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Comparison of Hard Palatal Volume and Lips Prominence in Patients with Nasal and Mouth Breathing

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Özet

Son on yıldan beri, nefes alma şeklinin orofasiyal büyüme üzerindeki etkisi, ortodontide önemli bir çalışma konusus ur . Fonksiyonel matris Moss teorisinin önceki çalışmalarına göre, sadece burun solunumunun dentofasiyal kompleksin uygun bir şekilde büyümesini sağladığı görülmüştür. Moss teorisi, normal burun solunum işlemlerinden etkilenen kraniyofasiyal yapıların gelişimini ortaya koymaktadır. Nazal hava yolu yetersizliği ile dentofasiyal deformiteler arasındaki ilişkiyi belirlemek önemlidir. Bazı araştırmalar bu ilişkiyi anlamaya çalışmış ancak dentofasiyal gelişme ve ağız solunumu arasındaki ilişki hala araştırılması gerekmektedir. Bu çalışmanın amacı,ağız solunumu ve burun solunumu yapan bireylerde dudak konumunun palatal yüzey anatomisine (maksiller ark)bağlı olarak üç boyutlu dijital ortodontik modeller ve sefalometrik filmler üzerinde karşılaştırılmasıdır.

Araştırma, Yakın Doğu Üniversitesi Ortodonti Anabilim Dalı'nda 40 hasta üzerinde gerçekleştirilmiştir. Bu çalışma, araştırmalar için kullanılan malzeme ve yöntemleri ,bunların sonuçlarındaki istatistik sonuçlarını sunmaktadır.

Damak hacım ve damak alanının ortalama değerleri, ağız solunumunun sert damak boyutlarında ciddi değişikliklere yol açtığını göstermektedir. ağızdan nefes alan'ın ortalama değerlerinin burundan nefes alan'ın ortalama değerlerine kıyasla daha düşük seyretmesi, ağız solunumuyapan hastalarda burun solunumu yapanlara kıyasla sert damak boyutlarında küçülmye neden olduğunu göstermektedir.

Üst dudak ve alt dudak ortalama değerleri, ağız solunumuna bağlı olarak dudak belirginliğinin değiştiğini göstermektedir. ağızdan nefes alanın ortalama değerlerinin burundan nefes alanın ortalama değerlerine göre yüksek olması, ağız solunumu yapan hastalarda burun solunumu yapan hastalara kıyasla dudak pozisyonunun daha protruziv konumlandığını belirtmektedir.

Anahtar Sözcükler: Anatomik özellikler, palatal hacim, buru solunumu, ağız solunumu, ortodonti, dudak konumu.

SUMMARY

Turk, M. Comparison of Hard Palatal Volume and Lips Prominence in Patients with Nasal and Mouth Breathing . Near East University, Institute of Health Sciences, Department of Orthodontics, Ph.D. Thesis, Nicosia, 2019.

Objective: To compare hard palatal surface area , volume and lip prominence in patients with nasal and mouth breathing via the experimental analysis.

Methods: Twenty mouth breathing subjects (9 females and 11 males study group (MSG) was compared with a control group (NCG) of Twenty nose-breathing subjects (11 females and 9 males) for each subject 3D investigations of digital dental casts and cephalometric X-rays were taken .

Exclusion Criteria: patients who had orthodontic treatment, palatal expansion, extraction, cleft lip and palate, patients with bad habits (thump sucking, toung thrus etc.) and patient with extracted teeth .This

Results:In mouth-breathing subjects, changes in physiological function of the upper respiratory tract resulted in skeletal adaptations of the maxillary arch. There is significant mean value difference found in MSG and NCG which is approximately 927 and 115 for PV and PA respectively, which means that hard palatal volume size decreased by 927 mm^3 in MSG as compared to NCG and hard palatal area size decreased by 115 mm^2 in MSG as compared to NCG.

There is significant mean value difference found in MSG and NCG which is approximately -0.5 and -2.15 for Upper Lip (ULP) and Lower Lip (LLP) respectively, which means that ULP protrusion increased by 0.5 in MSG as compared to NCG and LLP protrusion increased by 2.15 in MSG as compared to NCG.

Conclusions: Subjects with a mouth-breathing pattern have a different palatalmorphology with significantly smaller palatal surface areas and volumes compared with nose-breathing subjects. The upper and lower lip of MSG is protruded more than the upper and lower lop of NCG .

Keywords: Anatomical properties, palatal volume, nasal breathing, mouth breathing, orthodontics, lips prominence.

Contents

LİST OF SYMBOLS AND ABBREVİATİONS

UA	Upper Airway
3d	Three Dimensional
SNORT	Simultaneous Nasal and Oral Respirometric Technique
FVC	Forced Vital Capacity
FEV1	Forced Expiratory Volume İn One Second
PEF	Peak Expiratory Flow
MIP	Maximal İnspiratory Pressure
MEP	Maximal Expiratory Pressure
CFS	Chronic Fatigue Syndrome
SEID	Systemic Exertion İntolerance Disease
ADHD	Attention-Deficit/Hyperactivity Disorder
ADD	Attention Deficit Disorder
RME	Rapid Maxillary Expansion
OSAS	Obstructive Sleep Apnea Syndrome
OSA	Obstructive Sleep Apnoea
GH	Growth Hormone
IGF I	İnsulin-Like Growth Factor I
SFS	Short Face Syndrome
MRI	Magnetic Resonance İmaging

CT	Computed Tomography
MSG	Mouth Study Group
NCG	Nose Control Group
DCS	Direct Conversion Sensor
µm	Micrometre
cm	Centimeter
mm	Millimeter
STA	Soft Tissues Analysis
PV	Palatal Volume
PA	Palatal Area

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LİST OF TABELS

1. INTRODUCTION

1.1 Research Background

The main function of human body is breathing and hence it mainly depends on the adequate permeability of the nasal route. The physiologic breathing mode in the human being is nasal, regardless of age. The nasal cavity has a fundamental role in the physiology of respiration (Brant TCS. et al. 2008). It promotes filtering, heating and humidification of the inhaled air, causing it to reach the lungs at the ideal temperature and favoring the adequate oxygenation of the body (Yi LC et al. 2008). Any factor leading to the upper airway (UA) obstruction causes nasal breathing to be replaced by mouth breathing, among which mechanical events, allergic and nonallergic inflammatory diseases, congenital malformation and tumoral lesions. Mouth breathing has been studied since the beginning of the twentieth century, with scientific publications directed to the scope of dentistry emphasizing the occlusal consequences (Hartsook JT 1946). This condition, considered as a public health problem, is attracting growing scientific interest in recent years, and greater coverage in the multidisciplinary aspects surrounding it.

As discussed earlier, the nose breathing allows the proper performance of oral sensorimotor system of other human functions as well as orofacial structures physiological position. In such situations, balance achieved by muscles in facial's hard tissue and hence it is stimulus for the harmonious craniofacial development and growth. The naso-respiratory function can be replaced by a compensatory oral pattern, due to obstructive or habitual causes. The obstructive mouth breathing occurs when there is a mechanical hindrance to the airflow passage through the upper airways, because of enlarged adenotonsillar tissues, among other causes. On the other hand, in the habitual mouth breathing there is no upper airways obstruction, and it occurs as a result of flaccidity or bad positioning of orofacial muscles, transitory swelling of the nasal mucosa, and repaired airway obstruction. Being a multifactorial pathology, studies have been carried out in order to verify the effects of the different etiological factors of mouth breathing in the orofacial complex (de

Freitas FCN et al. 2001, Di Francesco RC et al. 2004, Ghasempour M et al. 2009, Souki BQ et al. 2009). In general, the establishment of mouth breathing mode may alterations in myofunctional aspects, body posture, craniofacial morphology, and dental occlusion, as well as in the behavior and the quality of life of the subjects. Among the morphological alterations mentioned, there are the hard palate modifications, which are expressed by the following classification: deep and atretic; high and narrow (Marchesan IQ et al. 1996, deep and narrow (Castelluci e Barbosa et al. 2009, Bianchini AP et al. 2007), ogival and narrow (Cattoni DM et al. 2007) ogival (Gouveia SA et al. 2009), and deep (Coelho AR et al. 2010).

Thus, the mouth breathing is nothing but the act of inhaling and exhaling using the mouth. This respiratory phenomenon is considered normal under increased physical activity because the increased need for oxygen under such circumstances can only be supplied by breathing through the mouth and nose simultaneously. However, using one's mouth to breathe in daily life or during sleep is a serious ailment which occurs in the presence of an obstruction in nasal and nasopharyngeal regions of the upper airway. Nasal obstructions can be due to physiologic factors like allergic rhinitis and polyps or anatomical factors such as a deviated septum and a narrow nasal area. Enlarged adenoids and tonsils are the most common causes of obstruction in the nasopharyngeal area, especially at ages 5–6 years. As compared to nasal breathing, the mouth breathing caused several negative impacts on the dentofacial deformities in human beings, however justifying the relationship between dentofacial deformities and mouth breathing still the research problem due to inconclusive results. This research presents the novel study that demonstrates the effects of nasal breathing and mouth breathing comparatively by considering the hard palatal and lip prominence.

1.2 Research Motivation

The resting position and functions based on structure of morphologically altered hard palatal may be adapted. Thus appropriate anatomical investigations and analysis is essential. The researchers required to conduct the statistical investigations of hard palatal in order to gain the more efficiency and accuracy in medical diagnosis as well as assists the medical expert this structure assessment. According to the hypothesis, mouth breathing and mixed breathing may lead the alterations in hard palatal area (maxillary arch) or volume as well as lip prominence, and various manifestations noticed as per the etiology of the mouth breathing. Several researches already presented on relationship between dentofacial deformities and nasal breathing, however the accurate study over the relationship between dentofacial deformities and mouth breathing is still challenging research problem for the researchers. Defining the appropriate elaboration of mouth breathing and it's related with dentofacial deformities based on experimental study is motivating factor of this research.

1.3 Problem Statement

The relationship between mouth breathing and dentofacial growth is still being debated after more than a century. Despite the existence of an extensive body of literature on this subject, the inconclusive results so far may be explained by different population selection criteria and the various diagnostic methods used for differentiating mouth breathers from nasal breathers. In order to determine this assumed relationship, the meaning of the term *mouth breathing* needs to be clearly established at first. Then to justify the negative effects of mouth breathing on dentofacial growth as compared to nasal breathing, preparation of the appropriate and conclusive experimental analysis is required.

1.4 Aim

To compare the anatomical characteristics of the maxillary arch, identified as palatal Surface area and volume, and lips prominence between mouth-breathing and nose-breathing subjects using a three dimensional(3d) analysis of digital dental casts and cephalometric X-rays.

2. General Informatıon

2.1 Mouth breathing

Mouth breathing is a serious ailment -which occurs in the presence of an obstruction in nasal and nasopharyngeal -regions of the upper airway. Chronic mouth breathing can cause problems in facial structures and oral health. Changes in facial structures include long anterior facial height, narrow facial width, a retrognathic mandible, open-mouthed posture, an incompetent and short upper lip, loss of tonus in perioral muscles, a pinched looking nose and a dull appearance. The intraoral consequences of mouth breathing are openbite, a Class II molar occlusion with increased overjet, protruding maxillary anterior teeth, and a V-shaped maxillary arch. Not every patient has the same growth changes due to oral breathing. The heritable characteristics of anatomical structures also seem to play a role in determining which patients will be most affected. A careful evaluation of the patient by otolaryngologists, pediatricians and orthodontists is needed before treatment decision.

If chronic mouth breathing develops due to obstruction of the airways, this can cause a multitude of problems in facial structures and oral health. Such patients have been described as having special facial characteristics generally referred to as adenoid facies (Emslie et al. 1952 ; Linder-Aronson 1970 ; Koski and Lähdemäki 1975), long face syndrome (Schendel et al. 1976), and respiratory obstruction syndrome (Ricketts 1968). This type of face reportedly features long anterior facial height, narrow facial width, a retrognathic mandible, open-mouthed posture, an incompetent and short upper lip, loss of tonus in perioral muscles, a pinched looking nose,. The intraoral consequences of mouth breathing are said to include open bite, a Class II molar occlusion with increased overjet, protruding maxillary anterior teeth, and a V-shaped maxillary arch with deep palatal vault showing in figures 2.3, 2.4,. Mouth breathers may also extend their heads in order to maintain a patent airway observed in figures 2.6 and 2.7.

In addition to these structural changes, mouth breathing can cause halitosis (breath malodor), increased incidence of caries, and marginal gingivitis around the maxillary anterior teeth. If diagnosed early, orthodontic and dentofacial orthopedic treatment of the patients is possible. However, in adult patients, orthognathic surgical treatment in addition to orthodontic treatment may be necessary.

Figure 1: Sagittal occlusal relationship in mouth breathing patients (Carlson, D.S. (2005).

As noticed in figure 2.3, Sagittal occlusal relationship in mouth breathing patients is said to include a Class II molar occlusion with increased overjet and protruding maxillary anterior teeth.

Figure 2 posterior crossbite and an anterior open-bite malocclusion in a mouth-breathing patient (Peltomaki,T. 2007)

The posterior crossbite is suggested to be due to transverse maxillary deficiency caused by an imbalance of forces between the muscle forces acting on these structures. The open bite is caused by extruded molar teeth due to an open-mouthed posture in response to an increased nasal resistance.

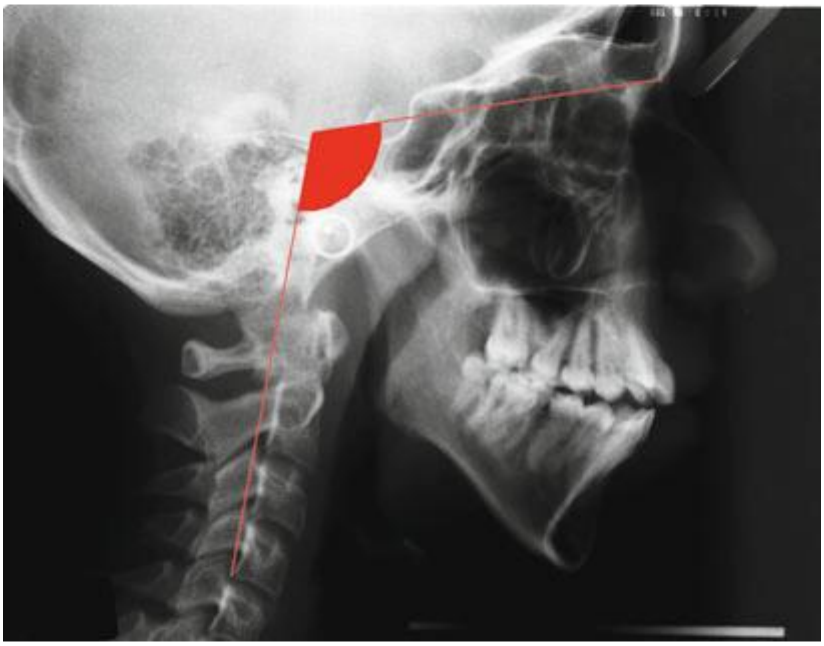

Figure 3: Lateral cephalometric radiograph of mouth breathing patient Pinto, J.A. (2009)

The Lateral cephalometric radiograph of the patient from the figure 2.6 is showing in figure 2.7. Note the dental protrusion and downward backward rotation of the mandible in addition to the extended head position. The causes of mouth breathing are summarized in section 2.2. The literature review presented in section2.3.

2.2 Causes of Mouth Breathing

There are various reasons due to which the mouth breathing caused. In this section we discuss some of them. The underlying cause of most cases of mouth breathing is an obstructed (completely blocked or partially blocked) nasal airway. In other words, there's something preventing the smooth passage of air into the nose. If human nose is blocked, the body automatically resorts to the only other source that can provide oxygen — human mouth. There are many causes of a blocked nose. These include:

- Stress and anxiety
- Nasal Congestion caused by allergies, a cold, or a sinus infection
- Enlarged adenoids
- Enlarged tonsils
- Deviated septum
- Nasal polyps
- Enlarged turbinates
- Nose shape, Jaw Shape, and Tumors (Rare cases)

Some people develop a habit of breathing through their mouth instead of their nose even after the nasal obstruction clears. For some people with sleep apnea, it may become a habit to sleep with their mouth open to accommodate their need for oxygen.

2.2.1 Stress and Anxiety

Stress and anxiety can also cause a person to breathe through their mouth instead of their nose. Stress activates the sympathetic nervous system leading to shallow, rapid, and abnormal breathing. Stress is human body's response to certain situations. It’s subjective, so something that is stressful for human being may not be stressful for someone else. There are many different kinds of stress and not all of them are bad. Stress can help individual act quickly in an emergency or help individual meet a deadline. Stress can affect human physical and mental health, and human behavior. Human body responds to stress by producing chemicals and hormones to help individual rise to the challenge. Human heart rate increases, human brain works faster, and individual have a sudden burst of energy. This response is basic and natural and is what kept our ancestors from falling victim to hungry predators.

2.2.2 Nasal Congestion

It is one of main and common cause for the mouth breathing. Nasal congestion, also called a stuffy nose, is often a symptom of another health problem such as a sinus infection. It may also be caused by the common cold. Nasal congestion is marked by:

- a stuffy or runny nose
- sinus pain
- mucus buildup
- swollen nasal tissue

Home remedies may be enough to alleviate nasal congestion, particularly if it’s caused by the common cold. However, if you experience long-term congestion,

2.2.3 Enlarged Adenoids

Enlarged adenoids are common in children. The adenoids can become enlarged due to an infection or may be enlarged from birth. The adenoids are glands that sit behind the nose above the roof of the mouth. When they grow large, they can cause snoring and breathing problems. The adenoids are glands that sit above the roof of the mouth and the tonsils. They are part of the immune system. These glands help trap germs that enter the nose or the mouth, in an effort to prevent infections. The size of the adenoids increases until a child is 6 years old, and then they slowly shrink. The adenoids usually disappear by the time a person is 16. Enlarged adenoids are rare in adults.

Most of the time, the adenoids become enlarged when the body is trying to fight off infection. They can remain enlarged, even after the infection is gone. Some children have enlarged adenoids from birth. Allergies can also cause this enlargement. Although it is rare, adults' adenoids can become enlarged, due to a chronic infection or allergy, pollution, or smoking. Even less common are enlarged adenoids resulting from a cancerous tumor.

Thus, the enlarged adenoids is one of cause that leads the mouth breathing in which breathing more through the mouth than the nose and bad breath or dry, cracked lips resulting from mouth breathing.

2.2.4 Enlarged Tonsils

Similar to enlarged adenoids, the enlarged tonsils commonly noticed in children’s. Some children have enlarged palatine tonsils (often simply referred to as "tonsils," on the left and right sides at the back of the throat , and others have enlarged adenoids (also called the pharyngeal tonsil, found at the back of the nose). The medical terms for these enlarged areas of tissue are "tonsil hypertrophy" and "adenoid hypertrophy." Sometimes both are enlarged. The possible signs of enlarged tonsils include the following:

- Snoring
- Pauses in breathing during sleep
- Mainly breathing through the mouth
- Strained breathing
- Restless sleep, waking frequently, bedwetting
- Unusual sleeping position (head bent back, knees drawn up to chest while lying on your front)
- Trouble swallowing, “hot potato” speech
- Frequent colds

The enlarged tonsils mainly affect ability to breathe through nose. Pauses in breathing during sleep, on the other hand, are mainly caused by enlarged palatine tonsils.

2.2.5 Deviated Septum

A deviated septum can be congenital. This means that a person was born with it. It can also occur as a result of an injury to the nose. People often get these injuries from contact sports, fighting, or car accidents. A deviated septum can also worsen with age. The septum is the cartilage in the nose that separates the nostrils. Typically, it sits at the center and divides the nostrils evenly. However, in some people, this isn't the case. Many people have an uneven septum, which makes one nostril larger than the other. Severe unevenness is known as a deviated septum. It can cause health complications such as a blocked nostril or difficulty breathing. An uneven septum is very common. According to the American Academy of Otolaryngology - Head and Neck Surgery, 80 % of all septums are deviated to some degree. A deviated septum requires medical attention only if it causes other health issues or negatively impacts quality of life.

2.2.6 Nasal Polyps

This condition also treated as benign growths of tissue in the lining of human nose. Nasal polyps are fleshy swellings that develop in the lining of the nose and paranasal sinuses, the air-filled spaces that are linked to the nasal cavity. They are non-cancerous growths. Polyps vary in size; they may be yellowish-brown or pink and are shaped like teardrops. As they grow, they eventually look like grapes on a stem. Polyps may grow in one or both nostrils at the same time; they can grow on their own or in clusters. Large polyps or clusters can cause breathing difficulties and can affect the patient's sense of smell. They may block the sinuses and cause problems, such as regular infections. Nasal polyps affect an estimated 4-40 % of the general population, and they seem to be 2-4 times more common in males than females. People who develop them tend to do so as young or middle-aged adults. Individuals with asthma, frequent sinus infections, and allergies are more likely to develop them. Some children with cystic fibrosis may develop nasal polyps. The facts about the nasal polyps are:

- Nasal polyps are much more common in men than women

- Often nasal polyps do not present any symptoms, making it difficult to know exactly how common they are
- Sometimes, nasal polyps can cause sleep apnea
- Nasal polyps can arise at any age

2.2.7 Enlarged Turbinates

The enlarged turbinates one of the cause of mouth breathing. The nasal turbinates are long, narrow passageways that help to warm and moisten the air that flows in through the nose. The turbinates are also called the nasal conchae. If the turbinates are too large, they can actually block airflow. Doctors call this condition turbinate hypertrophy. This condition can cause breathing problems (in such cases peoples does the mouth breathing), frequent infections, and nosebleeds. Some people have three while other people have four. Most people have superior, middle, and inferior turbinates. Enlargement of the inferior and middle turbinates most commonly causes turbinate hypertrophy. Both over-the-counter and surgical treatments can treat turbinate hypertrophy.

2.2.8 Nose Shape, Jaw Shape, and Tumors

The nose shape causes the mouth breathing. As noticed in figure, at age 10 the normal nasal breathing operations performed, however as the shape changes at age 17 leads the problem of mouth breathing in child. Sometimes, the shape of nose enlarges over the years than the regular progress which cause the difficulties for breathing. Similarly, the size and shape of jaw and presence of tumors also leads the mouth breathing. However this are the rare causes for the mouth breathing.

2.3 Literature Survey

There is still controversial issue within orthodontics and otolaryngology despite many attempts to establish a cause-and-effect relationship between nasal respiratory impairments and dentofacial deformities. The most prevalent view among clinicians is that a change in the mode of respiration, such as mouth breathing due to an inadequate nasal airway, could cause changes in craniocervical posture, maxillomandibular relationship, and position of the tongue. This in turn could affect dentofacial growth and positions of the teeth. However, clinicians from both sides of controversy can find ample evidence in the literature supporting their opinions, and the results of studies relating dentofacial features with respiratory pattern are far from being conclusive. Since there are treatment decisions that revolve around the degree of interplay between nasal obstruction and dentofacial development, the relationship must be further elucidated. If nasal obstruction has an effect on dentofacial development, early treatment for removal of the cause of this obstruction would be necessary. On the other hand, if dentofacial growth and development is not signifi cantly affected by the respiratory mode, then treatment of nasal obstruction in order to prevent abnormal orofacial development would not be indicated.

2.3.1 Studies (1990-2010) on Dentofacial and Physiologic Effects

The studies reported during the last two decades presented in this section. Heredity and environmental factors are both effective in the development of dental arches and postnatal determination of craniofacial features. One of the most important environmental factors is the predominant respiratory pattern. Nasal breathing is associated with normal posture of the tongue and lips and normal muscle activity. If there is nasal obstruction, this would likely affect the muscle forces acting on the dentofacial region. This change in muscular action may cause abnormal facial growth and development. It has been shown that during oral breathing masseter muscle activity is inhibited (Ono et al. 1998). Increased airway resistance also stimulates mechanoreceptors in the upper airway and increases the activities of the genioglossus and mylohyoid muscles due to forward positioning of the tongue and opening of the mouth to maintain the airway (Song and Pae 2001).

Long-term mouth breathing seems to affect the occlusion and facial morphology during periods of rapid growth. However, not every patient has the same growth changes due to oral breathing. The heritable characteristics of anatomical structures also seem to play a role in determining which patients will be most affected. In some patients a slight opening of the lips may be enough to provide the necessary airway, while in others a more exaggerated postural response of the mandible, tongue, and head will be necessary.

Children with narrow facial patterns also may be more susceptible to growth changes due to mouth breathing than children with broad facial features.

It is also possible for patients with a vertical facial growth pattern to be more likely to be mouth breathers. The severity of the obstruction will also determine if the child is a chronic mouth breather or a partial one. If the obstruction is severe, the changed postural responses will be in place longer causing more extensive growth changes in dentofacial structures.

The most common cause of oral breathing in children is enlarged pharyngeal lymphoid tissue. The enlargement of these tissues may adversely affect pharyngeal patency (Gross and Harrison 2000). Normally, the size of the adenoid tissue is dependent on the associated skeletal structures. However, abnormal growth of this tissue may predispose the patient to upper airway obstruction causing oral respiration. As a matter of fact, any reason that causes nasal resistance to increase for long periods of time, such as allergies or nasal eptal deformity, has the potential to cause chronic oral respiration.

During oral respiration, the mandible rotates open and the tongue is positioned lower in the mouth and no longer contacts the palate causing eruption of the molars and transverse maxillary deficiency .

When the tongue is in its correct position, it exerts transverse pressure on the teeth and alveolus, allowing proper growth . If the tongue is in a lower position, equilibrium of forces is disturbed. As a result the palate becomes narrow . Thus, the mandible rotates in a clockwise direction, losing contact with the soft palate, causing open bite and mandibular retrognathism.

However, this is only a mechanistic view of the possible interactions between mandibular growth and oral breathing. Complex epigenetic events may also be responsible for the growth changes in the mandible. It has been hypothesized that children with significantly enlarged adenoids will develop obstructive sleep apnea causing abnormal nocturnal growth hormone secretion causing somatic growth impairment (Peltomaki 2007). Due to this abnormal hormonal balance, mandibular ramus growth may be less than in healthy subjects causing the observed mandibular rotation in these children. This mandibular rotation also causes backward and downward displacement of the tongue (L'Estrange et al. 1996). Postural changes of the tongue lead to altered muscle forces to act on maxillary arch causing a constricted maxillary arch, high palate, and posterior crossbite in the transverse direction.

Craniocervical posture and oral breathing have also been the subject of various investigations. Oral breathing has been shown to be associated with head extension (Cuccia et al. 2008 ; Chaves et al. 2010 ; Neiva et al. 2009). This postural change moves the hyoid bone upward establishing an adequate airway (Gonzalez and Manns 1996). Since there is a relationship between head posture and altered muscle activity, long-term craniocervical changes may influence craniofacial growth as well as putting undue load on the neck and upper shoulders.

Mouth breathing in cleft palate patients is a clinically relevant subject as well (Hairfi eld et al. 1988). The airway size is reduced and nasal resistance is higher in cleft patients compared to noncleft subjects (Warren et al. 1984 , 1969). The large craniocervical angulation indicates an extended head position in these cases (Oosterkamp et al. 2007). The high prevalence of mouth breathing in these patients may be caused by various factors, such as septal deviation and effects of surgical techniques. Thus, a normal breathing pattern may not be established ever because of the open communication between the nose and mouth at birth (Warren et al. 1988).

In addition to these structural changes in the dentofacial region, mouth breathing may cause other oral diseases. Mouth-breathing patients often have inflamed labial gingival tissues around the maxillary incisors. The gingiva becomes inflamed and hyperplastic because the mouth remains open and the salivary flow is reduced. Since saliva performs essential roles including antimicrobial action and protection of oral tissues, a reduction in salivary flow will have negative impact on teeth and gingival tissues as well as generating odoriferous volatile compounds.

Clinically, the gingiva appears swollen, red, and shiny with the classic rolled up appearance.This lack of lip seal causes the mouth to become dry. Maxillary anterior teeth and gingiva are most at risk for the negative effects of this open-mouthed posture. The gingiva is inflamed, and there are decalcifications on teeth due to poor oral hygiene and mouth breathing.

Note the classic shiny red, swollen look of the gingival. There can be bone loss and pocket formation in the interproximal area if proper oral hygiene is not maintained. There is also an increased incidence of caries and halitosis (breath malodor). Correction of mouth breathing along with necessary dental treatments will improve the health of the oral cavity.

It has been difficult to determine the relationship between dentofacial morphology and oral breathing because respiration is a complex act which cannot be easily classified with the current techniques. There are multiple factors which determine if dentofacial growth of a person will be affected by the changes in the nasal airway. Thus, a careful evaluation of the patient by otolaryngologists, pediatricians, and orthodontists is needed before treatment decisions.

3. Mouth Breathing Diagnosıs And Treatment

As discussed earlier, mouth breathing has been reported to cause abnormal facial growth, attention problems associated with sleep disorders, and of reduction in quality of life. In addition, we highlight that increased oxygen load in the prefrontal cortex when changing from nasal breathing to mouth breathing. In this way, in the field of dentistry, the characteristics of mouth breathing have been investigated mainly for the purpose of discovering the effects of mouth-breathing and identifying habitual mouth breathers.

There are a number of findings reported as characteristic of mouth breathing, but they differ in different reports. For example, there are reports focused on rhinitis and open mouth at rest. Rhinitis is reported as a finding related to mouth breathing in some studies, but not in others. Open mouth at rest is also found to be characteristic of mouth breathing in some studies but not others, because there are some cases in which the mouth is habitually open without mouth breathing. Mouth breathing is determined by a combination of predisposing factors (i.e., facial type) and precipitating factors (i.e., local factors). In other words, all of the findings associated with mouth breathing may not apply to a given individual. Accordingly, to identify whether a person is a habitual mouth breather, he or she should be evaluated based not on the presence (or absence) of certain specified characteristics, but on the extent to which the various different characteristics in the spectrum of characteristics associated with mouth breathing apply.

Clinically, visual assessment is most commonly used (97.2%) to identify the characteristic findings of mouth breathing (Pacheco MCT et al. 2015). In visual assessment, the dentist (or other clinician) observes the patient for the presence of factors causing increased breathing resistance, such as adenoid facies, pharynx or palatine tonsil hypertrophy and deviated nasal septum (Wieler WJ et al. 2007); and observes whether the mouth-breathing route is closed at rest. Facial morphology and the condition of the front teeth and gingiva are also observed. Next in frequency after visual assessment, interviews (87.2%) and respiratory tests (59%) have been used to evaluate for mouth breathing (Pacheco MCT et al. 2015). In interviews, subjects are questioned about symptoms or habits that may induce mouth breathing, such as allergic rhinitis, nasal congestion, snoring, and open mouth during sleeping or resting (Fujimoto S et al. 2009, Pacheco MCT et al. 2015, Masahiro Sano et al. 2018). Respiratory tests used include a lip seal test, which evaluates whether a subject can keep his or her lips closed; a mirror test, which assesses the extent of clouding on a mirror held below the nose; and a water retention test, which evaluates the ability to hold water in one's mouth (Fujimoto S et al. 2009).

Namely, the methods and content of evaluation for detecting habitual mouth breathing are left to the discretion of the dentist. There is currently no unified screening method for detecting habitual mouth breathing. Moreover, there is little general awareness of the need for intervention in the case of habitual mouth breathing, and people in general do not know how to identify habitual mouth breathing. For this reason, early detection of habitual mouth breathing is delayed, and people are unlikely to ask their dentist about mouth breathing, or visit a dentist with mouth breathing as their main complaint. Creation of a screening process for detecting habitual mouth breathing without the use of special equipment would thus be useful not only for dentists, enabling them to detect mouth breathing on a uniform scale, but also for the general public, by raising awareness of the importance of mouth breathing prevention. In short, doctors mainly relay on two cases for the diagnosis of mouth breathing such as symptoms and questionnaires.

3.1 Diagnosis based on Symptoms

A doctor will often inspect a person's mouth, throat, and nose to identify any areas of swelling or abnormalities and observe their breathing pattern. They may also order imaging studies to examine the nasal passages and perform lung function tests to see if the lungs are impacted by asthma or other conditions. If a doctor suspects a person may have sleep apnea, they may order a sleep study.

This involves the individual going to a sleep center where monitoring equipment can identify if, when, and how often a person stops breathing while they are sleeping. Both children and adults can have sleep apnea.

You may not realize that you're breathing through your mouth instead of your nose, especially while you sleep. People who breathe through their mouth at night may have the following symptoms:

3.1.1 Snoring: Snoring is a common condition that can affect anyone, although it occurs more frequently in men and people who are overweight. Snoring has a tendency to worsen with age. Occasional snoring is usually not very serious and is mostly a nuisance for your bed partner. However, if you are a habitual snorer, you not only disrupt the sleep patterns of those close to you, but you also impair your own sleep quality. Snoring occurs when the flow of air through the mouth and nose is physically obstructed.

3.1.2 Dry Mouth

The dry mouth (xerostomia) might seem like an annoying thing that happens at night from time to time. But if it occurs regularly, It is one of symptom of the mouth breathing. Saliva is necessary for tooth and gum health, and enzymes in saliva help aid indigestion. If your mouth is dry throughout the night, your oral health might be affected without you even knowing it.

3.1.3 Bad Breath (Halitosis)

Breath odor affects everyone at some point. Bad breath is also known as halitosis or fetor oris. Odor can come from the mouth, teeth, or as a result of an underlying health problem. Bad breath odor can be a temporary problem or a chronic condition.

According to the American Dental Association, at least 50 % of adults have had halitosis in their lifetime. In addition to a bad smell in mouth, we may also notice a bad taste in mouth. If the taste is due to an underlying condition and isn't because of trapped food particles, it may not disappear even if brush teeth and use mouthwash.

3.1.4 Chronic Fatigue

The chronic fatigue syndrome (CFS) is a disorder characterized by extreme fatigue or tiredness that doesn't go away with rest and can't be explained by an underlying medical condition. CFS can also be referred to as myalgic encephalomyelitis (ME) or systemic exertion intolerance disease (SEID). The causes of CFS aren't fully understood yet. Some theories include viral infection, psychological stress, or a combination of factors. Because no single cause has been identified, and because many other conditions produce similar symptoms, CFS can be difficult to diagnose. There are no tests for CFS. The doctor will have to rule out other causes for fatigue when determining a diagnosis. While CFS was previously a controversial diagnosis, it's now widely accepted as a medical condition. CFS can affect anyone, though it's most common among women Trusted Source in their 40s and 50s. There's currently no cure, but treatment can relieve symptoms. However, CFS is considered one of the symptoms to diagnose the mouth breathing, it means that some studies reveals that mouth breathing cause the CFS in human beings.

3.2 Questions based Diagnosis

A doctor will ask questions to obtain a full medical history if they suspect mouth breathing is a problem for someone. They will ask when the person first noticed their symptoms, what makes their symptoms worse, and if anything makes them better.

Medical professionals may ask one or more than one questions to diagnose the possibility of mouth breathing disease. The 10 questions are more commonly used by doctors for the prediction as they delivered the higher accuracy of diagnosis..Which the respondents were asked about a variety of items conventionally reported to be characteristic of habitual mouth breathing. Of the 50 questions, 27 had 3 possible responses (yes, sometimes, or no), and 23 had 2 possible responses (yes or no).

Additional questions intended to reveal possible attributes of the mouth breathing group were also included, concerning gender, age, height, weight, history of asthma, incidence of allergic rhinitis, and history of smoking.

4. Effects Of Mouth Breathıng

Nasal obstruction, chronic allergic rhinitis and hypertrophic adenoids decrease capacity for nasal breathing (NB) and compensating for this by mouth breathing (MB) might be necessary (Oulis et al., 1994). Respiratory airway function influences facial morphology and both craniofacial (Gungor and Turkkahraman, 2009) and cervical functions (Huggare and Laine-Alava, 1997; McNamara, 1981). The breathing pattern may influence the development of the transverse relationship between the maxilla mandible, resulting in the development of a posterior cross bite (Rubin, 1980).

MB can affect the form of the jaw or cause malocclusions (Hartsook, 1946), and it has been shown to lead to the so-called “adenoid face”, which is characterized by a narrow upper dental arch, retroclined mandibular incisors, an incompetent lip seal, a steep mandibular plane angle and increased anterior facial height (Lessa et al., 2005; Peltomäki, 2007; Linder-Aronson, 1970). Ricketts (1968) suggested that head extension represents a functional response in MB patients to compensate for nasal obstruction.

There were several effects of MB studied. MB has been reported to cause changes in human head posture (Cuccia et al., 2008). The treatment of hypertrophic adenoids (Linder-Aronson, 1970) and nasal obstruction (Vig et al., 1980) with a nasal clip has been shown to alter head posture. Children with MB who have enlarged tonsils can develop the extension of their head posture and the low position of hyoid bone position (Behlfelt et al., 1990a,b). However, some authors have concluded that the hyoid position is maintained in a stable position in children with MB (Bibby, 1984; Ferraz et al., 2007). MB is associated with a low tongue posture and the absence of a contact surface between the tongue and soft palate; this latter factor was termed “posterior oral incompetence” by Ballard (1951). This problem is caused by enlarged adenoid tissue that reduces the airway space and leads to postural adaptations at the level of the oropharynx.

The hyoid bone drops in relation to the mandible, and creates a relatively constant air-space diameter in the anteroposterior direction. This neuromuscular recruitment may cause changes in the mandibular resting position and neck extension (Tourné, 1991). Thus, the breathing pattern could represent a major factor that underlies the hyoid bone position (Graber, 1978).

In this section, the aim is to present the study on various effects caused by the MB on human beings such as Craniofacial Development and Head Postured, Hyoid bone position, Long-narrow faces, Tongue Position, Growth of Maxilla, Hard Palate Dimension, Growth of Mndibule, Dental Malocclusion etc.

4.1 Craniofacial Development and Head Postured

In all individuals, muscular activity is reduced and upper airway resistance increased during sleep compared with wakefulness (Worsnop *et al.*, 2000). This does not have a notable effect on breathing in anatomically and functionally 'healthy' individuals. On the other hand, reduction of muscular tonus in children with large adenoids and tonsils, or with other underlying abnormal upper airway anatomy, may lead to airway obstruction and eventually to obstructive sleep apnoea (OSA). Interestingly, these children have been found to have similar craniofacial characteristics as adenoid face children (Guilleminault *et al.*, 1996; Shintani *et al.*, 1997; Agren *et al.*, 1998; Zucconi *et al.*, 1999; Kawashima *et al.*, 2000, 2002; Zettergren-Wijk *et al.*, 2006). The first treatment of choice of OSA children is removal of adenoids and tonsils (Nieminen, 2002; Guilleminault *et al.*, 2004).

It can thus be postulated that some children with a clinical diagnosis of an adenoid face could nowadays be diagnosed as having OSA. Of particular interest is the recent cephalometric study on 5-year-old children with polysomnographically verified OSA (Zettergren-Wijk *et al.*, 2006). This study showed that OSA children have a different facial morphology compared with age-matched controls. The mandibular plane angle was found to be posteriorly inclined, anterior face height to be greater, and posterior face height smaller, in the OSA than in the control children.

At the 5-year follow-up after adenotonsillectomy, no major *craniofacial and Head postured* differences were noted in many studies.

In a closer look at the growth changes it becomes evident that anterior face height remained greater in the OSA children than in the control children (difference on average 2.5 mm), but it increased on average by a comparable amount in both groups of children. Yet, the mandibular plane angle was decreased in the OSA children. This may be explained by the described greater posterior face height growth (ramus growth) in the OSA than in the control children (OSA children 5 mm, control children 3 mm).

OSA children with large adenoids and tonsils have also been found to have somatic growth impairment due to abnormal nocturnal growth hormone (GH) secretion (Goldstein *et al.*, 1987; Bar *et al.*, 1999; Nieminen *et al.*, 2002). Following adenotonsillectomy, a significant increase in the serum levels of GH mediators, i.e. insulin-like growth factor I (IGF I) and its binding protein, has been reported. Consequently, normalization and even catch-up of somatic growth have been observed (Bar *et al.*, 1999; Nieminen *et al.*, 2002).

4.2 Hyoid Bone Position

The MB having severe effects on hyoid bone position as well. The importance of the hyoid bone is related to its single relation, nonetheless, it provides connections to pharynx, mandible and cranial muscles, ligaments and fascia. Many of the characteristics of the so called Long Face Syndrome (LFS) group and the Short Face Syndrome (SFS) group could be explained based on the clockwise and counter-clock wise rotation of the mandible "in harmony" with the hyoid bone, tongue, pharynx and neck. The vital need to keep the air space pattern at the tongue base may explain this rotation in the LFS.

Adenoid tissue or tongue mass may reduce the air space and cause postural adaptations at the level of the oropharynx. A hyoid bone drop in relation to the mandible would represent an attempt to assure a relatively constant air-space diameter in the antero-posterior direction. This neuromuscular recruiting could cause changes in mandibular rest position and neck extension, thus influencing the craniofacial growth pattern· Thus, air space pattern and stability would represent major factors responsible for hyoid bone position· Since malocclusion may be caused by inadequate oral habit, such as atypical swallowing and oral breathing - hyoid bone position could serve as an important diagnostic guide· Numerous authors have studied the hyoid bone morphology and function, and others have investigated hyoid bone position in relation to the cranium and the cervical spine by means of cephalometric techniques.

4.3 Long and Narrow Faces

As discussed earlier this research, the mouth breathing leads another effects on dentofacial development of patients called long and narrow faces. Long and narrow face effects commonly noticed in mouth breathers. In medical terms the long and narrow face conditions is called as long face syndrome.

It is also referred as skeletal open bite, is a relatively common condition characterised by excessive vertical facial development. Its causes may be either genetic or mouth breathing. Long face syndrome is a common dentofacial abnormality. Its diagnosis, symptomology and treatments are complex and controversial. Indeed, even its existence as a "syndrome" is disputed.The Habitual mouth breathing can lead to long face syndrome "long face" or elongated facial features during a child's development.

4.4 Tongue Position

The effects of mouth breathing leads the changes in tongue position as well. The Mouth breathing changes the position of tongue called as a tongue “thrust.” This negatively affects speech, swallowing, and chewing. This could lead to a child feeling self-conscious. Depending on the severity of the speech impediment(s), a speech pathologist may be necessary to correct speech alterations and slurs. This effect is medically called as Tongue Trust syndrome.

Since 1958, the term "tongue thrust" has been described and discussed in speech and dental publications by many writers. Many school-age children have tongue thrust. For example, according to recent literature, as many as 67–95 percent of children 5–8 years old exhibit tongue thrust, which may be associated with or contributing to an orthodontic or speech problem. Up to the age of four, there is a possibility that the child will outgrow tongue thrust. However, if the tongue thrust swallowing pattern is retained beyond that age, it may be strengthened.

4.5 Growth of Maxilla

“All growth changes in size, shape, and spatial position, and the maintenance of all skeletal units are always secondary to specific functional matrices.” (i.e. capsular and periosteal matrix) (Moss M.L et.al, 1965). The capsular matrix includes oral, pharyngeal and nasal cavity. Whenever function carried out by capsular matrix is hampered the growth of skeletal units will be affected.

Assuming this, the growth of the sinus should also be dependent on functions carried out by nasal capsule. When the functioning of the nasal capsule is hampered due to mouth breathing, changes in the form of maxilla and paranasal sinuses should be expected. The four sets of paranasal sinuses – maxillary, frontal, sphenoid and ethmoidal could show poor development. These paranasal sinuses show growth by pneumatisation (Enlow D.H et al. 1990). In presence of stunted growth, impaired pneumatization is also a possibility which indicates the likelihood of dimensional changes in the sinuses especially maxillary sinus as it is largest of all the paranasal sinuses.

Maxillary sinus volume reaches nearly adult size between the ages of 12 and 15 years with biphasic growth spurts i.e. rapid growth during the first 3 years and then again from the age of 7–12. The growth of maxilla is also considered to be completed by 12–14 years (Enlow D.H et al. 1990). Therefore, it is decided to evaluate maxillary sinus in the age group of 12–14 years. Evaluation of maxillary sinus can be performed using radiographs (lateral and frontal), MRI and CT scans (Oktay H, 1992, Ikeda A et al. 1998). Lateral and frontal head films offer limited information about the maxillary sinus, with the inherent errors of a 2D representation of a 3D structure. Although MRI is most superior in soft tissue rendering, its use is limited by its cost and restricted accessibility.

The effects of mouth breathing on the growth maxillilary sinus are summarized as:

- The volume of maxillary sinus in mouth breathers was significantly lower than normal breathers. However it remains unclear whether it is because of improper functioning of nasal cavity or due to the underlying pathological condition.
- Another finding in our study was that the maxillary sinus volume of right and left side differed significantly amongst the mouth breathers, it suggests that chronic inflammation of the sinus is more likely the cause for this. The chronic inflammation causes thickening of bony wall of the sinus, thereby reducing its volume. However, chronic inflammation is prone to occur in poorly growing sinus, hence both these factors are interrelated and it is difficult to say which the main causative factor is.

4.6 Hard Palate Dimension

The bony structure which builds the division among the nasal cavity and oral cavity called the hard palate. Nasal breathing can stimulate the lateral growth of the maxilla, thus making the palate flat, affecting the breathing. Any factors that promote obstruction in the upper airway lead to a change from nose breathing to mouth breathing. In children, the causes of nasal obstruction are rhinitis allergy, adenoid hypertrophy, nasal polyps, rhinosinusitis, and obstructive sleep apnea syndrome.

Apart from the other effects, the mouth breathing also produces alterations in hard palate morphology, such as a narrow V-shaped maxillary arch and a high palatal vault (IS Indiarti et al. 2017). Many studies have shown that there is a relationship between mouth breathing and a high palatal vault.

4.7 Growth of Mandible

Mouth breathing leads to a new posture in order to compensate the decrease in nasal airflow and to allow respiration. The changes include a lower position of the mandible, and an anterior or a lower position of the tongue, usually associated with lower orofacial muscles tonicity. As a result, there is disharmony in the growth and development of orofacial structures, including narrowing of the maxilla, lower development of the mandible, alterations in the position of the head in relation to the neck, protrusion of the upper incisors and distal position of the mandible in relation to the maxilla.

4.8 Dental Maloclussion

As noticed earlier the mouth breathing is nothing but the para-functional habit whereby air passes exclusively or partially through the mouth instead of the nose, and it is accompanied by skeletal and functional alterations in the orofacial district. The causes of oral breathing are classified as both congenital and acquired. The former comprise: choanal atresia, nostril atresia and nasal septum deviations. The latter include: outcomes of nasal fractures, rhinopharyngitis, allergic rhinitis, nasal polyposis, chronic sinusitis, chronic adenotonsillitis, chronic hypertrophic rhinitis, adenotonsillar hypertrophy, malignant and benign tumours.

The most evident consequences of chronic oral breathing are represented by craniomaxillo facial alterations, mainly caused by abnormal mandible displacement and subsequent dysmorphism of the oralstructures and modified posture (Bernkoff et al. 1997). The tongue lies against the bottom of the mouth, thus allowing the passage of air via the oralroute. In the event of concomitant tonsillar hypertrophy, the tongue undergoes further anteriorisation, since its base is forced to move away from the posterior pharyngeal wall due to spatial constraints. The most frequent dysgnathia is represented by both dental and skeletal Class II, with reduction of the transverse diameter of the upper arch, ogival palate, mono- or bilateral posterior crossbite, and anterioropen bite with buccally inclined upper incisors.

It must be clarified that the malocclusion is not a consequence but, rather, the cause of oral breathing through incorrect mandible and tongue positioning due to the presence of dysmorphosis. Facial morphology is typical (the so-called “facies adenoidea”), characterised by labial incompetence with a short upper lip that has accentuated lower concavity, and a protruding and often erythematous lower lip. The tongue placed between the arches and hypotonia of the alar cartilages due to limited use can also be observed. In the most severe and complicated forms, the patient’s general appearance is asthenic and longilineal, with an underdeveloped thoracic cage, sunken or keeled sternum, winged scapulas, kyphosis and rachitic traits.

4.9 Periodontal Disease

As compared to the nasal breathers, 42 % water lost in mouth breather which leads the periodontal disease (Svensson S et al. 2006). Dryness is linked to various inflammatory conditions such as dry eye disease, exercise-induced asthma, and atopic dermatitis (Stevenson W et al. 2012).

In dry eye disease, decreased formation of tears or increased rate of evaporation causes inflammation of the ocular surface and associated damage. During exercise, lower airways are recruited in conditioning inspired air, especially at times of increased ventilation and prolonged duration of exercise (Daviskas E et al. 1991). This process of humidifying typically cold and dry air results in dehydration (Daviskas E et al. 1991).

Dehydration evokes release of inflammatory mediators and thereby leads to exercise-induced broncho constriction and asthma. Hydration status of the skin during wound healing influences expression of inflammatory signals in the epidermis with exaggerated response of pro-inflammatory cytokines in healing wounds under dry conditions compared to wounds that restore to normal healthy state in an optimally hydrated environment. Application of emollients on dry skin in individuals with or at an increased risk for developing atopic dermatitis decreases transepidermal water loss as well as improving hydration status of skin and providing relief in pruritis (Lio PA 2016).

In the oral cavity, tissues are protected from dessication by salivary mucins that bind with water and form a coating over the oral mucosa, thereby maintaining the tissue's hydration. In individuals with xerostomia, increased plaque and gingival inflammation is reported. Mouth breathing has also been reported to play a role in gingival inflammation

4.10 Gummy Smile

This is another effect of mouth breathing in patients.It may also cause gingivitis (inflamed gums) and halitosis (bad breath), especially upon waking if mouth breathing occurs during sleeping. The term "mouth-breather" is sometimes utilized as an insult to imply low intelligence.Apart from the above effects of mouth breathing, there other effects also such as Bad Breath, Facial Soft Tissue, Chewing Efficiency, Learning Process, Speech (Disorders), Throat And Ear Infections, and Quality Of Life. Such factors are more or less affected in mouth breathers. According to different studies, the facial soft tissue of severely obstructed mouth breathing children is different than in nasal breathing children. Changes in lips, nasolabial angle, nasal prominence, and chin thickness are associated with severe airway obstruction in children. Mouth breathing also leads the various infections at throat and ear.

5. Materıal And Methods

For this research as per the aim we received the ethical approval received from the Department of Orthodontics at the Near East University, and the subject's permission granted from patient themselves or parents prior to inclusion in this study. The section 5.1 presents the information of subjects as materials used for the comparative analysis. The section 5.2 demonstrates the background of software used to conduct the experiments and then presented the methodology to measure the readings for palatal dimensions and lips prominence of nasal breathers and mouth breathers.

5.1 Materials

The subjects include patient of both genders for this study. These subjects were sought for orthodontic treatment at the Department of Orthodontics at the Near East University. The maxillary cast and cephalometric radiograph were retrospectively selected from the records of treated cases, those are underwent treatment in the outpatient Department of Orthodontics at Near East University in Turkish republic of North Cyprus. In short, the subjects of this study described in two groups MSG and NCG with below properties:

- MSG: 20 patients for study group include 9 female and 11 male.
- NCG: 20 patients for control group include 11 female and 9 male

Subject Exclusion Criterio: patients who had orthodontic treatment, palatal expansion, extraction, cleft lip and palate, patients with bad habits (thump sucking, toung thrus etc.) and patient with extracted teeth are selected in this study. Mode of breathing was defined according to history and complete physical examination, lateral nasopharyngeal x-ray, and confirmed by questionnaire answered by the parents or by Patients themselves classifying them as clinically normal respiratory pattern or as exclusive mouth breathers. The two groups did not have a previous history of nasal respiratory surgery or orthodontic treatment. No significant differences were found between age and sex in the different mode of breathing.

5.2 Methods

For each subject we have to measure the palatal surface area and then compute the palatal volume at first. Secondly we need to compute the lips prominence as well for each subject of this research. First we present the study over the methods/tools used in this study, and then present the methodology used to get the results.

In order to measure palatal surface area and calculate palatal volume, Sirona Orthophos SL 3D/2D, (NC, USA) has been used to scan the casts in this work (as described above), the boundaries for the palate must be defined. The gingival plane and a distal plane were used as boundaries for the palate. The gingival plane was obtained by connecting the centre of the dentogingival junction of all erupted permanent teeth. The distal plane was created through two points at the distal of the second primary molars perpendicular to the gingival plane. Figure 5.7 demonstrates the outcome of palatal surface area measurement and palatal volume computations.

This is first research were we measuring the lips prominences of subjects for investigation of nasal and mouth breathers influences. We used the technique of Soft Tissues Analysis (STA) using the VistaDent OC Complete software. Using this tool we measured the values for both upper and lower lips prominence. The *Ls-NsPog* which stands for the upper lip prominence and *Li-NsPog* stands for the lower lip prominence. Figure 5.8 demonstrate the measurement process of upper lips prominence using VistaDent OC software. Figure 5.9 demonstrate the measurement process of lower lips prominence using VistaDent OC software.

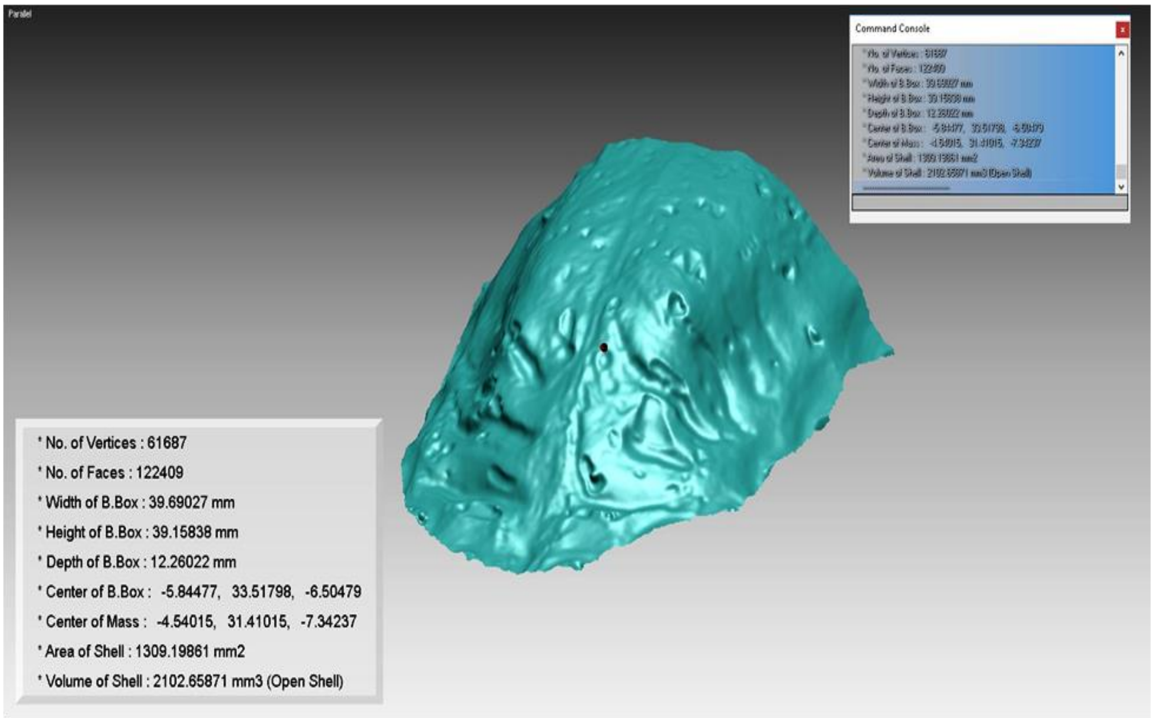

Figure 4: Palatal surface area and volume computations

As observed in figure 5.7, the gingival plane is constructed by connecting the midpoints of the dentogingival junction of all erupted teeth. The distal plane is built perpendicular to the dentogingival plane and passing from the two most distal points corresponding to the distal surface of the second permanent molars.

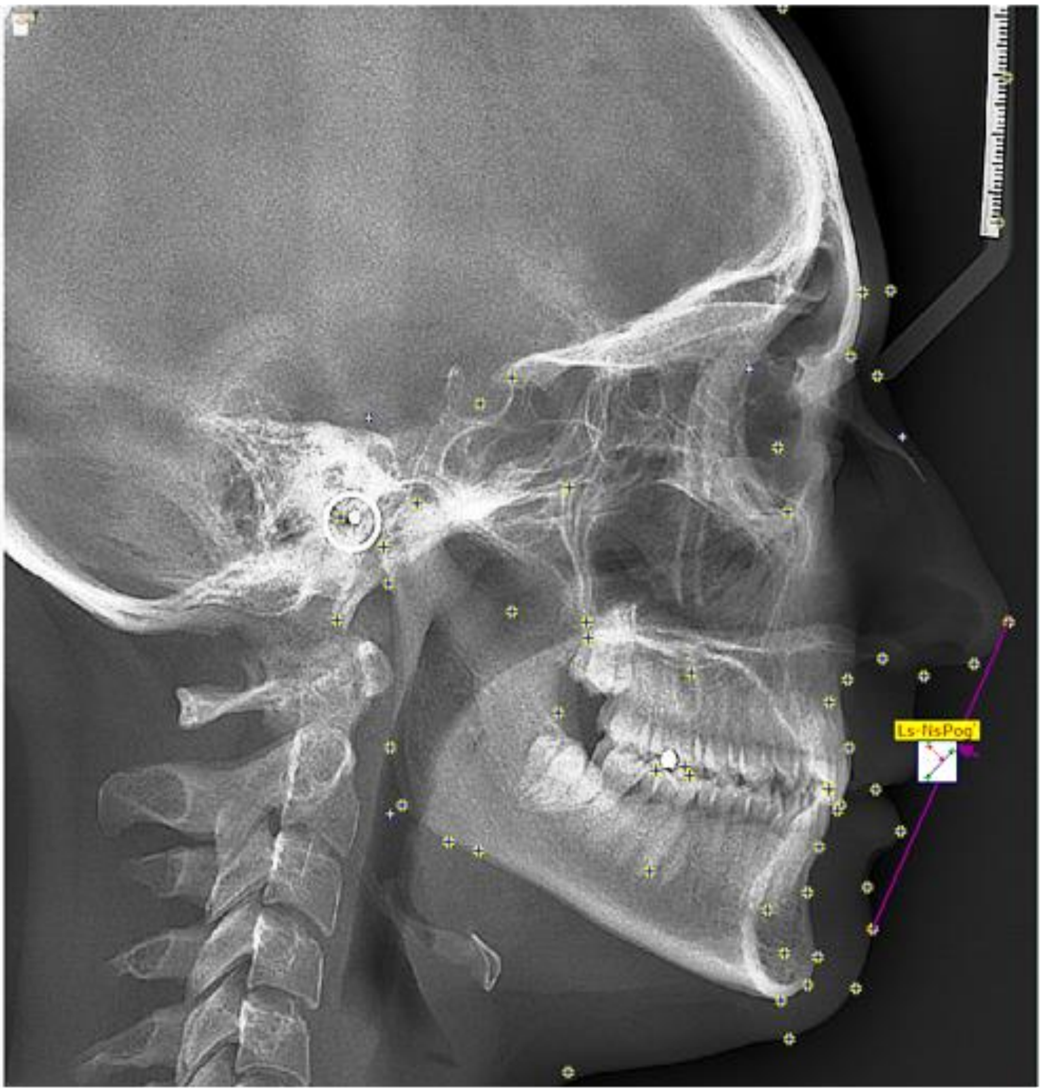

Figure 5: Measurement of upper lips prominence using VistaDent OC software

The figures 5.7 to 5.9 shows the process of measuring the various parameters such as upper lips prominence value, lower lips prominence value, hard palatal volume value, and hard palatal area value for both categories of groups such as MSG and NCG in this study. We record each subjects values under both categories using the methodology mentioned in this chapter for the comparative and statistical analysis between the nasal breathing and mouth breathing candidates.

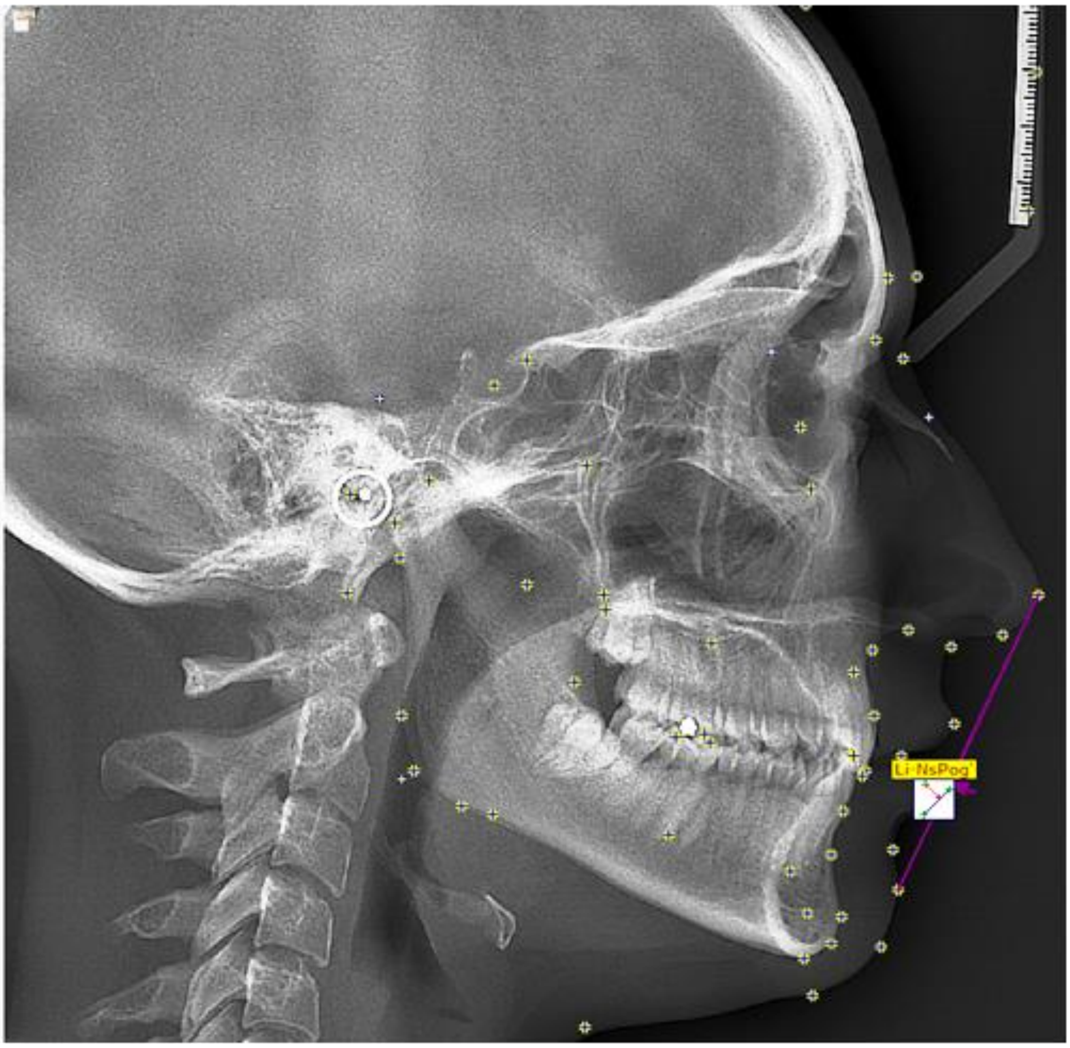

Figure 6: Measurement of lower lips prominence using VistaDent OC software

6. RESULTS

In this study, main aim is to present the novel comparative study of palatal measurements and lip prominence for both mouth breathers and nasal breathers to estimate the difference and effectively justify the relationship between mouth breathers and dentofacial deformities. In literature, some attempts presented to find the relationship between mouth breathing and dentofacial deformities, however some shown the differences and some did not, it is still research topic of discussions.

The mean values of palatal volume and palatal areas shows that sever changes in hard palatal dimensions due to the mouth breathing. The mean values for MSG are lower than the NCG which indicating the decreasing size of hard patatal dimensions due to mouth breathing as compared to the nasal breathers.

The computed mean and SD values for both groups to analyze the statistical differences. Table 1 (figure 7) and table 2 (figure 8) shows the statistical comparisons on PV and PA between MSG and NCG for mean and SD respectively

- There is significant mean value difference found in MSG and NCG which is approximately 927 and 115 for PV and PA respectively, which means that hard palatal volume size decreased by 927 mm^3 in MSG as compared to NCG and hard palatal area size decreased by 115 mm^2 in MSG as compared to NCG.

Table 1: Mean statistical comparison of PV and PA measures between MSG and NCG (*N*=20)

Variables	NCG	MSG	**Difference**
PV **(mm^3)**	7809.23	6836.26	**927.97**
PA **(mm^2)**	1688.61	1573.32	**115.29**

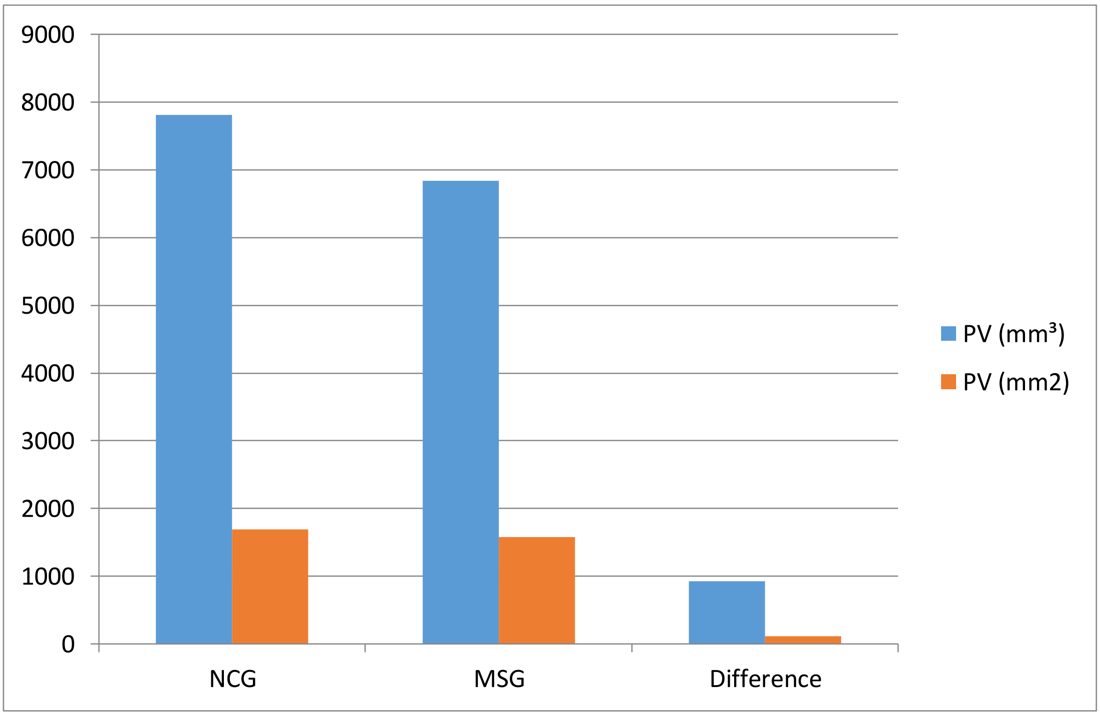

Figure 7 : Graphical representation for mean statistical comparison of PV and PA measures between MSG and NCG (*N*=20)

Table 2: SD statistical comparison of PV and PA measures between MSG and NCG (N=20)

Variables	MSG	NCG	**Difference**
PV **(mm³)**	2398.7	2836.1	437.4
PA **(mm^2)**	236.84	255.65	18.81

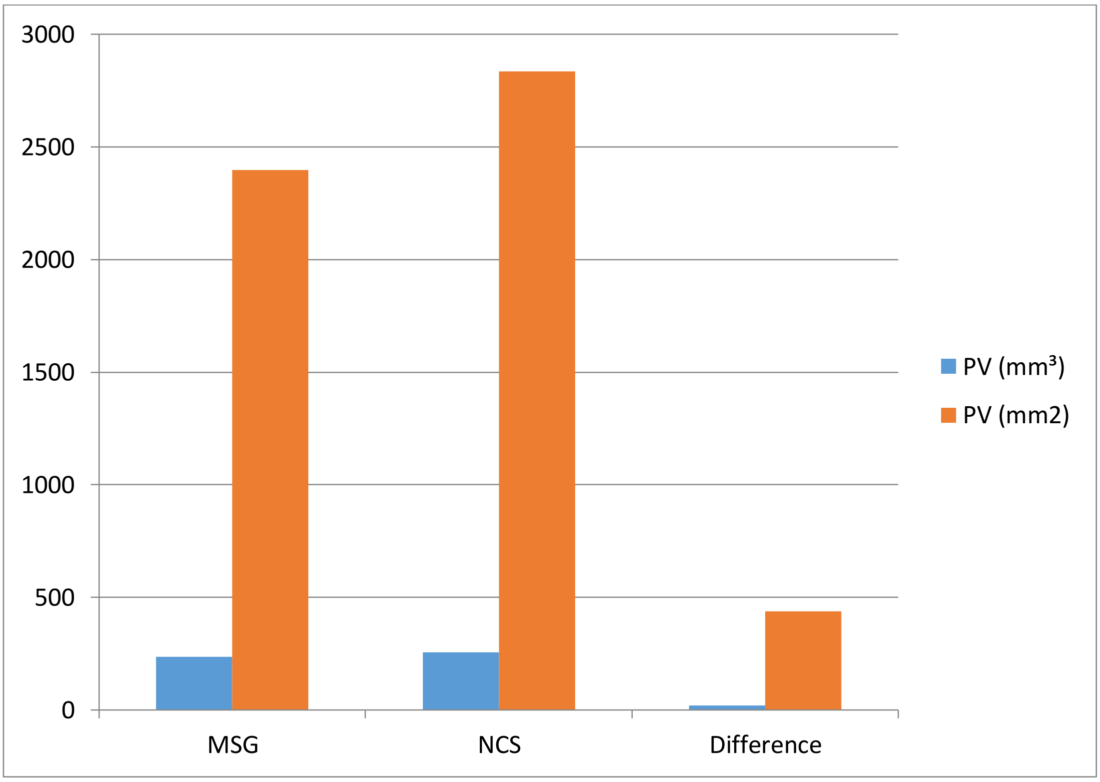

Figure 8: Graphical representation for SD statistical comparison of PV and PA measures between MSG and NCG (N=20)

- The statistical differences in tables 1 and table 2 revealed that mouth breathing leads to decreasing palatal volume and area surfaces deeper compared to nasal breathing. It means that nasal breathing seems to be normal for all patients; however the mouth breathing causes the dentofacial deformities significantly.
- The differences computed for mean and SD statistics further tested by using t-test as shown in table 3 (figure 9).

Table 3: t-test analysis for MSG and NCG using PV and PA differences

Variables	MSG	NCG	t	p
PV **(mm^3)**	2398.7	2836.1	0.73	0.04
PA **(mm^2)**	236.84	255.65	1.46	0.01

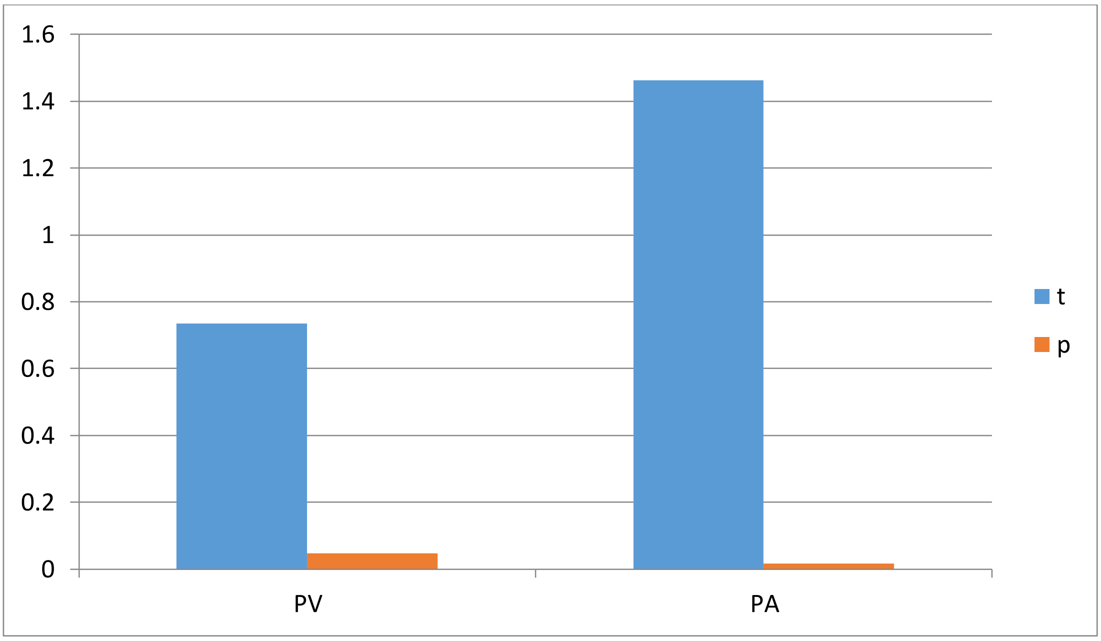

Figure 9: Graphical representation for outcomes of t-test

- The t-test outcomes over the PV and PA readings confirmed that there is significant systematic error noticed among MSG and NCG which means that there are effects of mouth breathing by considering the values of PV and PA.

- In this study, along with the hard palatal dimensions we measured and evaluated the lips prominence also.
- Further to determine the comparative study and reliability of methods we performed the statistical analysis based on the obtained readings under the both groups of subjects. The computation of the descriptive statistics in terms mean and standard deviation (SD) for the measurements in each group is presented in this chapter.
- the results in table 4 (figure 10) and table 5 (figure 11) demonstrate the mean and SD statistical computations of ULP and LLP measures for both control groups respectively.

Table 4 Mean statistical comparison of ULP and LLP measures between MSG and NCG (*N*=20)

Variables	MSG	NCG	**Difference**
ULP	-2.6	-3.1	**-0.5**
LLP	0.55	-1.6	**-2.15**

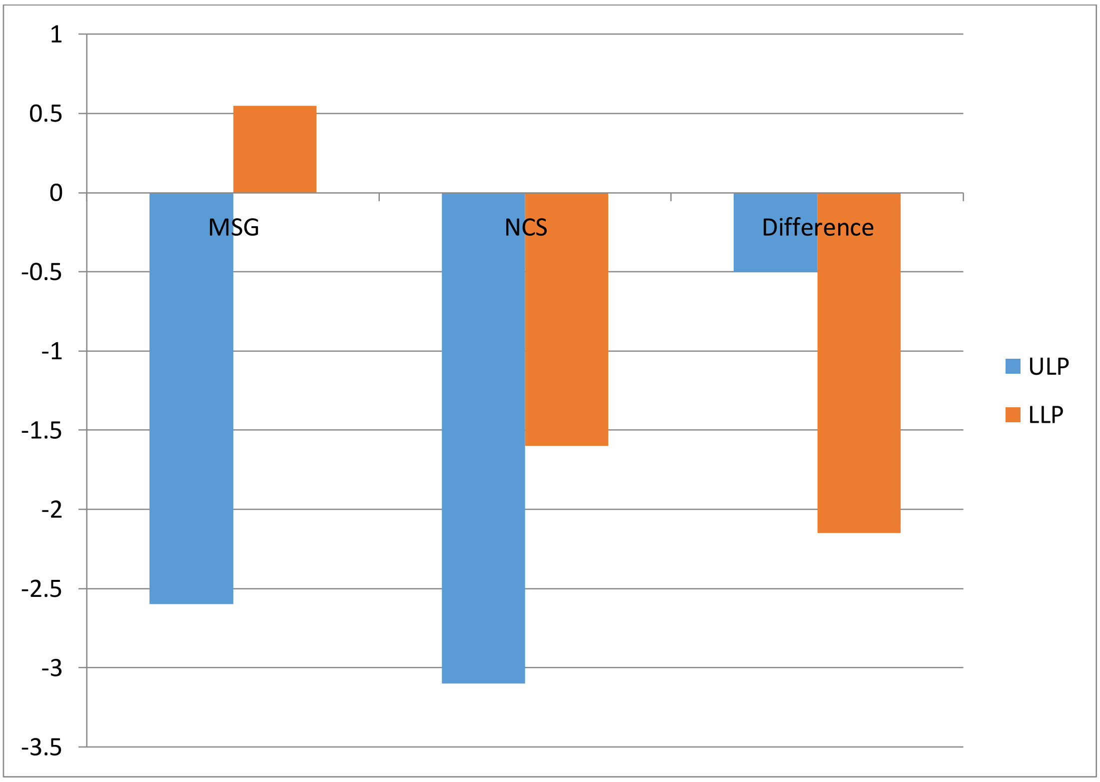

Figure 10 : Graphical representation for mean statistical comparison of ULP and LLP measures between MSG and NCG (*N*=20)

Table 5: SD statistical comparison of ULP and LLP measures between MSG and NCG (*N*=20)

Variables	MSG	NCG	**Difference**
ULP	3.3935	2.3373	1.0562
LLP	3.8179	2.5215	1.2964

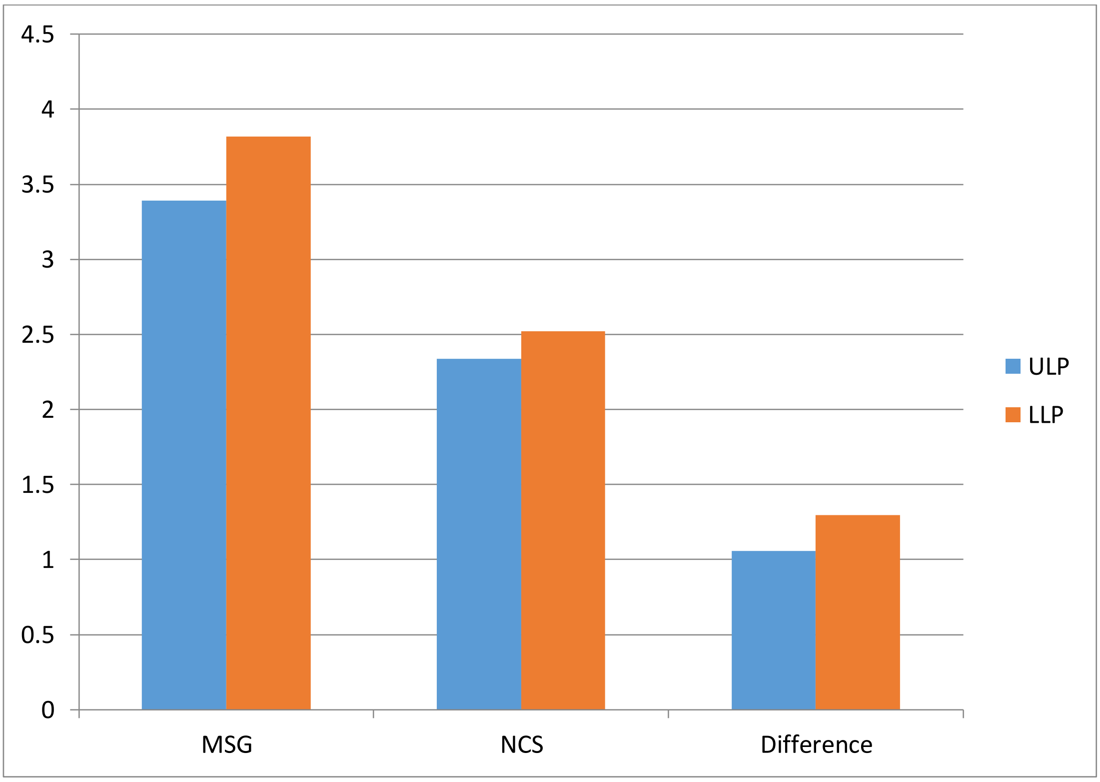

Figure 11: Graphical representation for SD statistical comparison of ULP and LLP measures between MSG and NCG (*N*=20

- The mean values of ULP and LLP shows that sever changes in lips prominence dimensions due to the mouth breathing. The mean values for MSG are higher than the NCG which indicating the narrowing size of face and large lips dimensions due to mouth breathing as compared to the nasal breathers. The SD values shows the similar trends matching to the mean analysis.

- There is significant mean value difference found in MSG and NCG which is approximately -0.5 and -2.15 for ULP and LLP respectively, which means that ULP protrusion increased by 0.5 in MSG as compared to NCG and LLP protrusion increased by 2.15 in MSG as compared to NCG.

- The differences computed for mean and SD statistics further tested by using t-test as shown in table 6.
-
- The t-test outcomes over the ULP and LLP readings confirmed that there is significant systematic error noticed among MSG and NCG which means that there are effects of mouth breathing by considering the values of ULP and LLP.

Table 6: t-test analysis for MSG and NCG using ULP and LLP differences

Variables	MSG	NCG	t	p
ULP	3.3935	2.3373	4.3	0.07
LLP	3.8179	2.5215	5.5	0.04

7. DISCUSSION

Is known that mouth breathing influenced the development of a different palatal morphology with a narrower and higher palatal vault compared to subjects with a nose-breathing pattern. These modifications in the anatomy of the maxilla were clearly quantified by 3D measurements of the palatal surface area and volume that have been reported as reliable indicators of palatal growth.

Conflicting conclusions are reported in the literature about the influence of the mode of breathing on the development of maxillofacial complex. This could be due to the fact that nasal airway inadequacy is usually subjective and the judgement of breathing mode differs among investigators.

In order to evaluate respiratory function and its effects on the morphology of the palatal region, a clear differentiation between nose and mouth breathers is required. However, this distinction is not easily made since most mouth breathers usually have some nasal respiratory capacity as well . Therefore, in this study, only data from a group of subjects classified at the end of complete physical examination as exclusive mouth breathers were included.

Moreover, the morphology of the palate and of the maxillaryarch has been assessed usually by measuring transverse dental distanceson study casts giving incomplete information about the 3D morphology of the palatal vault. To overcome this limitation, an evaluation of 3D characteristics of the maxillary arch by means of 3D technology has been used.

In previous studies, the PV and PA statistical analysis performed for MSG and NCG by taking the difference of mean and SD values.We first computed the mean statistics of all 20 observations under both categories (MSG and NCG), and then estimate the difference between mean values for PV and PA for both categories.

R. Lione et al. messuared the palatal volume and palatal area , and the difference between mouth group and nose group palatal volume is 1017 mm^3 . the difference between mouth group and nose group palatal area is 124.2 mm^2 **.** In our study total difference 927.97mm^3 for PV and 115.29mm^2 for PA, it approximately similar to *R. Lione et al* reasult.

It is significant to justify the mouth breathing and nasal breathing relationships with dentofacial deformities in patients. Similarly, the Standard Deviation statistics shows that 437.4 (PV) and 18.81 (PA) statistical differences (table 2).

Moreover, Bresolin et al. , Harari et al. , and Berwig et al. compared plaster casts of nasal and mouth breathers at the age of 8–12 years demonstrating that a change in the breathing pattern of children can lead to a narrowing of both intermolar and intercanine widths .

R. Lione et al had Statistical analysis and the P value was (0.000) for both of surface area and palatal volume . which that mean there is a significant difference between two groups.

In our study the P value (0.04) for the palatal volume and (0.01) for the palatal areea . It is also mean there is a significant difference between tww groups.

The results of the current investigation are in agreement with previous studies that showed that nasal deformities and maxillary growth deficiencies were correlated with increased nasal airway resistance .

However, our findings are in disagreement with those reported by Primozic et al. who did not find differences in palatal surface area and volume between mouth and the nose breathers. These conflicting results may be due to a different group selection since in this study the primary inclusion criteria was the abnormal respiratory pattern and not the dentition stage and occlusal characteristics.

The differences computed for both upper lip and lower lip justified the influence of mouth breathers on dentofacial deformities as compared to NCG group, that both of upper lip and lower lip are protruded in patient with mouth breathing.

The previous studies mainly based on palatal volume and surface area measurements to estimate the changes due to mouth breathing and diagnose the accurate dentofacial deformities in human beings. The outcomes of this study show the enough information to stop the debate over the relationship between mouth breathing and dentofacial deformities at large extend.

The value indicates that there is significant changes of mouth breathing lips prominence in payient with mouth breathing than the others in nasal breathing .

8. CONCLUSİON

Subjects with a mouth-breathing pattern have a different palatalmorphology with significantly smaller palatal surface areas and volumes compared with nose-breathing subjects.

The soft tissue changes are more prominence in MB patient .

The upper and lower lip of MB is protruded more than the upper and lower lip of NB .

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Table 1: MSG Measurements for 20 Patients (N=20)

Patient	ULP	LLP	PV (mm^3)	PA (mm^2)
A	-9	-6	7905.65309	1502.26675
B	4	6	9841.59172	1824.31827
C	3	8	8650.7949	1655.29297
D	-5	-2	9528.32482	1793.35809
E	-3	-3	8231.93511	1649.02135
F	-7	-5	2438.2912	1381.6422
G	0	5	11191.29369	2119.6821
H	0	5	5360.63173	2036.2967
I	-1	1	6671.35121	1617.26303

J	-6	0	8961.82743	1703.62671
K	-3	2	5753.11015	1328.06191
L	-3	0	9937.26529	1754.08804
M	-6	-3	8809.98194	1703.98025
N	-1	2	6272.64054	1701.45392
O	-3	-1	7554.66735	1570.03989
P	-1	1	4964.74683	1244.47222
Q	-5	-2	4925.55984	1734.2665
R	-3	1	8501.06261	1942.91861
S	2	5	8046.70292	1462.5683
T	-5	-3	12637.2826	2047.67621

Table 6.2: NCG Measurements for 20 Patients (N=20)

Patient name	ULP	LLP	PV (mm³)	PA (mm^2)
A	0	0	9031.77006 mm	1780.49436
B	-5	-4	9085.01929	1764.05441
C	0	2	3401.2297	1127.35515
D	-6	-5	9357.59125	1668.39152
E	-3	-1	5301.70093	1399.68008
F	-1	-1	5443.98606	1435.46091
G	-3	0	4392.11891	1329.63422
H	-6	-5	11186.98592	1858.34855

I	-3	-3	8617.46862	1759.96918
J	-3	1	7432.6011	1523.59417
K	-3	-1	4719.6382	1563.31231
L	-6	-5	4872.50949	1157.21544
M	-3	-1	9785.11721	1751.66576
N	-3	-2	7328.53941	1517.01654
O	3	4	2102.65871	1309.19861
P	-5	-5	7971.21853	1483.40491
Q	-6	-3	9875.08101	1743.0571
R	-3	-2	6984.09835	1399.28094
S	-2	1	11678.94697	2173.57484
T	-4	-2	4642.22823	1721.83115