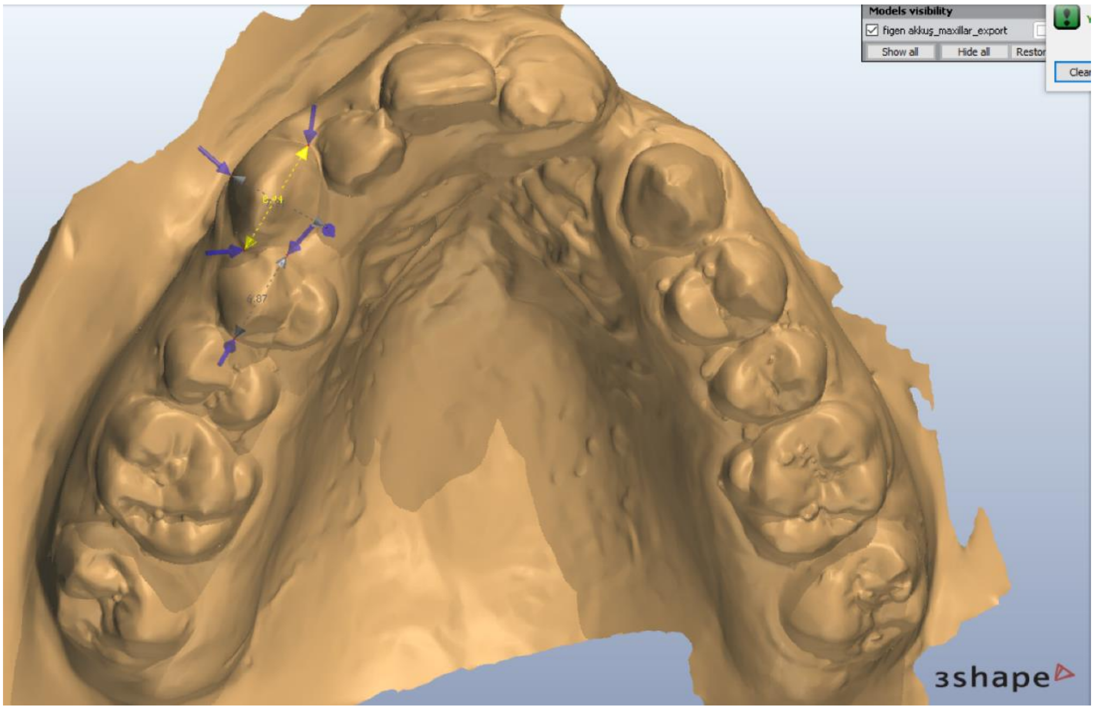


Figure 13: Mesio-Distal Dimension of the R Canine, Labio-Palatal Dimension of the R Canine, and Mesio-Distal Dimension of the R Premolar in CLP Patient.

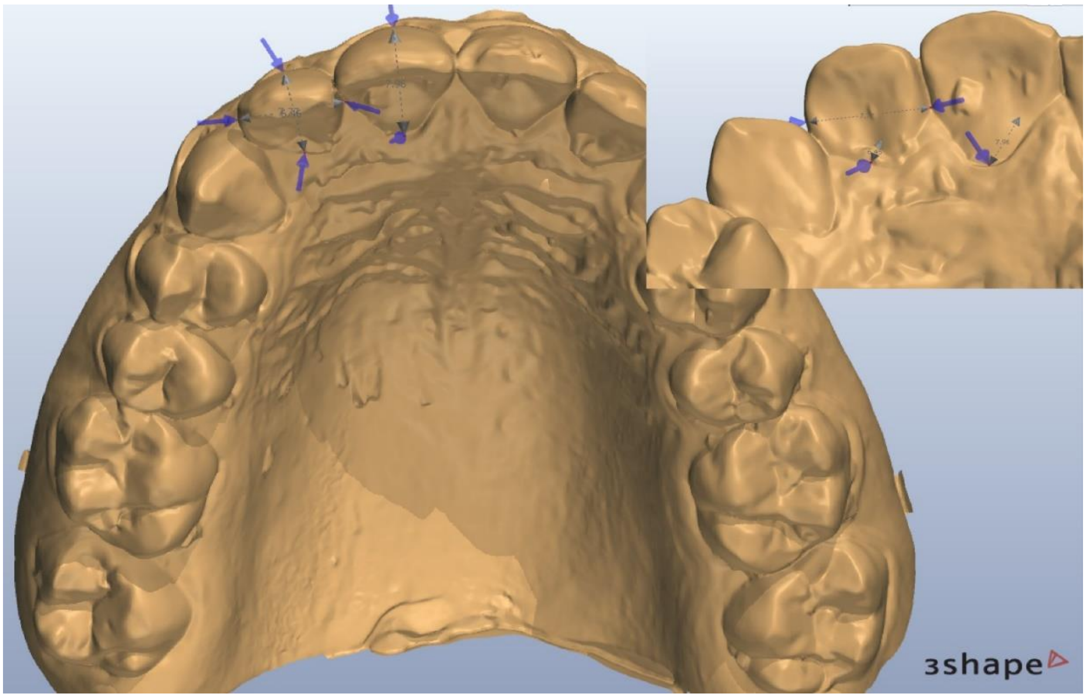


Figure 14: Mesio-Distal Dimension of the R Lateral, Labio-Palatal Dimension of the R Lateral, and Labio-Palatal Dimension of the R Cental in Class I Patient.

4. RESULTS

We found 17% of the teeth were congenitally absent in the CLP groups, In RCLP group mostly laterals were absent with a percentage of 64%. And in LCLP group also laterals were absent with a percentage of 85% with canines and second premolars next with 29%. Also, several malformation of the teeth has been noticed, 83 teeth of a total of 546 teeth of the CLP groups were malformed. Enamel hypoplasia was mostly noticed, then pegged shaped teeth mostly laterals and polydiastima (spacing of the teeth). And less noticed supernumerary teeth, macrodontia and mulberry molars (are a dental condition usually associated with congenital syphilis, characterized by multiple rounded rudimentary enamel cusps on the permanent first molars).

In (group 1) there are only statistically significant mean difference between right and left centrals mesiodistal and between right and left centrals labiolingual measurements between affected and not affected sides $p<0,05$. In these measurements, not affected (Right) side have a higher mean than the affected (Left) side (Table 1).

In (group 2) there is only statistically significant mean difference in right and left Canines labiolingual measurement between affected and not affected sides $p<0,05$. In this measurement affected (Right) side have a higher mean than not affected (Left) side (Table. 2).

In (group 3) there is no statistically significant mean difference between (Right) side and (Left) side ($p>0,05$) (Table 3) shows the values of mesiodistal and labiolingual measurements of Right and Left sides of class I (control group).

When comparing the (Right) sides between all three groups: we found a statistically significant mean difference in Centrals mesiodistal, Centrals labiolingual, Canines labiolingual measurements between groups $p<0,05$. And pairwise comparisons between groups were evaluated by Mann-Whitney u test. Bonferroni adjustment was done to the p values for Centrals mesiodistal measurement. For Centrals mesiodistal measurement; there was a statistically significant difference between Group 2 and Group 3 ($p=0,000$), and Group 1 and Group 3 ($p=0,023$). Group 3 mean was higher than in other groups. For Centrals labiolingual and Canines labiolingual measurements, pairwise comparisons between groups were evaluated by Dunnett's T3 test. For 11 labiolingual measurements; there was a statistically significant difference between Group 2 and Group 3 ($p=0,019$), and Group 1 and Group 3 ($p=0,015$). Group 3 mean was higher than in other groups. For canines labiolingual measurement; there was a statistically significant difference between Group 2 and Group 3 ($p=0,002$), and Group 1 and Group 3 ($p=0,004$). Group 3 mean was higher than in other groups (Table 4).

When comparing the (Left) sides between all three groups: we found a statistically significant mean difference in Centrals mesiodistal, Centrals labiolingual, canines labiolingual measurements between groups $p<0,05$. For Centrals mesiodistal measurement, pairwise comparisons between groups were evaluated by Tukey test. For Centrals mesiodistal measurement; there was a statistically significant difference between Group 1 and Group 3 ($p=0,000$). Group 3 mean was higher than in other groups. For centrals labiolingual and canines labiolingual measurements, pairwise comparisons between groups were evaluated by Dunnett's T3 test. For centrals labiolingual measurement; there was a statistically significant difference between Group 1 and Group 3 ($p=0,001$). Group 3 mean was higher than in other groups. For canines labiolingual measurement; there was a statistically significant difference between Group 1 and Group 3 ($p=0,020$). Group 3 mean was higher than in other groups (Table 5).

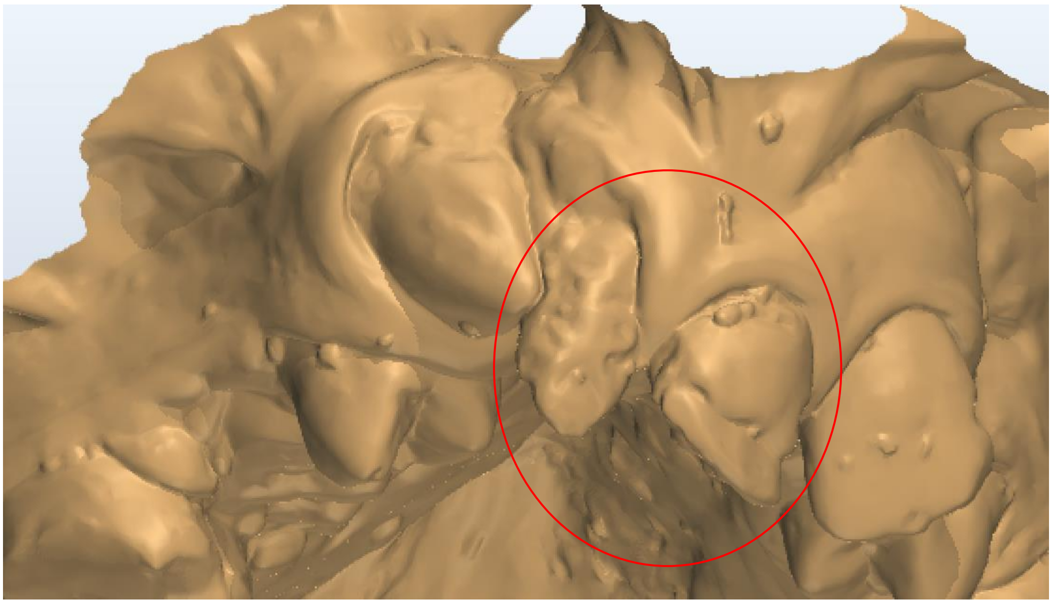
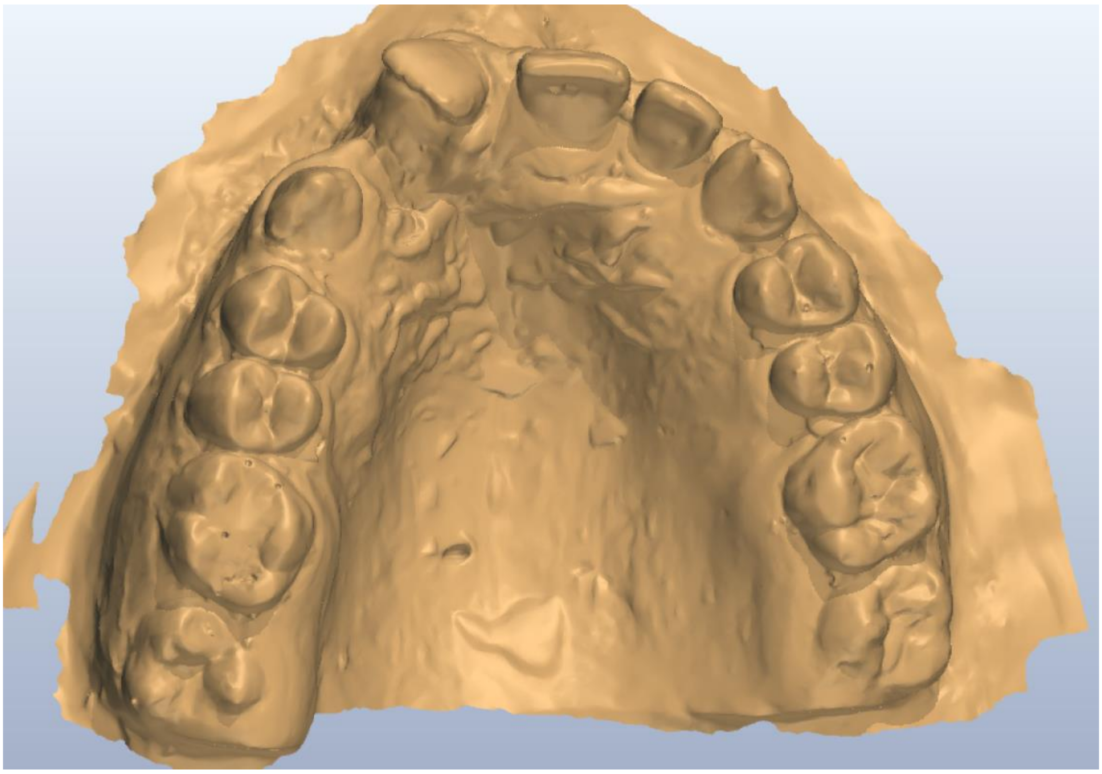


Figure 15: Enamel Hypoplasia



a

b

Figure 16: a: digital cast, b: panoramic x-ray showing an absent lateral.

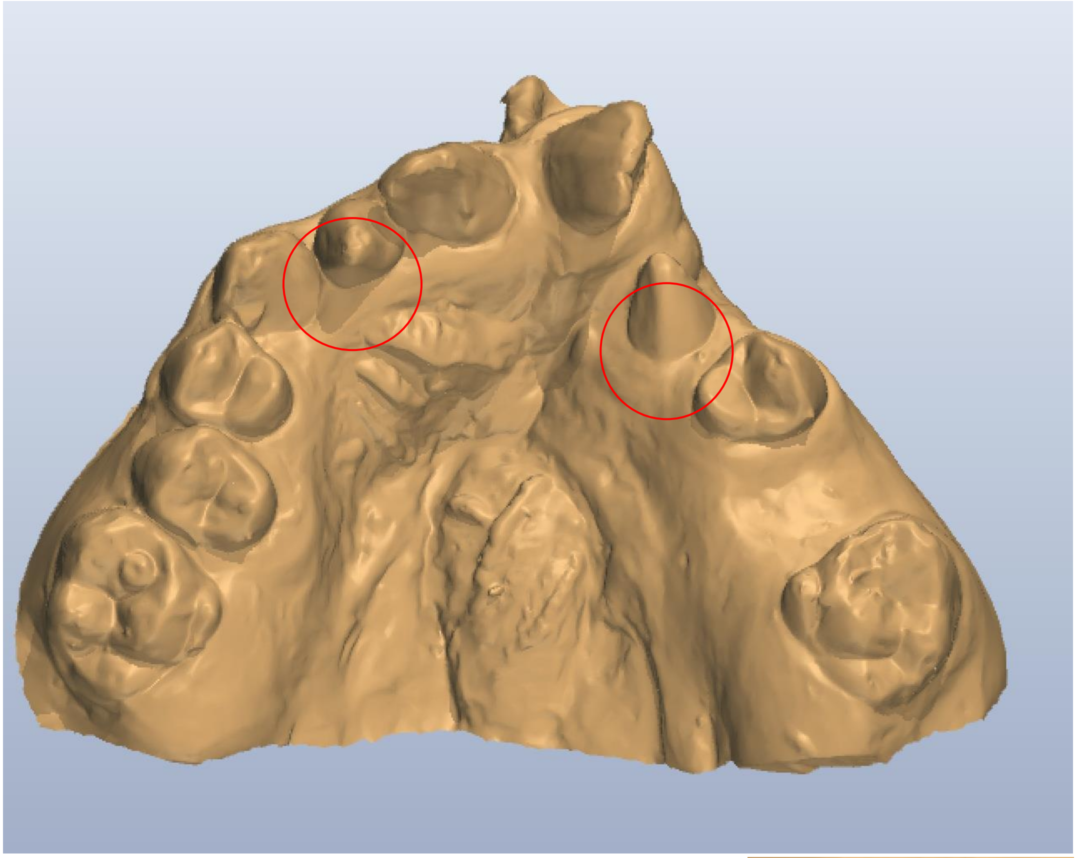
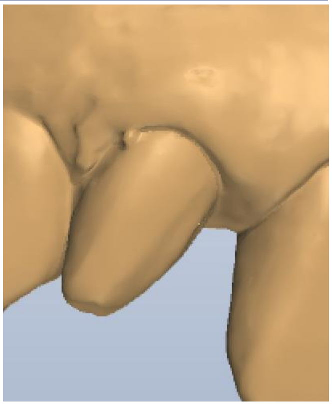


Figure 17: An upper cast showing peg shaped laterals.



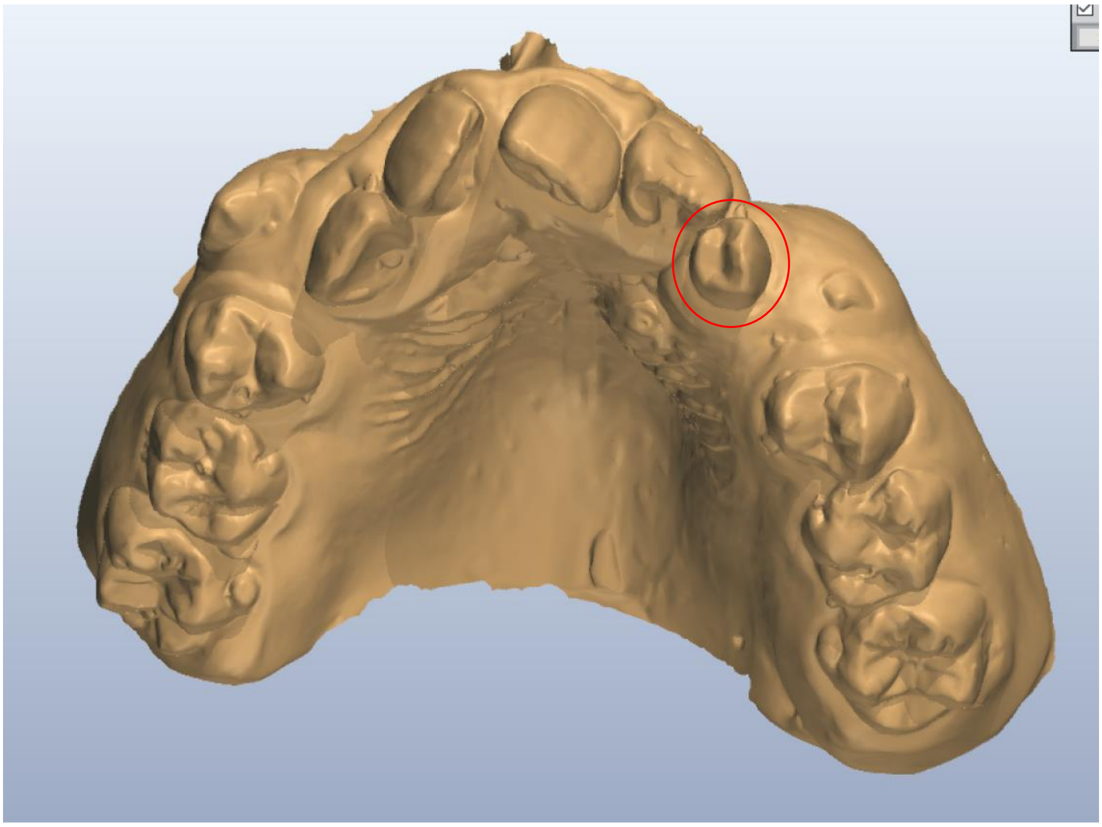
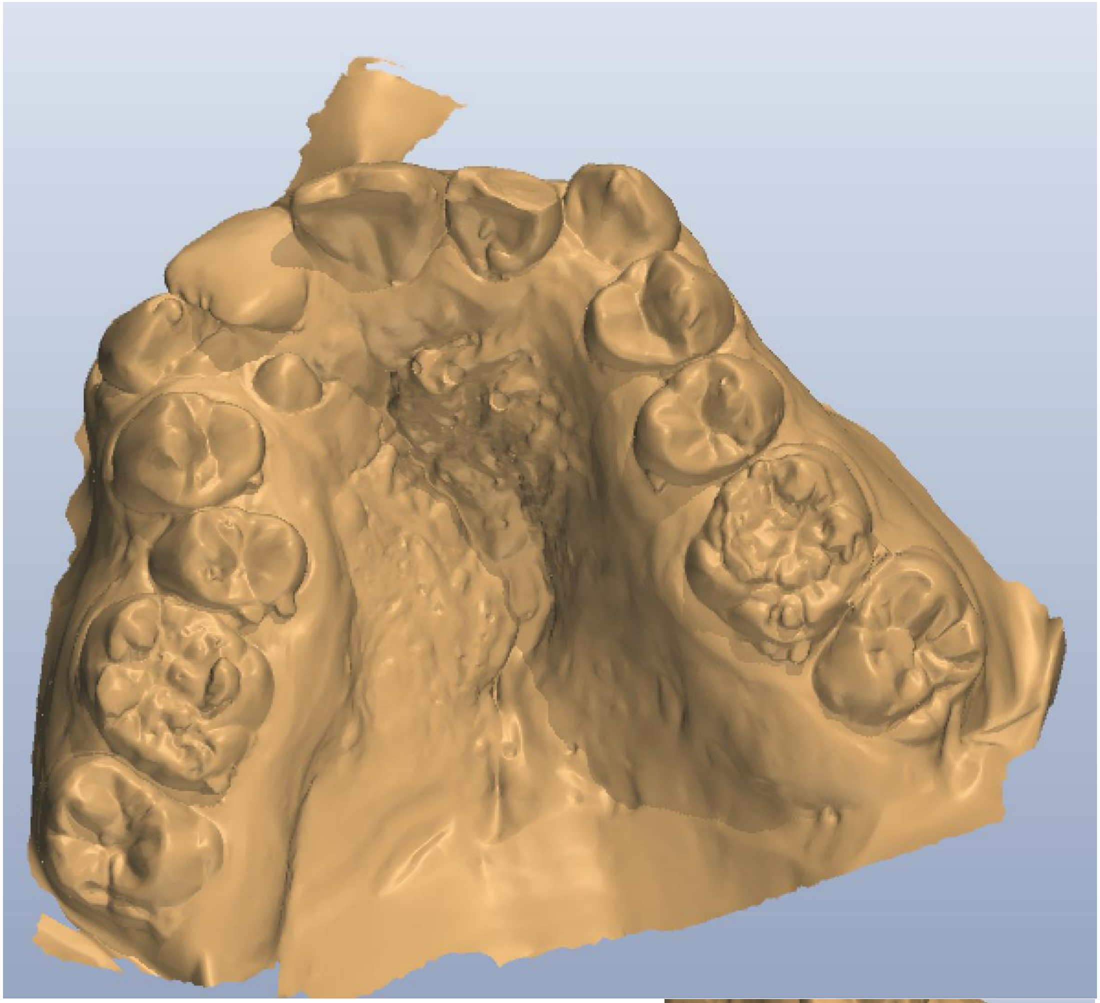


Figure 18: An upper cast showing a supernumerary tooth.



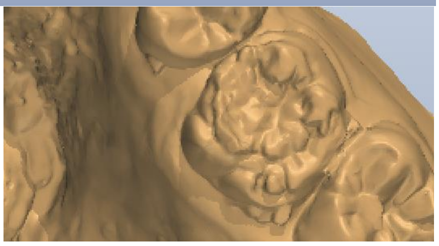


Figure 19: An upper cast showing a mulberry molars.

Table 1. (Group 1: Left side affected vs Right side nonaffected)

	group	N	Mean	Std. Deviation	Median	Minimum	Maximum	P value
11_21 mesodistal	notaffected	40	8,5256	,76112	8,6170	6,69	10,07	0,040[a]*
	affected	39	8,1916	,65370	8,3850	6,93	9,51	
	Total	79	8,3607	,72531	8,3960	6,69	10,07	
11_21 labiolingual	notaffected	40	7,2669	,67359	7,2195	5,53	8,57	0,045[a]*
	affected	39	6,8671	1,02318	6,9360	3,93	9,01	
	Total	79	7,0695	,88168	7,1350	3,93	9,01	
12_22 mesodistal	notaffected	33	6,7853	,83940	6,8010	5,37	8,69	0,481[b]
	affected	6	7,0307	,81581	7,2205	5,90	8,11	
	Total	39	6,8231	,83003	6,8700	5,37	8,69	
12_22 labiolingual	notaffected	33	6,5002	1,02840	6,5630	3,53	8,30	0,608[b]
	affected	6	6,3573	2,05609	6,0035	4,13	9,87	
	Total	39	6,4782	1,20399	6,5630	3,53	9,87	
13_23 mesodistal	notaffected	34	7,7761	,59561	7,8365	6,77	9,19	0,303[a]
	affected	29	7,9270	,54877	7,9820	6,88	9,50	
	Total	63	7,8455	,57495	7,9380	6,77	9,50	
13_23 labiolingual	notaffected	34	7,9774	,85308	7,8710	6,25	9,67	0,566[a]
	affected	29	7,8343	1,11391	7,7540	5,92	9,72	
	Total	63	7,9115	,97615	7,8310	5,92	9,72	
14_24 mesiodistal	notaffected	38	7,1650	,61328	7,1380	6,16	9,10	0,416[a]
	affected	37	7,2773	,57579	7,1430	6,36	8,42	
	Total	75	7,2204	,59375	7,1430	6,16	9,10	
14_24 labiolingual	notaffected	38	9,4916	,70026	9,5530	7,42	10,53	0,416[a]
	affected	37	9,4285	,84320	9,3930	7,47	11,00	
	Total	75	9,4605	,76946	9,5320	7,42	11,00	
15_25 mesodistal	notaffected	32	6,8641	,60793	6,9525	5,52	8,30	0,822[a]
	affected	29	6,9015	,68660	6,7680	5,81	8,66	
	Total	61	6,8819	,64132	6,9070	5,52	8,66	
15_25 labiolingual	notaffected	32	9,5123	,87808	9,6245	7,03	10,83	0,449[a]
	affected	28	9,3332	,94229	9,3145	6,32	10,52	
	Total	60	9,4287	,90530	9,5345	6,32	10,83	
16_26 mesiodistal	notaffected	41	10,5248	,79192	10,3340	8,92	12,63	0,523[a]
	affected	38	10,4134	,74566	10,2850	9,11	12,69	
	Total	79	10,4712	,76713	10,3190	8,92	12,69	
16_26 labiolingual	notaffected	41	11,5789	,81837	11,6820	9,65	13,47	0,477[a]
	affected	38	11,4581	,67291	11,5760	10,09	12,95	
	Total	79	11,5208	,74962	11,6030	9,65	13,47	

*atwo independent samples t test bMann-Whitney u test *p<0,05 statistically significant.*

Table 2. (Group 2: R side affected   vs L side nonaffected)

	group	N	Mean	Std. Deviation	Median	Minimum	Maximum	P value
11_21 mesodistal	notaffected	13	8,0500	,65515	8,0250	6,90	9,21	0,448
	affected	13	8,4244	,77699	8,0580	7,36	9,78	
	Total	26	8,2372	,72956	8,0415	6,90	9,78	
11_21 labiolingual	notaffected	13	6,6717	1,05282	6,7120	4,87	8,69	0,311
	affected	13	7,1340	,79175	7,2080	5,90	8,28	
	Total	26	6,9028	,94261	7,0115	4,87	8,69	
12_22 mesodistal	notaffected	5	6,1044	1,35437	6,5980	4,24	7,53	0,371
	affected	10	6,8386	,46042	6,9935	6,04	7,41	
	Total	15	6,5939	,88809	6,9590	4,24	7,53	
12_22 labiolingual	notaffected	5	6,4518	,68087	6,4390	5,69	7,46	0,594
	affected	10	6,6572	1,02988	6,7305	4,56	8,53	
	Total	15	6,5887	,90793	6,6270	4,56	8,53	
13_23 mesodistal	notaffected	14	7,9679	,55343	8,0100	6,81	8,95	0,494
	affected	12	7,8860	,39504	7,7910	7,38	8,64	
	Total	26	7,9301	,47924	7,8525	6,81	8,95	
13_23 labiolingual	notaffected	14	7,1626	1,19831	7,2745	5,36	8,80	0,046*
	affected	12	8,0844	,52602	8,1345	7,18	9,11	
	Total	26	7,5880	1,04311	7,7105	5,36	9,11	
14_24 mesiodistal	notaffected	14	7,0101	,43525	7,1040	6,18	7,76	0,635
	affected	14	7,0969	,36846	7,1515	6,12	7,72	
	Total	28	7,0535	,39816	7,1110	6,12	7,76	
14_24 labiolingual	notaffected	14	9,4838	,57902	9,3810	8,52	10,65	0,571
	affected	14	9,5668	,49084	9,6120	8,68	10,38	
	Total	28	9,5253	,52840	9,5055	8,52	10,65	
15_25 mesodistal	notaffected	13	6,6535	,57232	6,5020	5,87	7,98	0,793
	affected	14	6,6566	,38838	6,6500	5,94	7,23	
	Total	27	6,6551	,47603	6,5580	5,87	7,98	
15_25 labiolingual	notaffected	13	9,7302	,33034	9,6880	9,32	10,53	1,000
	affected	14	9,7228	,47213	9,6980	8,67	10,53	
	Total	27	9,7263	,40228	9,6880	8,67	10,53	
16_26 mesiodistal	notaffected	14	10,5967	,64503	10,5145	9,38	11,62	0,910
	affected	14	10,5485	,81929	10,6255	8,49	11,77	
	Total	28	10,5726	,72396	10,5400	8,49	11,77	
16_26 labiolingual	notaffected	14	11,6861	,56718	11,7635	10,79	12,76	0,701
	affected	14	11,5416	,64033	11,5745	10,43	12,46	
	Total	28	11,6139	,59810	11,7635	10,43	12,76	

*Mann-Whitney u test *p<0,05 statistically significant.*

Table 3. (Group 3: R side vs L side)

	group	N	Mean	Std. Deviation	Median	Minimum	Maximum	P value
11_21 mesodistal	notaffected	55	8,9449	,61011	9,0040	7,65	10,20	0,618
	affected	55	8,8957	,64256	9,0820	7,71	10,08	
	Total	110	8,9203	,62415	9,0570	7,65	10,20	
11_21 labiolingual	notaffected	55	7,6335	,51155	7,6280	6,14	9,30	0,421
	affected	55	7,5550	,50848	7,6240	5,93	8,70	
	Total	110	7,5943	,50920	7,6260	5,93	9,30	
12_22 mesodistal	notaffected	55	6,9742	,57324	6,9270	5,83	8,09	0,783
	affected	55	7,0040	,55712	6,9250	5,98	8,31	
	Total	110	6,9891	,56284	6,9260	5,83	8,31	
12_22 labiolingual	notaffected	55	6,7656	,48806	6,8010	5,40	7,81	0,710
	affected	55	6,8025	,54865	6,8820	5,54	8,29	
	Total	110	6,7841	,51719	6,8320	5,40	8,29	
13_23 mesodistal	notaffected	55	8,0486	,45978	8,0130	7,03	8,91	0,693
	affected	55	8,0133	,47500	7,9850	7,05	9,14	
	Total	110	8,0309	,46564	8,0070	7,03	9,14	
13_23 labiolingual	notaffected	55	8,5512	,65920	8,5360	7,02	10,75	0,190
	affected	55	8,3736	,74919	8,5070	6,40	9,87	
	Total	110	8,4624	,70803	8,5225	6,40	10,75	
14_24 mesiodistal	notaffected	55	7,2772	,50322	7,2400	6,28	8,42	0,963
	affected	55	7,2816	,49436	7,2670	6,30	8,36	
	Total	110	7,2794	,49653	7,2620	6,28	8,42	
14_24 labiolingual	notaffected	55	9,4156	,61129	9,4320	8,06	10,43	0,989
	affected	55	9,4173	,63326	9,4700	7,81	10,82	
	Total	110	9,4164	,61951	9,4580	7,81	10,82	
15_25 mesodistal	notaffected	55	6,9862	,46345	6,9790	6,03	8,36	0,538
	affected	55	6,9328	,44251	6,9340	6,26	8,27	
	Total	110	6,9595	,45181	6,9400	6,03	8,36	
15_25 labiolingual	notaffected	55	9,6572	,61123	9,6010	8,31	11,30	0,990
	affected	55	9,6588	,70980	9,6450	7,31	11,28	
	Total	110	9,6580	,65930	9,6350	7,31	11,30	
16_26 mesiodistal	notaffected	55	10,6631	,60221	10,7790	9,38	11,95	0,415
	affected	55	10,5677	,61888	10,6440	9,23	12,23	
	Total	110	10,6154	,60968	10,7035	9,23	12,23	
16_26 labiolingual	notaffected	55	11,7374	,59131	11,8390	10,36	12,77	0,588
	affected	55	11,6751	,61066	11,8230	10,27	12,86	
	Total	110	11,7062	,59911	11,8310	10,27	12,86	

atwo independent samples t test

Table 4. (R side of group 1 vs R side of group 2 vs R side of group 3)

	group	N	Mean	Std. Deviation	Median	Minimum	Maximum	P value
11 mesodistal	1,00	40	8,5256	,76112	8,6170	6,69	10,07	0,000[a]*
	2,00	13	8,0500	,65515	8,0250	6,90	9,21	
	3,00	55	8,9449	,61011	9,0040	7,65	10,20	
	Total	108	8,6819	,73508	8,8305	6,69	10,20	
11 labiolingual	1,00	40	7,2669	,67359	7,2195	5,53	8,57	0,002[b]*
	2,00	13	6,6717	1,05282	6,7120	4,87	8,69	
	3,00	55	7,6335	,51155	7,6280	6,14	9,30	
	Total	108	7,3820	,72147	7,4785	4,87	9,30	
12 mesodistal	1,00	33	6,7853	,83940	6,8010	5,37	8,69	0,279[a]
	2,00	5	6,1044	1,35437	6,5980	4,24	7,53	
	3,00	55	6,9742	,57324	6,9270	5,83	8,09	
	Total	93	6,8604	,74735	6,8700	4,24	8,69	
12 labiolingual	1,00	33	6,5002	1,02840	6,5630	3,53	8,30	0,370[a]
	2,00	5	6,4518	,68087	6,4390	5,69	7,46	
	3,00	55	6,7656	,48806	6,8010	5,40	7,81	
	Total	93	6,6546	,73891	6,7090	3,53	8,30	
13 mesodistal	1,00	34	7,7761	,59561	7,8365	6,77	9,19	0,060[c]
	2,00	14	7,9679	,55343	8,0100	6,81	8,95	
	3,00	55	8,0486	,45978	8,0130	7,03	8,91	
	Total	103	7,9477	,53018	7,9560	6,77	9,19	
13 labiolingual	1,00	34	7,9774	,85308	7,8710	6,25	9,67	0,000[b]*
	2,00	14	7,1626	1,19831	7,2745	5,36	8,80	
	3,00	55	8,5512	,65920	8,5360	7,02	10,75	
	Total	103	8,1730	,93729	8,3550	5,36	10,75	
14 mesiodistal	1,00	38	7,1650	,61328	7,1380	6,16	9,10	0,224[c]
	2,00	14	7,0101	,43525	7,1040	6,18	7,76	
	3,00	55	7,2772	,50322	7,2400	6,28	8,42	
	Total	107	7,2024	,54019	7,1300	6,16	9,10	
14 labiolingual	1,00	38	9,4916	,70026	9,5530	7,42	10,53	0,837[c]
	2,00	14	9,4838	,57902	9,3810	8,52	10,65	
	3,00	55	9,4156	,61129	9,4320	8,06	10,43	
	Total	107	9,4515	,63563	9,4940	7,42	10,65	
15 mesodistal	1,00	32	6,8641	,60793	6,9525	5,52	8,30	0,091[a]
	2,00	13	6,6535	,57232	6,5020	5,87	7,98	
	3,00	55	6,9862	,46345	6,9790	6,03	8,36	
	Total	100	6,9038	,53394	6,9180	5,52	8,36	
15 labiolingual	1,00	32	9,5123	,87808	9,6245	7,03	10,83	0,488[b]
	2,00	13	9,7302	,33034	9,6880	9,32	10,53	
	3,00	55	9,6572	,61123	9,6010	8,31	11,30	
	Total	100	9,6203	,68158	9,6235	7,03	11,30	
16 mesiodistal	1,00	41	10,5248	,79192	10,3340	8,92	12,63	0,620[c]
	2,00	14	10,5967	,64503	10,5145	9,38	11,62	
	3,00	55	10,6631	,60221	10,7790	9,38	11,95	
	Total	110	10,6031	,68085	10,5185	8,92	12,63	
16 labiolingual	1,00	41	11,5789	,81837	11,6820	9,65	13,47	0,531[c]
	2,00	14	11,6861	,56718	11,7635	10,79	12,76	
	3,00	55	11,7374	,59131	11,8390	10,36	12,77	
	Total	110	11,6718	,68029	11,7375	9,65	13,47	

*aKruskal-Wallis test bWelch ANOVA cANOVA *p<0,05 statistically significant*

Table 5. (L side of group 1 vs L side of group 2 vs L side of group 3)

	group	N	Mean	Std. Deviation	Median	Minimum	Maximum	P value
21 mesodistal	1,00	39	8,1916	,65370	8,3850	6,93	9,51	0,000[a]*
	2,00	13	8,4244	,77699	8,0580	7,36	9,78	
	3,00	55	8,8957	,64256	9,0820	7,71	10,08	
	Total	107	8,5818	,73624	8,6030	6,93	10,08	
21 labiolingual	1,00	39	6,8671	1,02318	6,9360	3,93	9,01	0,001[b]*
	2,00	13	7,1340	,79175	7,2080	5,90	8,28	
	3,00	55	7,5550	,50848	7,6240	5,93	8,70	
	Total	107	7,2531	,82573	7,3630	3,93	9,01	
22 mesodistal	1,00	6	7,0307	,81581	7,2205	5,90	8,11	0,820[c]
	2,00	10	6,8386	,46042	6,9935	6,04	7,41	
	3,00	55	7,0040	,55712	6,9250	5,98	8,31	
	Total	71	6,9830	,56370	6,9590	5,90	8,31	
22 labiolingual	1,00	6	6,3573	2,05609	6,0035	4,13	9,87	0,551[c]
	2,00	10	6,6572	1,02988	6,7305	4,56	8,53	
	3,00	55	6,8025	,54865	6,8820	5,54	8,29	
	Total	71	6,7444	,82893	6,8340	4,13	9,87	
23 mesodistal	1,00	29	7,9270	,54877	7,9820	6,88	9,50	0,052[a]
	2,00	12	7,8860	,39504	7,7910	7,38	8,64	
	3,00	55	8,0133	,47500	7,9850	7,05	9,14	
	Total	96	7,9713	,48747	7,9500	6,88	9,50	
23 labiolingual	1,00	29	7,8343	1,11391	7,7540	5,92	9,72	0,025[b]*
	2,00	12	8,0844	,52602	8,1345	7,18	9,11	
	3,00	55	8,3736	,74919	8,5070	6,40	9,87	
	Total	96	8,1745	,88096	8,3465	5,92	9,87	
24 mesiodistal	1,00	37	7,2773	,57579	7,1430	6,36	8,42	0,768[a]
	2,00	14	7,0969	,36846	7,1515	6,12	7,72	
	3,00	55	7,2816	,49436	7,2670	6,30	8,36	
	Total	106	7,2557	,50995	7,2090	6,12	8,42	
24 labiolingual	1,00	37	9,4285	,84320	9,3930	7,47	11,00	0,810[c]
	2,00	14	9,5668	,49084	9,6120	8,68	10,38	
	3,00	55	9,4173	,63326	9,4700	7,81	10,82	
	Total	106	9,4409	,69447	9,4715	7,47	11,00	
25 mesodistal	1,00	29	6,9015	,68660	6,7680	5,81	8,66	0,085[b]
	2,00	14	6,6566	,38838	6,6500	5,94	7,23	
	3,00	55	6,9328	,44251	6,9340	6,26	8,27	
	Total	98	6,8841	,52365	6,8260	5,81	8,66	
25 labiolingual	1,00	28	9,3332	,94229	9,3145	6,32	10,52	0,200[b]
	2,00	14	9,7228	,47213	9,6980	8,67	10,53	
	3,00	55	9,6588	,70980	9,6450	7,31	11,28	
	Total	97	9,5740	,76653	9,6650	6,32	11,28	
26 mesiodistal	1,00	38	10,4134	,74566	10,2850	9,11	12,69	0,561[a]
	2,00	14	10,5485	,81929	10,6255	8,49	11,77	
	3,00	55	10,5677	,61888	10,6440	9,23	12,23	
	Total	107	10,5104	,69050	10,5240	8,49	12,69	
26 labiolingual	1,00	38	11,4581	,67291	11,5760	10,09	12,95	0,268[a]
	2,00	14	11,5416	,64033	11,5745	10,43	12,46	
	3,00	55	11,6751	,61066	11,8230	10,27	12,86	
	Total	107	11,5806	,63917	11,6340	10,09	12,95	

*aANOVA bWelch ANOVA c Kruskal-Wallis test *p<0,05 statistically significant*

5. DISCUSSION

In our study, we chose patients with mild malocclusions class I as the control group because it's the closest representation of an ideal occlusion, and to avoid any possibility of dental malocclusions and malformations found in class II and class III as some literatures have claimed (Cua-Benward, Dibaj, & Ghassemi, 1992)(Sassouni, 1969). A study by Basaran et al, aimed to determine whether there is a prevalent tendency for intermaxillary tooth size discrepancies among different malocclusion groups (ie, Class I, Class II, Class II division 1, Class II division 2, and Class III). Found no sexual dimorphism for these ratios in each of five groups, so the sexes were combined for each group. Then, these ratios were compared among different malocclusion groups. The results showed no significant difference between subcategories of malocclusion, so these groups were combined as Class I, Class II, and Class III. No significant difference was found for all the ratios between the groups (Basaran, et al, 2006).

Another study done by Nie et al, in this study 60 subjects served as the normal occlusion group and 300 patients divided into 5 malocclusion groups (ie, Class I with bimaxillary protrusion, Class II Division 1, Class II Division 2, Class III, and Class III surgery). Tooth size measurements were performed on the models of normal occlusion and pretreatment models of patients by the Three Dimension Measuring Machine. Then, tooth size ratios, analyzed as described by Bolton. This study found no sexual dimorphism for these ratios in each of 6 groups, so the sexes were combined for each group. Then these ratios were compared among different malocclusion groups. The results showed no significant difference between subcategories of malocclusion, so these groups were combined to form 3 groubs: Class I, Class II, and Class III. And there analyzes showed that there is a significant difference for all the ratios between the groups, the ratios showing that Class III has bigger ratios than Class I and Class II and class I has bigger ratios then Class II. They concluded that intermaxillary tooth size discrepancy may be one of the important factors in the cause of malocclusions, especially in Class II and Class III malocclusions. So their study proved the fact that Bolton analysis should be taken into consideration during orthodontic diagnosis and therapy (Nie, & Lin, 1999).

Richardson et al, researched the black Americans to establish data on the mesiodistal crown dimension of the permanent teeth. Plaster casts were available of the teeth of 162 American blacks. The sample consisted of the casts of 81 males and 81 females. The study included mesiodistal crown measurements of 3,980 individual teeth. A modified random sampling technique was used in the selection the sample. Socioeconomically the sample is a cross section of the black community. This study found that the mean mesiodistal crown dimension of the permanent dentition of black males was larger than in black females for each type of tooth in the maxillary and mandibular arches (Richardson, & Malhotra, 1975).

Smith et al, evaluated Bolton's inter-arch ratios across populations and genders. The data were derived from systematically collected pre-orthodontic casts of 180 patients, including 30 males and 30 females from each of 3 populations (black, Hispanic, and white). 48 mesiodistal contact points were digitized on each model, and the lengths of the anterior, posterior, and overall arch segments were calculated. The results showed significant ethnic group differences in all 6 arch segment lengths and in all 3 inter-arch ratios. Whites displayed the lowest overall ratio (92.3%), followed by Hispanics (93.1%), and blacks (93.4%). The group differences were due primarily to the relationships between the posterior segments. The arch segments of males were significantly larger than females; the overall and posterior ratios were also significantly larger in males than in females. They concluded that inter-arch tooth size relationships are population and gender specific (Smith et al, 2000).

Bashara et al, examined the mesiodistal and buccolingual crown dimensions in three populations-57 subjects (35 boys and 22 girls) from Iowa City, Iowa; 54 subjects (30 boys and 24 girls) from Alexandria, Egypt; and 60 subjects (26 boys and 34 girls) from Chihuahua, Mexico. All subjects had normal Class I occlusion, with no history of orthodontic treatment. Comparisons of single teeth as well as sums of groups of teeth were performed between boys and girls within and between the two populations. The findings from this study indicated that all populations have significant differences in tooth dimensions between the sexes with boys having larger canines and first molars, they also reported that there is greater variation in the buccolingual than in the mesiodistal dimensions among the three populations and also there is a greater similarity in tooth dimensions among the boys from the three populations than among the girls, but the magnitude of these differences is considered to be of little clinical significance (Bishara et al, 1989).

Lavelle also, reported that tooth dimensions were greater in males than in females. The average degree of sexual dimorphism was 1.96 per cent for the maxillary teeth and 0.68 per cent for the mandibular teeth in Caucasians, the respective figures being 1.36 per cent and 0.96 per cent for Blacks, and 1.47 per cent and 1.53 per cent for Asians. Furthermore, the average mesiodistal crown diameter appeared greater in Blacks than in Caucasians, with that for Asians being intermediate. This relationship applied to the maxillary and mandibular dentitions in both male and female subjects (Lavelle, 1972).

Foster and Lavelle reported that for the normal control subjects involved in their study, the dimensions of the teeth of the males exceed those of the females with the exception of the dimensions for the upper first premolars and the lower first molars, the mesiodistal diameter of the lower second premolars and the buccolingual diameter of the lower second molar. Most of these differences between the sexes were statistically significant at the 5% level. In the cleft palate subjects, however, the sex differences were to some extent reversed. The upper incisors, canines and first premolars were larger in both dimensions in the females than in the males. In addition the lower incisors, canines, second premolars and second molars were larger in either the mesiodistal or the buccolingual dimension in the females. The first molars and upper second molars were larger in the males than in the females (Foster, & Lavelle, 1971).

Because of the contradictory results in different literatures mentioned above where some found that there are no differences in malocclusion as an effect of gender. And most literatures found that there is sexual dimorphism as larger teeth in males than females. And some found larger dimensions of several teeth in females than in males, we decided not to divide the sample to subgroups according to patients gender as reported by (Akçam, et al, 2008).

General researches reported smaller teeth in CLP patients than normal patients, as Werner & Harris found, where mesiodistal diameters of the permanent teeth of 70 isolated cleft lip and palate cases were analyzed. Subjects with unilateral cleft lip and palate exhibit significantly smaller crown sizes than controls. Size reduction averages 2.3 percent, which translates to a 5.2-mm mean difference summed across all 28 permanent teeth (Werner, & Harris, 1989). In our study, we found that to be true in the anterior segment not the posterior segment.

Leifert et al, compared space analysis measurements made on digital models with those from plaster dental casts. A set of alginate maxillary and mandibular impressions was taken from randomly chosen patients before treatment at the postgraduate orthodontic clinic at the College of Dental Medicine at Columbia university in New York, NY. One set of each impression was poured the same day in dental model plaster, and the other was sent to OrthoCad for construction of digital 3D virtual models. Fifty sets of models from 25 patients were selected to be studied; these included 25 plaster models and 25 digital models. The sample was collected based on the criteria of permanent dentition, Angle Class I molar relationship, crowding, and no orthodontic appliances or previous treatment. The dentitions on the plaster models were evaluated by using an orthodontic-style digital caliper (Pella Inc, Redding, Calif) to measure the mesiodistal widths. Arch lengths on the plaster model were measured with a brass wire. The digitized models were measured by using the OrthoCad measurement tools (version 2.17). Two examiners working independently recorded measurements from the plaster models. All teeth mesial to the first molar in each arch were measured by placing the digital caliper at the greatest mesiodistal width of each tooth, and the value was recorded. The arch length of the plaster dental model was constructed by bending a piece of brass wire over the contact points of the posterior teeth, the tips of the canines, and the incisal edges of the central and lateral incisors from first molar to first molar. The length of the brass wire represented the arch length available over basal bone or available space. The same measurements were made for the digitized models by using the OrthoCad software. All data were recorded, and, from them, arch length discrepancies for each kind of study model were calculated. The 2 examiners were trained to use the OrthoCad software. They found when comparing digitized models with conventional plaster dental study models, we found a slight (0.4 mm) but statistically significant difference in the space analysis measurements on the maxillary models; measurements on the mandibular models were not significantly different. No significant difference was found between the measurements of the 2 examiners. And building on that the accuracy of the software for space analysis evaluation on digital models is clinically acceptable and reproducible when compared with traditional plaster study model analyses (Leifert, Leifert, Efstratiadis, & Cangialosi, 2009).

Ghislanzoni et al, measured linear and angular measurements of tip and torque of each tooth in the dental arches of virtual study (3D) models to develop and validate these models. Maxillary and mandibular dental casts of 25 subjects (13 males, 12 females; age range 12 to 18 years) with a full permanent dentition through the first molars, no dental anomalies or craniofacial syndromes, and no cast restorations or cuspal coverage were selected from a parent sample of 60 subjects. The second molars often were absent or erupting and therefore were excluded from the analysis. In total, 25 maxillary dental arches and 25 mandibular dental arches from the same subjects were available to test the validity of the virtual analysis of the dentition. The dental casts were scanned by way of the ESM/ 3ShapeTMR-700 three-dimensional model scanner (ESM Digital Solutions, Dublin, Ireland) and converted into .stl files. The VAM software (Vectra, Canfield Scientific, Fairfield, NJ, USA) was used to edit the files by placing 60 points per arch. After checking for the consistency of point order, the operator exported the point coordinates (XYZ) as a .txt file. Digitization of landmarks was repeated at a one-month interval by the same operator to assess intra-operator repeatability. The data were then imported into Excel spreadsheets (Microsoft Excel, Microsoft, Redmond, WA, USA) for the dental and statistical analyses. They found that the study demonstrated that the digital analysis used in this study has adequate reproducibility, providing additional information and more accurate intra-arch measurements for clinical diagnosis and dentofacial research. (Ghislanzoni, Lineberger, Cevidanes, Mapelli, Sforza, & McNamara, 2013).

Kasparova et al, compared traditional plaster casts, digital models and 3D printed copies of dental plaster casts. To determine whether 3D printed copies obtained using open source system RepRap can replace traditional plaster casts in dental practice. 10 plaster casts used in this study were randomly selected and obtained from Orthodontic clinic of the Department of Stomatology, 2nd medical Faculty, Charles University, Prague. Informed consents were obtained from all patients or their legal representatives. No ethical approval was required for this study. All plaster casts were poured from patient's impressions (alginate impression material, Ypeen, Czech Republic) taken during orthodontic treatment. All of them were cast in conventional material (gypsum) and conventionally trimmed. There were no personal data written on the casts. They were subsequently numbered from 1 to 10. All of the plaster casts completely reproduced full arches, with no surface damage, loss of tooth material or breakage. The plaster casts were neither magnified nor landmarks premarked. Various orthodontic anomalies and positions of teeth were demonstrated to be taken as representative of commonly encountered orthodontists' cases. To capture 3D digital model of all plaster casts, inEos Blue scanner (Sirona, Austria) was used with the same protocol for all samples. InEos Blue is a non tactile scanner based on short-wavelength blue light. All plaster casts were scanned in multiple planes depending on the shape of the teeth and especially hard palate to cover all surfaces of the cast. Scanned data were saved as STL files; computer software inLab Biogeneric (Sirona, Austria) merged obtained data and composed a 3D digital model. The models were exported into the standardized stereolitography (STL) file format. The obtained 3D models of the plaster casts consist of approximately 260 000 vertices and 500 000 faces, and thus their size is approximately 25 MB. The resolution of the scanning (and of the obtained model too) is 19 μm, but the resolution of the RepRap printer is approximately 200 μm. Therefore we reduced and remeshed the models to approximately 55 000 faces using the open source mesh processing system MeshLab (Visual Computing Lab – ISTI – CNR, Italy) and Netfabb Studio Basic (netfabb GmbH, Germany). We used the Quadric edge collapse decimation method for reduction. The size of the reduced model is approximately 3 MB. Then the self-intersecting or duplicated faces, non-manifold edges and vertices were removed where needed. The last step of the STL model processing was filling of the holes which rendered the model ready and fully valid for the RepRap printer. Finally, the STL model was sliced into individual layers, the path of printing nozzle was computed and the STL was converted to GCODE file by Slic3r (Alessandro Ranellucci, Italy). The GCODE file contains all information needed by the 3D printer. Ten of the plaster casts were 3D printed on RepRap (Czech Republic) 3D printer (ABS plastic material, layer 0.35 mm, blue color). Layer of 0.35 mm is the thinnest layer which can be achieved by RepRap printers at the moment. One of the models was also printed on ProJetHD3000 3D printer (3D Systems, USA, clear resin) to compare the distances and quality of models printed on open source and commercial printers. Similar linear measurements were taken plaster casts and 3D printed copies by a single trained evaluator after initial training. A few outlier measurements were not included in the study to improve the methodology of measurements by the digital caliper, all measurements were performed twice, with one week interval using hand held digital caliper (Festa, China, accuracy 0.01 mm). A total of 160 measurements were statistically evaluated. Measured dimensions were selected as the distance between: Intercanine distance – distance between the occlusal tips of canines, The distance of tips of the canine and, mesio-palatal cusp of the first permanent molar in the jaw, The clinical crown height of canine, and the distance between mesial edge of the first incisor and cusp of canine. This study found that the precision of the distance measurements on the plaster models and on the RepRap 3D printed copies are the same. The distance measurements on the plaster models and on the RepRap 3D printed copies were equivalent. There was no significant difference between them (evaluated with paired t test). Therefore, RepRap 3D printed model can replace the process of plaster making (Kasparova, Grafova, Dvorak, Dostalova, Prochazka, Eliasova, & Kakawand, 2013).

Also Keating et al, studied the accuracy and reproducibility of a three-dimensional (3D) optical laser-scanning device to record the surface detail of plaster study models. To determine the accuracy of physical model replicas constructed from the 3D digital files. 30 randomly selected plaster study models, held in the Orthodontic Unit of University Dental Hospital, Cardiff, were used in the study. Each study model was cast in matt white Crystal R plaster (South Western Industrial Plasters, Chippenham, UK) and conventionally trimmed. To be included in the study the plaster study models had to completely reproduce the arch, show no surface marks, loss of tooth material, voids or fractures and demonstrate varying degrees of contact point and buccolingual tooth displacements. A hand held digital caliper (series 500 Digimatic ABSolute Caliper, Mitutoyo Corporation, Kawasaki, Japan), was used to manually measure the plaster models. This caliper had a measurement resolution of 0.01 mm, was accurate to 0.02 mm and automatically downloaded data eliminating measurement transfer and calculation errors. All plaster models were measured in a bright room without magnification. The plaster models were not prepared in any way prior to measuring and the anatomical dental landmarks used in the measurements were not pre-marked. A single examiner conducted all the measurements after an initial training period. Twenty linear dimensions were measured, on each model, in each of the three planes (x, y and z) with all measurements being recorded to the nearest 0.01 mm. The following dimensions were selected for measurement:

x plane:

1. intercanine distance – measured as the distance between:

(a) the occlusal tips of the upper canines;

(b) the occlusal tips of the lower canines.

2. interpremolar distances – measured as the distance between:

(a) the buccal cusp tips of the upper and lower first and second premolars;

(b) the palatal cusp tips of the upper first and second premolars;

(c) the lingual cusp tips of the lower first premolars;

(d) the mesiolingual cusp tips of the lower second premolars.

3. intermolar distances – measured as the distance between:

(a) the mesiopalatal cusp tips of upper first and second molars;

(b) the mesiobuccal cusp tips of the upper and lower first and second molars;

(c) the mesiolingual cusp tips of lower first and second molars;

(d) the disto-buccal cusp tips of the upper and lower first molars.

y plane:

1. in the upper arch the distance from the mesiopalatal cusp tip of the upper second molar to:

(a) the mesiopalatal cusp tip of the upper first molar;

(b) the palatal cusp tip of the upper first and second premolar;

(c) the cusp tip of the upper canine;

(d) the mesio-incisal corner of the upper lateral incisor.

These dimensions were measured on both sides of the upper arch.

2. in the lower arch the distance from the mesiolingual cusp tip of the lower second molar to:

(a) the mesiolingual cusp tip of the lower first molar and second premolar;

(b) the lingual cusp tip of the lower first premolar;

(c) the cusp tip of the lower canine;

(d) the mesio-incisal corner of the lower lateral incisor.

These dimensions were measured on both sides of the lower arch.

z plane:

1. The clinical crown height of all the teeth, in both upper and lower arches, from the second premolar to second premolar inclusive, measured as the distance between the cusp tip and the maximum point of concavity of the gingival margin on the labial surface. Measurements were made on two occasions separated by at least one week.

And on the 3D models A non-contact laser-scanning device (Minolta VIVID 900) was used to record the surface detail of each of the 30 study models using a telescopic light-receiving lens (focal distance f525 mm) and rotary stage (ISEL-RF1, Konica Minolta Inc., Tokyo, Japan). The rotary stage facilitated the acquisition of multiple range maps by moving the plaster study models in sequence by a controlled rotation as they were being scanned, thus ensuring the entire visible surface of each plaster model was captured. The stage was controlled by a computer software program (Easy3DScan Tower Graphics, Lucca, Italy) and integrated controller box (IT116G, Minolta Inc., Osaka, Japan). Easy3DScan was used to align, merge and simplify the range maps acquired at different angles to produce a composite surface dataset that was then imported into the RapidForm 2004 software program (INUS Technology Inc., Seoul, Korea) as a triangulated 3D mesh. An automated measuring tool was used to record the same measurements that had been conducted manually on the plaster study models. The 3D digital surface models were magnified and rotated on screen to aid identification of the anatomical landmarks as necessary. Linear distances between landmarks were calculated automatically to five decimal places. Replicate measurements were made on all digital model images with a time interval of at least one week. One pair of upper and lower plaster models were scanned individually using an identical protocol, adhering to the inclusion criteria listed previously. Only one set of models was evaluated due to the current cost of stereolithography. The scanned data for both upper and lower plaster models were saved as binary STL files and imported into the Magics RP software (Materialise Inc., Leuven, Belgium). A 3D Systems stereolithography machine (SLA-250/ 40, 3D Systems Inc., Valencia, CA, USA) containing a hybrid epoxy-based resin (10110 Waterclear, DSM Somos, New Castle, DE, USA) was used to construct replica (RP) models from the digital files using a build layer thickness of 0.15 mm. Identical measurements, in x, y and z planes, were made on the reconstructed stereolithography models to those recorded on the original plaster study models and virtual models. Replicate measurements were made one week later. After all measurements they found that mean difference between measurements made directly on the plaster models and those made on the 3D digital surface models was 0.14 mm, and was not statistically significant. The mean difference between measurements made on both the plaster and virtual models and those on the replica models, in the z plane was highly statistically significant. And they concluded that the Minolta VIVID 900 digitizer is a reliable device for capturing the surface detail of plaster study models three dimensionally in a digital format but physical models of appropriate detail and accuracy cannot be reproduced from scanned data using the replica technique described in their study (Keating, Knox, Bibb, & Zhurov, 2008)(Kusnoto, & Evans, 2002).

Mullen et al, studied the accuracy and speed of measuring the overall arch length and the Bolton ratio, and the time to perform a Bolton analysis for each patient by using software to analyze 3D models and compared them with hand-held plaster models. Pretreatment models from 30 patients in the Department of Orthodontics of West Virginia University's School of Dentistry were selected. The inclusion criterion was complete adult dentition from first molar to first molar in both arches. Alginate impressions of both arches of each patient were taken and sent to GeoDigm, which fabricated a plaster model and scanned it to produce the 3D model. The plaster model was returned with the 3D model for measurements. The plaster model and the 3D model were therefore made from the same impressions and should have had identical measurements. To determine the accuracy of performing a Bolton analysis. Digital calipers (S225, Fowler, Boston, Mass) were used to make measurements on the plaster models; all measurements were rounded to the nearest 0.1 mm. The MD width of each tooth was measured at its greatest width, by holding the calipers perpendicular to the occlusal plane of the tooth. The Bolton analysis was done by summing the MD widths of all maxillary teeth, right permanent first molar to left permanent first molar; summing the MD widths of all mandibular teeth, right permanent first molar to left permanent first molar; and dividing the mandibular sum by the maxillary sum and multiplying by 100. The times required to take all the measurements and to perform the Bolton analysis with plaster models and digital calipers were recorded in seconds with a stopwatch. This process was repeated to record the digital measurements with the emodel software. The data were analyzed by using a paired t test on each data set to determine the error in the measurements. This study found that there was no significant difference between the Bolton ratios calculated with the 2 methods. A significant difference in arch length calculations was found between the 2 methods, but it was within the range of error found in this study and was considered clinically insignificant. Significant differences were found in the time needed to make the measurements and the calculations between the 2 methods; the emodel software was an average of 65 seconds faster. and in conclusion emodel software for measuring a patient’s dentition and calculating the Bolton ratio is just as accurate and faster than using digital calipers with plaster models. A clinician who has switched to emodel software can be confident in his or her diagnoses using it (Mullen, Martin, Ngan, & Gladwin, 2007).

Because all these studies reporting about the 3D models' accuracy and reproducibility of plaster models and the accuracy of 3D analyzing programs, we preferred to use digital scanner and digital program in our study.

Akcam et al, reported statistically significant differences between premolar and first molar occlusal-gingival (OG) width between the CLP and Class I groups. The right lateral incisor OG width in the RCLP group found statistically smaller than the Class I group. The left lateral incisor and left canine OG width were smallest in the LCLP group and significantly smaller than in the control group. The right lateral incisor OG width was smallest in the RCLP group and statistically smaller when compared with the Class I group (Akcam, Toygar, Özer, & Özdemir, 2008).

Werner and Harris found that mesiodistal diameters of the permanent teeth of 70 isolated cleft lip and palate cases were analyzed. Subjects with unilateral cleft lip and palate (CLP) exhibit significantly smaller crown sizes than controls. Size reduction averages 2.3 percent, which translates to a 5.2-mm mean difference summed across all 28 permanent teeth. Bilateral cases are twice as affected, with a 4.2 percent reduction (9.3 mm). The baseline level of left-right asymmetry is significantly amplified across the whole dentition, encompassing both early- and late-forming teeth and constituting a 30-percent increase in overall asymmetry. Also, there is a localized peak of disproportionately high asymmetry centered on the upper lateral incisor but extending to both the central incisor and canine. The consistency of these differences across all tooth types and among early- and late-forming teeth implies that isolated CLP is a sequelae of a systemic, generalized restriction of these individuals' growth potential (Werner, & Harris, 1989). Our study findings similar to this study, where there significant difference mostly in the canine and central teeth.

Akcam et al, found that There were differences in right first and second premolar MD dimensions between the LCLP group and the Class I group and between RCLP group and the Class I group. The Class I group had smaller MD dimensions than both RCLP and LCLP groups. They found that left lateral incisor MD dimensions in LCLP group were smaller than the RCLP and the control group, where they didn't find any deference between right lateral incisors in the RCLP group and the control group. And they found that All LL dimensions in incisors region (canine to canine) in the CLP groups were smaller than in the Class I control group. In our study we found for the LL measurements of centrals and canines were statistically significant (Akcam, Toygar, Özer, & Özdemir, 2008). Surprisingly, we didn't find any significant difference in the low number of laterals that were not absent. And also, we didn't find any significant difference in the first and second premolars between CLP groups and the class I group. But we found significant difference in the MD and LL dimensions of centrals and LL dimensions of canines where the class I control group has the larger diameter than CLP groups.

Antonarakis et al, in a meta-analysis study found when comparing MD tooth sizes of the cleft side versus the non-cleft side in the non-syndromic unilateral CLP patients, that in the maxillary dentition, the central incisors, lateral incisors, and first molars are significantly larger on the non-cleft than on the cleft side. And when comparing MD tooth sizes of the cleft side in the non-syndromic unilateral CLP patients versus the same side in the control patients, they found maxillary second molars and first and second premolars of the cleft side in non-syndromic unilateral CLP patients are larger than in control patients, while the maxillary central and lateral incisors are smaller. And when comparing MD tooth sizes of the non-cleft side in the non-syndromic unilateral CLP patients versus the same side in the control patients, a similar trend is seen as for the cleft side versus the control patients. In the maxillary arch, all teeth except for the central incisors are larger in the non-syndromic unilateral CLP patients than in the control patients but with a low homogeneity seen in the results. The central incisors are larger in the control patients, again with a low homogeneity (Antonarakis et al,).

Kaplan et al, in a study similar to ours reported when comparing the cleft and non‑ cleft sides in individuals with CLP maxillary centrals MD and molars MD values were significantly greater in UCLP patients on the non‑ cleft side. LL measurements of maxillary molars were greater on the non-cleft side. When comparing the cleft side of URCLP group and the right side of the control group they found that MD dimensions of right centrals, and right canines were significantly smaller in URCLP group. And in LL measurements, right centrals, right first and second premolars, and right molars were also smaller in URCLP group. And when comparing the cleft side of ULCLP group and the left side of the control group MD measurements, the maxillary left centrals, and canines were greater in control group compared to ULCLP group. In LL dimensions, maxillary left centrals, canines, first and second premolars, and left molars were smaller in ULCLP group (Kaplan et al,).

In a study by Ranta, they found the upper lateral incisor is the most susceptible to injury in the area of cleft in both deciduous and permanent dentitions. This tooth is affected in most instances, even in the cases of microforms of the cleft lip. The prevalence of hypodontia increases strongly with the severity of cleft. More teeth are congenitally missing from the upper jaw than from the lower jaw; however, in the permanent dentition both jaws are affected. Very high prevalence of hypodontia are observed in connection with the Van der Woude syndrome associated with cleft and with the Pierre Robin anomaly. Hypodontia is similarly prevalent in subjects with isolated cleft palate with and without a positive family history of clefts. The prevalence of hypodontia varies largely in different populations. Asymmetric formation of the contralateral teeth is a milder form of hypodontia. The prevalence of asymmetrically developing pairs of teeth is far more common in children with clefts than in children with normal palates or lips. In the permanent dentition the timing of tooth formation is delayed in children from all cleft groups compared to noncleft children. The delay lengthens (with increasing severity of cleft) from 0.3 to 0.7 years and is similar in all permanent teeth in both jaws. In children with hypodontia, the delay is still more severe. As the child becomes older, the delay may increase. The size of the permanent teeth is smaller than in noncleft children and the metric asymmetry of the crown or root size is apparent in both jaws. Enamel defects and abnormalities in shape and size of both deciduous and permanent teeth are far more common in children and fetuses affected with cleft than in normal subjects. These abnormalities occur in both jaws. Dental abnormalities in number, size, shape, timing of formation, eruption, and the cleft itself seem to have a common cause in most instances. The postnatal environmental factors--nutrition, infections, and surgical treatment--may have an effect only on enamel defects and, perhaps, in some instances, on agenesis of the permanent teeth (Ranta, 1986).

Camprosi et al, reported after evaluating the prevalence of dental abnormalities of the primary and permanent maxillary dentitions in children affected by unilateral (UCLP) and bilateral (BCLP) cleft of the lip and palate that the prevalence rate for missing primary lateral incisors in UCLP subjects was 8.1% and it was 27.9% for the permanent lateral incisors. In BLCP subjects, the prevalence rates were 17% for the primary lateral incisors and 60% for the permanent lateral incisors. The second premolar was absent in 5.4% of UCLP subjects and in 8.8% in the BCLP sample. The statistical analysis revealed significant differences for the prevalence rates of all dental anomalies compared with the control group except for second premolar agenesis. This study concluded after evaluating the prevalence of dental abnormalities in number, size, and shape of the primary and permanent maxillary dentitions of children affected by CLP compared with a control group of subjects without cleft, that over one third of CLP subjects presented with absence of permanent lateral incisors. The prevalence rates for all other dental anomalies analyzed (supernumerary teeth, anomalies in size, shape, and enamel hypoplasia) were significantly greater in both UCLP and BCLP subjects when compared with the normal subjects (Camporesi, Baccetti, Marinelli, Defraia, & Franchi, 2010).

Menezes and Viera, studied the Dental abnormalities (tooth agenesis, supernumerary and impacted teeth, transposition, and structural anomalies) outside the cleft area in the permanent dentition of oral cleft individuals. They collected Pretreatment and treatment orthodontic records of 146 white subjects born with oral cleft between 1967 and 1987, from the National Museum of Health and Medicine, Washington, D.C. The archive consists of clinical records, dental casts (study models), and series of radiographs available for the patients in different periods, from early childhood until adult phase. The determination of cleft phenotype was based on the description present in the clinical files and confirmed through examination of the dental casts and radiographs. The occurrence of dental anomalies was determined by the examination of dental records and radiographic exams realized during the entire period of treatment. The most common dental anomalies include: Tooth absence, Supernumerary teeth, Transposition, Microdontia, Impacted teeth, and Structural anomalies such as: enamel hypoplasia, any other enamel defects, taurodontism, gemination, and fusion. They found that in 146 patients, 47 (32.19%) presented at least one dental anomaly outside the cleft area. No differences between male and female subjects were observed. Upper lateral incisors and premolars were the most commonly affected teeth (Menezes, & Vieira, 2008).

Paranaiba et al, reported dental anomalies were identified in 39.9% of the nonsyndromic cleft lip and/or palate patients, and tooth agenesis (47.5%), impacted tooth (13.1%), and microdontia (12.7%) were the most common anomalies. Cleft lip patients were less affected by dental anomalies compared with cleft palate or cleft lip and palate patients. Specifically, patients with unilateral cleft lip and palate were significantly more affected by dental anomalies than those with bilateral cleft lip and palate, and individuals with unilateral complete cleft lip and palate and complete cleft palate were significantly more affected by tooth agenesis than other cleft types. Agenesis of the premolars and maxillary lateral incisors were significantly more frequent in patients with unilateral complete cleft lip and palate. This study presented a high frequency of dental anomalies in nonsyndromic cleft lip and/or palate patients and further demonstrated that patients with unilateral cleft lip and palate were frequently more affected by dental anomalies than those with bilateral cleft lip and palate (Paranaiba, Coletta, Swerts, Quintino, De Barros, & Martelli-Júnior, 2013).

Răducanu et al, after assessing the dental morphological variations in a group of patients with cleft lip and/or palate, as compared with a group of healthy subjects. With a study sample included 48 patients with various types of CLP (15 girls and 33 boys) aged between 12.6 years and 17.3 years. The control group (without CLP) consisted of 1447 patients (545 girls and 903 boys). They found the proportion of patients with dental shape anomalies in the control group was 8.6%, while the proportion of patients with dental shape anomalies in the CLP group was 56.3%. With this regards, the frontal area was more affected in CLP group than controls. The most common morphological abnormality in the control group was supplementary cusp, while in the CLP sample it was dilaceration, a morphological anomaly consisting in an angulation, or a sharp bend or curve, in the root or crown of a formed tooth, was found in 26 (8.6%) teeth. Peg morphology, affecting usually the upper lateral incisor, was found in 18 (5.9%) teeth. The double teeth were represented by both fused and geminated teeth. Dental fusion is the union of two normally separated tooth germs and geminated teeth is the division of a tooth germ. The number of double teeth was 13 (4.3%). Enamel hypoplasia, defined as an enamel defect in which a tooth has less enamel than usual, was found in 19 (6.3%) teeth. Dens invaginatus, also known as dens in dente, is a shape abnormality showing a large spectrum of crown morphological variations. The affected teeth radiographically present an infolding of enamel and dentine which may extend more deeply into the pulp cavity and into the root. (0.3%) presented dens invaginatus. The teeth with shape anomalies were analyzed according with their position on the dental arch (anterior and posterior) of both patients with clefts and patients in the control group. In the anterior area, there were 32 teeth in patients with CLP and 36 in patients in the control group (representing 62.7% and 14.3% respectively of the total number of malformed teeth in each of the two samples). The difference registered between the frequency of malformed teeth in the anterior area in CLP and non- CLP patients was statistically significant, while in the posterior area the prevalence of malformed teeth did not register statistically significant differences (Răducanu, Didilescu, Feraru, Dumitrache, Hănţoiu, & Ionescu, 2015).

The majority of studied mentioned above reported that CLP patients have higher incidences of dental abnormalities such as enamel hypoplasia, missing teeth and peg-shaped teeth. And also that the timing of tooth formation and eruption in the permanent dentition is delayed in children from all cleft groups compared to noncleft children. Also reported that the size of the permanent teeth in CLP patients is smaller than in noncleft children and enamel defects and abnormalities in shape and size of both deciduous and permanent teeth are far more common in patients affected with CLP than in normal subjects. Our findings are mostly compatible with these findings. We found higher rates of hypodontia of the teeth in CLP patients than class I patients especially the lateral incisor in the CLP region. We also found that CLP patients are highly affected by hypoplasia more than Class I patients. We have noticed more incidents of malformed, misshaped teeth in CLP patients compared to the Class I normal patients, such as supernumerary and peg-shaped teeth.

In this study, the biggest challenge and even a limitation was the low number of CLP patient records. Even with the low number of records, we found there were a number of cases where the record was damaged and unusable in our research. Some of the records had large restoration or carious lesions and all of these records were discluded. Also, the high number of missing lateral teeth could affect the accuracy of the results.

6. CONCLUSION

This study revealed that patients affected with Cleft lip and palate:

- Have a high frequency of dental anomalies in number, size, and shape such as (tooth hypodontia, supernumerary teeth, enamel hypoplasia, and misshaped teeth).
- In LCLP, MD and LL dimensions of the right centrals were greater than the left centrals.
- In RCLP, all LL dimensions of the right canines were greater than the left canines.
- MD and LL dimensions of the centrals and the LL dimensions of the canines were greater in the control group compared with the other groups.
- Dental-size analysis should be included in planning orthodontic treatment.
- Technology use growing rapidly in orthodontics and dental fields in general, where they can provide faster more practical solutions to professionals.

7. REFERENCES

Akcam, M. O., Evirgen, S., Uslu, O., & Memikoğlu, U. T. (2010). Dental anomalies in individuals with cleft lip and/or palate. *The European Journal of Orthodontics*, *32*(2), 207-213.

Akcam, M. O., Toygar, T. U., Özer, L., & Özdemir, B. (2008). Evaluation of 3-dimensional tooth crown size in cleft lip and palate patients. *American journal of orthodontics and dentofacial orthopedics*, *134*(1), 85-92.

Al-Khateeb, S. N., & Abu Alhaija, E. S. (2006). Tooth size discrepancies and arch parameters among different malocclusions in a Jordanian sample. *The Angle Orthodontist*, *76*(3), 459-465.

Altuğ, A. T. (2017). Presurgical Nasoalveolar Molding of Bilateral Cleft Lip and Palate Infants: An Orthodontist's Point of View. *Turkish journal of orthodontics*, *30*(4), 118.

Antonarakis, G. S., Tsiouli, K., & Christou, P. (2013). Mesiodistal tooth size in non-syndromic unilateral cleft lip and palate patients: a meta-analysis. *Clinical oral investigations*, *17*(2), 365-377.

Araujo, E., & Souki, M. (2003). Bolton anterior tooth size discrepancies among different malocclusion groups. *The Angle Orthodontist*, *73*(3), 307-313.

Asquith, J. A., & McIntyre, G. T. (2012). Dental arch relationships on three-dimensional digital study models and conventional plaster study models for patients with unilateral cleft lip and palate. *The Cleft palate-craniofacial journal*, *49*(5), 530-534.

Baek, S. H., & Son, W. S. (2006). Difference in alveolar molding effect and growth in the cleft segments: 3-dimensional analysis of unilateral cleft lip and palate patients. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology, 102*(2), 160-168.

Basaran, G., Selek, M., Hamamcı, O., & Akkuş, Z. (2006). Intermaxillary Bolton tooth size discrepancies among different malocclusion groups. *The Angle Orthodontist*, *76*(1), 26-30.

Bishara, S. E., Jakobsen, J. R., Abdallah, E. M., & Garcia, A. F. (1989). Comparisons of mesiodistal and bnccolingnal crown dimensions of the permanent teeth in three populations from Egypt, Mexico, and the United

States. *American Journal of Orthodontics and Dentofacial Orthopedics*, *96*(5), 416-422.

Bongaarts, C. A., van't Hof, M. A., Prahl-Andersen, B., Dirks, I. V., & Kuijpers-Jagtman, A. M. (2006). Infant orthopedics has no effect on maxillary arch dimensions in the deciduous dentition of children with complete unilateral cleft lip and palate (Dutchcleft). *The Cleft palate-craniofacial journal*, *43*(6), 665-672.

Broadbent, T. R., & Woolf, R. M. (1984). Cleft lip nasal deformity. *Annals of plastic surgery*, *12*(3), 216-234.

Camporesi, M., Baccetti, T., Marinelli, A., Defraia, E., & Franchi, L. (2010). Maxillary dental anomalies in children with cleft lip and palate: a controlled study. *International journal of paediatric dentistry*, *20*(6), 442-450.

Christensen, K., Juel, K., Herskind, A. M., & Murray, J. C. (2004). Long term follow up study of survival associated with cleft lip and palate at birth. *Bmj*, *328*(7453), 1405.

Cobley, T. D. D., Orlando, A., Page, K., & Mercer, N. S. G. (2000). Modification of the Koken nasal splint. *The Cleft palate-craniofacial journal*, *37*(2), 125-126.

CRONIN, T. D. (1958). Lengthening columella by use of skin from nasal floor and alae. *Plastic and Reconstructive Surgery*, *21*(6), 417.

Cua-Benward, G. B., Dibaj, S., & Ghassemi, B. (1992). The prevalence of congenitally missing teeth in class I, II, III malocclusions. *The Journal of clinical pediatric dentistry*, *17*(1), 15-17.

Cutting, C., Grayson, B., Brecht, L., Santiago, P., Wood, R., & Kwon, S. (1998). Presurgical columellar elongation and primary retrograde nasal reconstruction in one-stage bilateral cleft lip and nose repair. *Plastic and reconstructive surgery*, *101*(3), 630-639.

Delaire, J. (1978). Theoretical principles and technique of functional closure of the lip and nasal aperture. *Journal of maxillofacial surgery*, *6*, 109-116.

Delaire, J. (1991). Fentes labiales congénitales. In *Chirugie des lèvres*. Masson Paris.

Doruk, C., & Kiliç, B. (2005). Extraoral nasal molding in a newborn with unilateral cleft lip and palate: a case report. *The Cleft palate-craniofacial journal*, *42*(6), 699-702.

Ezzat, C. F., Chavarria, C., Teichgraeber, J. F., Chen, J. W., Stratmann, R. G., Gateno, J., & Xia, J. J. (2007). Presurgical nasoalveolar molding therapy for the treatment of unilateral cleft lip and palate: a preliminary study. *The Cleft palate-craniofacial journal*, *44*(1), 8-12.

Foster, T. D., & Lavelle, C. B. (1971). The Size and Dentition in Complete Cleft Lip and Palate. *The Cleft palate journal*, *8*(2), 177-184.

Ghislanzoni, L. T. H., Lineberger, M., Cevidanes, L. H., Mapelli, A., Sforza, C., & McNamara, J. A. (2013). Evaluation of tip and torque on virtual study models: a validation study. *Progress in orthodontics*, *14*(1), 19.

Grayson, B. H., Santiago, P. E., Brecht, L. E., & Cutting, C. B. (1999). Presurgical nasoalveolar molding in infants with cleft lip and palate. *The cleft palate-Craniofacial journal*, *36*(6), 486-498.

Jaksˇić, N., Sˇćepan, I., Glisˇić, B., Stamenic, E., & Stamenković, Z. (2002). Mesiodistal size of deciduous teeth in subjects with unilateral cleft lip and palate. *Orthodontics & craniofacial research*, *5*(1), 17-21.

Kamdar, M. R. (2008). Primary bilateral cleft nasal repair. *Plastic and reconstructive surgery*, *122*(3), 918-919.

Kamiloglu, B. (2014). Presurgical Treatment of Cleft Lip and Palate Babies with a PNAM Appliance: A Series of Four Case Reports. *J Interdiscipl Med Dent Sci*, *2*(148), 2.

Kamiloglu, B. (2019). Associated Syndromes In Cleft Lip Palate And Isolated Cleft Palate Babies: A Retrospective Study In Cyprus.

Kaplan, M., Görgülü, S., Cesur, E., Arslan, C., & Altuğ, A. T. (2020). 3D evaluation of tooth crown size ın unilateral cleft lip and palate patients. *Nigerian journal of clinical practice*, *23*(5), 596-602.

Kasparova, M., Grafova, L., Dvorak, P., Dostalova, T., Prochazka, A., Eliasova, H., ... & Kakawand, S. (2013). Possibility of reconstruction of dental plaster cast from 3D digital study models. *Biomedical engineering online*, *12*(1), 49.

Keating, A. P., Knox, J., Bibb, R., & Zhurov, A. I. (2008). A comparison of plaster, digital and reconstructed study model accuracy. *Journal of orthodontics*, *35*(3), 191-201.

Kohout, M. P., Aljaro, L. M., Farkas, L. G., & Mulliken, J. B. (1998). Photogrammetric comparison of two methods for synchronous repair of bilateral cleft lip and nasal deformity. *Plastic and reconstructive surgery*, *102*(5), 1339-1349.

Kusnoto, B., & Evans, C. A. (2002). Reliability of a 3D surface laser scanner for orthodontic applications. *American journal of orthodontics and dentofacial orthopedics*, *122*(4), 342-348.

Lavelle, C. L. B. (1972). Maxillary and mandibular tooth size in different racial groups and in different occlusal categories. *American Journal of Orthodontics and Dentofacial Orthopedics, 61*(1), 29-37.

Leifert, M. F., Leifert, M. M., Efstratiadis, S. S., & Cangialosi, T. J. (2009). Comparison of space analysis evaluations with digital models and plaster dental casts. *American journal of orthodontics and dentofacial orthopedics*, *136*(1), 16-e1.

Liou, E. J. W., Subramanian, M., Chen, P. K., & Huang, C. S. (2004). The progressive changes of nasal symmetry and growth after nasoalveolar molding: a three-year follow-up study. *Plastic and reconstructive surgery*, *114*(4), 858-864.

Manchester, W. M. (1965). The repair of bilateral cleft lip and palate. *The British journal of surgery*, *52*(11), 878-882.

Markus, A. F., & Delaire, J. (1993). Functional primary closure of cleft lip. *British Journal of oral and maxillofacial surgery*, *31*(5), 281-291.

Maull, D. J., Grayson, B. H., Cutting, C. B., Brecht, L. L., Bookstein, F. L., Khorrambadi, D., ... & Hurwitz, D. J. (1999). Long-term effects of nasoalveolar molding on three-dimensional nasal shape in unilateral clefts. *The Cleft palate-craniofacial journal*, *36*(5), 391-397.

McComb, H. (1990). Primary repair of the bilateral cleft lip nose: a 15-year review and a new treatment plan. *Plastic and reconstructive surgery*, *86*(5), 882-9.

Menezes, R., & Vieira, A. R. (2008). Dental anomalies as part of the cleft spectrum. *The Cleft Palate-Craniofacial Journal*, *45*(4), 414-419.

Millard Jr, D. R. (1971). Closure of bilateral cleft lip and elongation of columella by two operations in infancy. *Plastic and reconstructive surgery*, *47*(4), 324-331.

Millard, D. R., Latham, R., Huifen, X., Spiro, S., & Morovic, C. (1999). Cleft lip and palate treated by presurgical orthopedics, gingivoperiosteoplasty, and lip adhesion (POPLA) compared with previous lip adhesion method: a preliminary study of serial dental casts. *Plastic and reconstructive surgery*, *103*(6), 1630-1644.

Mitchell, L. (2007). *An introduction to orthodontics*. Oxford University Press.

Mossey, P. A., Little, J., Munger, R. G., Dixon, M. J., & Shaw, W. C. (2009). Cleft lip and palate. *The Lancet*, *374*(9703), 1773-1785.

Mullen, S. R., Martin, C. A., Ngan, P., & Gladwin, M. (2007). Accuracy of space analysis with emodels and plaster models. *American Journal of Orthodontics and Dentofacial Orthopedics*, *132*(3), 346-352.

Mulliken, J. B. (1992). Correction of the bilateral cleft lip nasal deformity: evolution of a surgical concept. *The Cleft palate-craniofacial journal*, *29*(6), 540-545.

Mulliken, J. B. (2004). Bilateral cleft lip. *Clinics in plastic surgery*, *31*(2), 209.

Mulliken, J. B., Wu, J. K., & Padwa, B. L. (2003). Repair of bilateral cleft lip: review, revisions, and reflections. *Journal of Craniofacial Surgery*, *14*(5), 609-620.

Murthy, P. S., Deshmukh, S., Bhagyalakshmi, A., & Srilatha, K. T. (2013). Pre surgical nasoalveolar molding: changing paradigms in early cleft lip and palate rehabilitation. *Journal of international oral health: JIOH*, *5*(2), 70.

Ngai, C. W., Martin, W. L., Tonks, A., Wyldes, M. P., & Kilby, M. D. (2005). Are isolated facial cleft lip and palate associated with increased perinatal mortality? A cohort study from the West Midlands Region, 1995–1997. *The Journal of Maternal-Fetal & Neonatal Medicine*, *17*(3), 203-206.

Nie, Q., & Lin, J. (1999). Comparison of intermaxillary tooth size discrepancies among different malocclusion groups. *American Journal of Orthodontics and Dentofacial Orthopedics*, *116*(5), 539-544.

Pai, B. C. J., Ko, E. W. C., Huang, C. S., & Liou, E. J. W. (2005). Symmetry of the nose after presurgical nasoalveolar molding in infants with unilateral cleft lip and palate: a preliminary study. *The Cleft palate-craniofacial journal*, *42*(6), 658-663.

Paranaiba, L. M. R., Coletta, R. D., Swerts, M. S. O., Quintino, R. P., De Barros, L. M., & Martelli-Júnior, H. (2013). Prevalence of dental anomalies in patients with nonsyndromic cleft lip and/or palate in a Brazilian population. *The Cleft Palate-Craniofacial Journal*, *50*(4), 400-405.

Penfold, C., & Dominguez-Gonzalez, S. (2011). Bilateral cleft lip and nose repair. *British Journal of Oral and Maxillofacial Surgery*, *49*(3), 165-171.

Precious, D. S. (2009). Primary bilateral cleft lip/nose repair using the “Delaire” technique. *Atlas of the Oral and Maxillofacial Surgery Clinics of North America*, *17*(2), 137-146.

Răducanu, A. M., Didilescu, A. C., Feraru, I. V., Dumitrache, M. A., Hănţoiu, T. A., & Ionescu, E. (2015). Considerations on morphological abnormalities of permanent teeth in children with cleft lip and palate. *Rom J Morphol Embryol*, *56*(2), 453-457.

Randall, P. (1965). A lip adhesion operation in cleft lip surgery. *Plastic and Reconstructive Surgery*, *35*(4), 371-376.

Ranta, R. (1986). A review of tooth formation in children with cleft lip/palate. *American journal of orthodontics and dentofacial orthopedics, 90*(1), 11-18.

Richardson, E. R., & Malhotra, S. K. (1975). Mesiodistal crown dimension of the permanent dentition of American Negroes. *American journal of orthodontics*, *68*(2), 157-164.

Sassouni, V. (1969). A classification of skeletal facial types. *American journal of orthodontics*, *55*(2), 109-123.

Shetty, V., Vyas, H. J., Sharma, S. M., & Sailer, H. F. (2012). A comparison of results using nasoalveolar moulding in cleft infants treated within 1 month of life versus those treated after this period: development of a new protocol. *International journal of oral and maxillofacial surgery*, *41*(1), 28-36.

Shetye, P. R., & Grayson, B. H. (2017, September). NasoAlveolar molding treatment protocol in patients with cleft lip and palate. In *Seminars in Orthodontics* (Vol. 23, No. 3, pp. 261-267). WB Saunders.

Singh, G. D., Levy-Bercowski, D., & Santiago, P. E. (2005). Three-dimensional nasal changes following nasoalveolar molding in patients with unilateral cleft lip and palate: geometric morphometrics. *The Cleft palate-craniofacial journal*, *42*(4), 403-409.

Smith, S. S., Buschang, P. H., & Watanabe, E. (2000). Interarch tooth size relationships of 3 populations:"Does Bolton's analysis apply?". *American Journal of Orthodontics and Dentofacial Orthopedics*, *117*(2), 169-174.

Spengler, A. L., Chavarria, C., Teichgraeber, J. F., Gateno, J., & Xia, J. J. (2006). Presurgical nasoalveolar molding therapy for the treatment of bilateral cleft lip and palate: a preliminary study. *The Cleft palate-craniofacial journal*, *43*(3), 321-328.

Stuart Hunter, W., & Priest, W. R. (1960). Errors and discrepancies in measurement of tooth size. *Journal of dental research*, *39*(2), 405-414.

Talmant, J. C. (2000). Current trends in the treatment of bilateral cleft lip and palate. *Oral and Maxillofacial Surgery Clinics of North America*, *12*(3), 421-442.

Talmant, J. C., & Lumineau, J. P. (2004). Therapeutic approach to cleft lip-maxilla-palate: for normal facial growth. A protocol and various technics to restore nasal respiration. *L'Orthodontie francaise*, *75*(4), 297-319.

Trott, J. A., & Mohan, N. (1993). A preliminary report on open tip rhinoplasty at the time of lip repair in unilateral cleft lip and palate: the Alor Setar experience. *British journal of plastic surgery*, *46*(5), 363-370.

Ward, B. P., & SA, S. (1999). Hausamen JE. *Maxillofacial Surgery. London: Churchill-Livingstone*, 991-1004.

Werner, S. P., & Harris, E. F. (1989). Odontometrics of the permanent teeth in cleft lip and palate: systemic size reduction and amplified asymmetry. *The Cleft palate journal*, *26*(1), 36-41.