EVALUATION OF SPEECH IN MAXILLARYDEFECTS AND ITS CORRECTION USING PALATOGRAPHY- AN IN-VIVO STUDY

DISSERTATION

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Certificate

This is to certify that the thesis entitled : **''Evaluation of speech in maxillary defects and its correction using palatography An In-Vivo Study''** is a genuine work done by **Dr.Nikhil.S.Rajan**, Postgraduate student during the period 2010-2013 under my guidance and supervision. The dissertation is submitted in partial fulfillment of the requirements for the award of Master of Dental Surgery, Branch I (Prosthodontics), The Tamilnadu Dr M.G.R Medical University, Chennai.

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DECLARATION

I hereby declare that this dissertation entitled ***"Evaluation of speech in maxillary defects and its correction using palatography An In-Vivo Study''*** is a bonafide work undertaken by me and that this thesis or a part of it has not been presented earlier for the award of any degree, diploma, fellowship or similar title of recognition.

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I walked in here with an empty mind, trembling hands, unsure footsteps and a lot of fear. I came here from darkness not knowing what to do. A vibrant light entered my life and showed me the way. She taught me to fill my empty mind with gratitude, hold up my trembling hands in prayer, take my unsure footsteps towards God and replace my fear with love. When I celebrated my meager victories, she congratulated me but reminded me about the virtue of humility.

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TABLE OF CONTENTS

Abstract

Introduction:

Most of the literature review is on speech analysis and correction of palatal defects. These defects are either corrected by surgical procedures or prosthetic rehabilitation. Even after surgical correction some patients need prosthesis for speech correction and to prevent nasal regurgitation of food. Few of the patients are entirely dependent on prosthesis rehabilitation alone since, surgical correction is not possible when the defects are large due to excision as in cases of oral cancer, trauma or unrepaired clefts. This study is an attempt to present that the prosthesis alone may not totally correct speech defects and palatography is an inevitable tool for correcting articulatory defects thereby improving speech. It was observed that the prosthesis alone can correct speech defects, yet the clarity of certain vowels and volume of mouth was found to be defective since with the help of palatography and modification of the existing prosthesis the exact articulation of these sounds can be corrected.

Materials and Methods

1. Percentage of consonants correct for 20 words (regional language) was used to assess the intelligibility at three clinical Intervals (Before correction of the defect , after correction of the defect with prosthesis and after modifying the prosthesis using palatography)
2. Nasometer (Dr Speech) was used to assess the nasalance for three vowels |a|, |i| and |u| at three clinical intervals (Before correction of the defect , after correction of the defect with prosthesis and after modifying the prosthesis using palatography)

3. Formant evaluation (f_0-f_5) for three vowels |a|, |i| and |u| was done using PRAAT software at three clinical visits (Before correction of the defect , after correction of the defect with prosthesis and after modifying the prosthesis using palatography)

Results

Modified prosthesis using palatography was found to be significantly superior in terms of intelligibility, nasality and formant evaluation showing a higher significance for all the three methods namely Percentage of consonants correct, Nasometer and PRAAT software.

Conclusion

As per the results obtained, in patients with cleft palate, it was clearly evident that palatal obturators modified by palatography showed a significance of $P< 0.001$ in terms of nasality and intelligibility. In spectrographic evaluation using PRAAT software the significance level was found to be $P<0.05$ for all the three vowels using a modified obturator prosthesis.

INTRODUCTION

Introduction

The most common intraoral defects are in the maxilla, in the form of an opening into the antrum and naso-pharynx. Defects in the maxilla may be divided into those resulting from congenital malformations and acquired defects resulting from surgery of oral neoplasms. The opening produced may be small or big/large and may include any portion of the hard and soft palate, the alveolar ridges, and the floor of the nasal cavity (Chalian et al., 1971). Post-surgical maxillary defects pre-dispose the patient to hypernasal speech, fluid leakage into the nasal cavity, and impaired masticatory function. These defects can be corrected by surgical intervention, prosthetic rehabilitation or a combination of both surgical and prosthetic intervention[1].

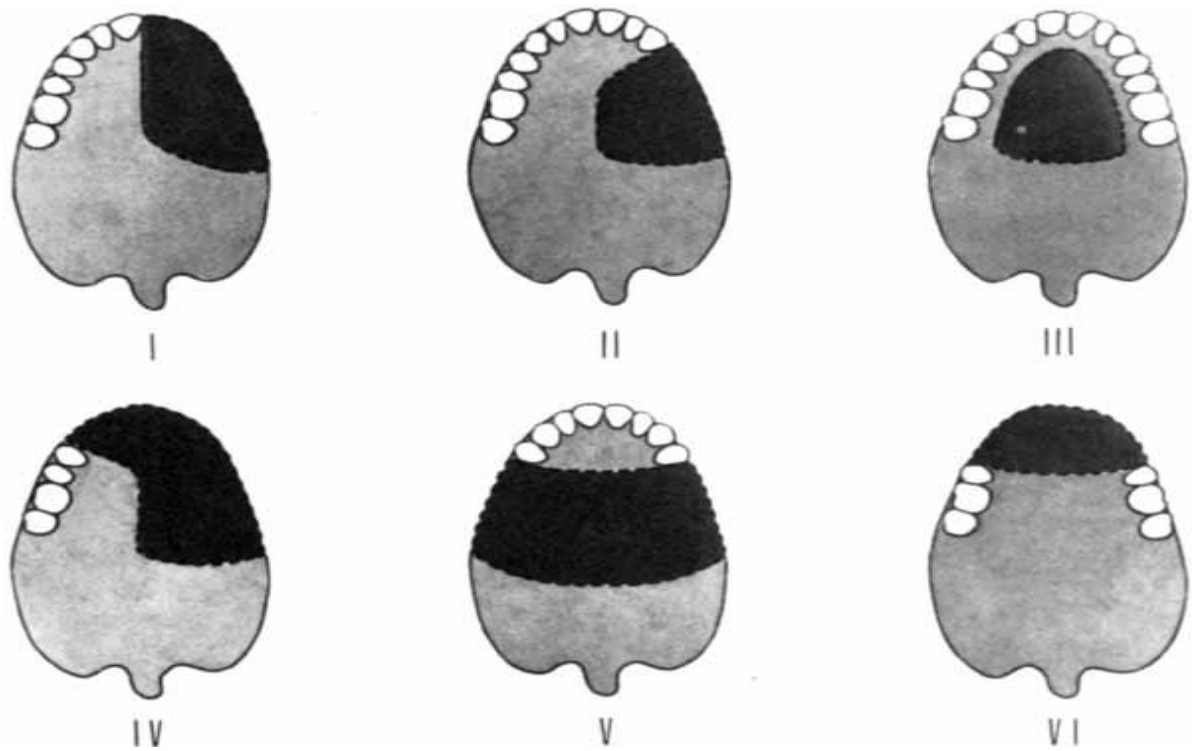
Treatment options are:

1. Surgical correction
2. Prosthodontic rehabilitation

1.1 Surgical correction of maxillary defects

This involves a multidisciplinary approach were the defect is surgically closed by placing a graft into the defect. The major disadvantage of surgical correction is that it cannot be done in cases of large defects, new born babies and in medically compromised patients were surgery is not indicated. Surgical relapse is commonly seen in cases of patients corrected with grafts were the alveolar bone undergoes normal expansion during the growth period. Such patients have to undergo prosthetic intervention such as obturator prosthesis to correct the defect.

1.1.1 Armany's classification for partially edentulous maxillectomy dental arches [2]



Class I Midline resection. ***Class II*** *Unilateral* resection. ***Class III*** Central resection.

Class IV *Bilateral* anterior-posterior resection. ***Class V*** *Posterior* resection. ***Class VI*** Anterior resection.

1.1.2 The rehabilitative procedure required for each age group of cleft lip and palate patients.[3]

Age of patient	Operative procedure
0 - 3 days	Counseling of parents Feeding plate fitting
4 - 6 months	Surgical closure of lip
1 1/2 - 2 years	Surgical closure of palate
1 - 3 years	Indirect speech therapy – by parents under guidance of speech therapist
3 - 6 years	speech therapy Nasendoscopy ± Pharyngoplasty
9 – 11 years	Alveolar bone grafting ± pre-grafting orthodontic therapy
14 years	Comprehensive orthodontic therapy
18 years	Orthognathic surgery Lip/nose revision surgery

1.2 Prosthodontic correction with obturator prosthesis

Definition. An obturator (Latin: obturare,to stop up) is a disc or plate, natural or artificial, which closes an opening or defect of the maxilla as a result of a cleft palate or partial or total removal of the maxilla for a tumour mass (Chalian et al., 1971)[1].

Types

Surgical obturator

Temporary obturator

Definitive obturator

1.2.1 Significance of restoration.

The main objective of an obturator patient is to restore the function of mastication, deglutition, speech and to achieve normal oro-facial appearance (Beumer III et al., 1979).The goals of prosthetic rehabilitation for total and partial maxillectomy patients include separation of oral and nasal cavities to allow adequate deglutition and articulation, possible support of the orbital contents to prevent enophthalmos and diplopia, support of the soft tissue to restore the midfacial contour, and an acceptable aesthetic results (Wang, 1997). Prosthodontic management of palatal defects has been employed for many years.

1.3 History

Ambroise Pare was the first to use artificial means to close a palatal defect as early as the 1500s. The early obturators were used to close congenital rather than acquired defects. Claude Martin described the use of surgical obturator prosthesis in 1875. Fry described the use of impressions before surgery in 1927, and Steadman described the use of an acrylic resin prostheses lined with gutta-percha to hold a skin graft within a maxillectomy defect in 1956 (Desjardins, 1978; Huryn & Piro, 1989). Numerous articles appear in the literature describing

techniques for the fabrication of hollow obturators to decrease the weight of the prostheses and to make comfortable and well-tolerated prostheses (Payne & Welton, 1965; Ampil et al., 1967; Brown, 1969; Chalian& Barnett, 1972; Buckner, 1974; Benington & Clifford, 1982; Orr, 1986; Benington, 1989; Wu & Schaaf, 1989; Schmaman & Carr, 1992; Didier et al., 1993; Wang & Hirsch, 1997; McAndrew et al 1998).

The construction of the definitive obturator will vary with the type of resection and the presence or absence of teeth. If the obturator is not properly designed and constructed, the stress on the remaining hard and soft tissues may be pathological and may lead to premature loss of abutment teeth and chronic irritation of soft tissues. Even after rehabilitation of these maxillary defects the patient reports with some amount of hyper-nasality and unintelligible speech.

1.4 Speech

Speech is the use of systematized vocalization to express verbal symbols or words." (Sheridan: 1964).Speech is a very sophisticated autonomous and unconscious activity.

Speech in matured man is a learned habitual neuromuscular pattern which makes use of anatomical structures designed primarily for respiration and deglutition.

Specialists in acoustics have evaluated the process of speech production for a long time. In 1900 Alexander Melville Bell managed to make the first visual representation of the spoken word. He was followed in 1940 by Potter, Kopp & Green, who succeeded in providing the foundations of the sound analysis method with a spectrograph, using: frequency, intensity and time as parameters.

The acoustic theory of the speaking process refers to the sound source and to the way of its production. Exhalation with little compressions and dilatations of the surrounding medium is recognized as a source of sound formation. In this way the resonance room is constituted. [4]

The organs involved in mastication, deglutition and respiration take part in speech. Air from the lungs is modulated as it passes through the respiratory passages, oral cavity and nasal cavity producing speech. Thus – Surd, Sonant, Consonants, Respiration, Phonation, Resonations, Articulations, Neurologic Integrations, Audition can be regarded as components of speech.

1.4.1 Production of sounds in speech:

The sound produced can be divided-According to place of production as: Bilabial – p, b, w, m, Labio dental – f, v,

Linguo dental – th ,

Linguo alveolar – t, d, s, z (azure), l, n,

Palatal – ch, j, z (zeal),

Velar – k,g, ng.

1.4.2 Speech phonemes as-

Vowels – a e i o u (Laryngeal sounds),

Voiceless consonants- p, t, f, s (Formed with a column of air without laryngeal phonation),

Voiced consonants - b, d, g (Combine laryngeal phonation and air flow).

1.4.3 Consonants

They are further divided by the duration of the sound, the principal resonating chamber and the articulators used to form the sound-According to manner of production: Plosive – p, b, t, d, k, g,

Fricative – f, v, th, s, z,

Affricative – ch, j,

Semivowel – w, l,

Nasal – m, n, ng .

1.5 Conditions affecting speech:

When these structures are affected automatically speech is affected-Lungs, Larynx, Pharynx, Soft palate, Nasal cavity, Hard palate, Tongue, Mandible, and Cheeks.

Phonetics – The science of sounds used in speech.

Phonetic value – The character or quality of vocal cords.

The ***surd*** is any voiceless sound and is produced by separation of the vocal folds (glottis open) with no marginal vibration.

The ***sonants*** are voiced sounds and include all vowels and vowel like sounds.

Consonants are articulated speech sounds, and all require articulation to impede, constrict, divert, or stop the air stream at the proper place and time to produce the desired sound...

The spoken sound modulation is connected to: - Static sound forming components:

Teeth ("S", "S"),

Hard palate - (anterior area: "T", "D"),

Alveolar bone; - Dynamic articular components:

Tongue ("L", "T", "D"),

Lips ("B", "P"),

Soft palate, the mandible's movement.

The phonetic adaptation of a patient with complete denture is achieved depending on: Selection and placing of the artificial teeth, Thickness of maxillary prosthetic base in the frontal area, optimal space for the tongue, Individual adaptation capacity, and Patients' sound recognizing capacity.[4]

1.6 Speech Analysis:

Speech outcomes are relevant in guiding treatment and to evaluate the efficiency of the maxillary obturator prosthesis provided to correct the defect. The maxillofacial prosthodontist often receives referred patients who have experienced partial surgical resection of the maxilla (maxillectomy) as a part of cancer therapy or a congenital defect as in cleft palate. Maxillary defects often results in a high level of morbidity with significant psychological and functional implications for the patient. Such disabilities include inability to masticate and disturbances of deglutition and speech.

Phonetic dentistry or gnathophonics (the new field) is connected, on one side, to dentistry, on another side to articulatory, acoustical and perceptive phonetics, on the third side, to speech technology and artificial intelligence. Dentistry treatment and denture wearing may significantly alter the upper part of the vocal tract and the ability of articulating the complex sound sequences used in speech[5].

Based on reasoning backed by articulatory phonetics, put forward several hypotheses, including that that the temporo-mandibular articulation state may significantly affect the pronunciation of the diphthongs and plosives and the hypothesis that the lack of inter-dental spaces between the incisors is equally detrimental, as to the too large spaces, as in case of diastema or lack of teeth.[5]

To rectify these defects of articulatory phonetics palatography is been done.

1.7 Palatography:

Palatography is a technique used to identify which parts of the mouth are used when making different sounds. This technique is often used by linguists doing field work on little-known natural languages. It involves painting a colouring agent, such as a dye or a mixture of charcoal and olive oil on the tongue or the roof of a person's mouth and having that person pronounce a specific letter or sound. A photograph is then made of the mouth roof and tongue in order to determine how the sound was articulated. The technique can also be performed electronically using a tool called a pseudo-palate, which consists of a retainer-like plate lined with electrodes that is placed on the roof of the mouth while the speaker pronounces a sound. A record made through palatography is called a **palatogram**[6].

Palatography has been used to determine the optimum thickness and shape of the palatal surfaces. This approach was developed in a study of phonetics to determine the contact position of the tongue relative to the palate in the production of specific sounds essentially, application of these techniques ensured contact between the tongue and palate during articulation of these sounds.

The “s” and “sh” phonemes have received particular attention. Palatography frequently has served as the basis for determining the shape of the anterior palatal vault most conducive to satisfactory sound articulation.[7]

The shape of the palatal vault is of particular interest to prosthodontist central and lateral lisping may develop when the contours of the prosthesis are incorrect. Patients whose speech is sensitive to a changed relationship of the tongue to a palatal prosthesis may require surface texture to orient the tongue. Because the lack of texture on the palatal portion of a complete denture can impede proper articulation, one solution is to add palatine rugae.[7]

Early diagnosis of sub mucosal cleft palate is important. In children too young to tolerate naso-endoscopy and video-fluoroscopy, the diagnosis depends on the patient's clinical history and intraoral examination findings. Kratzsch and Opitz investigated the relationship of palatine rugae to points (landmarks) and distances on the cleft palate during the period from birth to the time of early mixed dentition. The authors identified changes in the distances from the lateral palatine rugae points of the first and third rugae to the incisal point, the canine point and the tuberosity line. The results of their study indicated that a comparison of distances from the palatine rugae with distances between equivalent points revealed the changes that occurred in the anterior palate during various stages of growth.

Static palatography has been widely used to investigate consonant articulation. The method is based on the observation of the tongue print (a black paste is spread on the tongue before the production) either directly onto the palate (direct palatography) or onto a pseudo palate (indirect palatography).[8]

Static palatograms have been obtained by tongue modeling of an impression material on the external surface of palatal plate and oral surface of the artificial teeth during repetition of phonemes and words.[4]

This study involves the use of palatography in modifying the obturator prosthesis in cases of maxillary defects were by correcting the intelligibility of speech to near normal.

Aims:

To determine the efficiency of modified palatal obturator prosthesis using palatography in terms of intelligibility of speech, nasality and change in formants.

Objectives:

1. To access the intelligibility of speech for 20 words using Percentage of consonants correct by listener scale analysis before correction of the defect, after correction of the defect with prosthesis and after modification of the prosthesis with palatography.
2. To evaluate the nasalence for three vowels |a|, |i| and |u| (a, e and u) before correction of the defect, after correction of the defect with prosthesis and after modification of the prosthesis with palatography.
3. To access the change in formants (f_0-f_5) for three vowels |a|, |i| and |u| (a, e and u) before correction of the defect, after correction of the defect with prosthesis and after modification of the prosthesis with palatography.

REVIEW OF LITERATURE

3.1 History

Cleft lip (*cheiloschisis*) and **cleft palate** (*palatoschisis*), which can also occur together as **cleft lip and palate**, are variations of a type of clefting congenital deformity caused by abnormal facial development during gestational period. Approximately 1 in every 600 newborn babies worldwide is born with this defect. This means that, assuming 15 000 children are born per hour worldwide (United States Bureau of the Census, 2001); a child is born with a cleft somewhere in the world approximately every 2½ minutes.

3.2 Surgical Phase

The knowledge of cleft lip and the surgical correction received a big boost during the period between the Renaissance and the 19th century with the publication of Pierre Franco's Petit Traite and Traite des Hernies in which he described the condition as "lievre fendu de nativite" (cleft lip present from birth). The first documented Cleft lip surgery is from China in 390 BC in an 18 year soldier, Wey Young-Chi.

The treatment of cleft lip and palate should be initiated soon after birth and continues up to adulthood. The morphological rehabilitation of clefts involves plastic lip surgery at 3 months of age and palate surgery around 1 year of age, as well as secondary alveolar bone graft performed between 9 and 12 years of age[46].

Cleft lip and palate is a congenital anomaly. In 1996 **NM King et al**[3] in his study suggested that empathic counseling and help with feeding ensures that the infant can cope with the primary

surgery to the lip and palate. With the help of nasendoscopy, nature of the speech abnormality and appropriateness of additional palatal surgery can be assessed, and also nasendoscopy is used in case of osteotomy surgery where in again speech is compromised.

There was no previous attempt made to classify the dental arches for patients who have had partial resection of the maxilla. There were no proper framework designs for maxillary obturators. In 2001 **Mohamed A. Aramany**[2] proposed a classification for partially edentulous maxillectomy dental arches based on the frequency of occurrence of maxillary defects in a population of 123 patients.

A brief overview of the progress and evolution of philosophies of obturator framework designs was accomplished by **Gregory R. Parr et al**[9] in 2003. It begins in 1530 AD with Ambrose Pare´ who described the first button-shaped sponge and metal obturator, and continues through the formation of the American Academy of Maxillofacial Prosthetics and concludes with a simplified discussion of complex surgical-prosthetic coordination and the use of vascularized free flaps with osseointegrated dental implants.

The design and fabrication of oral appliances to replace parts of the palate missing due to congenital defects or lost through tumours, infection or trauma had been a considerable challenge for clinicians throughout the history of dentistry. In 2005 **C. D. Lynch et al**[10] in his study revealed that significant advances were made during the eighteenth century towards resolving the problem of constructing satisfactory obturators by the first ‘surgeon-dentist’, Pierre Fauchard.

3.3 Prosthetic Phase

A new type of mechanical palatal exerciser, called the Lubit Palatal Exerciser (LPE), was described. **Erwin C Lubit et al** [11] in 1970 presented the case report of 28 patients involved in the therapeutic program (with LPE) to demonstrate the changes in the velopharyngeal structures and speech proficiency. The beneficial changes had been observed in all of them.

In 1991 **M. El-Dakkak**[12] studied ten patients in whom the surgical defect involved the posterior margin of the soft palate which lead to velopharyngeal insufficiency were given with speech aid obturator one month before the evaluation. Prosthetic management of each subject was evaluated as reflected in adequacy of velopharyngeal closure and speech competency.

The purpose of their electromyographic study done by **Takashi Tachimura et al**[13] in 2000 was to examine whether levator veli palatini muscle activity during speech can be changed with placement of a speech appliance and to clarify whether or not the change is related to the type of speech appliance used.

A prosthesis used to close a palatal defect in a dentate or edentulous mouth is referred to as an obturator. In 2001 **Filiz keyf**[1] provided obturator prosthesis which restored masticatory functions and improved speech, deglutition and cosmetics for maxillary defect (hemimaxillectomy) patients.

In 2003 **Filiz keyf et al**[14] presented a patient case who underwent soft palate resection for cancer, the resected portion of the soft palate was confined to the posterior segments. With an

alternative Impression Technique a Speech-Aid Prosthesis with a speech bulb was adapted to the patient. Following placement of the special prosthesis excellent restoration of speech and improvement of velopharyngeal function was achieved.

In 2005 **A. Nekora-Azak et al**[15] presented a clinical report describing the prosthodontic rehabilitation of an edentulous patient with a maxillary defect using the biofunctional prosthetic system. The advantage of this technique was to provide patients with optimal form, function, and aesthetics in complete dentures.

Definitive obturation is initiated approximately 3 to 4 months after surgery when healing is complete. According to **Won-suck Oh et al**[16] (2006) the impression for definitive obturator prosthesis should include the skin-graft mucosal junction, lateral aspect of the orbital floor, and the dynamic physiology of the velopharyngeal mechanism during speech and swallowing. The obturator bulb must also be contoured to prevent obstruction of nasal breathing and to maintain nasal resonance during speech.

In 2006 **M. Oki et al**[17] conducted a study, the aim was to investigate whether the vibratory characteristics of obturator prostheses are affected by bulb design, i.e.: the hollow or buccal flange type, and different lateral and medial bulb heights. And the vibration analysis suggested that buccal flange obturator prosthesis with high lateral and low medial walls is preferable.

Resilient denture liner is a soft and resilient material that is applied to the fitting surface of a denture in order to allow a more distribution of load. In 2006 **Michael Josef Kridanto Kamadjaja**[18]

reported a case about using the hollow obturator with resilient denture liner on post hemimaxillectomy to overcome pain occurring with intimate contact with the mucosa, and also in preventing the fluid entering into the cavum nasi and sinus.

In 2007 a patient underwent treatment for malignant melanoma which necessitated the excision of all his teeth, the alveolar bone, and the hard palate. **Yohsuke Taira et al**[19] fabricated a silicon obturator with a soft denture liner material, and inserted into the maxillary defect, and an acrylic denture was mechanically connected to the silicon obturator. And the report suggested that a detachable silicon obturator could be an option in the recovery of postsurgical maxillary defect.

Fabricating a successful obturator prosthesis used for the prosthetic rehabilitation of congenital or acquired defects in maxilla depends on making a detailed impression and constructing the prosthetic parts compatible with the oral tissues. The clinical report presented by **Bora Bagis et al**[20] in 2008 described an intraoral technique for impression making and fabrication of open hollow obturator prosthesis.

Persons with a congenital or craniofacial defect are unique, and oral problems must be evaluated individually to the most ideal treatment. **Ayse Mese et al**[21] described the oral rehabilitation of a cleft lip and palate patient with removable partial denture. The changes in appearance, function, and psychological well-being have an enormous impact on patient's personal lives and are rewarding for the maxillofacial prosthodontist providing this care.

In 2009 **Suha Turkaslan et al**[22] explained that avoiding immediate obturator construction may cause serious facial appearance problems due to soft tissue contracture and disfigurement that may have a negative effect on the patients' psychology. When wearing the permanent obturator is neglected, the dynamics of non-supported soft tissue changes towards serious contracture and facial disharmony.

Pharyngeal obturator is a prosthesis which closes the palatal and pharyngeal defects improving the speech and other function. **K.Kasim Mohamed et al**[23] in 2010 discussed a case report with palatopharyngeal insufficiency, its impression procedures, fabrication of prosthesis and improvements in speech.

In 2010 **Ramaraju A V et al**[24] described a clinical case of sub-total maxillectomy due to osteomyelitis, which was successfully rehabilitated with a hollow bulb obturator, retained in a unique combination of a cast clasp and zest anchor type of radicular ball attachment. The placement of radicular attachments and the process of making the prosthesis hollow had a significant effect on the stability and retention of the obturator prosthesis in partially edentulous maxillectomy patients.

Nabeela Riaz et al[25] in 2010 revealed that Quality of life after prosthodontic therapy with obturator prostheses depended on functioning of the obturator prosthesis, impairment of ingestion, speech and appearance, the extent of therapy, and the existence of pain. Orofacial rehabilitation of patients with maxillofacial defects using obturator prostheses is an appropriate treatment modality.

In 2011 **subramaniam elangovan et al**[26] described how to achieve the goal for esthetics and phonetics and also described the fabrication of a hollow obturator by two piece method, which is simple and may be used as definitive obturator for maximum comfort of the patient.

Patients with extensive head and neck injuries due to trauma and/or extensive surgical procedures often exhibit restricted mouth opening. A modification of the standard impression procedure is often necessary. **Shuchi Tripathi et al**[27] in 2011 made an alteration in the final impression procedure using altered cast technique for fabricating an obturator prosthesis with soft palate extension, and the result obtained was quite satisfactory.

Malignancies treated through surgical intervention creates anatomic defect which forms communication among the oral cavity, nasal cavity and maxillary sinus, in which case it is very difficult for the patient to perform functions like mastication, swallowing, and phonation. **Naveen YG et al**[28] in 2011 provided Definitive obturator prosthesis which restored the missing structures and acted as a barrier between the communications among the various cavities.

In 2011 **Prakash Somani et al**[29] reported a case of rehabilitation of a compromised Armany class I maxillectomy defect with a definitive hollow bulb obturator.

Maxillectomies triggered by cancer lesions leave communication between oral and nasal cavities which allow the exchange of oral and nasal fluids which hinders speech, mastication and deglutition (swallowing). In 2011 **José Federico torres teran et al**[30] in his study described an

unconventional, modified, and hard to build prosthetic devices such as the design of a hybrid retention prosthetic obturator (swing lock).

Post surgical maxillary defects predispose the patients to hypernasal speech, fluid leakage into the nasal cavity, impaired masticatory function, recurrent upper respiratory tract infection and facial disfigurement. **Nayana Anasane et al**[31] in 2011 in his case report revealed that these disabilities are minimized or eliminated almost immediately with the help of Definitive Hollow Bulb obturator.

In 2011 **Sunit K et al**[32] presented an article which focused on an innovative method of fabricating a palatal obturator which aims at restoring the normal functions along with improving aesthetics. It also enables to devise the fabrication of prosthesis in two parts (Split obturator) for easy insertion, removal and be self-cleansable.

Palatal defect of any extent causes multiple problems in speech, mastication and esthetics. Palatal obturator is the only substitute which covers the defect, eliminates hypernasality and improves the communication. **Rajani Dable**[33] in 2011 in her study discussed about hollow bulb Obturator prosthesis for an edentulous patient which becomes more critical in terms of its movements as there is no mechanical retention available.

Javier Montero et al[34] in 2011 in his article described the prosthetic rehabilitation of an edentulous patient: a woman of 53 years old with a cleft palate who was treated surgically, with a view to

sealing the defect and allowing the patient to acquire better speech quality, and improve her nutrition and well-being.

In velopharyngeal dysfunction, hypernasality and regurgitation of food and liquids is common if defect is not obturated. **Ramya R et al**[35] in 2011 presented a case report of speech aid prosthesis with recording the contours of a partial soft-palate defect for prosthetic obturation.

Defects created in the maxillary bone, principally after resection of malignant tumors surgical, trauma or congenital defects can be corrected either by surgical reconstruction or by placement of maxillary obturator prosthesis. **RT-Cayon Velazquez**[36] in 2011 reviewed the recent and classic literature on palatal obturators and five clinical cases treated with a palatal obturator were reported.

In 2011 **Shyammohan .A et al**[37] in his article suggested a protocol for speech therapy in cases of velopharyngeal insufficiency to be done in union with a prosthodontist. Speech therapy in obturator cases demands a team approach comprising the patient, speech therapist, prosthodontist, and parents/relatives for an effective outcome and the absence of any one can scuttle the result.

3.4 Tools for speech evaluation

W. Hardcastle et al[38] in 1989 reviewed recent developments in Electropalatography (EPG) as a technique for investigating spatio-temporal details of tongue contacts with the hard palate in both normal and pathological speech.

The purpose of the paper presented by **John E. Riski et al**[39] in 1989 was to illustrate the value of combined aerodynamic and endoscopic examination of velopharyngeal function in the revision of prosthetic speech appliances. Combined measures enabled the clinician to identify accurately the site of under or over obturation, and any needed revision was completed accurately and efficiently.

In 1997 an investigation of speech adaptation to palatal modification (to an artificial palate) in [s] production was conducted using acoustic and perceptual analyses by **Shari R. Baum et al**[40]. Productions of [sa] were elicited at five time intervals, 15 min apart, with an artificial palate in place. And the results revealed improvement in both acoustic and perceptual measures at the final time interval relative to the initial measurement period.

In a preliminary investigation **Shari R. Baum et al**[41] examined the ability of individual speakers to adapt to a structural perturbation to the oral environment in the production of [s] in 2000. Results of acoustic and perceptual analyses generally revealed improvement after practice, few consistent effects of vowel context, few negative aftereffects, and an absence of quick recall of adaptive strategies. Moreover, extensive individual differences were found in both the degree of initial perturbation and the extent of adaptation.

In 2000 **H. Yoshida et al**[42] conducted a study to reveal the acoustic characteristics associated with hypernasality and to ascertain their correlation to the severity of hypernasality, 30 speech samples produced by 15 maxillectomy patients were acoustically analysed with and without obturator prosthesis in place. Normalized 1/3-octave spectral analysis demonstrated the spectral characteristics of hypernasality.

Retrospective study conducted by **M. Brent Seagle et al**[43] spans the years 1988 to 2000 and looks specifically at the treatment procedures and outcomes for the correction of velopharyngeal insufficiency(VPI) and the results revealed VPI resolution and the establishment of normal nonnasal speech in more than 95% of the 75 patients for whom outcomes were determined.

A strong association was found between ratings of 'velopharyngeal function' and 'hypernasality' and the pattern of nasal airflow during the bilabial nasal-to-stop combination. **Hans Dotevall et al**[44] in 2002 assessed the nasal airflow dynamics during the velopharyngeal closing phase in speech which presented with quantitative, objective data that appear to distinguish between perceptually normal and deviant velopharyngeal function with high sensitivity and specificity.

Jana Rieger et al[45] in 2002 in his study concluded that Rehabilitation with a maxillary obturator is successful in restoring preoperative speech function but rehabilitation of individuals with involvement of the soft palate may be more challenging.

The purpose of the study done by **Makio Kobayashi et al**[46] in 2002 was to investigate the effect on the vibratory characteristics of a cast hollow obturator prosthesis retainer when varying its

bulb height, bulb parts with high (H), middle (M), and low (L) lateral walls were prepared and concluded that the L type is preferable from the standpoint of its vibratory characteristics.

Obturators have been developed for surgical defects caused by cancer of the maxillary sinus and alveolar ridge. Outcome research is necessary to develop evidence-based practice guidelines. **Marsha Sullivan et al**[47] in 2002 in his study concluded that obturation is an effective intervention for defects of the maxillary sinus and alveolar ridge on speech performance.

Some patients presenting velopharyngeal dysfunction need treatment with a palatal prosthesis, and few researches attempt to evaluate the judgement of its efficacy. In the same way **Joao Henrique Nogueira PINTO et al**[48] in 2003 in his study concluded that the prosthetic treatment of velopharyngeal dysfunction demonstrated efficacy in improving speech, despite of the heterogeneous sample.

Mean nasalance magnitudes and mean nasalance distances were obtained with three devices the Nasometer, the NasalView, and the OroNasal System. **Tim Bressmann et al**[49] in 2005 in his study used these systems and explained that these three systems measure nasalance in different ways and provide nasalance scores that are not interchangeable.

Subjective ratings of the efficacy of the obturator–speech bulbs by the clinicians did not correspond to the percent intelligibility. **George Bohle et al**[50] in 2005 in his clinical assessments and cephalometric analysis: a memorial Sloan –Kettering study revealed that a strong statistical and

clinical correlation exists supporting the efficacy of speech bulb– obturator intervention after velopharyngeal insufficiency for improved intelligibility of both words and sentences.

Viviane de Carvalho-Teles et al[51] in 2006 conducted a study, the objective of which was to evaluate the efficacy of the palatal obturator prosthesis on speech intelligibility and resonance of patients who had undergone inframedial structural maxillectomy. The results of this study indicated that maxillary obturator prosthesis was efficient to improve the speech intelligibility and resonance in patients who had undergone maxillectomy.

The aims of the study done by **A.O.Arigbede et al**[52] in 2006 were to assess the effectiveness of the maxillary obturator as a speech rehabilitation aid and to examine the influence of the classes of surgical defects on speech intelligibility (SI). Results support the widely held view that the maxillary obturator is a useful speech rehabilitation aid and moreover SI is affected by the class of defect.

Sanskrit, an ancient language, has an arrangement of alphabets that is orderly and scientific and therefore provides a simple means to understand the production of phonemes and memorize them. In 2007 **Kalpesh Gajiwala**[53] in his article demonstrates the inherent advantage of this arrangement of Sanskrit alphabets to effectively analyze defective cleft palate speech and provides a tool for surgeons to decide a course of action in their routine clinical practice.

A clinical study done by **Hiiseyin Kurtulmus et al**[54] in 2007 in which a comparison of speech assessment results before and after the obturator showed some differences. Fourier

transform analysis revealed a change in the formantic spectrum and the noise/harmonis ratio decreased and the formants were more meaningful after the implantation in the bisyllabic word.

The study done by **Triona Sweeney et al**[55] in 2008 aimed to evaluate the relationship between perceptual assessment and acoustic measurements of nasality using controlled speech stimuli. The strong relationship between perceptual and acoustic assessments of nasality indicated that the Temple Street Scale and the Nasometer are both valid clinical tools for the evaluation of nasality when a carefully constructed speech sample is used.

The aim of the study done by **Suha Turkaslan et al**[56] in 2009 was to evaluate the articulation performance of obturator patients with three different buccal extension designs and they concluded that Obturators improve speech intelligibility irrespective of their buccal extension levels, nevertheless, medium size buccal extension enables the optimum sealing for better articulation.

The aim of the study done by **Aveliny Mantovan Lima-Gregio et al**[57] in 2010 was to investigate frequency spectral aspects of F1, F2, F3, nasal formant (FN) and anti-formant, in

Hertz, for vowels [a] and [ɐ̃] at different velopharyngeal openings produced in the bulb of a palatal prosthesis replica used by a patient with velopharyngeal insufficiency and concluded that significant changes were observed in the studied spectral values according to changes in the velopharyngeal opening size.

The correction of VPI was temporarily done with a pharyngeal obturator since the child presented with a very little movement of the pharyngeal walls during speech, compromising the outcome of a possible pharyngeal flap procedure (pharyngoplasty). The program of intensive speech therapy was conducted in three phases. After the program involving the use of a pharyngeal obturator, **Nachale Helen Maciel BISPO et al**[58] in 2011 observed absence of hypernasality and compensatory articulation with improved speech intelligibility.

Separation of the nasal and oral cavities by dynamic closure of the velo-pharyngeal port is necessary for normal speech and swallowing. Velo-pharyngeal dysfunction (VPD) may either follow repair of a cleft palate or be independent of clefting. **Jeffrey L. Marsh**[59] in 2011 in his study explained that matching the specific intervention for management of VPD with the type of dysfunction, that is, differential management for differential diagnosis, maximizes the result while minimizing the morbidity of the intervention.

3.5 Palatography

The aim of the study done by **Bortun Cristina et al**[4] in 2004 was to assess the phonetic alterations in complete denture wearers caused by position, size and material (resin or ceramics) of the frontal artificial teeth. This was performed using the static palatographies and spectrograms,

which evaluated the most important spaces for the phonetic modulation, in relation to various settings of the artificial teeth.

The objectives of the study done by **Thierry Legou et al**[8] in 2008 was to provide an automatic analysis of the tongue print characteristic (size, shape, position onto the palate…) in order to allow an objective description of the linguopalatal contact and the other one concerns the shape of the palate. The knowledge of the palate shape can be a key point to understand certain consonant productions and can be used for static direct and indirect palatography.

The paper presented by **H.-N. L.** Teodorescu[5] in 2010 explains the use of indices such as SQI, SII and of the distances which provides the practitioner with the grounds of an automated method for assessing the quality of the performed prosthetic act. From the speech rehabilitation perspective, this is a major step ahead in the current technology and solves a fundamental problem in dentistry.

Amandeep Bhullar et al[7] in 2011 in his study about Palatal Rugae explained that Palatal Rugae are anatomical wrinkles or folds called 'plica palatine', the irregular connective tissue located on the anterior third of the palate behind the incisive papilla. They are stable landmark, which once formed; do not undergo any changes except in length, and thus palatoscopy or palatal rugoscopy is used as an aid in clinical dentistry.

MATERIALS AND METHODOLOGY

4.1 MATERIALS

Materials used for the study.

1. Polyvinyl Siloxane Impression material-Putty and light body (Elite H.D+) (Fig1)
2. Type III Dental Stone (Gold stone, Asian Chemicals India) (Fig 2)
3. Impression Compound (Ashlate, Asian Acrylates , Mumbai India) (Fig 3)
4. Green Stick Compound (DPI PINNACLE , Dental Products of India Ltd) (Fig 4)
5. Korecta no.4 wax (Factor II USA) (Fig5)
6. Betadiene Solution(Betadiene Germicide Gargle 2% , Win Medicare)`(Fig 6)
7. Heat cure acrylic resin (Acralyn-H , Asian Acrylates , Mumbai) (Fig 7)
8. Cold mould seal (Acralyn-H, Asian Acrylates, Mumbai) (Fig 8)
9. Autopolymerizing acrylic resin (DPI RR, Dental Products of India Ltd) (Fig 9)
10. Gauze(Surgicom, Tamilnadu) (Fig 10)

4.1.1 Equipments

1. Nasometer (Dr Speech) (Fig 11)
2. Sony Vaio (vpceb14en) Laptop
3. PRAAT software (Fig 12)
4. Sony Ic Audio recorder (ICD-UX512F) (Fig 13)
5. Sound Recording studio at NISH of Max 20db (Fig 14)

4.2 METHODOLOGY:

Selection of patients

Ten patients aged between 6-25 years, eligible for treatment criteria were selected.

Inclusion Criteria

i) Age group 6 – 35 years (Speaking age group)

ii) Subjects desire for a palatal obturator

iii) Willingness to comply with the study requirements

Exclusion Criteria

i) Patients aged above 35 years

ii) Patients with neuromuscular disorders

iii) Patients with having congenital and acquired defects of the vocal chord

Ethical committee clearance number: SMIMS/IHEC/2012/A1

STUDY DESIGN

In vivo study

STUDY SETTINGS

The study was conducted at the department of Prosthodontics, Sreemookambika Institute of Dental Sciences, Kulasekharam. The speech outcomes were recorded in a Sound proof room (20db max) at NISH (National Institute of Speech and hearing, Trivandrum).

STUDY PERIOD

6 months

STUDY GROUP

A group of ten patients having congenital maxillary defects were selected

A total of ten patients were included after evaluation of the patient to fit within the inclusion category. A detailed case history was taken and evaluated (Appendix 1). All treatment options were explained to the patient. Once the treatment was found feasible, the procedures, advantages, precautions, maintenance and care were explained to the patient and the patient's informed consent for the treatment was obtained on paper (Appendix 2).

The following diagnostic aids were used to evaluate the patient's nasalance and the type of obturator to be planned for the treatment purpose.

1 Diagnostic cast

Diagnostic Impressions-two of the concerned arch (maxillary arch) and one of the opposing arches – were made in Polyvinyl Siloxane Impression material-Putty and light body

(Elite H.D) using perforated stock impression trays. The impressions were poured in type III dental stone.

2 Nasometer

Acoustic data obtained with Nasometer [Dr Speech] helps to evaluate the percentage of nasalance in patients with congenital maxillary defects which in turn helps in the treatment planning of the patient.

Nasalance is measured in terms of frequency by time

$$Nasalance = \frac{Frequency}{Time}$$

3. PRAAT Software

Digital acoustic analysis (or spectrogram) was done with PRAAT Software using vowels a, e, u, and the formants were evaluated from $f_0 - f_5$ at three clinical visits.

4. Sound Lab:

The speech outcomes were recorded in Sound proof room (20db max).

4.2.1 Introduction

This study involves a total of ten patients aged between 6 –25 years who presented with unintelligible speech. These patients were not satisfied with their speech outcome even after surgical correction and prosthetic rehabilitation. A detailed intra-oral examination was done. (to

evaluate the extent of the palatal defect). Then the treatment plan was made to provide obturator prosthesis in order to close the defect.

Speech outcome measurements were collected prospectively at three clinical visits- (1) before correcting the defect, (2) after correcting the defect with prosthesis (3) after modification of the prosthesis with palatography.

Acoustic data were obtained using Nasometer to determine nasalance. Digital acoustic analysis (or spectrogram) were done using PRAAT Software using vowels a, e, u, and the formants were evaluated from $f_0 – f_5$ at the above mentioned three clinical visits.

4.2.2 Clinical procedure (Fig 15 - Fig 36)

A detailed case history was taken and evaluated. Speech outcomes were measured before correction of the defect in terms of intelligibility (Using PCC), Nasalance (Using Nasometer Dr Speech), Formant Evaluation (Using PRAAT software)

4.2.3 Making of the Impression and Fabrication of prosthesis

Impressions were made with Perforated Stock Impression trays (Zhermeck) using polyvinyl Siloxane Impression material-Putty and light body (Elite H.D) and palatal obturator prosthesis was constructed using heat cure acrylic resin.

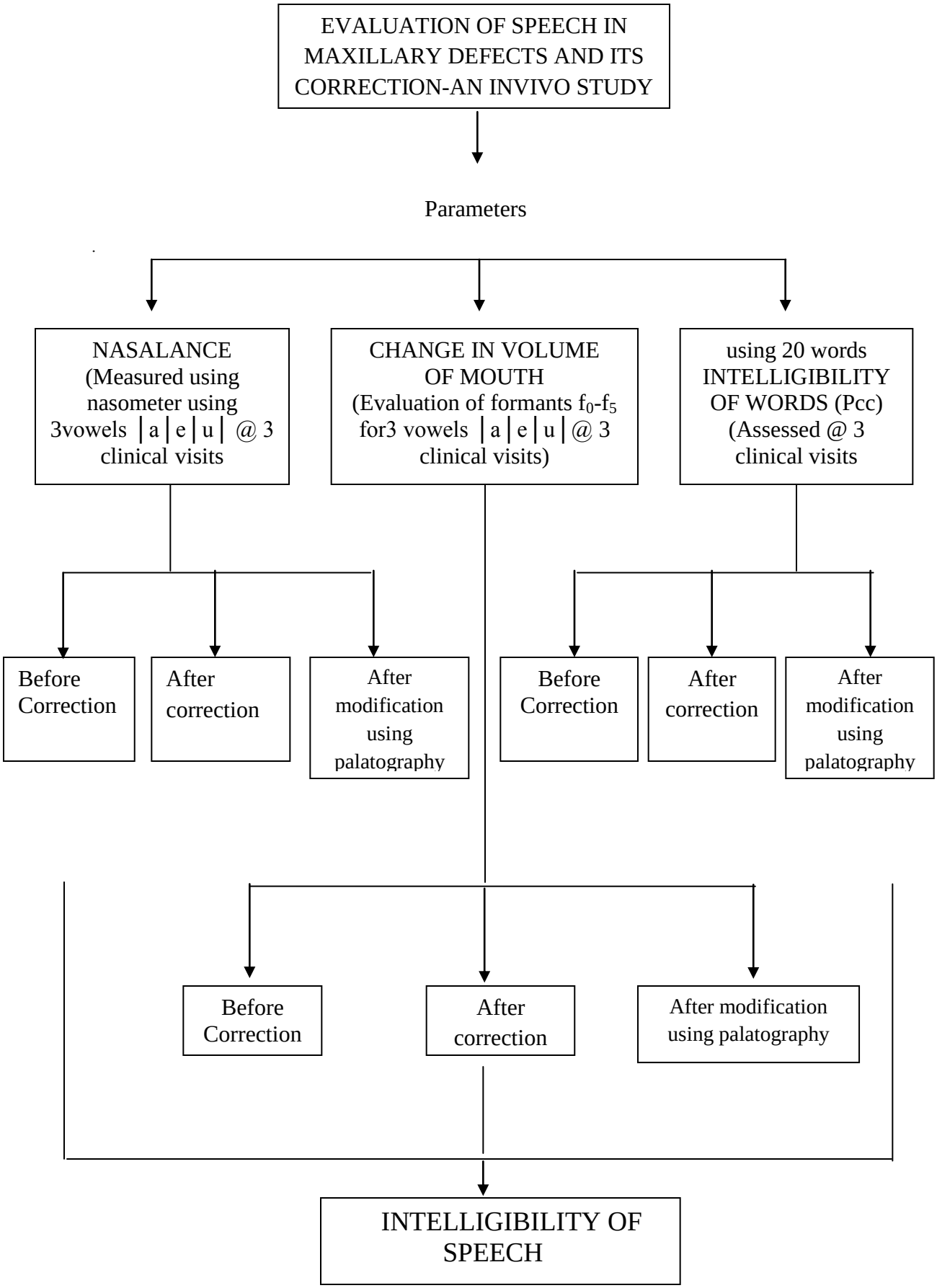
After delivering the prosthesis the speech outcomes were again determined and recorded, but the patient were not at all satisfied with the speech results even after providing the prosthesis.

4.2.4 Palatography

Palatography was done using mouth temperature flowing wax-Korecta no:4 wax (Factor II USA). The wax was double boiled and painted onto the chameo surface of the prosthesis and molded by asking the patient to repeat few words (like Cha, Ta, Da, Sa, Saraswathy, Mississippi) to elicit the type of articulatory deficiency which was corrected by molding the wax in the deficient areas where by intelligibility of speech was improved markedly.

After palatography the modifications were incorporated onto the prosthesis with self cure acrylic resin and again the speech outcomes were evaluated, thus the values elicited after the procedure had a marked increase in intelligibility of speech.

Speech evaluation and acoustic data analysis were done in sound proof room of $20_{db.}$


EVALUATION OF SPEECH IN MAXILLARY DEFECTS AND ITS CORRECTION-AN INVIVO STUDY
Parameters
NASALANCE (Measured using nasometer using 3vowels │a│e│u│ @ 3 clinical visits
CHANGE IN VOLUME OF MOUTH (Evaluation of formants f_0-f_5 for3 vowels │a│e│u│@ 3 clinical visits)
using 20 words INTELLIGIBILITY OF WORDS (Pcc) (Assessed @ 3 clinical visits
Before Correction
After correction
After modification using palatography
Before Correction
After correction
After modification using palatography
Before Correction
After correction
After modification using palatography
INTELLIGIBILITY OF SPEECH

RESULTS

5.1.1 Results For Intelligibility by (PCC) Percentage of Consonants Correct

Association between	**t-value**	**Degrees of freedom**	**P value**	**Inference**
Before Prosthesis and After Prosthesis	8.78	9	P<0.001	Highly Significant
Before Prosthesis and after modified prosthesis	29.06	9	P<0.001	Highly Significant
After Prosthesis and after Modified prosthesis	29.06	9	P<0.001	Highly Significant

Table I (Intelligibility assessment with Student's t paired test)

Variation	Sum of Squares	Degrees of freedom	Mean squares
Between	721.67	2	360.835
Within	91.3	27	3.381481
Total	812.97	29	

Table II (Intelligibility assessment with ANOVA One Way table)

Fobserved 106.709146

From the table for 0.01 significant level the F value is 99.46

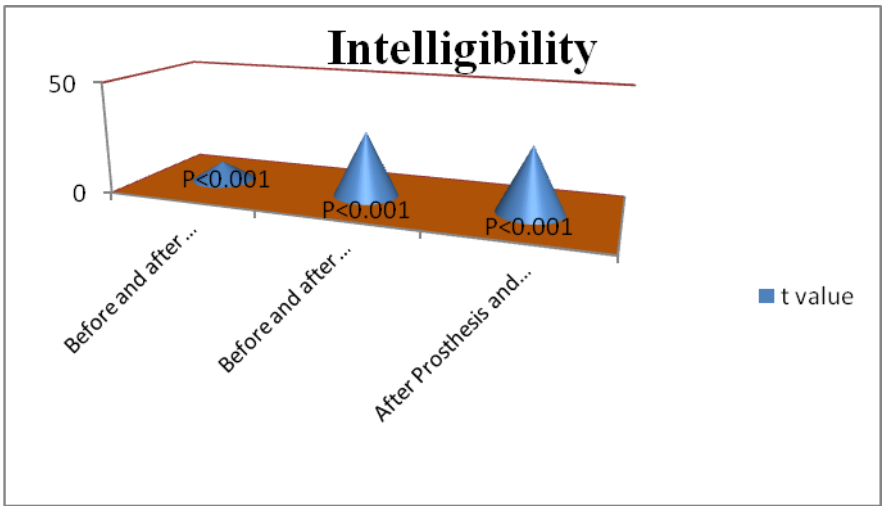
Calculated value is greater than tabled value, which shows that the there is difference in treatment and the variability is highly significant

ANOVA	Source of Variation	Degrees of freedom	Sum of Squares	Mean Sum of Squares	F ratio	Degrees of freedom	F0.001
1	Persons	2	721.67	360.84	299.7245039	2,18	10.390
2	Treatment	9	69.6	7.73	6.423627134	9,18	5.760
3	Error	18	21.67	1.20			
4	Total	29	812.97				

Table III (Intelligibility with ANOVA Two way table)

Therefore the difference between the treatment and the difference between the persons are highly significant and the significance level is less than 0.001

Intelligibility by (PCC) Percentage of Consonants Correct



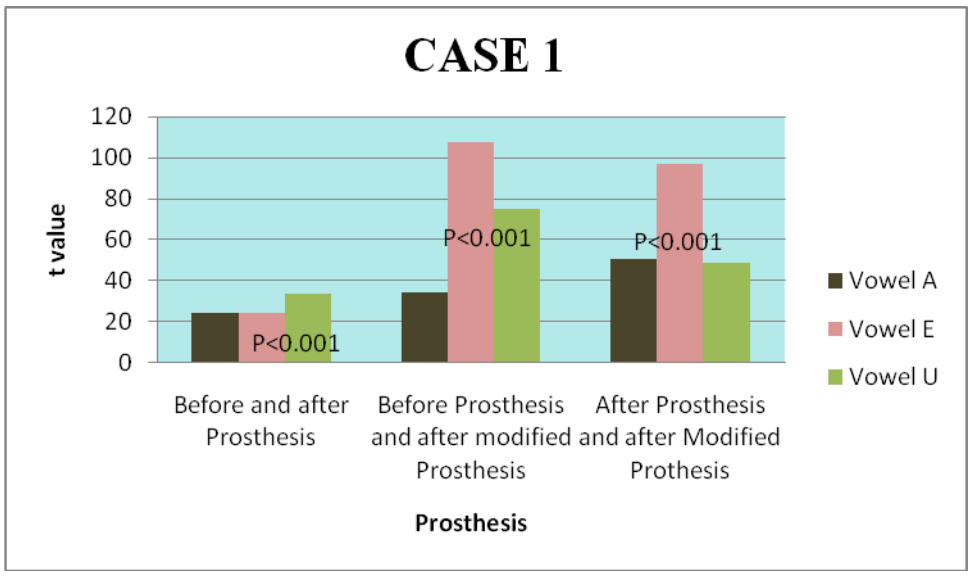
Graph No.1

Tables I, II, III and Graph no1 shows the difference between before prosthesis and after prosthesis is highly significant with P < 0.001, the difference between before prosthesis and after modified prosthesis is highly significant with P< 0.001 and the difference between after prosthesis and after modified prosthesis is highly significant with P< 0.001.

5.1.2 Results of Nasalance Using Nasometer

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t-value	P value	Inference	t-value	P value	Inference	t-value	P value	Inference
A	23.73	P<0.001	Highly significant	33.69	P<0.001	Highly significant	50.26	P<0.001	Highly significant
E	23.77	P<0.001	Highly significant	107.34	P<0.001	Highly significant	96.76	P<0.001	Highly significant
U	33.11	P<0.001	Highly significant	75.07	P<0.001	Highly significant	48.36	P<0.001	Highly significant

Table IV (CASE No. 1)

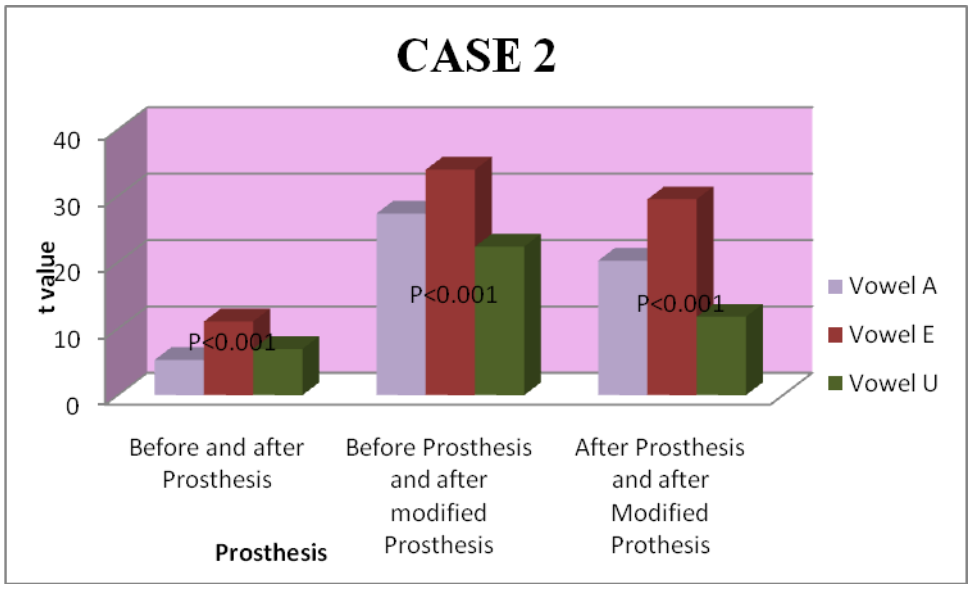


Graph No.2

Table IV and Graph No 2 shows that for case 1 there is significant difference between before prosthesis and after prosthesis, before prosthesis and after modified prosthesis and after prosthesis and after modified prosthesis, where the P value is less than 0.001respectively.

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t-value	P value	Inference	t-value	P value	Inference	t-value	P value	Inference
A	6.96	P<0.001	Highly significant	22.38	P<0.001	Highly significant	11.81	P<0.001	Highly significant
E	11.1	P<0.001	Highly significant	33.97	P<0.001	Highly significant	29.51	P<0.001	Highly significant
U	5.31	P<0.001	Highly significant	27.36	P<0.001	Highly significant	20.26	P<0.001	Highly significant

Table V (CASE No.2)

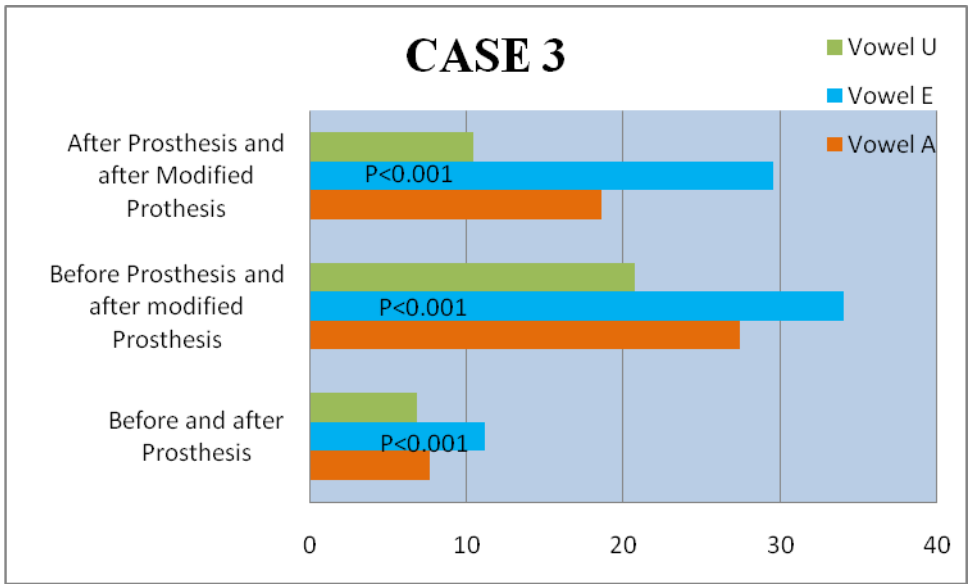


Graph No.3

Table V And Graph No 3 shows that for case 2 there is significant difference between before prosthesis and after prosthesis, before prosthesis and after modified prosthesis and after prosthesis and after modified prosthesis, where the P value is less than 0.001respectively.

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t-value	P value	Inference	t-value	P value	Inference	t-value	P value	Inference
A	7.59	P<0.001	Highly significant	27.41	P<0.001	Highly significant	18.59	P<0.001	Highly significant
E	11.12	P<0.001	Highly significant	34.02	P<0.001	Highly significant	29.54	P<0.001	Highly significant
U	6.79	P<0.001	Highly significant	20.73	P<0.001	Highly significant	10.36	P<0.001	Highly significant

Table VI (CASE No.3)

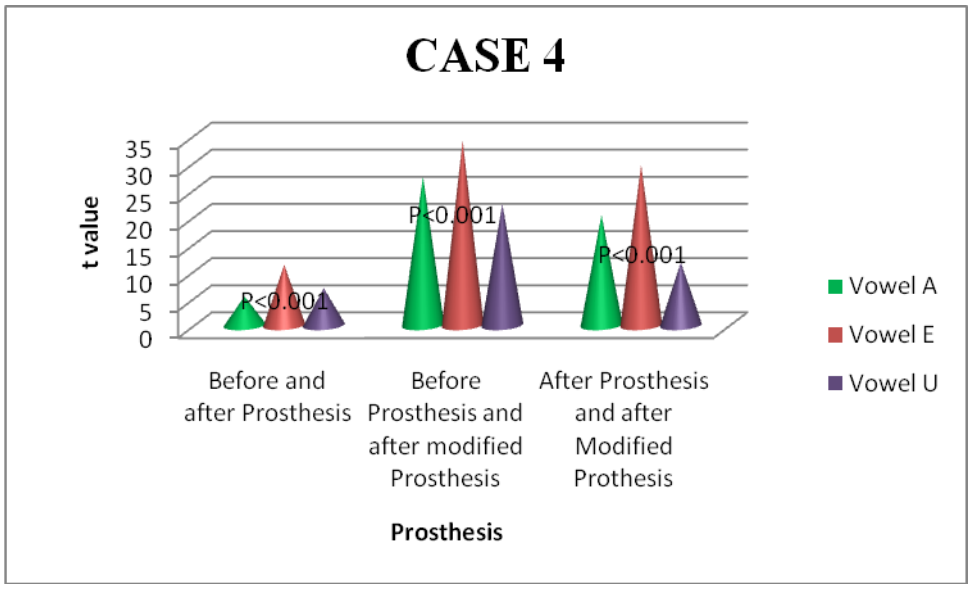


Graph No.4

Table VI and Graph No.4 shows that for case 3 there is significant difference between before prosthesis and after prosthesis, before prosthesis and after modified prosthesis and after prosthesis and after modified prosthesis, where the P value is less than 0.001respectively.

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t-value	P value	Inference	t-value	P value	Inference	t-value	P value	Inference
A	5.32	P<0.001	Highly significant	27.41	P<0.001	Highly significant	20.31	P<0.001	Highly significant
E	11.16	P<0.001	Highly significant	34.06	P<0.001	Highly significant	29.58	P<0.001	Highly significant
U	6.81	P<0.001	Highly significant	22.38	P<0.001	Highly significant	11.64	P<0.001	Highly significant

Table VII (CASE No. 4)

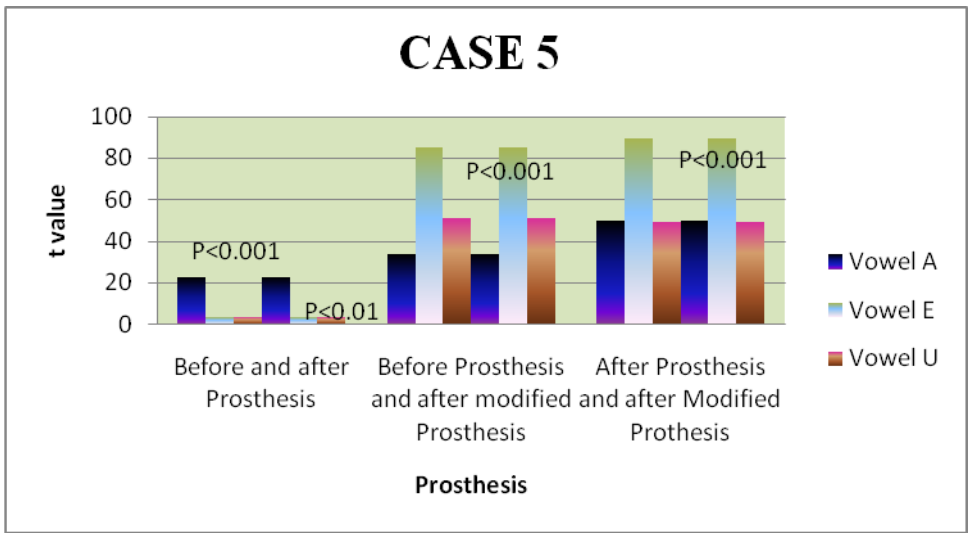


Graph No. 5

Table VII and Graph No.5 shows that for case 4 there is significant difference between before prosthesis and after prosthesis, before prosthesis and after modified prosthesis and after prosthesis and after modified prosthesis, where the P value is less than 0.001 respectively.

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t-value	P value	Inference	t-value	P value	Inference	t-value	P value	Inference
A	22.77	P<0.001	Highly significant	33.82	P<0.001	Highly significant	49.74	P<0.001	Highly significant
E	3.65	P<0.01	Highly significant	85.39	P<0.001	Highly significant	89.26	P<0.001	Highly significant
U	3.22	P<0.01	Highly significant	51.16	P<0.001	Highly significant	49.5	P<0.001	Highly significant

Table VIII (CASE No.5)

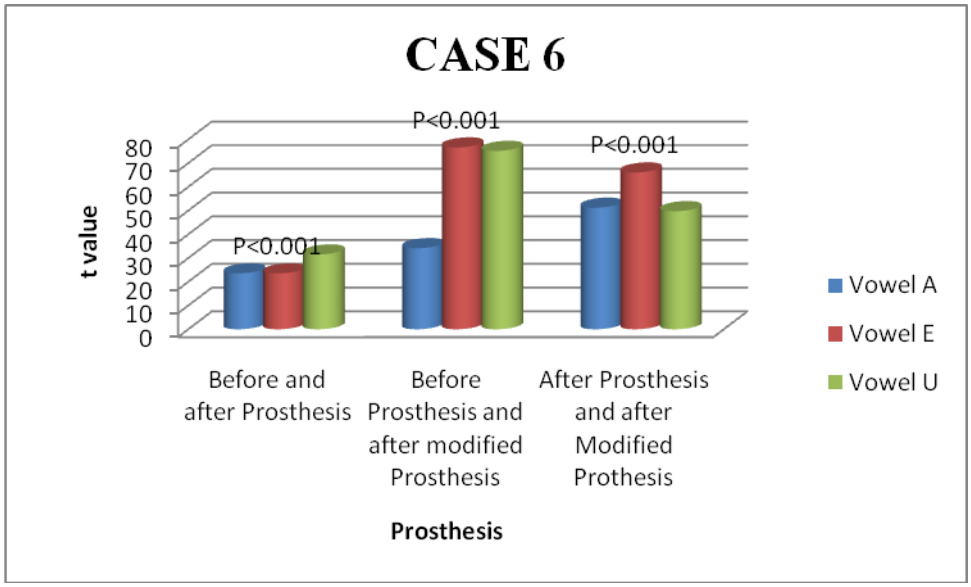


Graph No.6

Table VII and Graph No.6 shows that for case 5 there is significant difference between before prosthesis and after prosthesis, before prosthesis and after modified prosthesis and after prosthesis and after modified prosthesis, where the P value is less than 0.001 respectively. For vowel E and U the difference between before prosthesis and after prosthesis is significant and the P value is only less than 0.01.

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t-value	P value	Inference	t-value	P value	Inference	t-value	P value	Inference
A	23.57	P<0.001	Highly significant	34.17	P<0.001	Highly significant	51.23	P<0.001	Highly significant
E	23.56	P<0.001	Highly significant	76.62	P<0.001	Highly significant	66.08	P<0.001	Highly significant
U	31.52	P<0.001	Highly significant	75.19	P<0.001	Highly significant	49.77	P<0.001	Highly significant

Table IX (CASE No.6)

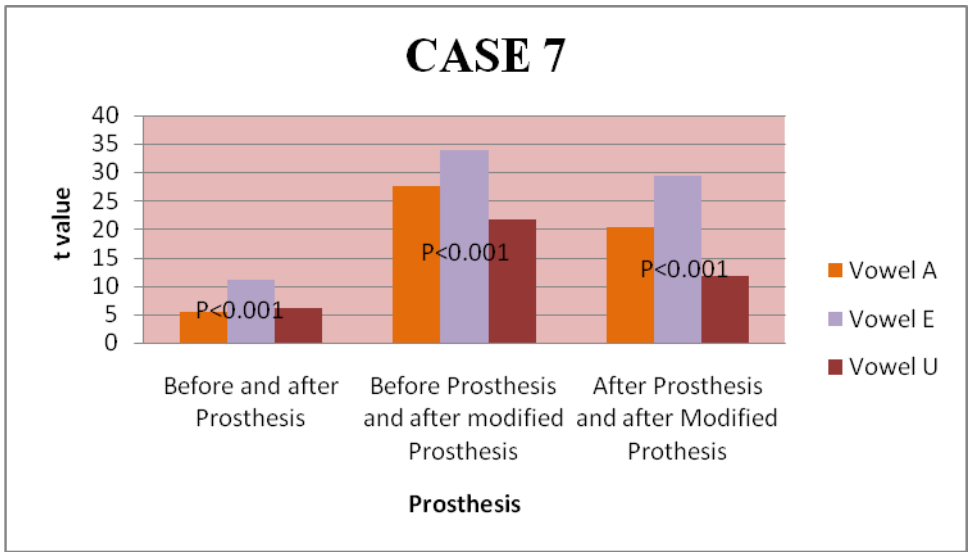


Graph No.7

Table IX and Graph No.7shows that for case 6 there is significant difference between before prosthesis and after prosthesis, before prosthesis and after modified prosthesis and after prosthesis and after modified prosthesis, where the P value is less than 0.001 respectively.

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t-value	P value	Inference	t-value	P value	Inference	t-value	P value	Inference
A	5.37	P<0.001	Highly significant	27.54	P<0.001	Highly significant	20.26	P<0.001	Highly significant
E	11.04	P<0.001	Highly significant	33.96	P<0.001	Highly significant	29.46	P<0.001	Highly significant
U	6.08	P<0.001	Highly significant	21.65	P<0.001	Highly significant	11.64	P<0.001	Highly significant

Table X (CASE No.7)

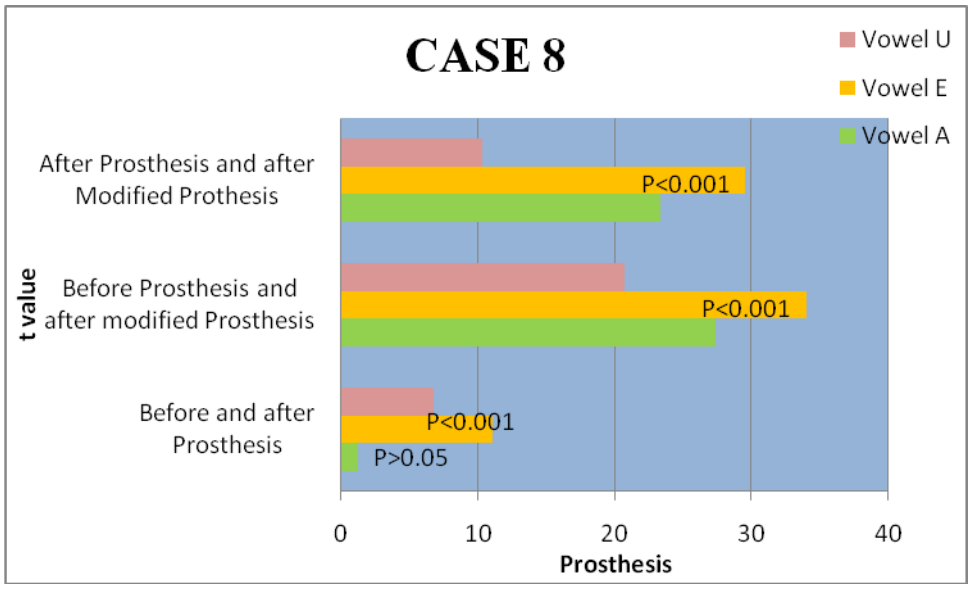


Graph No. 8

Table X and Graph No.8 shows that for case 7 there is significant difference between before prosthesis and after prosthesis, before prosthesis and after modified prosthesis and after prosthesis and after modified prosthesis, where the P value is less than 0.001 respectively.

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t- value	P value	Inference	t- value	P value	Inference	t- value	P value	Inference
A	1.203	P>0.05	Not Significant	27.36	P<0.001	Highly significant	23.29	P<0.001	Highly significant
E	11.1	P<0.001	Highly significant	33.98	P<0.001	Highly significant	29.55	P<0.001	Highly significant
U	6.79	P<0.001	Highly significant	20.66	P<0.001	Highly significant	10.33	P<0.001	Highly significant

Table XI (CASE No.8)

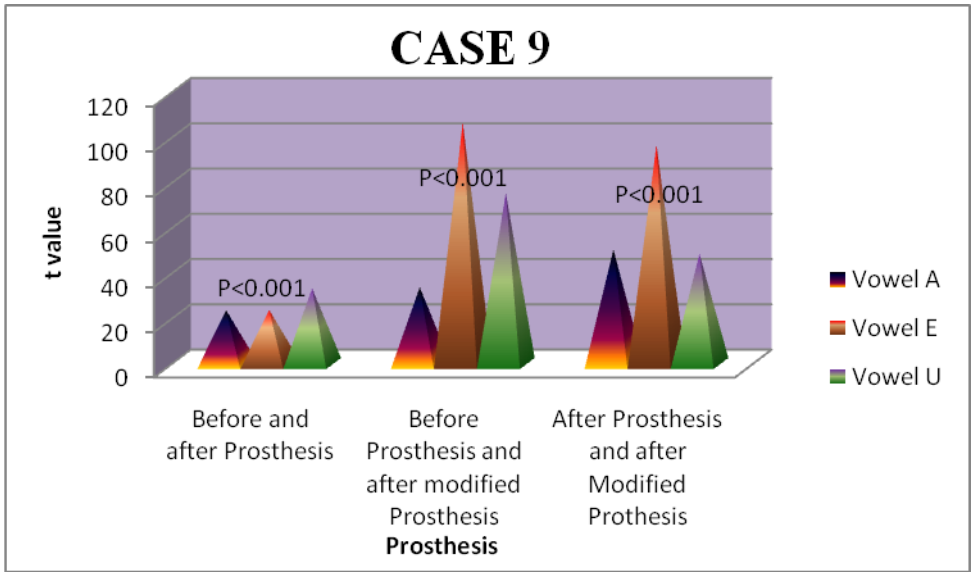


Graph No. 9

Table XI and Graph No.9shows that for case 8 there is significant difference between before prosthesis and after prosthesis, before prosthesis and after modified prosthesis and after prosthesis and after modified prosthesis, where the P value is less than 0.001 respectively and the difference between before Prosthesis and after prosthesis is not significant for Vowel A, where the P value is greater than0.05.

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t-value	P value	Inference	t-value	P value	Inference	t-value	P value	Inference
A	23.66	P<0.001	Highly significant	33.71	P<0.001	Highly significant	50.34	P<0.001	Highly significant
E	23.76	P<0.001	Highly significant	106.47	P<0.001	Highly significant	96.53	P<0.001	Highly significant
U	33.18	P<0.001	Highly significant	75.25	P<0.001	Highly significant	48.49	P<0.001	Highly significant

Table XII (CASE No.9)

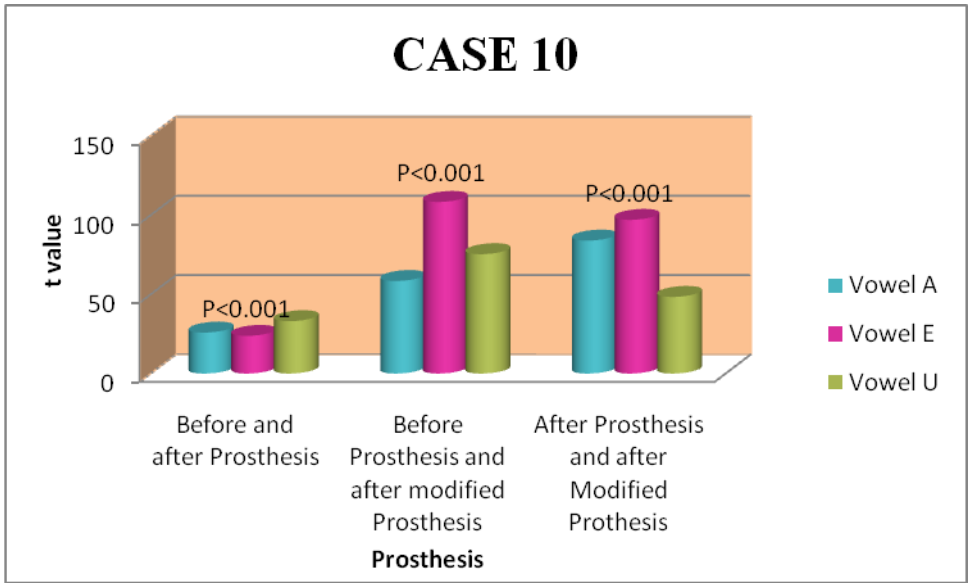


Graph No. 10

Table XII and Graph No.10 shows that for case 9 there is significant difference between before prosthesis and after prosthesis, before prosthesis and after modified prosthesis and after prosthesis and after modified prosthesis, where the P value is less than 0.001 respectively.

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t-value	P value	Inference	t-value	P value	Inference	t-value	P value	Inference
A	25.87	P<0.001	Highly significant	58.42	P<0.001	Highly significant	83.92	P<0.001	Highly significant
E	23.78	P<0.001	Highly significant	108.31	P<0.001	Highly significant	96.99	P<0.001	Highly significant
U	33.06	P<0.001	Highly significant	75.34	P<0.001	Highly significant	48.38	P<0.001	Highly significant

Table XIII (CASE No.10)



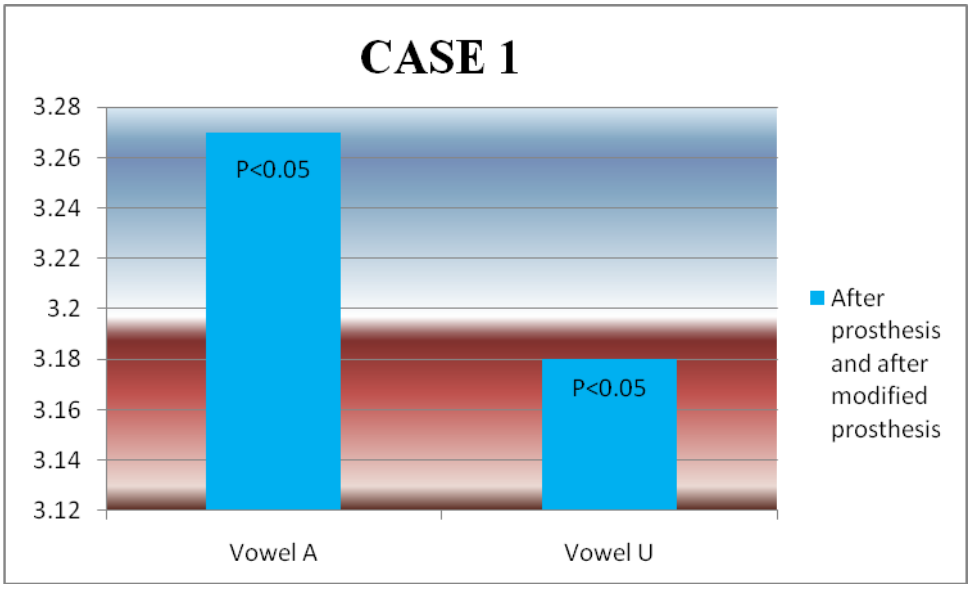
Graph No.11

Table XIII and Graph No.11 shows that for case 10 there is significant difference between before prosthesis and after prosthesis, before prosthesis and after modified prosthesis and after prosthesis and after modified prosthesis, where the P value is less than 0.001 respectively.

5.1.3 Results for Formant Evaluation using PRAAT software

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t- value	P value	Inference	t- value	P value	Inference	t- value	P value	Inference
A	1.94	P>0.05	Not Significant	1.68	P>0.05	Not Significant	3.27	P<0.05	Significant
E	2.068	P>0.05	Not Significant	2.54	P>0.05	Not Significant	3.18	P<0.05	Significant
U	2.11	P>0.05	Not Significant	2.34	P>0.05	Not Significant	2.36	P>0.05	Not Significant

Table XIV (CASE No.1)

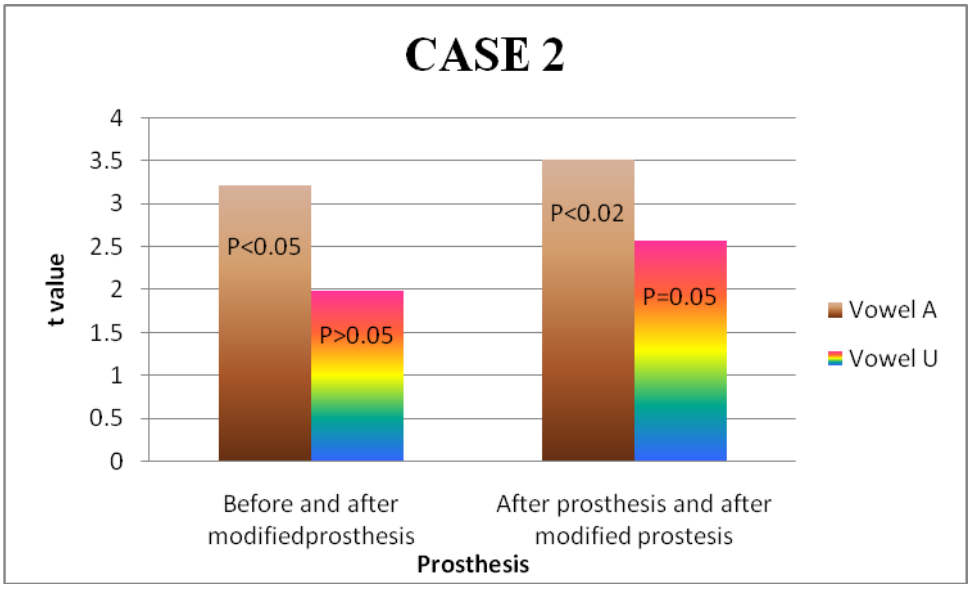


Graph No. 12

Table XIV and Graph No.12 shows that for Case 1 the difference between after prosthesis and after modified prosthesis is significant and the P value is less than 0.05 for vowels [a] and [u].

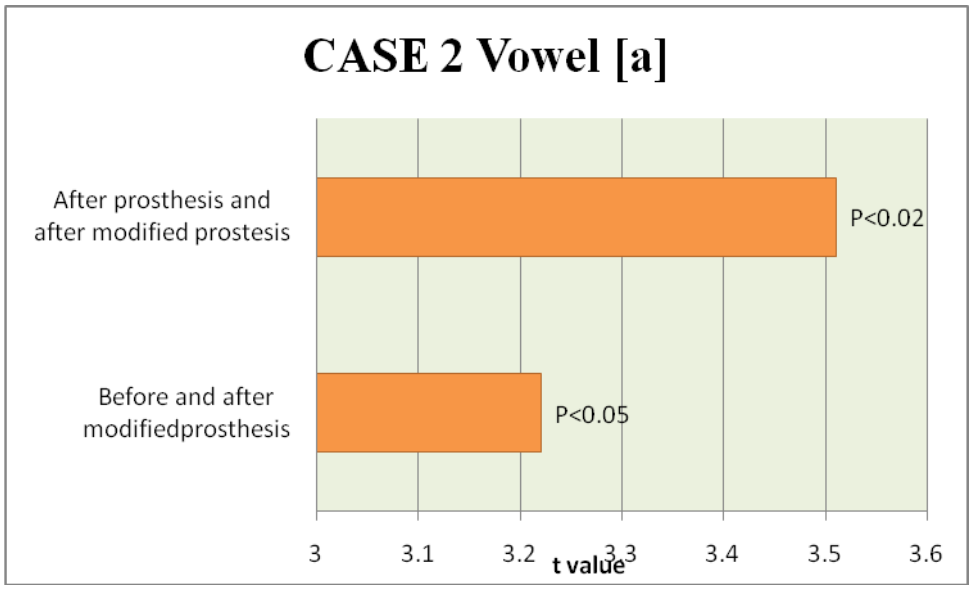
Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t- value	P value	Inference	t- value	P value	Inference	t- value	P value	Inference
A	2.55	P>0.05	Not significant	3.22	P<0.05	Significant	3.51	P<0.02	Significant
E	1.92	P>0.05	Not significant	2.23	P>0.05	Not Significant	1.79	P>0.05	Not Significant
U	2.36	P>0.05	Not significant	1.99	P>0.05	Not Significant	2.57	P=0.05	Just Significant

Table XV (CASE No.2)



Graph No.13

Table XV and Graph No.13 shows that for Case 2 in Vowel [a] the difference between before prosthesis and after prosthesis is significant, where P<0.05 and the difference between after prosthesis and after modified prosthesis is significant, where P<0.02. In vowel [u] the difference between before prosthesis and after prosthesis is not significant, where P>0.05 and the difference between after prosthesis and after modified prosthesis is just significant, where P=0.05.

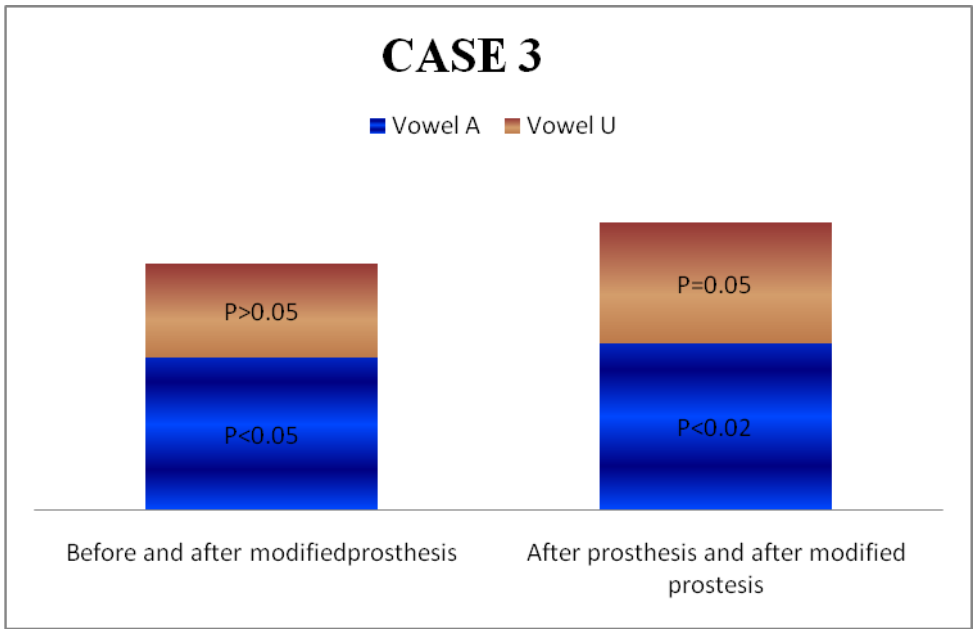


Graph No. 14

It was also found that for case 2 for vowel [a],the difference is significant (P<0.05) between before prosthesis and after modified prosthesis. The difference between after prosthesis and after modified prosthesis is also found to be significant with P value less than 0.02.

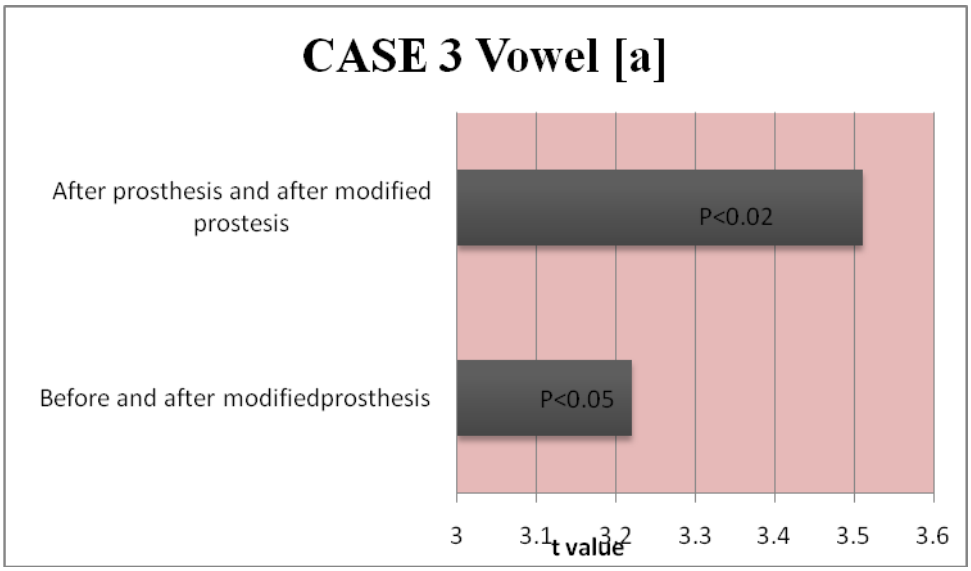
Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t- value	P value	Inference	t- value	P value	Inference	t- value	P value	Inference
A	2.546	P>0.05	Not significant	3.226	P<0.05	Significant	3.52	P<0.02	Significant
E	1.95	P>0.05	Not significant				1.79	P>0.05	Not Significant
U	2.52	P>0.05	Not significant	1.99	P>0.05	Not Significant	2.57	P=0.05	Just Significant

Table XVI (CASE No.3)



Graph No.15

Table XVI and Graph No.15 shows that for Case 3 in Vowel [a] the difference between before prosthesis and after prosthesis is significant, where P<0.05 and the difference between after prosthesis and after modified prosthesis is significant, where P<0.02. In vowel [u] the difference between before prosthesis and after prosthesis is not significant, where P>0.05 and the difference between after prosthesis and after modified prosthesis is just significant, where P=0.05.

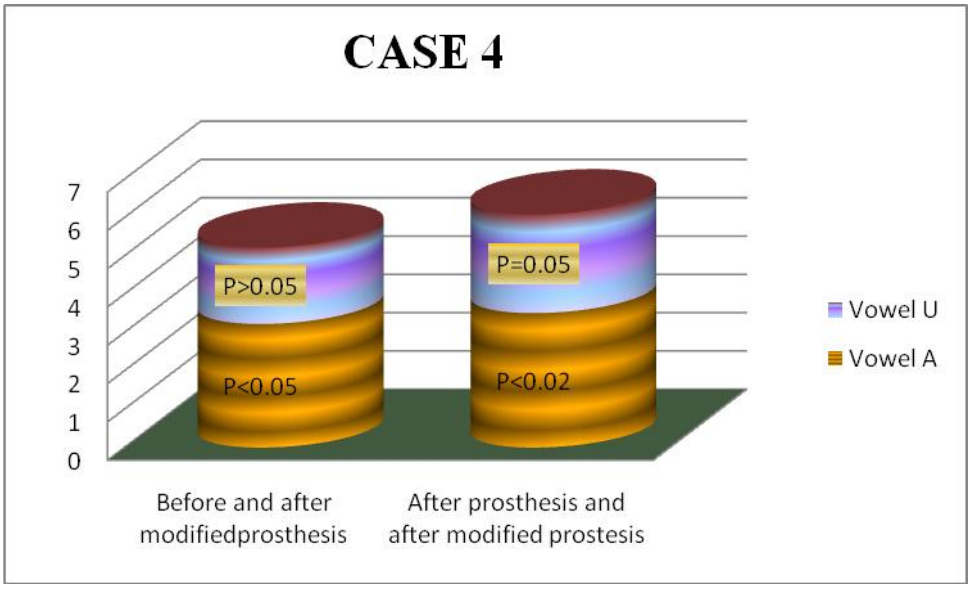


Graph No.16

It was also found that for case 3 for vowel [a], it was found that the difference is significant (P<0.05) between before prosthesis and after modified prosthesis. The difference between after prosthesis and after modified prosthesis is also found to be significant with P value less than 0.02.

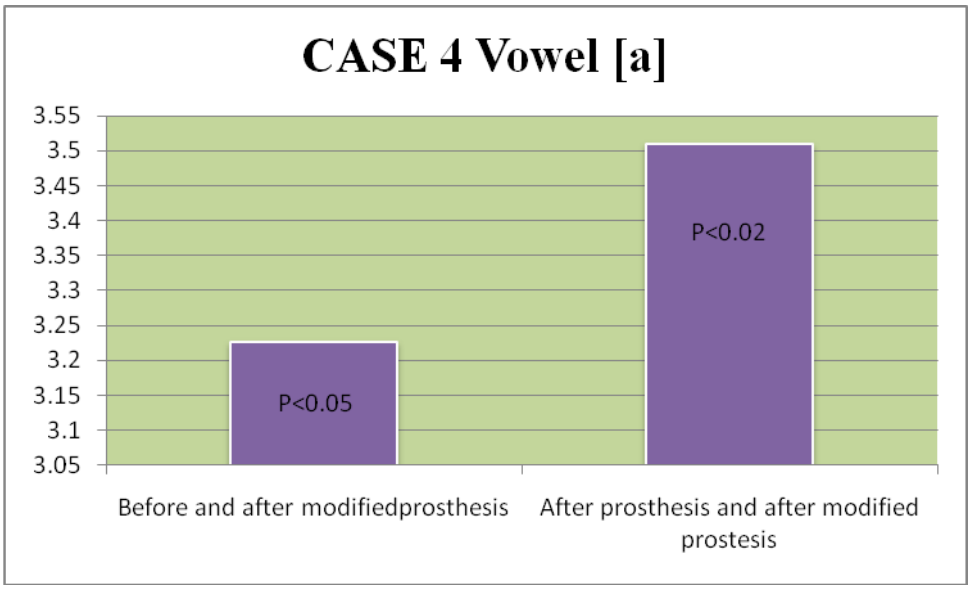
Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t-value	P value	Inference	t-value	P value	Inference	t-value	P value	Inference
A	2.549	P>0.05	Not Significant	3.226	P<0.05	Significant	3.51	P<0.02	Significant
E	1.92	P>0.05	Not Significant				1.78	P>0.05	Not Significant
U	2.52	P>0.05	Not Significant	1.99	P>0.05	Not Significant	2.57	P=0.05	Just Significant

Table XVII (CASE No.4)



Graph No.17

Table XVII and Graph No.17 shows that for Case 4 in Vowel [a] the difference between before prosthesis and after prosthesis is significant, where P<0.05 and the difference between after prosthesis and after modified prosthesis is significant, where P<0.02. In vowel [u] the difference between before prosthesis and after prosthesis is not significant, where P>0.05 and the difference between after prosthesis and after modified prosthesis is just significant, where P=0.05.

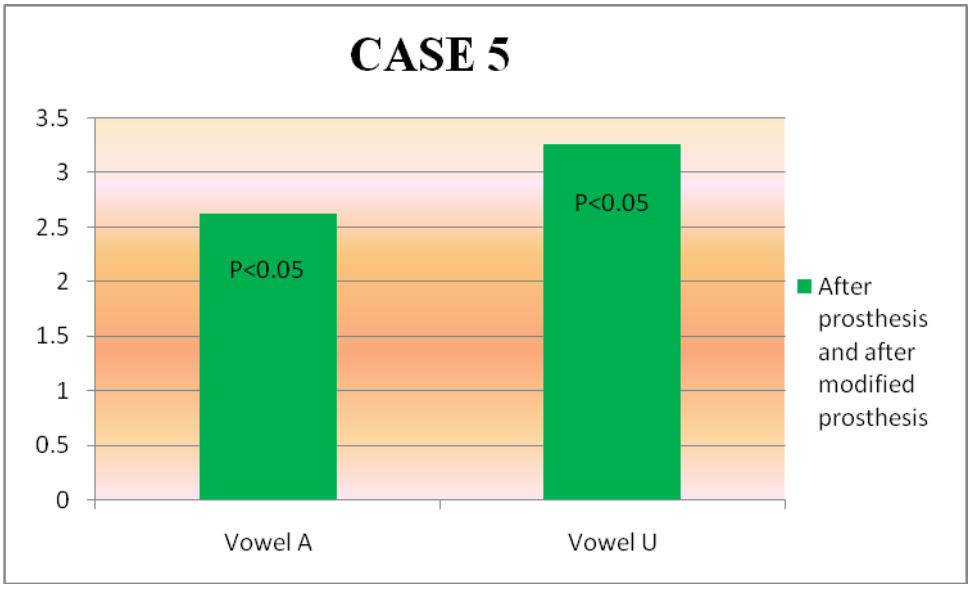


Graph No.18

It was also found that for case 4 for vowel [a], it was found that the difference is significant (P<0.05) between before prosthesis and after modified prosthesis. The difference between after prosthesis and after modified prosthesis is also found to be significant with P value less than 0.02.

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t- value	P value	Inference	t- value	P value	Inference	t- value	P value	Inference
A	1.87	P>0.05	Not significant	1.687	P>0.05	Not Significant	2.62	P<0.05	Significant
E	2.14	P>0.05	Not significant	2.54	P>0.05	Not Significant	3.26	P<0.05	Significant
U	2.43	P>0.05	Not significant	2.46	P>0.05	Not Significant	1.64	P>0.05	Not Significant

Table XVIII (CASE No.5)

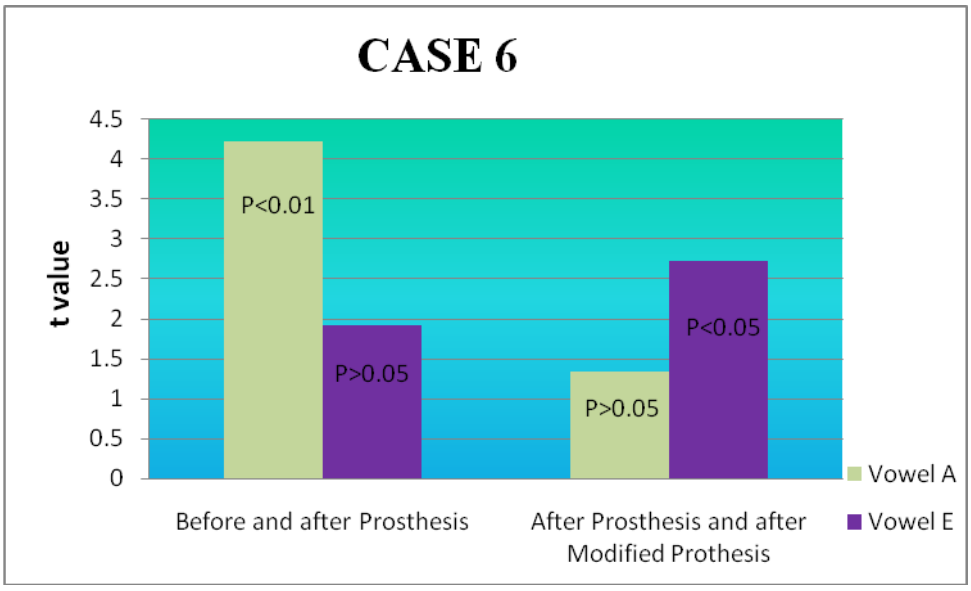


Graph No. 19

Table XVIII and Graph No.19 shows that for Case 5 the difference between after prosthesis and after modified prosthesis is significant and the P value is less than 0.05 for vowels [a] and [u].

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t- value	P value	Inference	t- value	P value	Inference	t- value	P value	Inference
A	4.22	P<0.01	Highly significant	1.69	P>0.05	Not Significant	1.34	P>0.05	Not Significant
E	1.92	P>0.05	Not significant	2.54	P>0.05	Not Significant	2.73	P<0.05	Significant
U	2.61	P<0.05	Significant	2.38	P>0.05	Not Significant	1.91	P>0.05	Not Significant

Table XIX (CASE No.6)

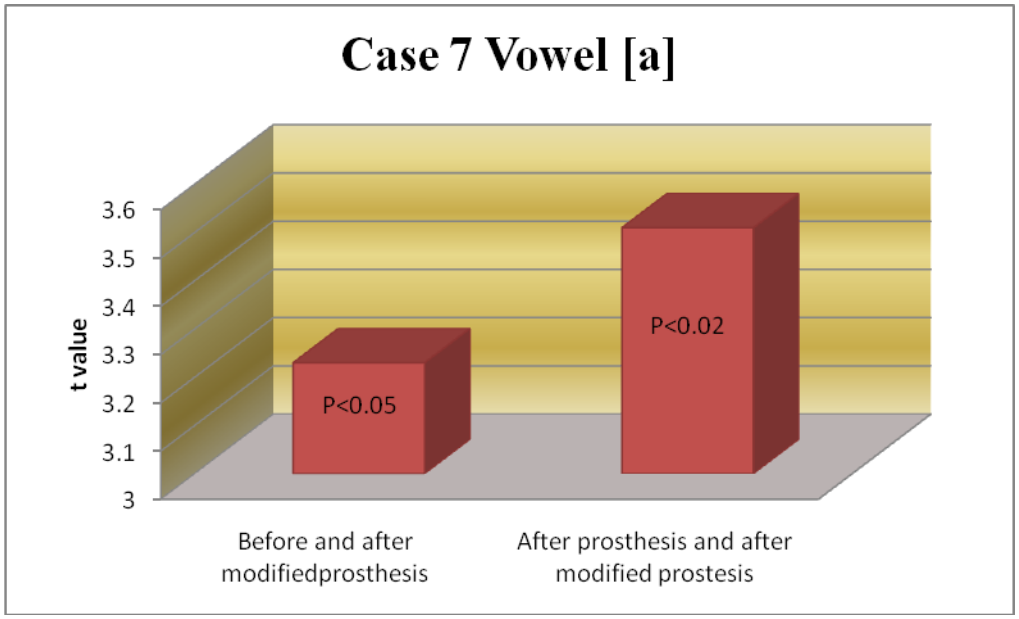


Graph No.20

Table XIX and Graph No.20 shows that for Case 6 the difference is found between before and after prosthesis is highly significant with P value less than 0.01 for vowel [a] and for the same vowel there is no significant difference between after prosthesis and after modified prosthesis, P value is greater than 0.05. For another vowel [e], there is significant difference between after prosthesis and after modified prosthesis; P value is less than 0.05 while the difference is not significant between before prosthesis and after prosthesis; P value is greater than 0.05

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t- value	P value	Inference	t- value	P value	Inference	t- value	P value	Inference
A	2.55	P>0.05	Not Significant	3.23	P<0.05	Significant	3.51	P<0.02	Significant
E	1.92	P>0.05	Not Significant	2.23	P>0.05	Not Significant	1.79	P>0.05	Not Significant
U	2.64	P<0.05	Significant	1.99	P>0.05	Not Significant	2.48	P>0.05	Not Significant

Table XX (CASE No.7)

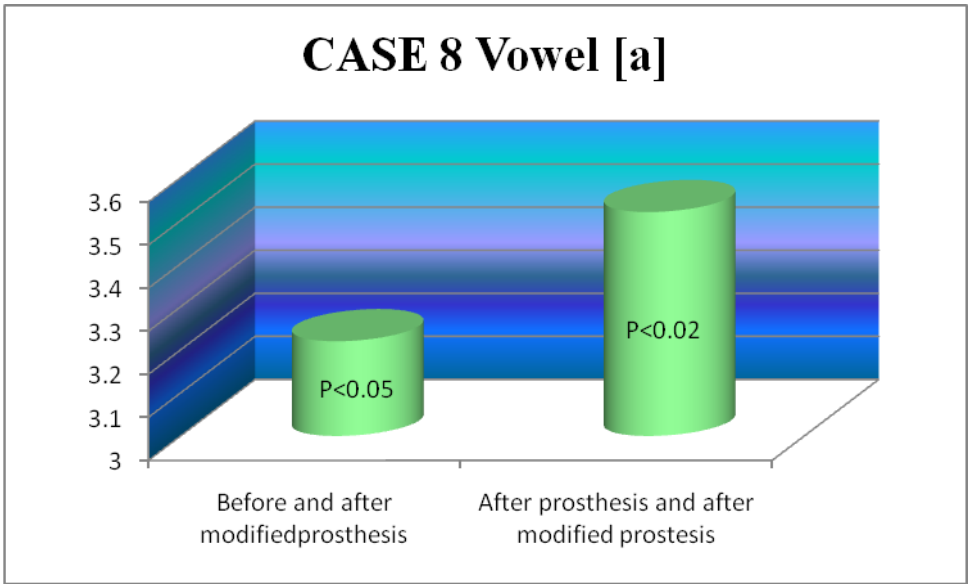


Graph No. 21

Table XX and Graph No.21 shows that in case 7 for vowel [a], it was found that the difference is significant (P<0.05) between before prosthesis and after modified prosthesis. The difference between after prosthesis and after modified prosthesis is also found to be significant with P value less than 0.02.

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t- value	P value	Inference	t- value	P value	Inference	t- value	P value	Inference
A	2.55	P>0.05	Not significant	3.22	P<0.05	Significant	3.52	P<0.02	Significant
E	1.92	P>0.05	Not significant	2.23	P>0.05	Not Significant	1.795	P>0.05	Not Significant
U	2.52	P>0.05	Not significant	1.95	P>0.05	Not Significant	2.35	P>0.05	Not Significant

Table XXI (CASE No.8)

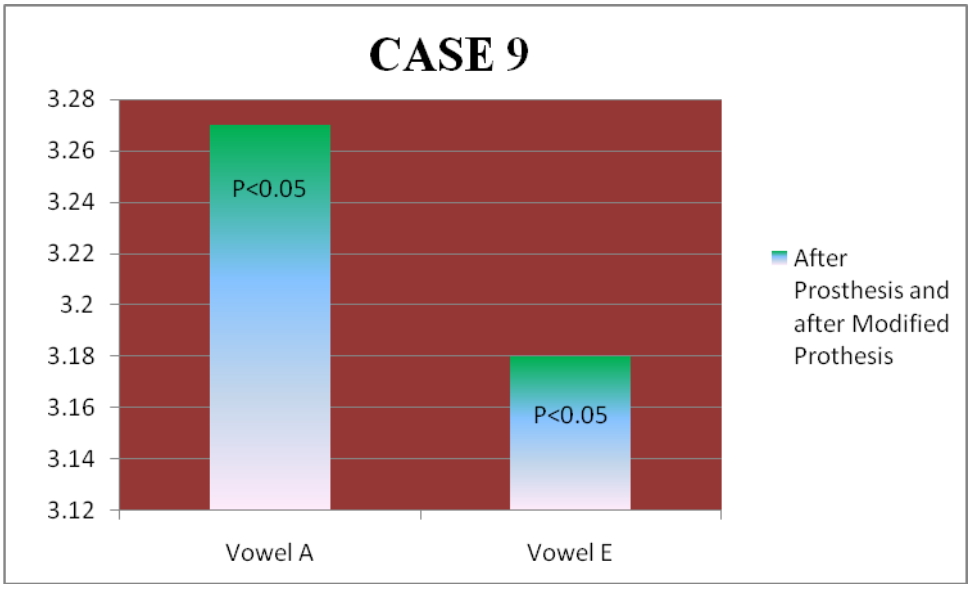


Graph No. 22

Table XXI and Graph No.22 shows that in case 8 for vowel [a], it was found that the difference is significant (P<0.05) between before prosthesis and after modified prosthesis. The difference between after prosthesis and after modified prosthesis is also found to be significant with P value less than 0.02.

Vowel	Difference b/w Before Prosthesis and After Prosthesis			Difference b/w Before Prosthesis and After modified Prosthesis			Difference b/w After Prosthesis and After Modified Prosthesis		
	t- value	P value	Inference	t- value	P value	Inference	t- value	P value	Inference
A	1.94	P>0.05	Not significant	1.69	P>0.05	Not Significant	3.27	P<0.05	Significant
E	2.15	P>0.05	Not significant	2.54	P>0.05	Not Significant	3.18	P<0.05	Significant
U	1.8	P>0.05	Not significant	2.26	P>0.05	Not Significant	2.36	P>0.05	Not Significant

Table XXII (CASE No.9)

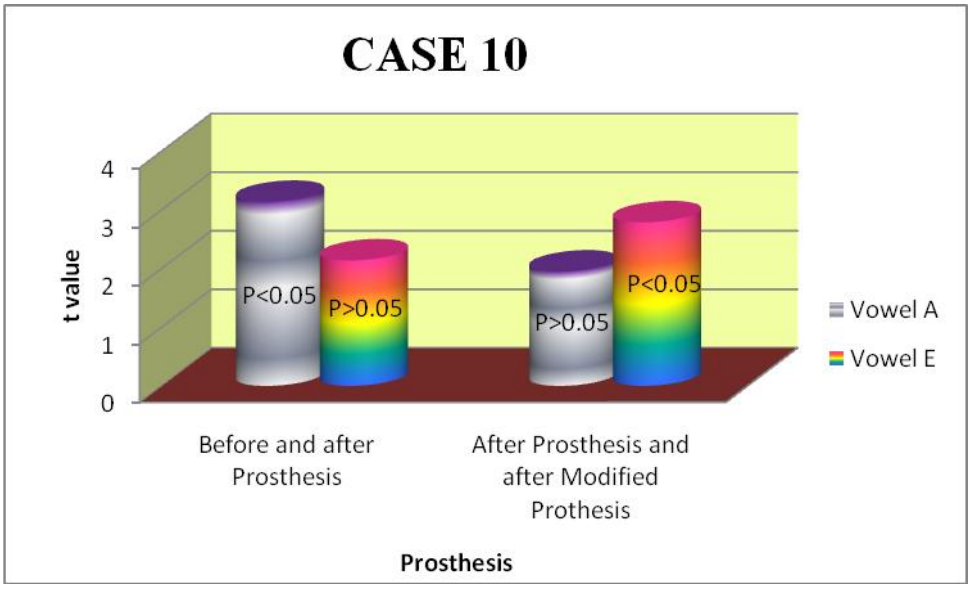


Graph No.23

Table XXII and Graph No.23 shows that for Case 9 the difference between after prosthesis and after modified prosthesis is significant and the P value is less than 0.05 for vowels [a] and [u].

Vowel	**Difference b/w Before Prosthesis and After Prosthesis**			**Difference b/w Before Prosthesis and After modified Prosthesis**			**Difference b/w After Prosthesis and After Modified Prosthesis**		
	t- value	**P value**	**Inference**	**t- value**	**P value**	**Inference**	**t- value**	**P value**	**Inference**
A	3.14	P<0.05	Significant	1.68	P>0.05	Not Significant	1.95	P>0.05	Not Significant
E	2.14	P>0.05	Not significant	2.54	P>0.05	Not Significant	2.79	P<0.05	Significant
U	2.36	P>0.05	Not significant	2.39	P>0.05	Not Significant	2.31	P>0.05	Not Significant

Table XXIII (CASE No.10)



Graph No. 24

Table XXIII and Graph No.24 shows that for Case 10 the difference is found to be highly significant between before and after prosthesis, P value is less than 0.05 for vowel [a] and for the same vowel there is no significant difference between after prosthesis and after modified prosthesis, P value is greater than 0.05. For another vowel [e], there is significant difference between after prosthesis and after modified prosthesis; P value is less than 0.05 while the difference is not significant between before prosthesis and after prosthesis; P value is greater than 0.05

RESULTS

5.2 STATISTICAL ANALYSIS

5.2.1 Intelligibility: PCC (Percentage of Consonants Correct)

In intelligibility of words using listeners scale two tests have been applied.

1. Student's t paired test to assess the intelligibility between before prosthesis and after prosthesis, before prosthesis and after modified prosthesis and after prosthesis and after modified prosthesis.
2. ANOVA-One way was used to assess the variability between before prosthesis, after prosthesis and after modified prosthesis
3. ANOVA –Two way was also used to show the variability between cases and between prosthesis

For all the 10 cases there existed highly significant difference between before prosthesis and after prosthesis, between before prosthesis and after modified prosthesis and between after prosthesis and after modified prosthesis where the P value is found to be 0.001.

In order to compare the change of prosthesis before, after and after modification, in all cases One way ANOVA is applied and it was found to be highly significant where the P value is less than 0.01.

5.2.2 Nasalance Using Nasometer

For the cases from case 1 to case 10 except for vowel [a] for case 8 the effect of prosthesis and modified prosthesis was found to be highly significant for all the tree vowels with P value which is less than 0.001.For case 5 for vowel [e] and [u] the prosthesis was significant for 0.01 P value.

Conclusion:

This instrument is found to be significantly effective between before prosthesis and after prosthesis, between before prosthesis and after modified prosthesis and between after prosthesis and after modified prosthesis.

5.2.3 Formant Evaluation using PRAAT Software

In order to compare the effectiveness of the prosthesis and modified prosthesis the Student's t paired test was applied. The comparison was applied for each case separately. For each individual case the comparison was made between**:-**

1. Before prosthesis and after prosthesis.
2. Before prosthesis and after modified prosthesis.
3. After prosthesis and after modified prosthesis.

It was inferred that if the calculated value of t statistic was greater than tabled value then the difference between the above said cases was significant for 5 degrees of freedom.

For case 1, for the vowel [a] and [e] the difference between prosthesis and modified Prosthesis was found to be significant where the P value was less than 0.05.

For Case 2, for vowel [a], there was significant effect between before Prosthesis and after modified Prosthesis, the P value was less than 0.05. For the same vowel [a], we got significance between after Prosthesis and after modified Prosthesis, where the P value was less than 0.02. Also for vowel [u] there was effectiveness which was just significant between after Prosthesis and after modified Prosthesis, where the P value was equal to 0.05.

For Case 3, for vowel [a] the modified Prosthesis was significant than before prosthesis where the P value was less than 0.05. For vowel [a] the modified Prosthesis was also seemed to be effective than Prosthesis where the P value was less than 0.02. For vowel [u] the modified Prosthesis was found to be just significant than prosthesis. P value was equal to 0.05.

For Case 4, for vowel [a] the modified treatment was found to be significant where the P value was less than 0.05 and the modified prosthesis was also significant compared to Prosthesis for this case where the P value was less than 0.02. For the vowel [u] the modified Prosthesis value was just significant P=0.05.

For Case 5, for the vowel [a] and [e] the modified Prosthesis was found to be significant when compared to prosthesis where the P value was less than 0.05.

For Case 6, for vowel [a], we found that the Prosthesis was effective and it was highly significant where the P value was less than 0.01, and for vowel [e] the modified Prosthesis was found to be significant were the P value was less than 0.05.

For Case 7, for vowel [a] the modified Prosthesis was found to be significant and the P value was less than 0.05 also modified Prosthesis is found to be significant for the vowel [a] than Prosthesis, where the p value was less than 0.02, for vowel [u] the Prosthesis was found to be significant with P value less than 0.05.

For Case 8, the modified Prosthesis was significant for the vowel [a] and the P value was <0.05. Modified Prosthesis was superior to Prosthesis and it was found to be significant again for the vowel [a], P<0.02.

For the Case 9, for vowel [a] and [e] the modified Prosthesis was found to be significant when compared to Prosthesis and the P value was less than 0.05.

For the Case 10, for vowel [a] the Prosthesis was found to be effective where the P value was less than 0.05 and for vowel [e] the Prosthesis with modified ones was found to be significant with P value less than 0.05.

Conclusion:

The modified prosthesis was found to be significant when compared to before prosthesis and after prosthesis respectively for almost all cases. Cases 2, 3, 4, 7 and 8 were found to be

significant uniformly for vowel [a]. For cases 2, 3 and 4 the modified prosthesis was just significant for vowel [u].

For cases 1, 5 and 9 the modified prosthesis was significant when compared to prosthesis for vowel [a] and [e].

For case 6 and case 10 the effect of prosthesis was found to be significant for vowel [a] and modified prosthesis was significant for vowel [e] when compared to after prosthesis. For case 7 also the effect of prosthesis was significant for the vowel [u].

Modified prosthesis was found to be significantly superior to prosthesis for all the three methods namely PRAAT, NASOMETER AND Percentage of Consonants correct.

DISCUSSION

Discussion

The objectives of this In-vivo clinical study were to assess**:-**

1) Intelligibility of words using percentage of consonants correct (PCC) for 20 words (regional language) at three clinical visits (Before correction, after correction with prosthesis and after modifying the prosthesis using Palatography)
2) The change in nasalance using nasometer at three clinical visits (Before correction, after correction with prosthesis and after modifying the prosthesis using Palatography)
3) The change in formants of three vowels (a, e, u) using spectrography (PRAAT Software) at three clinical visits (Before correction, after correction with prosthesis and after modifying the prosthesis using Palatography)

The organs involved in mastication, deglutition and respiration take part in speech. Air from the lungs is modulated as it passes through the respiratory passages, oral cavity and nasal cavity producing speech. Thus – Surd, Sonant, Consonants, Respiration, Phonation, Resonations, Articulations, Neurologic Integrations, Audition can be regarded as components of speech.

The acoustic theory of the speaking process refers to the sound source and to the way of its production. Exhalation with little compressions and dilatations of the surrounding medium is recognized as a source of sound formation. In this way the resonance room is constituted[4]. When these structures are affected automatically, speech is affected-Lungs, Larynx, Pharynx, Soft palate, Nasal cavity, Hard palate, Tongue, Mandible, and Cheeks.

Cleft palate is a genetic disorder that occurs when an oro-nasal communication is present between the palate and the base of the nose. During pregnancy, the maxilla is not completely merged, and the defect is only seen at birth. Possible causes are hormonal imbalances, nutritional deficiencies, infections, radiation during pregnancy, alcohol or cigarette

The resulting defect requires corrective surgery. In case of cleft palate, surgery is postponed until after the first year of life to avoid disturbing the normal development of speech and the risk of aspiration of food, which causes infections such as otitis and pneumonia[60.]

Maxillary defects created either by surgical treatment of benign or malignant neoplasms, by congenital malformations or by trauma are provided with a **prosthesis** which cl**os**es the abnormal communication between oral and nasal cavities to allow adequate deglutition and articulation, possible support of the orbital contents to prevent enophthalmos and diplopia, support of the soft tissue to restore the midfacial contour, improve speech and an acceptable aesthetic results (Wang, 1997). Such a prosthesis used to close a palatal defect in a dentate or edentulous mouth is referred to as an **obturator**[1]**.**

Even after closing the defect with obturator prosthesis, patients were not satisfied with their speech outcomes in terms of nasality and intelligibility

Historically, speech characteristics have been an integral part of any description of the sequelae of cleft palate. The structural issues of velopharyngeal function, fluctuating middle ear disease and hearing loss, and dental or occlusal deviations place children with clefts at high risk for

speech difficulties. For the most part, children with clefts of the primary palate only, involving the lip and alveolar process, do not demonstrate significant speech problems. In these patients, although there may be labial and dental or occlusal deviations that present hazards to precise articulation, they are often transitory and do not prevent the acquisition of acceptable articulation. Their significance for speech often depends upon the severity of the deviation and

the existence of a combination of factors including velopharyngeal closure problems. There have been several reviews focusing on dental and occlusal conditions and relationships to speech in persons with or without clefts (Starr, 1979; Peterson-Falzone, 1988; Moller, 1994). Reviews of more general characteristics of speech in individuals with cleft palate have been published more recently (Harding and Grunwell, 1996; Wyatt et al., 1996)[61]

.

There are other complex cases of cleft palate involving function, aesthetics and phonetics that require a more invasive restorative intervention. However, an alternative conservative treatment can be sought in conventional prostheses for patients who choose not to undergo surgery. Obturator prosthesis is especially indicated in patients with a tissue deficiency, several fistulae, soft palate dysfunctions, or uncoordinated nasopharyngeal sphincter action, which can lead to **hypernasal speech**. Prosthodontic care has a long and rich history in the care of patients with cleft lips and palates. With increased knowledge of craniofacial growth and development and improved surgical and orthodontic treatment, today's cleft palate/lip patients receive better care, and in less time.[60]

Articulation treatment for persons with cleft palate has been an integral component of clinical management since the 1940s. However, research studies focusing on the direct effect of articulation treatment have been limited. In general, the literature has shown that articulation treatment results in

overall improvement in speech intelligibility (Prins and Bloomer, 1965; Chisum et al., 1969; Shelton et al., 1969; Van Demark, 1971, 1974b; Albery and Enderby, 1984; Van Demark and Hardin, 1986; Ysunza et al., 1992)[61].

Investigations of speech articulation in the 1950s and 1960s focused on description of articulation errors, frequency of errors, type of error, and comparisons with normative data. Clearly, speakers with cleft palate performed less well than speakers without cleft palate at very early ages (Olson,1965; Bzoch, 1965). Based on earlier literature reviews, it has been proved that speakers with cleft palate performed less well than their noncleft palate peers at all ages, although there was considerable variation in speakers with seemingly similar structures and that, indeed, some developed normal articulation. Speech sounds requiring intraoral pressure were mostly affected, nasal consonants and semivowels were least affected, errors increased with increased phonetic complexity, and there was frequent evidence of weak pressure consonant production and audible nasal air emission accompanying pressure consonants[61].

The impact of denture on speech has been studied since 1950s in the papers of Pound[63] and by Allen[64], and continued sporadically in the 1960s by Rothman[65], Martone and Black[66], and Silverman[67]. During the last two decades, several groups started investigating methodically the relationships between speech, on one side, and dental treatment and prosthetic denture, on the other.

The shape of the palatal vault is of particular interest to prosthodontist, Snow described the significance of adequate but not excessive contour in the anterior palatal and premolar areas. Central and lateral lisping may develop when the contours of the prosthesis are incorrect. Patients whose

speech is sensitive to a changed relationship of the tongue to a palatal prosthesis may require surface texture to orient the tongue.[7]

Palatography have been used in complete dentures in order to improve intelligibility of speech after prosthetic rehabilitation, palatography mainly helps to determine articulatory pattern of the tongue to the artificial palate. Earlier literature reviews have stated the use of charcoal coated on to the palate and tongue in order to elicit the articular pattern, later this charcoal was replaced by pressure indicating paste and mouth temperature flowing wax to mold artificial palate where the articular defect can be corrected by changing the surface contour of the artificial palate.

In the present study the surface texture to the palatal prosthesis was provided with palatography.

In the present study palatography was incorporated in modifying the obturator prosthesis where by the articulatory pattern of the tongue to the artificial palate can be modified by using mouth temperature flowing wax (Korecta no 4) and the intelligibility of speech is corrected to near normal.

In the present in-vivo study all ten patients had congenital maxillary defect (cleft palate) and their chief complaint was unintelligible speech (Unintelligibility may be due to articulatory or phonological defects). Indeed, excessive nasality or hyper nasality is probably the signature characteristic of persons with cleft palate. In general, we expect persons with clefts involving the primary palate only to have no more resonance problems than speakers without cleft palate.

Resonance distortion is, for the most part, the direct effect of coupling of the nasal space with the oral-pharyngeal space during vowel and vocalic productions.

Speech evaluations for these patients were done, using three vowels |a| ahh. |i| eee, |u| ooo, at three clinical visits and Intelligibility, Nasality and Formants were evaluated in these visits. Intelligibility of speech have been measured by listener scale analysis where the Percentage of consonants correct is been evaluated, previous literatures stated the use of listener scale analysis for qualitatively measuring the intelligibility of speech[61]. In this study intelligibility of speech had been evaluated in three clinical visits.

Nasometer is the main instrumental source of diagnostic information used in this study because of its ease of usage and relatively low cost.

A large number of nasometric studies have been published over the last decade (e.g., Seaver et al., 1991; Dalston et al., 1993; Kummer et al., 1993b; Watterson et al., 1993; van Doorn and Purcell, 1998; Nichols, 1999). The metric provided by nasometry is called ‘‘nasalance’’ and is the number that is typically reported in the literature. Specifically, nasalance is a ratio of the nasal acoustic output relative to oral plus nasal acoustic output and is expressed as a percentage. Thus, the higher the nasalance score, the greater the relative degree of nasality[61].

The use of spectrographic analysis has benefited the study and understanding of hyper nasality, particularly regarding the study of the temporal aspects of nasalization[68-69]. Ever since the technique was invented in the 1940s, the most common use made of spectrographic analysis has

been in the observation of vowel formant frequencies. There has been only limited application of the technique to the diagnosis and treatment of hyper nasality, limiting the scope of what could otherwise be a very useful tool in clinical practice as it may foster facilitates pre/post-therapy comparisons[70-71].Until now very few studies have formally addressed the relationship of the size of the gap and hyper nasality, nevertheless, research involving artificial openings has shown that even an experimental opening of $20mm^2$ can have a considerable negative effect on speech, especially in regard to hyper nasality[72-74].

In the present study spectrographic evaluation of three vowels |a|, |e|, |u| were done at three clinical visits using PRAAT software.

In the above result tables and graphs it is evident that the modified prosthesis (using palatography) in comparison with un-modified prosthesis and before placement of prosthesis has higher significance rates in terms of the given parameters intelligibility and nasality where the $p<0.001$ eliciting higher significance for all the three vowels, |a|. |i| and |u|

In spectrographic evaluation using PRAAT software the modified prosthesis had significant values for vowels |a| |i| and |u| when compared to un-modified prosthesis and before placement of prosthesis, but the significance level varied from case1 to case 10 where the defect of the patient also varied from hard palate defect to soft palate defect. Patients having soft palate defect had higher significance to vowel |i| than that of vowel |a|, further studies have to be carried out to evaluate the spectrographic changes of the modified prosthesis to the specific types of maxillary defects and to evaluate the quality of life in cleft palate patients with modified prosthesis.

Uniqueness of the study (Advantages of the study)

The uniqueness of this study lies in the fact that

(1) Within the same day after delivering the modified prosthesis (incorporating the palatographical changes) the patient attains high level of intelligibility.

(2) The patient need not go for a speech therapy program. (Earlier literature has revealed the importance of speech therapy for at least 1 month duration to improve intelligibility of speech and the values obtained then for intelligibility were less compared to the present study).

(3) There is no need of relining of the prosthesis since a coating is also given on the intaglio surface of the prosthesis which severely reduces nasalance.

SUMMARY AND CONCLUSION

Summary and Conclusion

Congenital maxillary defects as in cleft palate, patients usually complain of facial disfigurement, speech problems and regurgitation of food through nose. The patients involved in the present study were having congenital maxillary defect (cleft palate). Most of the patients' chief complaints were unintelligibility of speech and regurgitation of food through nose. Treatment of such patients can be either by surgical closure of the defect or by prosthetic rehabilitation. Thirty percent of the patients had already underwent surgical correction but there defect had relapsed after 10 to 12 years of surgery, another forty percent of the patients had large maxillary defect, where surgical correction was not advised by the cleft palate team (Smile train), the rest thirty percent of the patients were not aware of the treatment procedures for their defect and were motivated by other patients who complied with this study.

Evaluation of speech in these ten patients was done at three clinical intervals (Before treatment, after treatment with prosthesis and after placement of modified prosthesis using palatography). Speech was assessed for Intelligibility (Using percentage of consonants correct), Nasality (Using Nasometer) and Formant evaluation (PRAAT software). Before treatment their speech evaluation was done for all the above mentioned parameters and regular obturator prosthesis was delivered to the patient, speech evaluation was again performed, patients were not satisfied with their speech outcomes in terms of nasality and intelligibility. In complete denture prosthesis Palatography had been used in order to improve intelligibility of speech by correcting the articulatory pattern to the artificial palate, which was incorporated in this study where mouth temperature flowing wax was used to mould the articulatory pattern in obturator prosthesis which was further modified according to the

moulded pattern obtained. Speech evaluation was again done for the above mentioned parameters and was found that the modified obturator prosthesis using palatography had higher significance with $p<0.001$ in terms of intelligibility and nasality when compared to before treatment and after placement of prosthesis. In formant evaluation patients with only hard palate defect had significance in vowel |a| and |u| when compared to |i|, while patient with both hard and soft palate defects had significance valued for vowels |i| and |u|.

1. From the present study it is evident that the prosthesis corrects all speech defects except the perfect articulation of consonants.

2. Concept of palatography has shown to correct speech to near normal with correction of consonants

3. Correction of speech by speech therapy prolongs duration of treatment phase. This present study indicates an immediate prosthesis placement along with palatography which in turn decreases the duration of treatment phase.

Hence a prosthesis modified using palatography provides patients with full confidence of near normal speech.

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PATIENT EVALUATION SHEET

NAME: **M/F:**

HOME ADDRESS: **DATE OF BIRTH:**

PHONE (WORK) : **HOME:**

DATE: **OCCUPATION:**

CHIEF COMPLAINT

HISTORY OF PRESENTING ILLNESS

PAST DENTAL HISTORY

PAST MEDICAL HISTORY

Any current treatments	
Previous hospitalization	
Current medications	

H/o Cardiac disease

H/o known Drug allergy

Compromised immune system

PERSONAL HISTORY

Family history		Frequency of brushing	
Mouth breathing		Preferred side chewing	
Parafunctional habits			

EXTRA-ORAL EXAMINATION

Symmetry of face			
Colour of conjunctiva		Sclera	
Complexion			
Facial Profile			

TMJ

Palpation:	Crepitus		Tenderness	
Auscultation:	Clicking		Crepitus	
Range of motion:	Restricted		Unrestricted	
Opening pattern:	Deviation			
Regional lymph nodes:	Enlarged		Tender	
Para nasal Sinuses:	Pain on Palpation			
Muscles of mastication:	Tenderness			

Lips

Presence of cleft:	
Exposure on normal smile:	
Exposure on exaggerated smile:	
Midline deviation	

INTRA-ORAL EXAMINATION

TEETH

Missing		Caries	
Periodontically involved			
Pockets		Mobility	
Restored		Fractured	

Occlusion

Crowding			
Overjet		Overbite	
Spacing		Lateral contacts	
Protrusive contacts		Centric Relation	
Fremitus		Excessive wear	

SOFT TISSUE

ORAL MUCOSA:

Color		Texture	
Lesions		Inflammation	
Swelling			

TONGUE

Colour:		Lesions	
Size		Position	

GINGIVA

Color		Size	
Consistency		Texture	
Position		Palpation	

PALATE

Defects

Armany's classification: Class-I Class-II

Class-III Class-IV

SPEECH ANALYSIS

Intelligibility by pcc

Nasality

Formant evaluation

TREATMENT PLAN

Obturator prosthesis

Hollow/Solid Bulb

Speech bulb for velo-pharyngeal defects

Palatal Lift Prosthesis

APPENDIX 1

APPENDIX 2

Consent Form

I here by declare that I agree to comply with all the treatment procedures needed for “Evaluation of speech in maxillary defects and its correction using palatography ”, a study for which an obturator prosthesis will be placed inside my mouth in regard to treatment of the defect and evaluation of speech will be accessed during different phases (a period of 3 months) of treatment. Doctor has explained to me all the procedures along with the advantages of the study, clearly illustrating the difficulties which I may have to undergo during the course.

The doctor has promised that my further treatment in regard to speech will not be hindered if at all am not participating in the study.

Doctor’s Name Patient’s Name

Signature Signature

உறுதிமொழிப்படிவம்

இதன்படி நான் உறுதிபட கூறுவது என்னவென்றால் மேல்தாடை குறைபாடுகளின் பேச்சுத்திறனை அளவிடவும் மற்றும் அதை சரி செய்வதற்குமான எல்லா சிகிட்சை முறைகளையும் நான் மனபூர்வமாக ஏற்கிறேன். இந்த ஆய்வில் தாடை குறைபாட்டை சரிசெய்ய அப்சுரேட்டர் (Obturator) என்னும் உபகரணம் வாயில் வைத்த பின் பேச்சு திறனை வெவ்வேறு நிலைகளில் (சிகிச்சையின் 3 மாத கால அவகாசத்தில்) மதிப்பீடு செய்யப்படும். மருத்துவர் சிகிச்சை செய்முறைகளையும் அதன் குறை நிறைகளையும் என்னிடம் மிகவும் தெளிவாக விளக்கியுள்ளார்.

இந்த ஆய்வில் நான் பங்கெடுத்தாலும், இல்லையென்றாலும் என் மேற்கொண்ட பேச்சு திறனுக்கான சிகிச்சை முறையில் எந்த விதமான பாதிப்பும் ஏற்படாது என்று மருத்துவர் உறுதி கூறுகிறார்.

மருத்துவர் பெயர் சிகிட்சை பெறுபவரின் பெயர்

கையொப்பம் கையொப்பம்

രോഗികളുടെ അറിവിലേക്കായി

ആരോഗ്യമുള്ളതും പ്രമേഹമുള്ളതുമായ മോണരോഗികളിൽ മോണ ചികിത്സയ്ക്ക് മുൻപും പിൻപും ഉള്ള നൈട്രിക് ഓക്സൈഡ് എന്ന പദാർത്ഥത്തിന്റെ രക്തത്തിലെ അളവിലുണ്ടാകുന്ന വ്യതിയാനത്തിന്റെ ഒരു താരതമ്യ പഠനം

നിങ്ങളെ മേൽ പറഞ്ഞ പഠനത്തിലേക്ക് സ്വാഗതം ചെയ്യുന്നു. ഈ പഠനത്തിൽ പങ്കെടുക്കുന്നതിന് മുൻപ് താങ്കൾ ഇതിന്റെ പ്രാധാന്യത്തെപ്പറ്റി അറിഞ്ഞിരിക്കേണ്ടതുണ്ട്. ഈ പഠനത്തെപറ്റി എന്തെങ്കിലും സംശയമുണ്ടെങ്കിൽ ചോദിച്ചു മനസ്സിലാക്കാനുള്ള എല്ലാ സ്വാതന്ത്ര്യവും താങ്കൾക്കുണ്ട്. ഇതിൽ പങ്കെടുക്കാനും, പങ്കെടുക്കാതിരിക്കുവാനുമുള്ള പൂർണ്ണ അവകാശവും താങ്കൾക്കുണ്ട്.

1. ഈ പഠനത്തിന്റെ ഉദ്ദേശ്യം എന്ത് ?

ആരോഗ്യമുള്ളതും പ്രമേഹമുള്ളതുമായ മോണരോഗങ്ങളിൽ നൈട്രിക്ക് ഓക്സൈഡ് എന്ന പദാർത്ഥത്തിനുള്ള സ്വാധീനം മനസ്സിലാക്കുന്നതിനും മോണചികിത്സ മുലം നൈട്രിക്ക് ഓക്സൈഡിന്റെ അളവിലുണ്ടാകുന്ന വ്യതിയാനം കണ്ടുപിടിക്കുന്നതിനുമായാണ് ഈ പഠനം നടത്തുന്നത്.

2. എന്നെ എന്തുകൊണ്ട് ഈ പഠനത്തിൽ ഉൾപ്പെടുത്തുന്നു ?

ഈ പഠനത്തിലേക്കായി 30 വീതം ആരോഗ്യമുള്ളതും പ്രമേഹമുള്ളതുമായ മോണരോഗികളേയും 30 പൂർണ്ണ ആരോഗ്യമുള്ളവരേയും ആവശ്യമുണ്ട്. നിങ്ങളിൽ ഈ പഠനത്തിനു വേണ്ട എല്ലാ മാനദണ്ഡങ്ങളും ഉണ്ടെന്നതിനാലാണ് ഈ പഠനത്തിൽ ഉൾപ്പെടുത്തുന്നത്.

3. ഞാനിതിൽ പങ്കെടുക്കണമോ ?

ഈ പഠനത്തിൽ പങ്കെടുക്കണമോ വേണ്ടയോ എന്നു തീരുമാനിക്കുവാനുള്ള പൂർണ്ണ അവകാശം നിങ്ങൾക്കുണ്ട്. നിങ്ങൾ ഇതിൽ പങ്കെടുക്കുവാൻ തീരുമാനിക്കുകയാണെങ്കിൽ ഒരു സമ്മത പത്രത്തിൽ ഒപ്പിട്ടു നൽകേണ്ടതുണ്ട്. ഈ പഠനത്തിൽ നിന്നും ഏതു സമയത്തും പിൻവാങ്ങാനുള്ള സ്വാതന്ത്ര്യവും നിങ്ങൾക്കുണ്ട്. ഇതു നിങ്ങളുടെ മറ്റു ചികിത്സകളെ യാതൊരുവിധത്തിലും ബാധിക്കുന്നതായിരിക്കില്ല എന്നുള്ളത് പ്രത്യേകം പറയേണ്ടതുണ്ട്.

4. ഞാൻ ഈ പഠനത്തിൽ പങ്കെടുത്താൽ എന്തു സംഭവിക്കാം ?

പരിശോധകൻ നിങ്ങളോട് ചില ചോദ്യങ്ങൾ ചോദിക്കുകയും ദന്തശുചിത്വവും മോണയുടെ ആരോഗ്യവും പരിശോധിക്കുന്നതുമാണ്. മോണ ചികിത്സയ്ക്ക് മുൻപും 4 ആഴ്ചകൾക്ക് ശേഷവും 4 ml വീതം രക്തം ശേഖരിക്കുന്നതുമായിരിക്കും.

5. ഈ പഠനത്തിൽ പങ്കെടുക്കുന്നതുകൊണ്ട് എന്തെങ്കിലും അപകട സാധ്യതഉണ്ടോ ?

ഇതിൽ പങ്കെടുക്കുന്നതുകൊണ്ട് യാതൊരുവിധത്തിലുമുള്ള അപകടസാദ്ധ്യതയും ഇല്ല.

6. ഞാൻ ഈ പഠനത്തിൽ പങ്കെടുക്കുന്നുവെന്നുള്ള വിവരം രഹസ്യമാക്കി വെയ്ക്കുമോ ?

നിങ്ങളിൽ നിന്നും ശേഖരിക്കുന്ന എല്ലാ വിവരങ്ങളും രഹസ്യമാക്കി വെയ്ക്കുന്നതായിരിക്കും. നിങ്ങളെ പറ്റിയുള്ള വിവരങ്ങൾ ആരോടും വെളിപ്പെടുത്തുന്നതായിരിക്കില്ല.

കൂടുതൽ വിവരങ്ങൾക്കായി താഴെ പറയുന്നവരെ നിങ്ങൾക്ക് ബന്ധപ്പെടാവുന്നതാണ്.

രോഗികളുടെ അറിവിലേക്കായി

മേൽത്താടിയെല്ലിന്റെ വൈകല്യങ്ങളാൽ സംസാരത്തിലുണ്ടാകുന്ന വ്യതിയാനങ്ങളുടെ വിശകലനവും അതിനോടനുബന്ധിച്ചുള്ള ചികിത്സയും

നിങ്ങളെ മേൽ പറഞ്ഞ പഠനത്തിലേക്ക് സ്വാഗതം ചെയ്യുന്നു. ഈ പഠനത്തിൽ പങ്കെടുക്കുന്നതിന് മുൻപ് താങ്കൾ ഇതിന്റെ പ്രാധാന്യത്തെപ്പറ്റി അറിഞ്ഞിരിക്കേണ്ടതുണ്ട്. ഈ പഠനത്തെപറ്റി എന്തെങ്കിലും സംശയമുണ്ടെങ്കിൽ ചോദിച്ചു മനസ്സിലാക്കാനുള്ള എല്ലാ സ്വാതന്ത്ര്യവും താങ്കൾക്കുണ്ട്. ഇതിൽ പങ്കെടുക്കാനും, പങ്കെടുക്കാതിരിക്കുവാനുമുള്ള പൂർണ്ണ അവകാശവും താങ്കൾക്കുണ്ട്.

1. ഈ പഠനത്തിന്റെ ഉദ്ദേശ്യം എന്ത് ?

മേൽത്താടിയെല്ലിന്റെ വൈകല്യങ്ങളാൽ സംസാരത്തിലുണ്ടാകുന്ന വ്യതിയാനങ്ങൾ Nasometer എന്ന ഉപകരണം ഉപയോഗിച്ച് നിർണ്ണയിക്കുവാനും Obturator എന്ന ഉപകരണം ഉപയോഗിച്ച് ആ വ്യതിയാനങ്ങൾ മാറ്റുന്നതിനും സംസാരത്തിന്റെ സ്പുടതയിലുണ്ടാകുന്ന മാറ്റം വിശകലനം ചെയ്യുന്നതിനുമാണ് ഈ പഠനം നടത്തുന്നത്.

2. എന്നെ എന്തുകൊണ്ട് ഈ പഠനത്തിൽ ഉൾപ്പെടുത്തുന്നു ?

ഈ പഠനത്തിലേക്കായി 20 മേൽത്താടിയെല്ലിന് വൈകല്യമുള്ളവരെ ആവശ്യമുണ്ട്. നിങ്ങളിൽ ഈ പഠനത്തിനു വേണ്ട എല്ലാ മാനദണ്ഡങ്ങളും ഉണ്ടെന്നതിനാലാണ് ഈ പഠനത്തിൽ ഉൾപ്പെടുത്തുന്നത്.

3. ഞാനിതിൽ പങ്കെടുക്കണമോ ?

ഈ പഠനത്തിൽ പങ്കെടുക്കണമോ വേണ്ടയോ എന്നു തീരുമാനിക്കുവാനുള്ള പൂർണ്ണ അവകാശം നിങ്ങൾക്കുണ്ട്. നിങ്ങൾ ഇതിൽ പങ്കെടുക്കുവാൻ തീരുമാനിക്കുകയാണെങ്കിൽ ഒരു സമ്മത പത്രത്തിൽ ഒപ്പിട്ടു നൽകേണ്ടതുണ്ട്. ഈ പഠനത്തിൽ നിന്നും ഏതു സമയത്തും പിൻവാങ്ങാനുള്ള സ്വാതന്ത്ര്യവും നിങ്ങൾക്കുണ്ട്. ഇതു നിങ്ങളുടെ മറ്റു ചികിത്സകളെ യാതൊരുവിധത്തിലും ബാധിക്കുന്നതായിരിക്കില്ല എന്നുള്ളത് പ്രത്യേകം പറയേണ്ടതുണ്ട്.

4. ഞാൻ ഈ പഠനത്തിൽ പങ്കെടുത്താൽ എന്തു സംഭവിക്കാം ?

പരിശോധകൻ നിങ്ങളോട് ചില ചോദ്യങ്ങൾ ചോദിക്കുകയും Nasometer എന്ന ഉപകരണം ഉപയോഗിച്ച് Obturator - ന്റെ ഉപയോഗത്തിന് മുൻപും പിൻപും സംസാരത്തിന്റെ സ്പുടതയിലുണ്ടാകുന്ന മാറ്റങ്ങൾ വിശകലനം ചെയ്യുകയും ചെയ്യും.

5. ഈ പഠനത്തിൽ പങ്കെടുക്കുന്നതുകൊണ്ട് എന്തെങ്കിലും അപകട സാധ്യതഉണ്ടോ ?

ഇതിൽ പങ്കെടുക്കുന്നതുകൊണ്ട് യാതൊരുവിധത്തിലുമുള്ള അപകടസാദ്ധ്യതയും ഇല്ല.

6. ഞാൻ ഈ പഠനത്തിൽ പങ്കെടുക്കുന്നുവെന്നുള്ള വിവരം രഹസ്യമാക്കി വെയ്ക്കുമോ ?

നിങ്ങളിൽ നിന്നും ശേഖരിക്കുന്ന എല്ലാ വിവരങ്ങളും രഹസ്യമാക്കി വെയ്ക്കുന്നതായിരിക്കും. നിങ്ങളെ പറ്റിയുള്ള വിവരങ്ങൾ ആരോടും വെളിപ്പെടുത്തുന്നതായിരിക്കില്ല.

കൂടുതൽ വിവരങ്ങൾക്കായി താഴെ പറയുന്നവരെ നിങ്ങൾക്ക് ബന്ധപ്പെടാവുന്നതാണ്.

FIGURES

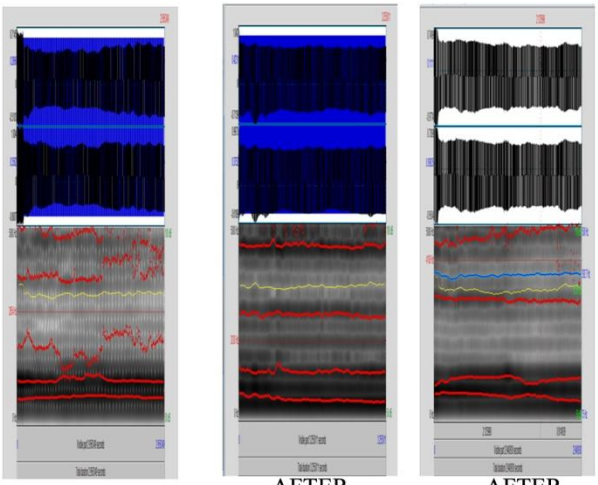

FIG.35 SPEECH CORRECTION TO NEAR NORMAL- FORMANT EVALUATION AFTER PALATOGRAPHY

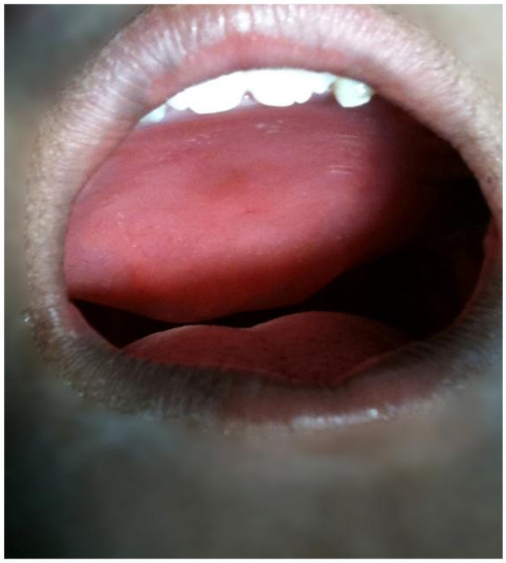

FIG 36. FINAL PROSTHESIS

FIG 33. SPEECH EVALUATION WITH NASOMETER AND PRAAT SOFTWARE

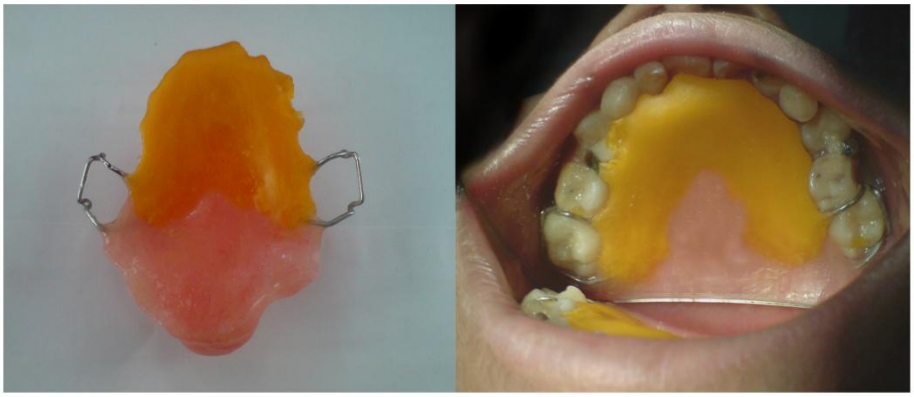

FIG 34. PALATOGRAPHY USING KORECTA WAX -INTRA ORAL VIEW

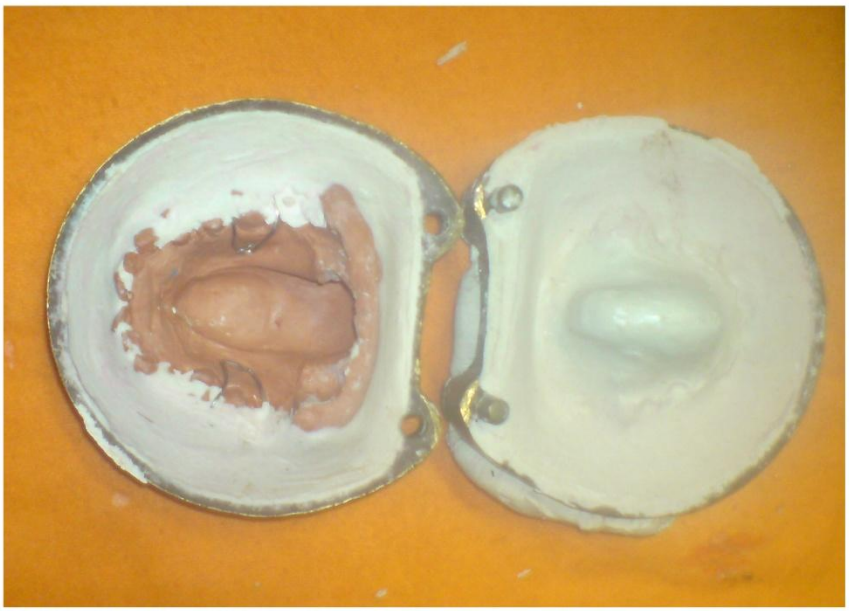

FIG 31.DEWAXING

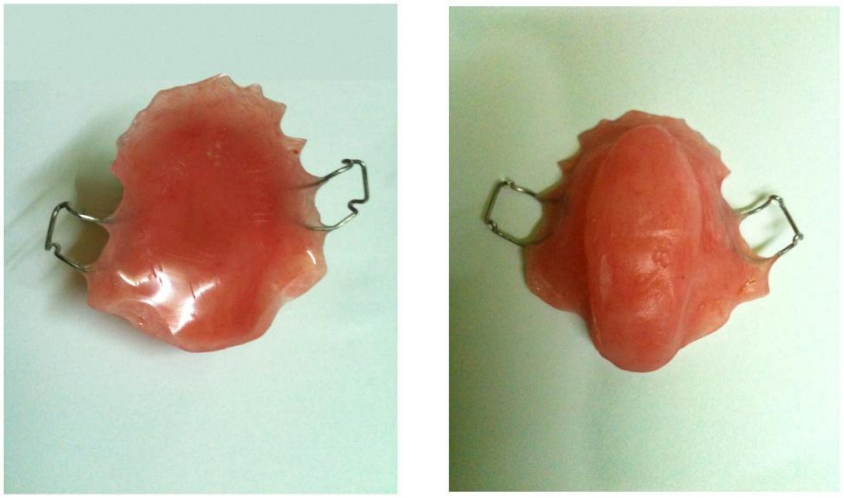

FIG.32. CAMEO AND INTAGLIO SURFACE OF HOLLOW BULB OBTURATOR

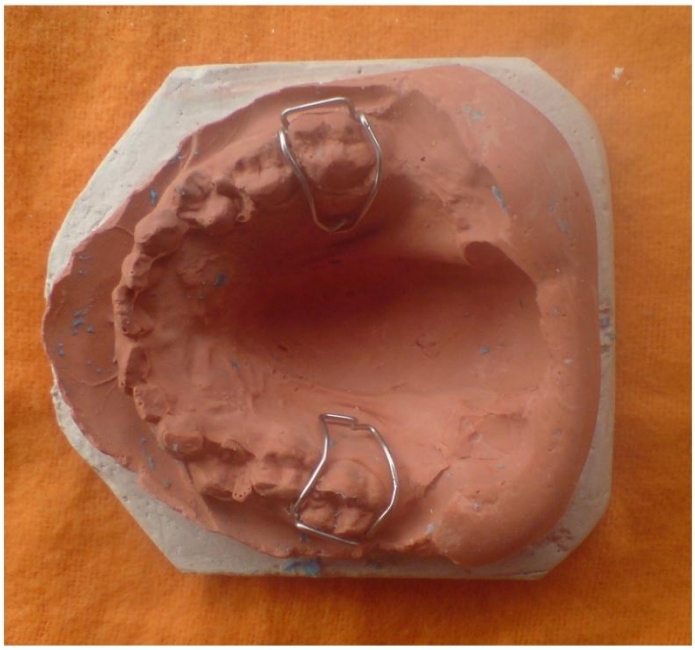

FIG 29. MASTER CAST WITH VELOPHARYNGEAL DEFECT

FIG.30 WAXUP AND INVESTING OF MASTER CAST

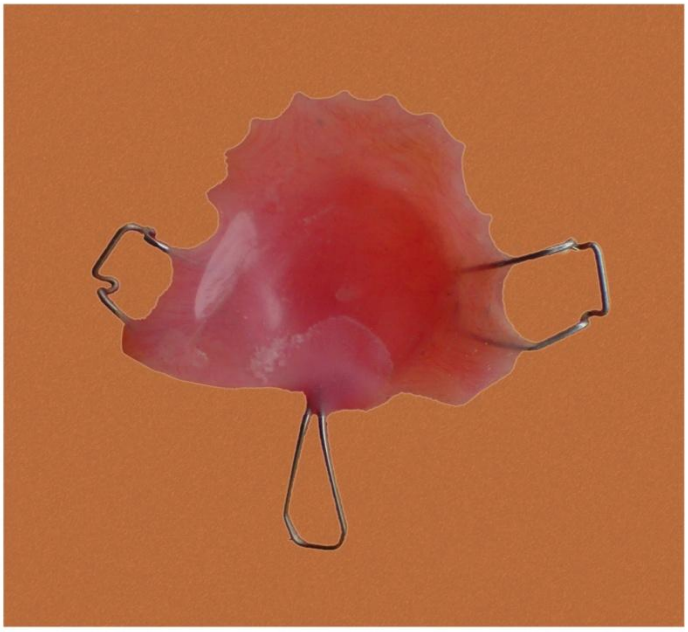

FIG 27. 21 GAUGE STAINLESS STEEL ORTHODONTIC WIRE EXTENDING INTO THE VELOPHARYNGEAL DEFECT

FIG. 28. IMPRESSION OF THE VELOPHARYNGEAL DEFECT USING MCCORD AND TYSON TECHNIQUE

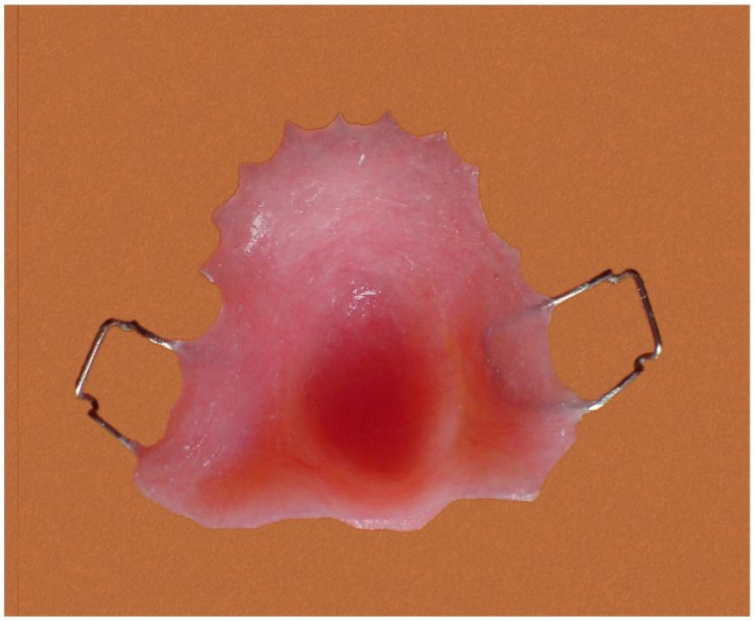

FIG 25. FLOOR OF THE ACRYLISED HOLLOW BULB OBTURATOR WITH ADAMS CLASP

FIG. 26. ROOF OF THE HOLLOW BULB OBTURATOR DONE WITH AUTOPOLYMERISING RESIN USING SALT METHOD

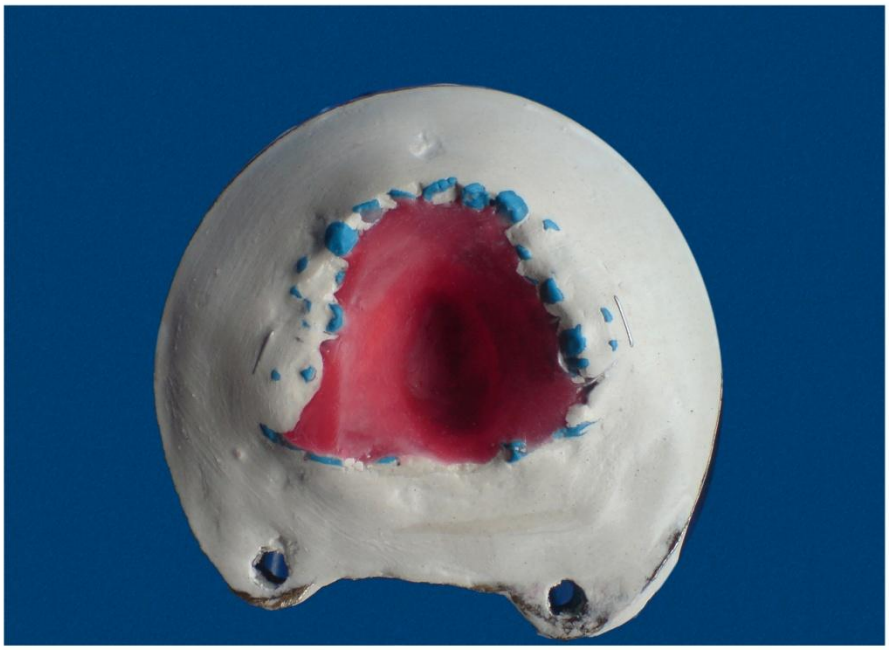

FIG 23. INVESTING OF MAXILLARY CAST

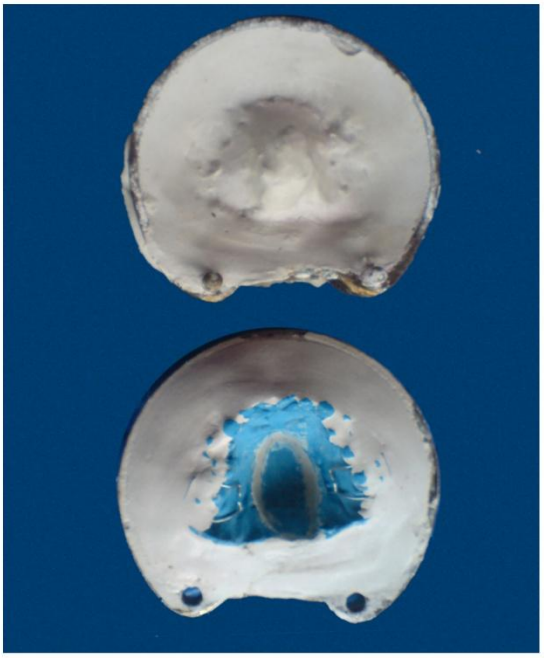

FIG. 24. DEWAXING

FIG 21. VARSITY FLASK-COMPONENTS

FIG. 22. VARSITY FLASK UNIT

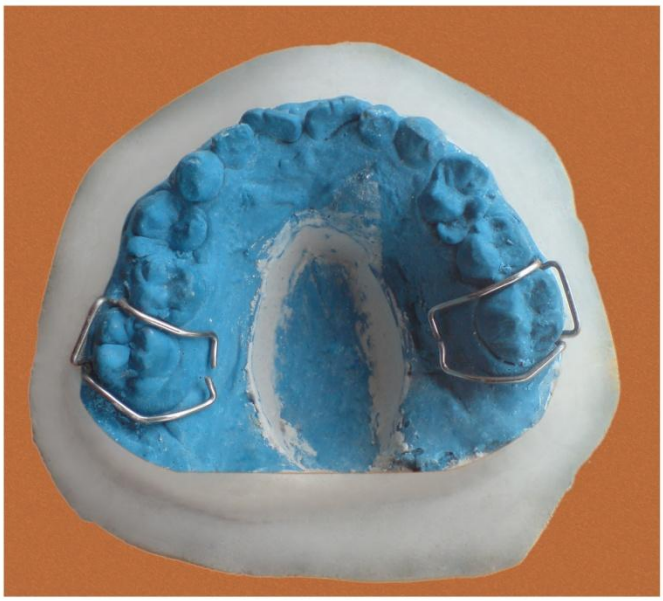

FIG 19 MAXILLARY CAST WITH ADAMS CLASP BLOCK OUT DONE WITH PLASTER OF PARIS

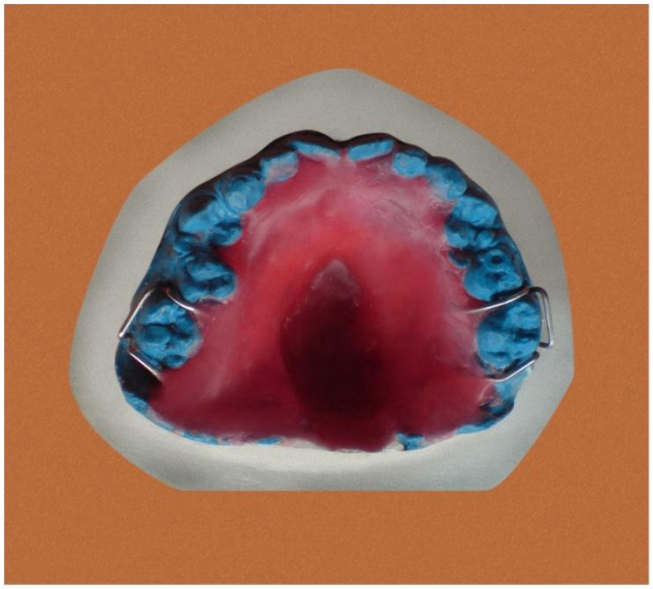

FIG. 20 MAXILLARY CAST WAX UP FOR FLOOR OF THE HOLLOW BULB OBTURATOR

FIG 17. MAXILLARY AND MANDIBULAR IMPRESSION

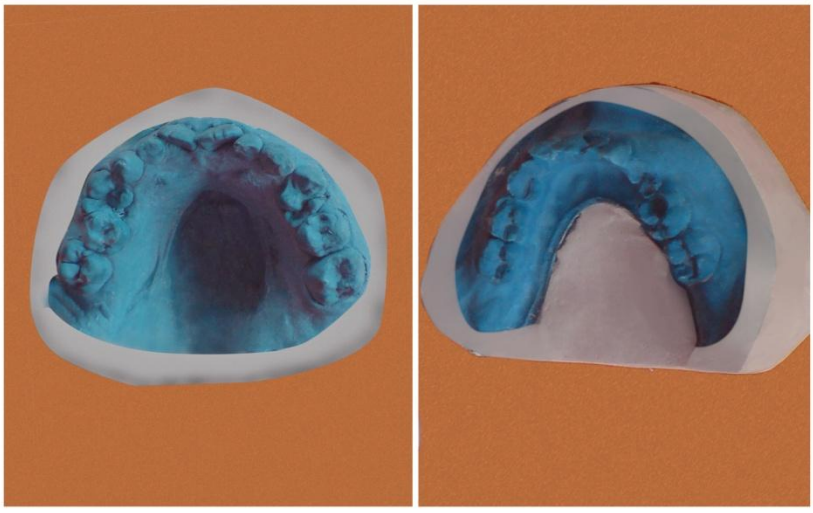

FIG.18 MAXILLARY AND MANDIBULAR CAST

FIG 15. FACIAL PROFILE -FRONTAL AND LATERAL VIEW

FIG 16. INTRA ORAL VIEW OF THE DEFECT

FIG 13.SONY IC AUDIO RECORDER [ICD-UX 512F]

FIG 14. SOUND RECORDING STUDIO [NISH]

FIG 11.NASOMETER [DOCTOR SPEECH]

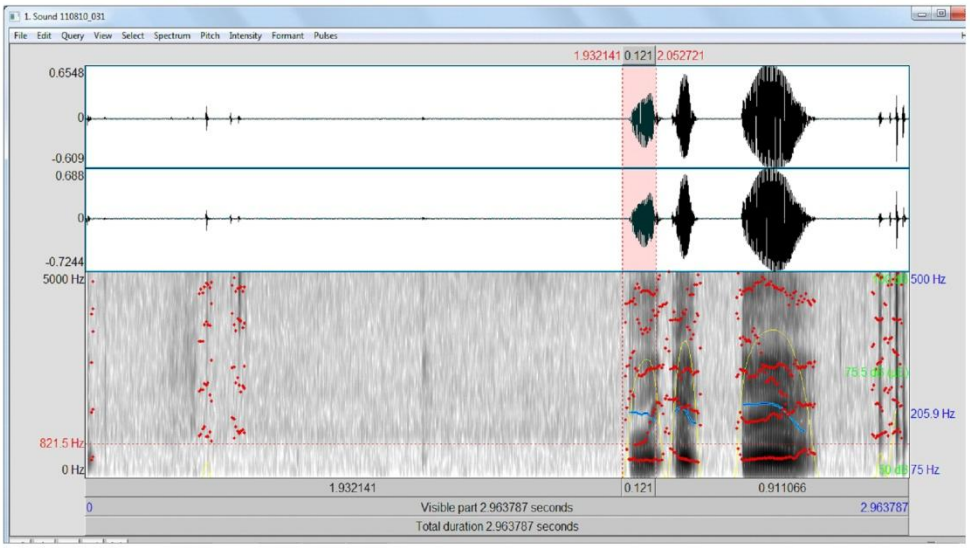

FIG 12. PRAAT SOFTWARE

FIG 9. AUTOPOLYMERISING ACRYLIC RESIN [DPI RR]

FIG 10. GAUZE [SURGICOM]

FIG 7. HEAT CURE ACRYLIC RESIN[ACRALYN H]

FIG 8. COLD MOULD SEAL

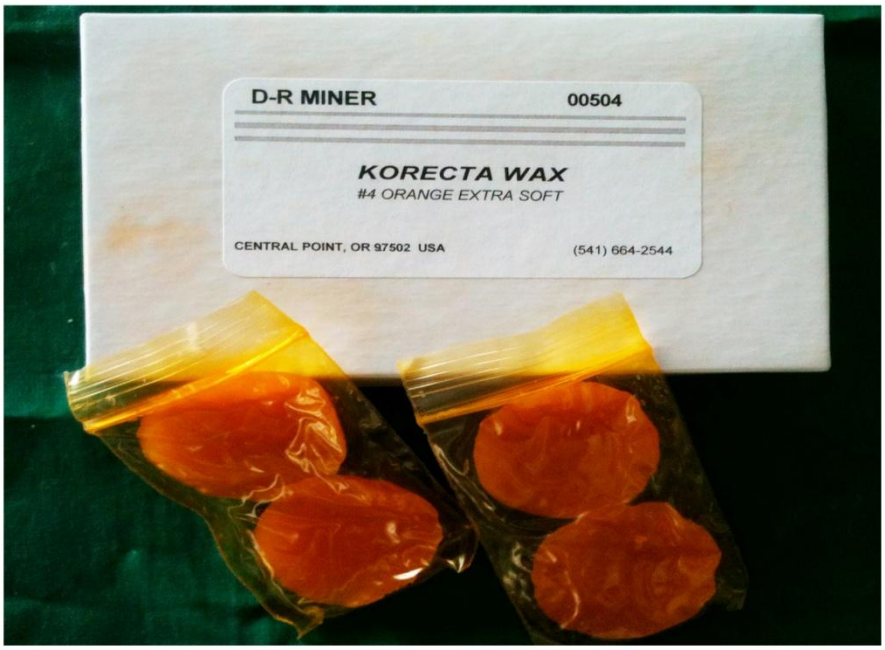

FIG 5.KORECTA NO.4 WAX [FACTOR II,USA]

FIG 6.BETADINE SOLUTION

FIG 3 IMPRESSION COMPOUND

FIG 4, GREEN STICK COMPOUND

FIG .1 POLYVINYL SILOXANE ,IMPRESSION MATERIAL,PUTTY AND LIGHT BODY ELITE HD +

FIG.2 TYPE III DENTAL STONE