HYPERNASALITY IN SINGING AMONG CHILDREN WITH CLEFT PALATE: A PRELIMINARY STUDY

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KUALA LUMPUR

2017

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RESEARCH REPORT SUBMITTED TO THE DEPARTMENT OF ORAL AND MAXILLOFACIAL CLINICAL SCIENCES, FACULTY OF DENTISTRY, UNIVERSITY MALAYA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER IN CLINICAL DENTISTRY (ORAL AND MAXILLOFACIAL SURGERY)

FACULTY OF DENTISTRY
UNIVERSITY OF MALAYA
KUALA LUMPUR

2017

UNIVERSITY OF MALAYA

ORIGINAL LITERARY WORK DECLARATION

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Registration/Matric No: **DGJ 140003**

Name of Degree: **Master of Clinical Dentistry (Oral and Maxillofacial Surgery)**

Title Research Report: **Hypernasality in Singing among Children with Cleft Palate: A Preliminary Study**

Field of Study: **Oral and Maxillofacial Surgery**

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ABSTRACT

Background. Hypernasality is a common problem encountered by most children with cleft palate velopharyngeal insufficiency/ inadequacy (VPI), despite undergoing satisfactory palate repair with the absence of a fistula. Speech therapy has been advocated to treat hypernasality in these children with no residual VPI, after primary palate repair. Previous studies done among classical singers implied that singing closes the velopharyngeal complex longer and tighter as compared to speaking. Thus, hypernasality reduces. As to date, no studies have been conducted to compare voice production in speaking and singing among children with cleft palate. ***Objectives.*** This study aims to document differences of hypernasality among children with cleft palate during speaking and singing and to compare the nasality score ratings by trained as well as untrained listeners. ***Methods***. Twenty participants with cleft palate aged between 7 to 12 years old were randomly selected from the Cleft Lip and Palate Association of Malaysia (CLAPAM) database for this study. Audio recordings were made of these children reading a passage and singing a common local song, both in the Malay Language. The degree of hypernasality was judged through perceptual assessment. Three trained listeners i.e. a speech therapist, a classical singer and a linguistic expert, who are academicians and 2 untrained listeners i.e. a cleft volunteer worker and a national high school teacher assessed the recordings using the Visual Analog Scale (VAS), judging the degree of hypernasality and audible nasal emission. ***Results.*** Inter-rater and intra-rater reliability was verified using intra-class correlation coefficients (ICC) on hypernasality and audible nasal emission of both task of speaking and singing. Significant reduction of hypernasality were observed during singing as compared to speaking, indicating that when a cleft palate child sings, hypernasality reduces. ***Conclusions.*** The act of singing significantly reduces hypernasality. However, future researches are necessary to objectively measure nasality, the octave differences in singing compared to speaking as

well as proper visualization of the VP complex during singing among children with cleft palate.

ABSTRAK

Latar belakang. *Hypernasality* adalah masalah biasa yang dihadapi oleh kebanyakan kanak-kanak sumbing lelangit kerana kekurangan fungsi velopharyngeal (VP) mereka walaupun telah menjalani pembedahan pembaikan lelangit yang memuaskan dengan ketiadaan fistula. Oleh itu, terapi pertuturan telah diperjuangkan sebagai satu cara merawat hypernasality di kalangan kanak-kanak sumbing lelangit sebagai tambahan kepada rawatan pembedahan lelangit. Kajian terdahulu di kalangan penyanyi klasik ada menyatakan bahawa kompleks VP tutup lebih kuat dan lebih lama ketika menyanyi berbanding ketika seseorang bercakap. Sehingga kini, tiada kajian yang telah dijalankan untuk membandingkan pengeluaran suara berkaitan dengan nada ucapan dan nyanyian di kalangan kanak-kanak sumbing lelangit. ***Objektif.*** Kajian ini bertujuan untuk mendokumentasikan perbezaan *hypernasality* dalam kalangan kanak-kanak sumbing lelangit semasa bercakap dan menyanyi dan membandingkan skor sifat bunyi sengau oleh pendengar terlatih dan juga pendengar yang tidak terlatih. ***Kaedah.*** Seramai dua puluh kanak-kanak yang berusia antara 7 hingga 12 tahun yang mengalami lelangit rekah telah dipilih secara rawak dari pangkalan data *Cleft Lip and Palate Association of Malaysia* (CLAPAM) untuk kajian ini. Rakaman audio hasil daripada kanak-kanak ini membaca petikan dan menyanyi lagu masyarakat tempatan dalam Bahasa Melayu telah direkodkan. Sampel ucapan dan nyanyian ini dinilai oleh tiga pendengar terlatih dan dua pendengar tidak terlatih menggunakan skala analog visual (VAS) berdasarkan tahap *hypernasality* dan *audible nasal emission.* ***Keputusan.*** Kebolehpercayaan *interrater* dan *intrarater* telah disahkan menggunakan *Intraclass Correlation Coefficients* (ICC) untuk penilaian *hypernasality* dan *audible nasal emission* semasa bercakap dan menyanyi. Perbezaan yang signifikan dalam *hypernasality* dan *audible nasal emission* telah diperhatikan semasa bercakap dan menyanyi. Kajian menunjukkan bahawa apabila seorang kanak-kanak sumbing lelangit menyanyi, *hypernasality* dan *audible nasal emission* akan berkurangan. ***Kesimpulan.*** Aktiviti nyanyian dapat mengurangkan tahap *hypernasality* dan *audible nasal emission* kanak- kanak sumbing lelangit. Walau bagaimanapun, kajian yang lebih mendalam perlu dijalankan secara objektif pada masa depan bagi mengukur perbezaan oktaf dalam nyanyian berbanding percakapan serta visualisasi kompleks VP dalam nyanyian kanak-kanak sumbing lelangit.

ACKNOWLEDGEMENTS

I would like to express my sincere thanks to all those who have contributed in the preparation of this research. I would have not been able to complete this without guidance and blessings from God Almighty. First and foremost, to my supervisor, Prof. Dato' Dr. Zainal Ariff as well as my co-supervisors, Dr. Yap Jin Hin, and Prof. Dr. Stefanie Pillai. My sincere gratitude for their guidance, support and encouragement without whom, none of this would be possible. Thank you also to Miss Najihah, for assisting me with the statistical analysis. My acknowledgement also goes to Dr Siti Mazlipah Ismail, the Head of Department together with all the lecturers for their patience and encouragement throughout my years as a postgraduate student. Special thanks also go to the speech therapist, Ms. Puspa Maniam for her guidance and assistance in completion of this project. I want to express my appreciation to my colleagues and staff of the Department of Oral and Maxillofacial Surgery for their support and friendship throughout this master's programme. I also wish to extend my appreciation to my younger sister, Ms Samantha George for her enthusiasm and willingness to lend a helping hand in completion of this project. Last but not least, my parents, husband and family members for their patience and concern throughout the process of writing this report.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS AND ABBREVIATIONS

CLP	:	Cleft Lip and Palate
CLAPAM	:	Cleft Lip and Palate Association Malaysia
PPW	:	Posterior Pharyngeal Wall
VP	:	Velopharyngeal
LMM	:	Low Mandible Maneuver
VAS	:	Visual Analogue Scale
EAI	:	Equal Appearing interval

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

1.1 Background

Hypernasality is a very common problem encountered by most children with cleft palate due to excessive nasal resonance experienced during speech. Most children with cleft palate, with surgically repaired cleft, often experience hypernasality due the inadequacy of their velopharyngeal (VP) function despite undergoing a satisfactory palate repair with the absence of a fistula.

With the presence of a short velum and extensive scarring, children with cleft palate often produce a hypernasal sound due to their VP port incompetence. Although the palate has been repaired surgically and anatomically, due to compensatory production and mislearning, it is insufficient for normal speech production.

This problem then leads to low intelligibility during speech and thus, compromises the child's social well-being. Therefore, speech therapy has been advocated to treat hypernasality among these children once the structural defect has been treated adequately (Akafi, Vali, Moradi, & Baghban, 2013).

Auditory-perceptual judgement has always been accepted as the mainstay tool in assessing hypernasality, especially in a clinical setting as it serves to evaluate the speech status of an individual and also indirectly provides information regarding their VP complex in the absence of a fistula (Moon, Kuehn, Chan, & Zhao, 2007). It has been reported that expert listeners as well as untrained listeners agreed to a certain degree on who were hypernasal and who needed intervention (Brunnegard, Lohmander, & van Doorn, 2012). Perceptual speech evaluation is considered to be a useful test to determine the severity of hypernasality in patients prior to therapy and also to test the effectiveness of speech rehabilitation methods during a follow up.

In singing, nasal resonance plays an important role in enhancing one's vocal tone. Some believe that the nasal passages and sinuses of the head are the source of the "ring", which is a concentration of acoustic energy at around 3,000 Hz, a significant element needed for good voice quality production (Bartholomew, 1934). However, nasal resonance has to be regulated together with the midface vibrations to produce normal and comprehensible singing tones.

Previous studies which were done on classically trained singers and non-cleft palate individuals implied that the VP port closes longer and tighter during the act of singing compared to speaking (Austin, 1997; Kummer, 2013). Thus, reduces hypernasality. This research is a first observational study, which dictates that hypernasality is reduced during the act of singing compared to the act of speaking among children with cleft palate based on the perceptual judgement of trained as well as untrained listeners. We hope that the outcome of this study will improve our understanding of hypernasality and contribute towards solving this clinical problem.

1.2 Aim

The aim of this study is to document differences of hypernasality among cleft palate children during speaking and singing.

1.3 Objectives

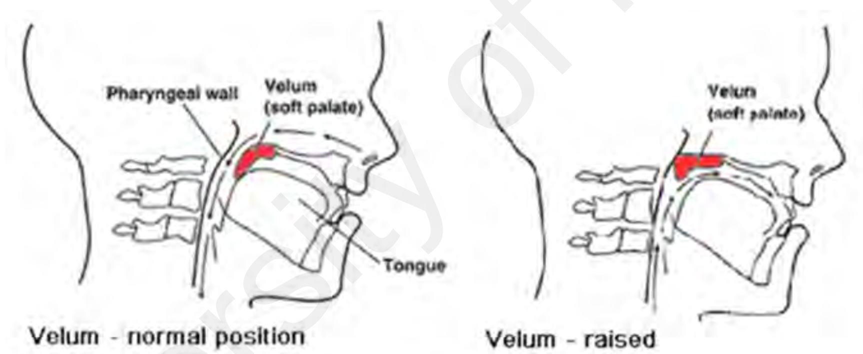
Through this study, we should also be able to compare the nasality score ratings by untrained as well as trained listeners and to assess the severity of hypernasality in children with cleft during singing compared to speaking.

CHAPTER 2: LITERATURE REVIEW

2.1 Velopharyngeal Function

VP port functions as a valve that barricades the nasal cavity from the oral cavity during daily activities such as speaking, singing, whistling, blowing, sucking, kissing, swallowing, gagging and vomiting (Nohara et al., 2007). This valve closure is obtained by a coordinated synchronized action of the velum (soft palate) together with the lateral and posterior pharyngeal walls (PPW) (Kuehn & Moon, 1998). The VP port functions to regulate and control sound and airflow pressure energy in the oral as well as nasal cavities. Its closure is like a sphincter which requires a harmonized coordinated action in all dimensions (Kummer, 2013).

2.1.1 Velar Movement



A **B**

Figure 2.1: A: The VP port is open at rest and production of nasal sounds

B: The VP port is closed for speech on production of oral sounds.

(Kummer, 2013)

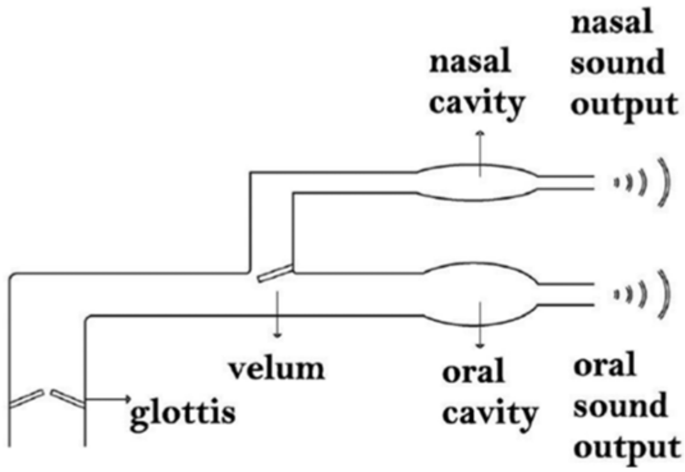


Figure 2.2: A simple vocal tract model

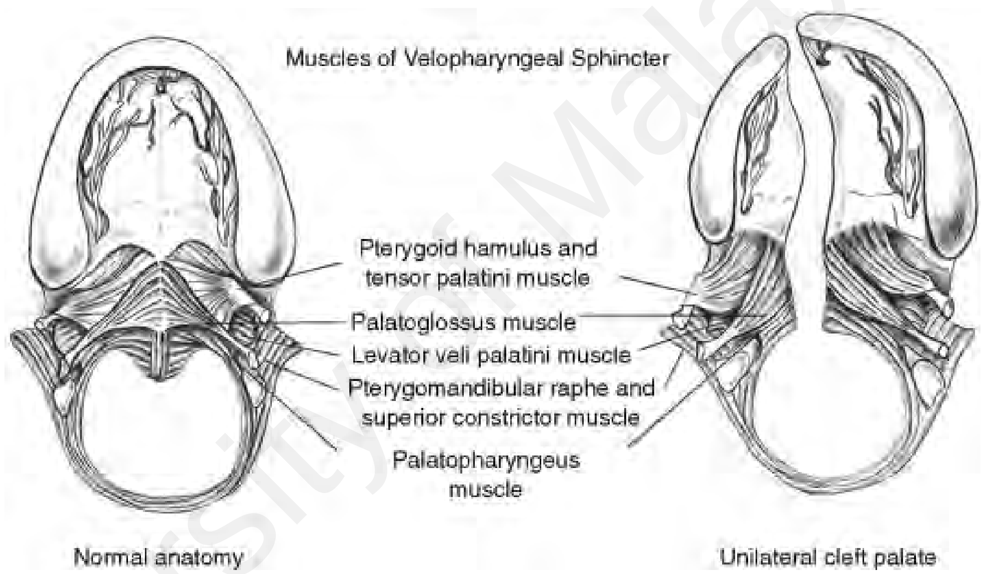
(Sundberg et al., 2007)

During nasal breathing, the nasal cavity is kept patent as the velum is positioned downwards and is at rest at the base of the tongue. During phonation for oral sound production, it rises to contact the posterior and lateral pharyngeal walls. In order to maximize optimal contact with the pharyngeal walls, the velum tends to slightly curve inwards. As the movement of the velum has to be rapid and quick in speech production, a high muscular activity at the VP port is of great importance (Cheng et al., 2006).

In earlier scientific researches, only a dual classification was constructed for the VP port; it was either closed or open (Fowler & Morris, 2007). In recent years, researchers have discovered that there is a range of motions in the VP port with various rates of movement to produce the required speech phonemes (Kent 1997; Seikel, King, & Drumright, 2000) . VP activity includes positioning the velum toward and away from the PPW and medial movement of the lateral pharyngeal wall (Kent, 1997; Kuehn & Moon, 1998; Zemlin 1998). .

Pruzansky and Mason (1969) mentioned that the velum does not just ascend but also stretches and lengthens during function. Therefore, the velum is actually longer when at function compared to when at rest. The sufficient length of the velum is the length from the posterior part of the hard palate to the PPW in which the velum is able to make contact with the PPW.

The five muscles involved in velar closure are the *levator veli palatini, musculus uvulae, tensor veli palatini, palatoglossus* and the *palatopharyngeus.* However, elevation of the velum is produced from contraction of the *levator veli palatini* muscle which is the main muscle that is repositioned during cleft palate closure (Kent, 1997, Seikel et al.,2000; Zemlin, 1998).



A B

Figure 2.3: Anatomy of the VP mechanism: A: Normal anatomy

B: Anatomic distortion associated with complete cleft palate

(Picture from pocketdentistry.com)

2.1.2 Lateral Pharyngeal Wall Movement

The lateral pharyngeal walls move medially to make contact with the velum during VP port closure. However, the amount of movement varies from one person to another and occasionally, some individuals may be present with asymmetrical movements of both pharyngeal walls (Lam, Hundert, & Wilkes, 2007).

2.1.3 Posterior Pharyngeal Wall (PPW) Movement

The PPW contributes to the VP port closure by moving slightly, anteriorly to assist contact. Although, its movement is minimal compared to the velum and lateral pharyngeal walls, it is however, evident in most normal speakers. Some individuals have a Passavant's ridge which is a shelf like bulge of the PPW (Zemlin, 1998).

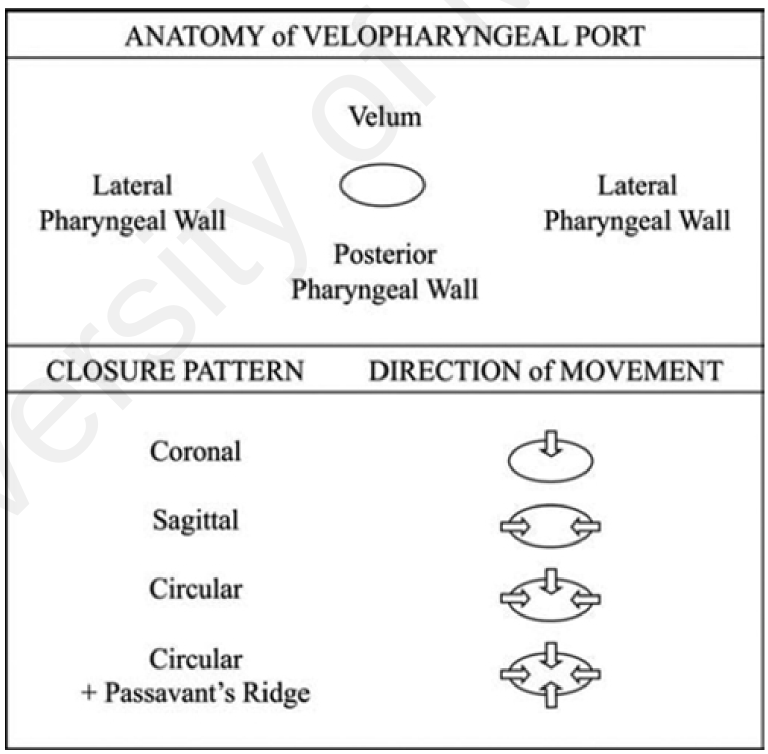


Figure 2.4: Various patterns of closure of the VP complex

(Fisher & Sommerlad, 2011)

2.2 Velopharyngeal (VP) Dysfunction

According to Kummer (2011), VP dysfunction can be further subdivided into three types. The first type is the VP insufficiency, which underlines an anatomical or structural defect, which impairs adequate VP port closure. A repaired palate is often related to a short velum due to scarring or presence of a fistula post-surgery (Woo, 2012).

The next type is the VP incompetence (VPI) which relates to the neurophysiological component of the VP port. Abnormal insertion of the *levator palatini* muscles can also deter normal palate movement. Poor elevation of the velum and insufficient movements of the pharyngeal walls leads to an inadequate closure of the port (Trost-Cardamone, 1989). Another component, which is often overlooked, is the VP mislearning. VP mislearning is the abnormal positioning of the VP without the presence of any pathology (Trost-Cardamone, 1989).

2.3 Speech Production

Speech is produced in a coordinated manner involving many physiological components such as respiration, phonation, resonance and articulation. Speech in humans can be described as a source filter model (Wakita, 1999). It first begins with the vibration of the vocal folds, followed by a stimulation force from our breath pressure. Next, the tongue, jaw and lips alters the shape of the vocal tract, providing a resonating acoustic filter mechanism component which in turn, reduces or amplifies sound production (Baken, 1987; Weerasinghe, Sato, & Kawaguchi, 2006).

In phonation, the vocal folds have to vibrate for vowels and stop vibrating for silent consonants then vibrate again for vowels or consonants (Kent & Moll, 1969). Whenever a syllable is to be produced, laryngeal and subglottic pressure has to increase. When it is stressed, it is higher in pitch, longer in duration and is more accurate as compared to an unstressed one depending on the pressure used.

The rate of vibration in the vocal folds and tension of the laryngeal muscles control the length and mass of the vocal fold which eventually changes the pitch throughout a sentence. This is commonly seen in a sentence which usually begins with a low frequency pitch and eventually ends with a high frequency pitch (Kent & Moll, 1969).

2.3.1 Resonance and Velopharyngeal Function in Speech

Lung and sound energy from the vocal folds produce air pressure and travel upwards once speech begins. This is followed by vibration of these sound waves at the supraglottic tract at the pharyngeal cavity, followed by the oral cavity and nasal cavity. This sound energy is further moulded by the pharyngeal tract to add a resonant quality to speech. Infants produce sound at a higher pitch as they have a small resonating cavity. Women who usually have a shorter vocal tract as compared to men, produce higher formant frequencies in their vocal sound. These factors change vocal resonance and lead to a perception of various vocal qualities in speech (Sataloff, 1992).

The VP port closes during production of all oral sounds. During the production of oral phonemes (all sounds with the exception of /m/, /n/, and /ng/), the VP port closes, whereas for nasal sounds, the VP port opens, allowing acoustic energy to be shared between the oral and pharyngeal cavities. According to some studies, some amount of VP port opening in speech during production of oral sounds is acceptable and would not be perceived as hypernasal (Bloomer, 1953; Kataoka, Warren, Zajac, Mayo, & Lutz, 2001; Young, Zajac, Mayo, & Hooper, 2001; Zajac, 2000).

2.3.2 Articulation in Speech

The sound energy that is produced from phonation and resonance is further modified by articulators in the oral cavity, which include the tongue, lips and teeth. This is done by changing the size and shape of the oral cavity through the movement and placement of the articulators and also by moulding the sound and airstream released. Vowel sounds are modified in the oral cavity by the tongue height, tongue position and with the presence or absence of lip rounding (Kummer, 2013).

Pressure sensitive consonants such as plosives, fricatives and affricates require intraoral pressure build up which is produced by partial or complete block of the oral cavity. Plosives phonemes such as *phonemes* (/p/, /b/, /t/, /d/, /k/, /g/) require high intraoral pressure build up followed by a sudden release. For production of fricative phonemes (/f/, /v/, /s/, /z/, /ʃ/, /ʒ/, /h/), they require a slow release of air pressure through a restricted opening. Affricate phonemes (/ʧ/, /ʤ/) are formed by a combination of plosive and fricative phonemes which require a high pressure released through a small opening of the oral cavity (Kummer, 2013).

According to McDonald and Baker (1951), nasal resonance increases when the oral cavity is kept small because the nose can accommodate lesser sound energy due to its smaller size. Therefore, perception of nasality is higher on articulation of the vowel /u/ and /i/ as compared to /a/.

2.4 Speech Disorders among Children with Clefts

Among the more common speech disorders seen among children with cleft are speech sound production articulation disorder, dysphonia and resonance (hypernasality, hyponasality or mixed resonance). The reasons behind this may be due to VP incompetence, presence of dental anomalies such as missing teeth, airway obstruction or even due to hearing loss often seen in cleft palate patients. Children born with a cleft lip and palate (CLP) are at risk for disorders of speech sound production (articulation disorder), resonance (hypernasality, hyponasality, cul-de-sac resonance or mixed resonance), and even voice dysphonia (Kummer, 2014).

Most cleft patients are present with a *hypoplastic maxilla* against a normal mandible causing a Class III skeletal profile with a class III *malocclusion*. This causes the tongue tip to be anterior to the alveolar ridge, which causes an obligatory distortion (Fronting), or if the child tends to pull back, the tongue it causes a compensatory error. For obligatory distortion, lateral lisp on sibilants is heard due to interference of the teeth, which diverts the airflow, whereas for the compensatory disorders, in which there is an anterior crossbite present, there would be a palatal-dorsal placement for /t/ and /d/ due to interference of the teeth (Kummer, 2011).

VP dysfunction is present in almost all cleft palate patients. Though the palate has been repaired surgically, 20-30% of these children would to a certain extent exhibit some form of VP insufficiency (Witt & D'Antonio, 1993). When there is a leak of air between the oral cavity and nasal cavity, it causes insufficient pressure to produce oral speech sound thus, hypernasality emerges (Woo, 2012).

2.4.1 Hypernasal Speech Production

Closure and opening of the VP port is necessary throughout speech. Coordinated movement of the velum together with the pharyngeal walls and voice production is essential in speech. Therefore, the movement of the velum for oral sounds should occur before phonation. If this is delayed, a hypernasal speech is produced (Ha, Sim, Zhi, & Kuehn, 2004). Hypernasality is a resonance abnormality characterized by sound escape into the nasal cavity during speech, easily identified with vowel sounds (Woo, 2012). There are two distinctive components in a hypernasal speech, which includes hypernasality and audible nasal emission/turbulence. In the Americleft modifications article, hypernasality was defined as ‘‘any abnormal increase in nasal resonance during speech production’’ and audible nasal emission was defined as ‘‘any abnormal escape of air from the nasal cavity accompanying the production of oral pressure consonants" (Chapman et al., 2016).

For oral consonants and vowels, the velum has to be kept high up so the VP port is closed. On the contrary, for the nasal consonants, the velum descends rapidly and the pharyngeal wall relaxes to open the VP port complex for nasal resonance.

For normal speech production, which has a combination of oral and nasal sounds, rapid movement of the velum and pharyngeal walls is essential, especially when the closure is weak (Hardin-Jones, Chapman, & Scherer, 2006). In addition, vowels which precede or follow a nasal consonant will be affected by the delay in descending of the velum just before the nasal consonant and also if there is a delay in the ascending, the velum just after the nasal consonant (Bunnell, 2005). The closure of the VP complex should also be maintained at a high height during the production of high pressure consonants such as plosives, fricatives and affricates (Moll, 1962). To produce high-pressure consonants such as fricatives, the VP force is greater as compared to vowels. The firmness of this closure would be reduced with fatigue . Therefore, the velar and pharyngeal wall position has to be synchronized and modified together with the production of each and every syllable.

Hypernasality may directly impact speech intelligibility and would require either an invasive or non-invasive intervention to improve speech intelligibility, resonance, and communication among the younger age group (Dickson & Maue-Dickson, 1980).

2.5 Speech Assessment

Assessment of speech is essential to develop a diagnosis that would aid treatment especially in speech therapy. There are many ways to assess speech, which include invasive and non-invasive methods. Examples of invasive methods are nasometer, nasofluoroscopy and videofluoroscopy. Non-invasive methods include digital sensor screening, lateral cephalometric radiographs, auditory-perceptual assessment and MRI screening. The diagnosis of VP dysfunction includes a range of various speech impairments characterized by inappropriate nasal resonance, frequent nasal air emission, nasal turbulence, grimacing and nasalized plosives. The ideal assessment should also be non-invasive, easily repeatable and reproducible without increased exposure to ionizing radiation and allow a three dimensional evaluation of the VP region (Bettens, Wuyts, & Van Lierde, 2014).

2.5.1 Perceptual Speech Assessment

Perceptual assessment has been established as the gold standard and basis of evaluation of any speech defect that includes nasality (Kuehn & Moller, 2000; Weerasinghe et al. 2006). According to Kuehn & Moller (2000), a speech problem does not exist unless it is perceived by the listener and the examiner's ears are said to be the best tool in speech assessment (John, Sell, Sweeney, Harding-Bell, & Williams, 2006). Even if other instrumented evaluation shows that there is abnormality of speech, a normal perceptual speech assessment overrules other assessments and is the main determinant of whether or not treatment is started (Kummer, 2014). Perceptual assessment has been the main tool used for diagnosis and management of speech disorders of cleft children (Vogel, Ibrahim, Reilly, & Kilpatrick, 2009).

2.5.1.1 CAPS-A Method

The Cleft Audit Protocol for Speech – Augmented (CAPS-A) is a method in evaluation of speech. One of its authors was also involved with the production of the Great Ormond Street Speech Assessment (GOS.SP.ASS), which is another tool to evaluate speech in cleft and non-cleft patients. This tool is an accepted, valid and reliable tool in assessment of a small sample and is recommended for use in audit studies (John et al., 2006).It can be used alone or with the GOS.SP.ASS, each having comparable results (Sell, Harding, & Grunwell, 1999). This protocol captures all the recommended speech parameters such as hyponasality, hypernasality, intelligibility, nasal escape, articulation and much more. CAPS-A tool is known for its simplicity and reliability. However, data produced from this method of analysis are categorical and limited.

2.5.1.2 Equal-Appearing Interval (EAI)

EAI scaling is the most frequently used method of evaluation for hypernasality and audible nasal emission used in cleft speech assessment. (Whitehill, Lee, & Chun, 2002; Zraick & Liss, 2000). EAI scaling involves partition scaling in which a finite set of numbers or categories are assigned to stimuli by listeners. The endpoints for EAI are fixed, and scaling is performed using whole numbers (e.g., between 1 and *n*). Usually, a five-point and seven-point scales are frequently used in the clinical setting of speech assessment with the highest number usually indicative of the most severe problem (Kuehn & Moller, 2000; Lohmander & Olsson,2004).

2.5.1.3 Direct Magnitude Estimation (DME) and Visual Analogue Scale (VAS)

Besides EAI scale ratings, other ratio-based methods, such as Direct Magnitude Estimation (DME) or VAS have been suggested and used. Previous studies conducted regarding the comparison between EAI methods with DME and VAS, has suggested that these ratio-based methods do provide a higher validity and reliability of hypernasality, audible nasal emission and voice quality, as compared to EAI (Kelchner et al., 2010; Whitehill et al., 2002; Zraick & Liss, 2000). Direct Magnitude Estimation (DME) has been used for hypernasality ratings but its weakness is that it is less familiar to most speech therapists and clinicians and it requires training prior to usage. Therefore it demands more time for the assessment analysis (Whitehill et al., 2002). VAS has been used as a method of assessment for most subjective variable studies such as pain, nausea and discomfort levels because it allows a continuum level of measurement.

2.5.2 Differences in Assessment between Trained and Untrained Listeners.

In most perceptual studies, including studies related to cleft palate which assess speech, speech language pathologists or speech therapists are employed as listeners (Lohmander & Olsson, 2004; Whitehill et al., 2002). Untrained listeners have also been recruited in other studies and compared with professional assessment (Lewis, Watterson, & Houghton, 2003; Persson, Lohmander, Jönsson, Óskarsdóttir, & Söderpalm, 2003; Starr, Moller, Dawson, Graham, & Skaar, 1984; Tönz et al., 2002). Most untrained and trained listeners nasality scores were in accordance and untrained listeners are mostly able to distinguish between speakers who need intervention and those who do not need intervention (Brunnegard, Lohmander, & van Doorn, 2009; Starr et al., 1984; Tönz et al., 2002). However, they discovered that professional listeners could differentiate better between hypernasality and articulation disorders compared to untrained listeners.

Lewis et al. (2003), demonstrated in his study that trained listeners who are speech language pathologists, tend to give lower ratings as compared to untrained listeners. Untrained listeners were also discovered to be numb to audible nasal air emission and/or nasal turbulence and were not familiar towards the assessment of this disorder (Brunnegard et al., 2009; Persson, Lohmander, & Elander, 2006).

There was a suggestion by Riski (2001) to use a rating scale with fewer points to increase intra-rater reliability. However, this study challenges this statement by using the VAS, which has a wide range of intervals due to its objectivity and ease of use.

2.6 The Singing Voice

For singing, the tone begins in the larynx with vibrations of the vocal folds. The primary laryngeal sounds are produced with these vibrations (voice source signal) using subglottal pressure which is produced during expiration (Weikert & Schlomicher-Thier, 1999). Midface vibration felt during speaking are caused by symphathethic acoustic vibrations rather than actual oral-nasal communication (Titze, 2004).

The actual status of the VP port in singing has not been well defined in the literature, but it has known to be similar in speech and most classical singers do not use the VP opening to establish pharyngeal resonance. According to Gregg (1999), the VP port opening is not desirable during classical singing on production of oral sounds as it would reduce the acoustic signal by causing splitting of the resonating system. Therefore, it is unlikely that singers would allow opening of the VP port for a long time (Gregg, 1999).

Yanagisawa, Mambrino, Estill, and Talkin (1991) used velar and laryngeal videoendoscopy to analyze the behavior of the soft palate in both male and female singers. They discovered that the soft palate was constantly closed, even for an /i/ as sung in "twang" qualities. In a follow up study, Yanagisawa et al. (1991), using the simultaneous velar and laryngeal videoendoscopy, examined the positioning of the soft palate in singers of both sexes during production of the nasal consonant /n/. Pershall and Boone (1987) also used videoendoscopy below and above the velum for studying supraglottal participation in professional singers of both sexes. They found that the velum was closed throughout the entire pitch range in all subjects.

In an earlier study, Wooldridge (1956) did an experiment by filling the nasal passages of six professional singers with cotton gauze. Acoustic analysis and perceptual judgments by a jury of professional singers failed to differentiate between the differences of the recordings of those with cotton gauze and those without cotton gauze occlusion in their nasal cavity. This indicated that the nasal passages were not being utilized as resonators and, therefore, did not contribute to the tones produced in singing.

Vennard (1964), looked at lateral skull x-rays and recordings of five classically trained baritones during vowel and short-phrase production with and without the nasal passages filled with gauze and water. He concluded that there were no consistent differences observed for the X-rays and vocal recordings during the normal and abnormal conditions.

A study by McIver (1995) used nasometry to examine nasalance during sung vowels in 30 classically trained vocal performance students. Analysis of the results indicated that nasalance was present intermittently for each of the five vowels during each singing condition. He also discovered that the lower the vowel height, the higher the nasalance score would be and vowels preceding nasal consonants had greater nasalance than those following nasal consonants.

Austin (1997) used a photodetector to compare VP closure during singing versus speaking in four classically trained singers. At both tasks of speaking and singing, the relative percentage of VP opening was compared between the four singers and showed the VP port was closed for a prolonged length of time during singing and sustained vowels as compared to speaking.

Birch et al. (2002) studied the nasal airflow and VP opening in singers using aerodynamic measures and flexible nasoendoscopy. He discovered that 15 out of 17 singers had small amounts of nasal airflow on vowels during at least one of the experimental tasks; however, no consistent patterns were noted among pitch, loudness, and/or vowel height. He concluded that perhaps the size of VP opening in these singers was too small to be seen endoscopically albeit being present.

In conclusion, these studies, which analysed the status of the VP port during singing in classical singers, showed a mixed closure position of the VP port. Gramming et al. (1993) discovered that singers changed their velum position to determine pitch to achieve targeted formant frequencies or pitch. In addition, Tanner, Roy, Merrill, and Power (2005), discovered that trained sopranos do permit nasal airflow through the VP port during classical singing but the airflow is controlled through a small gap through the VP port and is within normal limits for VP adequacy. Thus, a singer is never perceived as hypernasal.

A recent study by Nair, Nair, and Reishofer (2016) produced MRI images of the VP space in function to illustrate the low mandible maneuver (LMM) in classical singing. This study emphasized that the VP port is maintained closed with the nasal space fully obliterated and there is an increase in resonance space during this LMM which is present during the act of singing.

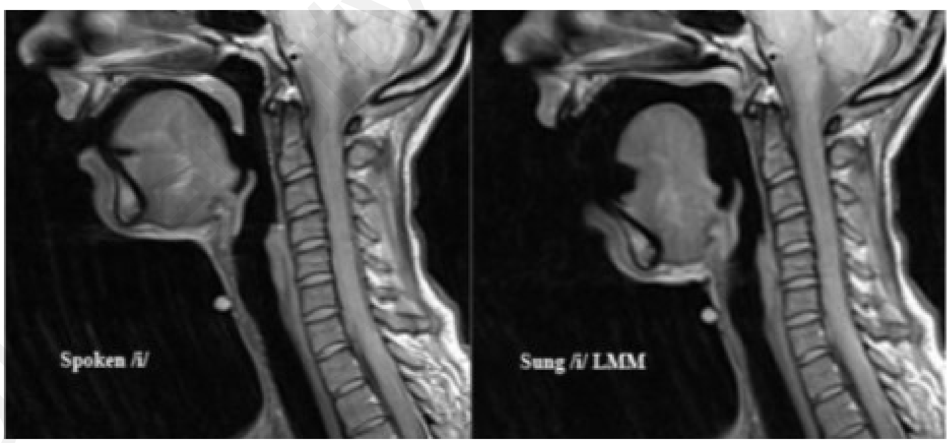


Figure 2.5: MRI images which illustrates the LMM—left image, speaking /i/ and the right image, singing /i/ with full classical resonance. (MRI courtesy of the Medical University of Graz, Austria).

(Nair et al., 2016)

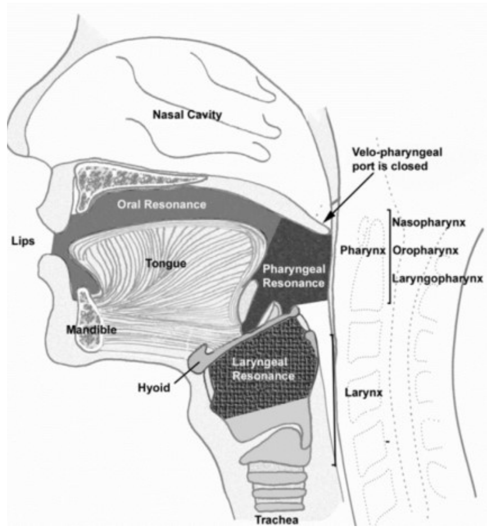


Figure 2.6: : The resonance spaces in singing when the VP complex is closed as most phonemes require the nasal space to be obliterated in singing

(Nair et al., 2016)

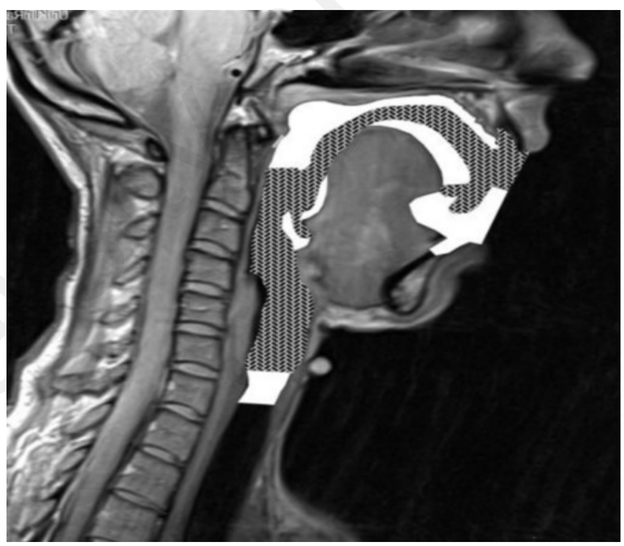


Figure 2.7: An illustration showing increase in vocal resonance spaces as the mandible is lowered. The dark herring-boned area denotes the resonance space available during a non-LMM /i/ vowel. The white areas are the spaces that are added during LMM (Image from collaboration with the Medical University of Graz, Austria).

(Nair et al., 2016)

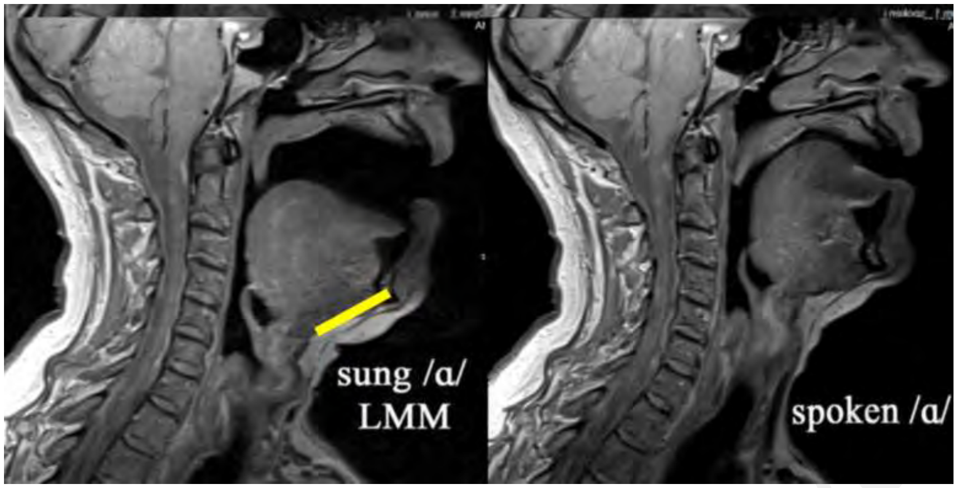


Figure 2.8: Images showing spoken /ɑ/(right) and sung /ɑ/(left) with full classical resonance. Yellow line indicates the position of the mandible. The velum appears further extended and stretched when the vowel is sung (Images from Medical University of Graz, Austria).

(Nair et al., 2016)

To date, all research of VP port closure during singing were done on singers and none on individuals with cleft palate.

2.7 Hypotheses

In keeping with this line of research, the central null hypothesis is that there are no significant differences in auditory-perceptual judgement of hypernasality among children with cleft palate in singing and speaking. This study will also examine the differences in scoring of hypernasality and audible nasal emission between trained and untrained listeners.

CHAPTER 3: MATERIALS AND METHODS

3.1 Subject Selection

All subjects recruited for this study provided written consents. Subjects were recruited from those who were registered with the CLAPAM (Cleft Lip and Palate Association Malaysia) database. A total of 300 parents/ guardians of children with cleft palate between the ages of 7-12 years of age were identified. Subject's parents were interviewed over the phone to confirm that they are not syndromic, had undergone only one primary palatal repair and were currently undergoing speech therapy. A total of 155 children with cleft palate fulfilled the requirements but only 26 responded and agreed to attend due to other commitments and logistics factors. Out of this number, 6 were excluded due to the presence of residual fistula.

3.1.1 Inclusion Criteria

Subject selected for this study were school going children between the ages of 7-12 years old with existing cleft palate deformities who matched these criteria: undergone a primary palatal surgery, non-syndromic, undergoing speech therapy, able to sing and read in the Malay language and have the ability to produce the required speech and singing samples.

3.1.2 Exclusion Criteria

Subjects who were unable to read or sing in the Malay language were not considered for this study. Subjects also excluded from this study were patients whom had other co-existing pathologies other than CLP that affected their speech or pharyngeal space. Subjects with mental retardation, syndromic, hearing loss were also excluded from this study as to eliminate any bias during perceptual speech assessment. Subjects who had any surgeries affecting the VP space such as adenoidectomy and pharyngoplasty were also excluded from this study. Lastly, subjects with existing palatal fistulas were excluded too.

3.2 Evaluation Parameters

Recordings of each of the subjects were done in a sound proof room. Subjects were asked to read a pre-determined passage, The *Kampung* passage which is a speech assessment tool developed by a speech therapist in the Malay language. Subjects' voices were digitally recorded into the Sony Linear D-100 PCM recorder and a microphone was placed at a fixed distance of 3cm away from the right side of the subject's mouth. Subjects were then asked to sing a local common Malay song consisting of nasal and oral sounds. The digital recordings were then transferred into a computer and saved in a mp3 format using the "Audacity" software and the file was renamed into a specified number to mask the identity of the patients. These recordings were assessed by 2 lay persons, who consist of: the secretary of the CLAPAM society **(Listener 1)** and a high school Malay language teacher **(Listener 2)**. Three trained professionals were also involved; they are: a classical singer cum music lecturer at the University of Malaya **(Listener3)**, a language and linguistic expert who is a Professor of the Language and Linguistics Faculty at University of Malaya **(Listener 4)** and a speech therapist at the Universiti of Malaya **(Listener 5)**. All the trained professionals are academicians with more than 10 years of experience and a have a special interest in hypernasality.

Figure 3.1: Sony Linear PCM – D100 recorder used for audio recording

Figure 3.2 : Microphone used for recording

All listeners were invited for a listening session at the Department of Music, Faculty of Arts and Cultural Science, University of Malaya. At the beginning of the ratings session, information was disseminated by the main investigator about the rating procedure, rating scale and terminology of the categories that had to be rated. A brief introduction was conducted explaining normal resonance, hypernasality and audible nasal emission to improve consistency. Each listener was asked to rate the degree of hypernasality and severity of audible nasal airflow of the recordings.

During the listening assessment session, a standard pair of earphones and the blinded audio samples were used in a randomized sequence to exclude any order and ratings. They were rated using VAS by placing a mark on a 100mm bar. For each sample, two bars were provided including the label "normal" on the left end and "severe" on the right end. The other bar used to rate the frequency of audible nasal emission was labelled with "none" on the left side and "very frequent" on the right side of the bar (Baylis, Chapman, Whitehill, & Group, 2015). Hypernasality was defined as "any abnormal increase in nasal resonance during speech production which is most easily perceived on vowels and voiced consonants" and audible nasal airflow was defined as "any abnormal or inappropriate audible escape of air from the nasal cavity accompanying the production of oral pressure consonants" (John et al., 2006).

Each sample could be listened to as often as needed, however, once the listener moved on to the next sample, the listener was asked not to return to a previous one. All listeners worked on their own tempo and could pause whenever they wanted. The first author answered any questions during the rating procedure.

3.3 Statistical analysis

Data was gathered from all listeners' assessment including subject details which were keyed into and analysed using the IBM SPSS Statistics software version 23. Differences in mean of speaking and singing among listeners were computed and assessed for normality distribution and analysed using paired t-test. A p value of <0.005 was considered to be significant. Prior to analysis, an intra-rater and inter-rater reliability test was both carried out for the untrained listeners and for all listeners' ratings to be compared with the speech therapist's ratings. For intra-rater reliability testing, all samples from the 20 recordings were reassessed by the untrained listeners one month after the first assessment.

CHAPTER 4: DATA ANALYSIS AND RESULTS

4.1 Demographic Data

This study captured data from 20 children with cleft palate between the ages of 7- 12 years of age who were randomly selected from the CLAPAM database. The mean age at the time of evaluation was 9 years old, with the majority of the cohort being males (65%). All the subjects were undergoing speech therapy treatment. The most common cleft type was the left unilateral complete cleft (45%, n = 9), followed by the right unilateral cleft lip/palate (30%, n = 6), isolated cleft palate (15%, n = 3) and bilateral complete cleft lip/palate (10%, n =2). All subjects have only undergone primary palatoplasty before the age of 2 years and have been undergoing speech therapy for a mean duration of less than a year. The participants presented with an audible hypernasal speech. The racial distribution of the subjects consisted of 16 Malays, 3 Indians and 1 Chinese. All subjects were enrolled in national primary schools, which use the Malay language as their main medium of instruction.

Table 4.1: List of Subjects' data

Subject	Gender	Age	Race	Types of cleft	Duration of speech therapy
1	M	7	Malay	left unilateral complete cleft lip and palate	2 months
2	M	8	Malay	right unilateral complete cleft lip and palate	1 ½ years
3	M	8	Indian	right unilateral complete cleft lip and palate	5 months
4	F	9	Malay	left unilateral complete cleft lip and palate	3 months
5	M	8	Malay	right unilateral complete cleft lip and palate	4 months
6	F	10	Malay	right unilateral complete cleft lip and palate	6 months
7	M	9	Indian	left unilateral complete cleft lip and palate	10 months
8	M	9	Malay	right unilateral complete cleft lip and palate	7 months
9	F	7	Malay	left unilateral complete cleft lip and palate	7 months

Table 4.1 Continued

10	M	7	Malay	bilateral complete cleft lip and palate	2 months
11	M	11	Malay	isolated cleft palate	1 month
12	F	12	Malay	left unilateral complete cleft lip and palate	8 months
13	M	10	Indian	isolated cleft palate	1 year
14	F	9	Malay	left unilateral complete cleft lip and palate	2 months
15	M	12	Malay	left unilateral complete cleft lip and palate	3 months
16	F	9	Malay	bilateral complete cleft lip and palate	6 months
17	M	12	Chines e	right unilateral complete cleft lip and palate	5 months
18	M	9	Malay	left unilateral complete cleft lip and palate	8 months
19	F	10	Malay	isolated cleft palate	1 year
20	M	7	Malay	left unilateral complete cleft lip and palate	10 months

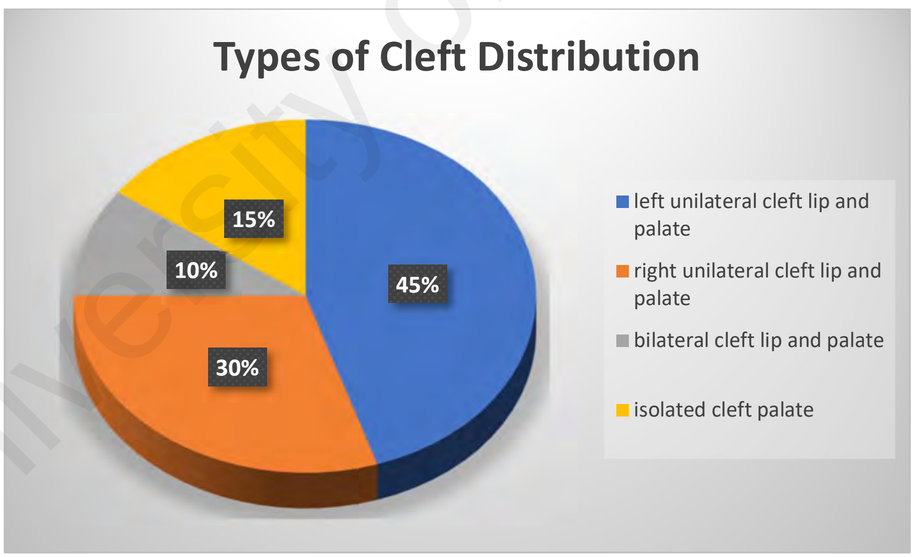


Figure 4.1: Types of cleft distribution among subjects

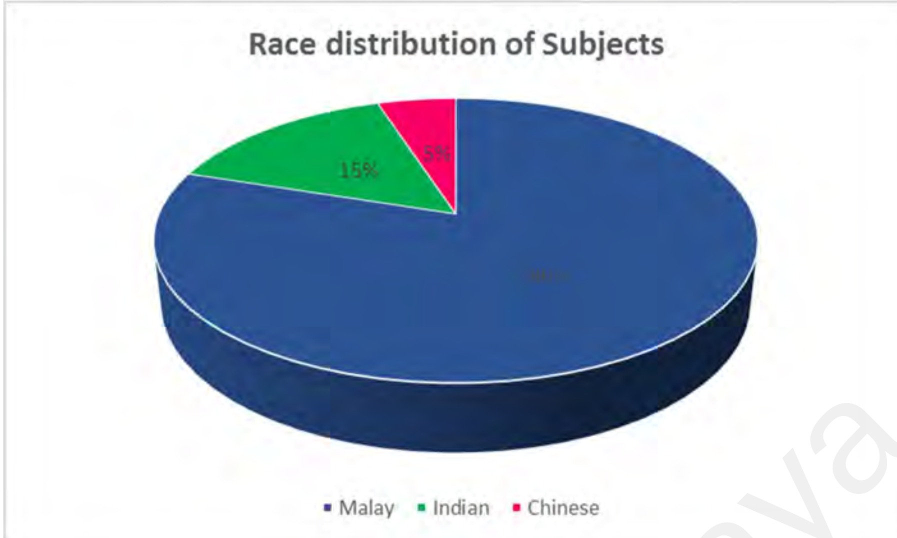


Figure 4.2: Race distribution among subjects

4.2 Intra-rater and Inter-rater Reliability

For inter-rater and intra-rater reliability, intra-class correlation coefficients (ICC) were calculated. Intra-listener and intra-listener reliability was verified using a two-way fixed model with consistency agreement (ICC (3,1)) using SPSS software version 23.0 (SPSS Inc., IBM PC version). The levels of agreement were assessed based on Cicchetti (1994), which is, excellent: 0.75–1.00, good: 0.60–0.74, fair: 0.40–0.59, poor: <0.40.

For both the untrained listeners, (Listener 1& Listener 2), the assessment was repeated one month later, and the ICC levels of agreement were found to be excellent for both listeners at hypernasality assessment in both speaking and singing tasks. Reliability results for audible nasal emission displayed 'excellent' agreement in speech assessment for Listener 1 and 'good' for Listener 1's singing assessment as well as for both task assessments for Listener 2.

4.3 Intra-rater Reliability Test for the Untrained Listener

Table 4.2: Intra-rater hypernasality ICC values for Listener 1 & Listener 2

Listener 1	ICC Values	95% CI	Level of Agreement
Speaking	0.903	0.772-0.960	Excellent
Singing	0.952	0.883-0.981	Excellent
Listener 2	**ICC Values**	**95% CI**	**Level of Agreement**
Speaking	0.852	0.634-0.939	Excellent
Singing	0.919	0.808-0.967	Excellent

Table 4.3: Intra-rater audible nasal emission ratings for Listener 1 & Listener 2

Listener 1	ICC Values	95% CI	Level of Agreement
Speaking	0.771	0.507-0.902	Excellent
Singing	0.638	0.283-0.839	Good
Listener 2	**ICC Values**	**95% CI**	**Level of Agreement**
Speaking	0.822	0.603-0.925	Good
Singing	0.831	0.623-0.930	Good

4.4 Inter-rater Reliability Test

Interrater reliability test for the trained listeners were assessed in comparison to the speech therapist ratings.

Table 4.4: Inter-rater hypernasality and audible nasal emission ICC values in comparison with Listener 5

	Speech sample	Listener 1 & Listener 5		Listener 2 & Listener 5		Listener 3 & Listener 5		Listener 4 & Listener 5	
		ICC value	95% CI	ICC values	95% CI	ICC values	95% CI	ICC values	95% CI
Hypernasality	Speaking	0.629	0.063-0.853	0.758	0.390-0.904	0.78	0.443-0.913	0.525	0.200-0.812
	Singing	0.589	0.038-0.837	0.596	0.020-0.840	0.813	0.528-0.926	0.629	0.063-0.853
Audible Nasal Emission	Speaking	0.147	-1.155-0.662	0.192	-1.042-0.680	0.556	-0.122-0.842	0.079	-1.328-0.635
	Singing	0.258	-0.874-0.706	0.047	-1.407-0.623	0.552	-0.132-0.823	0.502	-0.257-0.803

Table 4.5: Inter-rater levels of agreement in comparison with Listener 5

	Hypernasality Ratings	Audible nasal emission Ratings
Listener 1 & 5	**Level of Agreement**	
Speaking	Good	Poor
Singing	Fair	Fair
Listener 2 & 5	**Level of Agreement**	
Speaking	Excellent	Poor
Singing	Good	Poor
Listener 3 & 5	**Level of Agreement**	
Speaking	Excellent	Fair
Singing	Excellent	Fair
Listener 4 & 5	**Level of Agreement**	
Speaking	Fair	Poor
Singing	Good	Fair

The level of agreement of hypernasality ratings scored by the speech therapist were generally 'excellent' and comparatively 'good' in all listeners and tasks except for Listener's 1 singing assessment and Listener 4's speaking assessment which both rated 'fair'. However, audible nasal emission ratings were displayed to be generally 'fair' and 'poor' as compared to the speech therapist among all listeners.

4.5 Comparison of Mean Hypernasality and Audible nasal emission Ratings among all Subjects

All subjects showed a mean reduction in hypernasality ratings on singing as compared to speaking. As all data were assessed by the Shapiro-Wilk W test ($p>0.05$), a paired sample t-test was conducted to compare the mean hypernasality ratings of all listeners in the speaking and singing tasks. There was a highly significant difference in the scores of speaking (M=49.1, SD= 21.7) and singing (M=38.1 SD=19.7). These results suggest a reduction in hypernasality scores in singing, (M= 10.1, SD= 5.9) p= 0.000. Specifically, results suggest that when a cleft palate patient sings, their hypernasality reduces.

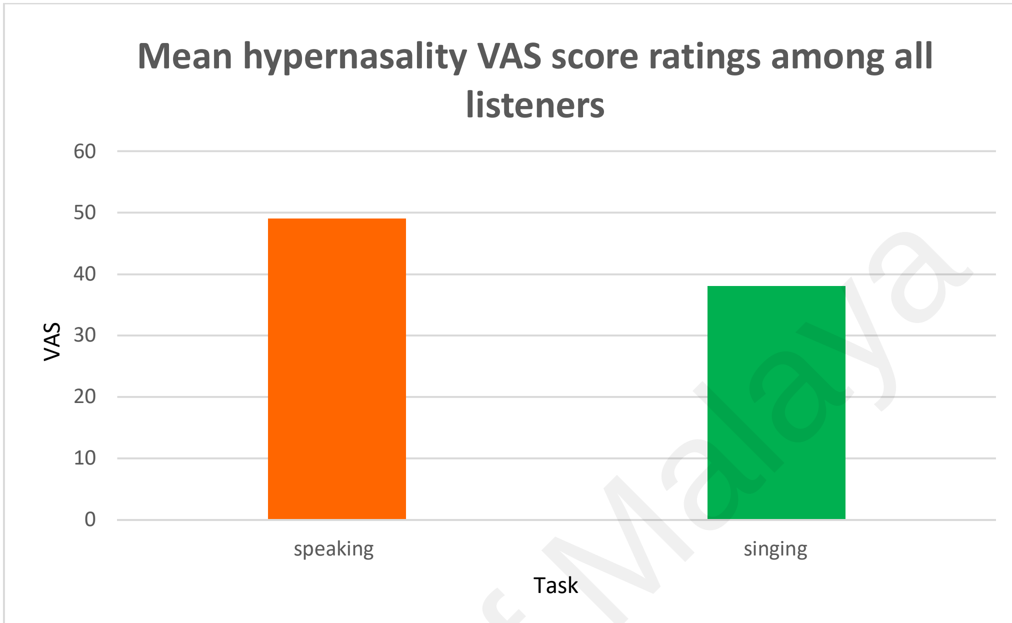


Figure 4.3: Mean hypernasality VAS score ratings among all listeners

For audible nasal emission, the data is also normally distributed as assessed by the Shapiro-Wilk test ($p>0.05$). Thus, a paired sample t-test was conducted to compare mean audible nasal emission ratings each in speaking and singing. There was a highly significant difference in the scores of speaking (M= 45.1 SD=16.9) and singing (M= 34.9, SD=15.0). These results suggest a reduction in audible nasal emission scores in singing, (M=10.25, SD= 5.64) p= 0.000. Specifically, results also suggest that the audible nasal emission of a subject with cleft palate reduces when he/she sings.

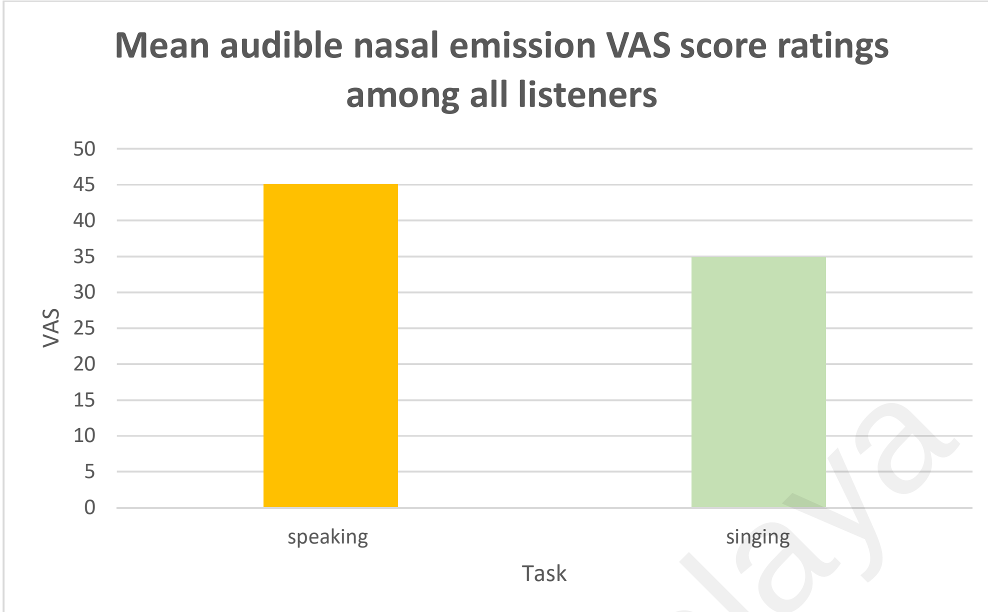


Figure 4.4: Mean audible nasal emission VAS score rating among all listeners

As all data entered were normally distributed and assessed by the Shapiro-Wilk W test, a paired t-test was conducted to compare the mean ratings of hypernasality and audible nasal emission of trained and untrained listeners. There were no significant statistical differences noted for hypernasality ratings p>0.005, between the means of trained and untrained listeners. However, the differences in ratings for audible nasal emission among trained and untrained listeners for both tasks were statistically significant.

Table 4.6: Hypernasality Assessment among Trained and Untrained Paired Samples Statistics

		Mean	Std. Deviation	mean differences with 95% CI	p values
Speaking assessment	Untrained	48.245	29.54378	-1.417(-10.406-7.573)	0.745
	Trained	49.6617	18.6607		
Singing assessment	Untrained	33.2075	27.36647	-8.149 (-17.237- 0.940)	0.076
	Trained	41.3563	17.4581		

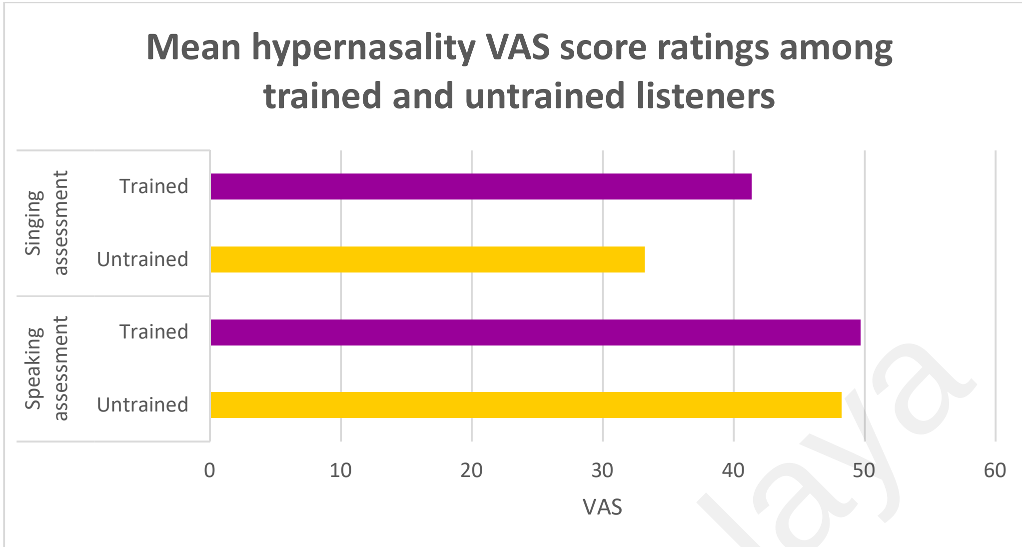


Figure 4.5: Mean hypernasality VAS score ratings among trained and untrained listeners in assessment of speech and singing.

Table 4.7: Audible nasal emission assessment among trained and untrained paired samples statistics

		Mean	Std. Deviation	mean differences with 95% CI	p values
Speaking assessment	Untrained	34.9000	22.86896	-17.083(-26.222-(-7.943))	0.001
	Trained	51.9833	16.88090		
Singing assessment	Untrained	24.5250	18.98717	-17.292(-24.584-(-9.993)	0.000
	Trained	41.8170	15.28959		

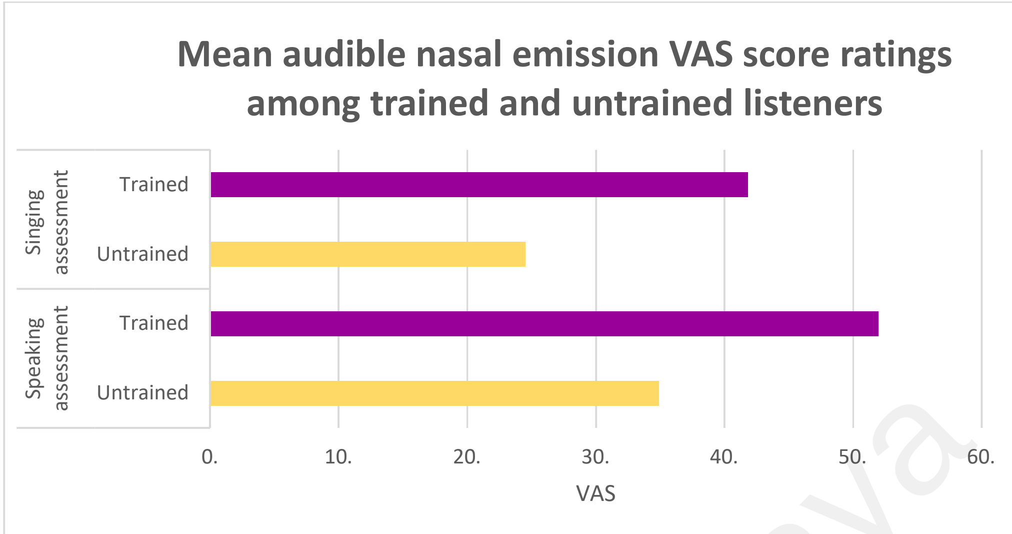


Figure 4.6: **Mean audible nasal emission VAS score ratings among trained and untrained listeners**

Both trained and untrained listeners gave lower ratings of hypernasality and audible nasal emission scores for singing as compared to speech ratings. Untrained listeners also rated hypernasality and audible nasal emission of the children with cleft palate (for both singing and speaking) in a much lower scale as compared to trained listeners.

4.6 Comparative Hypernasality Ratings Data of Paired Sample Test

Table 4.8: Comparative mean hypernasality ratings data of paired sample test of all listeners

		Mean	Std. Deviation	Mean differences with 95% CI	p values
Listener 1	Speaking	46.1150	29.13647	11.28 (7.370-15.190)	0.000
	Singing	34.8350	26.18451		
Listener 2	Speaking	50.3750	31.75104	18.8 (10.291-27.300)	0.000
	Singing	31.5800	29.99775		
Listener 3	Speaking	55.5000	22.93584	11.950 (6.998- 10.291)	0.000
	Singing	43.5500	21.83786		
Listener 4	Speaking	57.4350	25.07138	3.84 (1.136- 6.552)	0.008
	Singing	53.5910	23.43844		
Listener 5	Speaking	36.0500	23.79623	9.122 (4.462- 13.781)	0.001
	Singing	26.9280	19.96150		

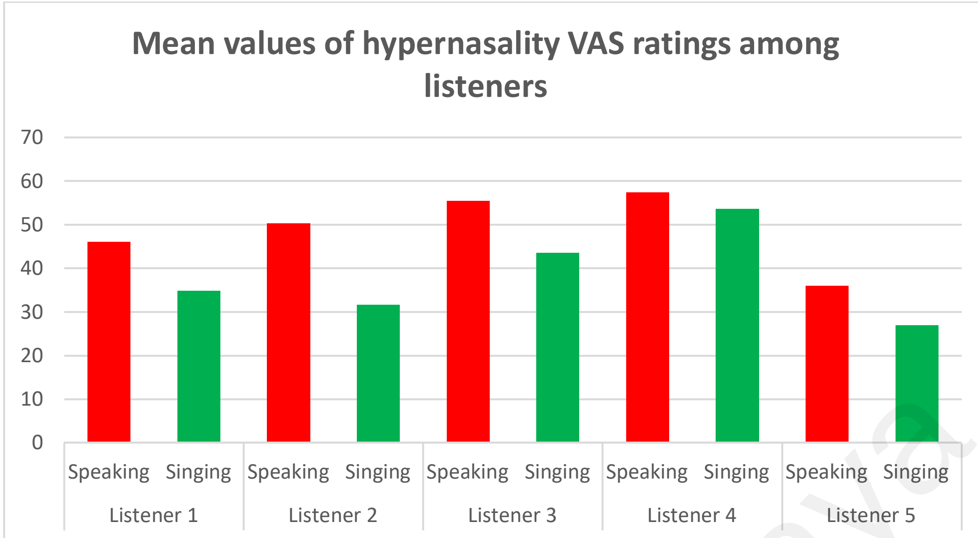


Figure 4.6.1: Mean VAS values of hypernasality ratings of each listener's assessment of all speakers in speaking and singing.

4.7 Comparative audible nasal emission Ratings of Paired Sample Test

Table 4.9: Comparative mean audible nasal emission rating data paired sample test of all listeners

		Mean	Std. Deviation	Mean differences with 95% CI	p values
Listener 1	Speaking	34.0000	24.29858	7.3 (4.086-10.514)	0.000
	Singing	26.7000	22.55076		
Listener 2	Speaking	35.8000	22.81874	13.45 (6.734-20.167)	0.000
	Singing	22.3500	17.14727		
Listener 3	Speaking	57.9000	24.28536	13.8 (3.793-5.861)	0.002
	Singing	44.1000	21.75921		
Listener 4	Speaking	55.3000	23.90353	2.3 (-0.790-5.390)	0.136
	Singing	53.0000	22.72722		
Listener 5	Speaking	42.7500	24.94599	14.4 (6.312-22.488)	0.001
	Singing	28.3500	16.86252		

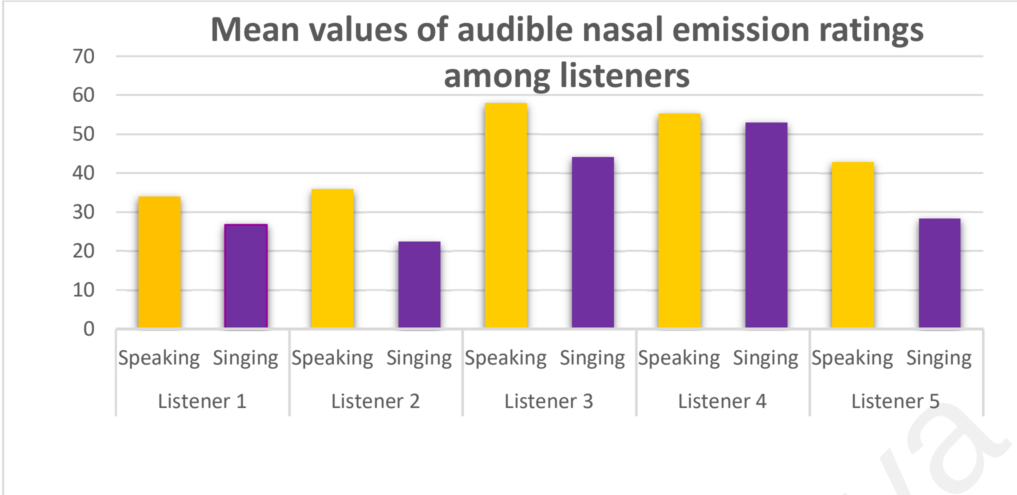


Figure 4.7: Mean VAS values of audible nasal emission ratings of all speakers in speaking and singing.

All listeners' assessment of the cohort showed a significant reduction in both the task of speaking and singing for both hypernasality and audible nasal emission assessment with a $p<0.005$ except for Listener 4. Although Listener 4's assessment showed a reduction for hypernasality and audible nasal emission in singing as compared to speaking, the ratings were statistically not significant as the results showed $p= 0.008$ and $p=0.136$ for each task.

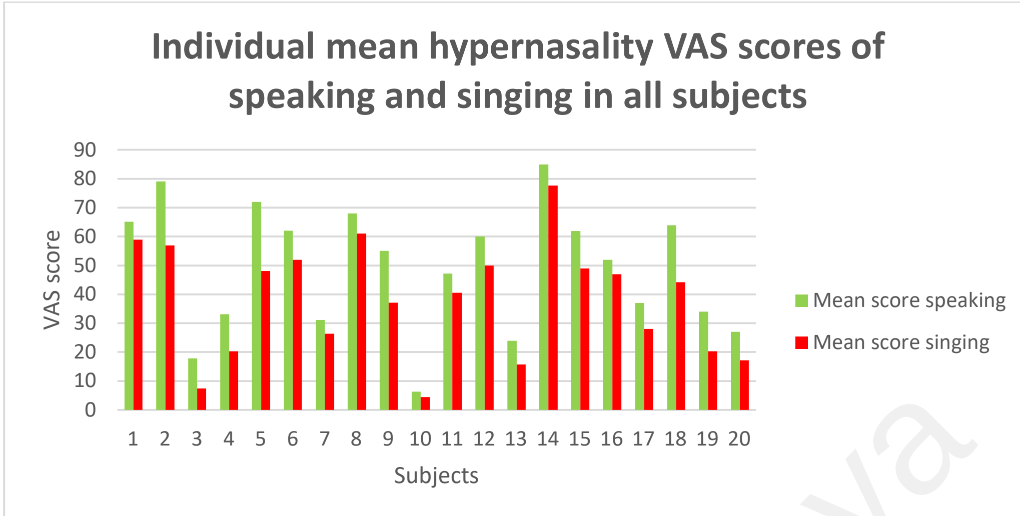


Figure 4.8: **Individual mean of hypernasality scores of all speakers on speaking and singing**

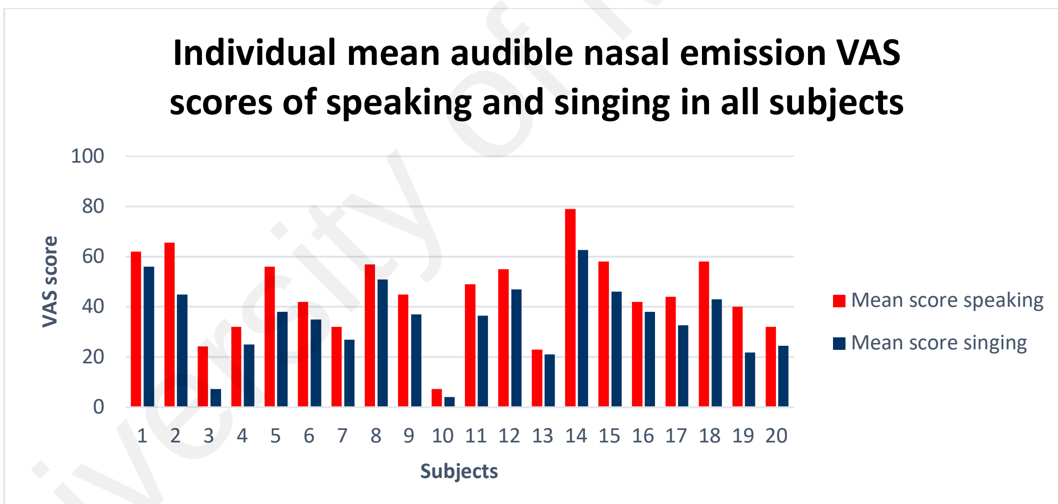


Figure 4.9: Individual mean audible nasal emission scores of all speakers on speaking and singing

All individuals demonstrated a reduction in hypernasality and audible nasal emission when they sang as opposed to speaking.

CHAPTER 5: DISCUSSION

Hypernasality is a difficult problem experienced by many children with cleft palate even following post primary repair of the palate. Fortunately, speech therapy has been an accepted line of treatment in the management of post-repair cleft palate cases. Generally, this study has revealed that hypernasality among children with cleft palate reduces during singing compared to speaking.

Kummer (2013) mentioned in her book, *Cleft Palate & Craniofacial Anomalies (2013)*, that the VP port closes longer and tighter during the act of singing compared to speaking. However, the finding was referred to a separate study done by Austin (1997), who compared velum movement in speaking and singing among classically trained singers and not individuals with cleft palate. Thus, this study is the first cross-sectional observational study which attempts to prove a reduction in hypernasality and audible nasal emission among individuals with cleft palate when they are singing as compared to speaking and the outcome has been favourable.

5.1 Demographic Data

Since there have been no academic studies about this topic and considering the preliminary nature of study, a sample size of 20 individuals is regarded as suitable for a pilot study. According to the literature, a sample group of 10 - 30 or 5-10% of the future project's sample size is adequate for a pilot study (Connelly, 2008; Isaac, 1995).

This study captures an age range of 7-12 years of age, with the mean age of 9 years old. This age group was chosen because at this age, the child is fairly independent and confident in speech and is also able to follow directions and commands which is necessary in this study.

5.2 Trained and Untrained Listeners' Assessment

Hypernasality and audible nasal emission is the most typical presentation of a VP dysfunction. In this study, the detection and assessment of its severity was carried out by untrained and trained individuals equipped with just the human ear.

Untrained listeners are individuals who interact with children with cleft palates and are aware of this abnormality but are not involved in its assessment and grading, whereas trained listeners are professionals involved with speech and singing assessment and detection of abnormalities of speech in daily life.

5.2.1 Intra-rater and Inter-rater Reliability of the Untrained Listeners.

Both the untrained listeners showed good and excellent intra-rater reliability of hypernasality and audible nasal emission. This shows that lay people are able to identify speech defects and are consistent in their judgement. The untrained listeners fared well in assessing hypernasality compared to the speech therapist except for Listener 1, who had poor interrater agreement with the speech therapist for the assessment of the singing task. This could be because she was not well versed in the field of singing as she had no experience in singing, being a homemaker and does voluntary work. On the other hand, Listener 2 has had piano lessons when he was younger.

5.2.2 Inter-rater Reliability of the Trained Listener

When a listener listens to a speech sample, internal standards in them, which have developed through experience and exposure to similar conditions, are used in comparison to analyse its severity. These internal standards which develop over time are preserved in the memory of each individual and differ from one listener to another (Kent, 1996; Keuning, Wieneke & Dejonckere,1999; Lee, Whitehill, & Ciocca, 2009; Oliveira, Scarmagnani, Fukushiro, & Yamashita, 2016).Listener 4, who is a linguistic expert, disagreed with the speech therapist when analysing hypernasality in speaking. Listener 4's assessment also did not show significant statistical changes of hypernasality and audible nasal emission reduction of children with cleft palate singing compared to speaking. This could be due to her internal standards, which could have been influenced by external factors such as articulation, vocal intensity and phonetic context, which were not in accordance with the speech therapists. As stated in the literature (Keuning et al., 1999; Lee et al., 2009), listeners often use their personal criteria and standards in auditory perceptual assessment of hypernasality and audible nasal emission. Therefore, their ratings are occasionally not in consensus (Oliveira et al., 2016).

All listeners fared poorly in the assessment of audible nasal emission as compared to the ratings of the speech therapist, consistent with the findings of Persson et al. (2006) who found low levels of reliability ratings of audible nasal emission. This is probably due to the listeners' unfamiliarity with the audible nasal emission assessment. Brunnegard et al. (2009) mentioned that audible nasal emission has to be very prominent and obvious before someone reports it as an abnormality.

5.2.3 Comparison between the Trained and Untrained Listeners' Ratings

This study also reported no significant differences between ratings of trained and untrained listeners which incidentally, is similar to the findings of Brunnegard et al. (2012) , which reported agreements in these two groups of listeners.

In this study, untrained listeners also tend to give lower ratings in all components of assessment compared to the trained listeners. This is probably caused by their lack of exposure and training in this field of speech, therefore their level of acceptability tends to be lower since they are inclined to be lenient in their assessment. Although they were not in agreement on the nasality ratings, they did agree on the ranking of the severity of the speakers similar to the findings of Brunnegard et al. (2009).

5.3 Differences between Speaking and Singing

The statistical findings indicated a highly significant difference in hypernasality among cleft palate patients during singing compared to speaking, therefore rejects the null hypothesis. Nasality ratings and audible nasal emission ratings seemed to be lower when singing compared to speaking among children with cleft palate. Singing is a pneumatic activity comparable to speaking. Its physiological movement can be considered similar to speaking. However, pneumatic activities such as blowing and sucking have a different levator activity as compared to speech which is neither rapid nor accurate (Nohara et al., 2007). Singing can be considered a form of connected speech comprising of different pitches and glissandos.

5.3.1 Anatomical Differences in Speaking and Singing

In a study by Yanagisawa et al. (1991), research was conducted on nine professional singers using a dual endoscopic study which showed that regardless of the singer's voice range in the highest fundamental frequency, the lateral pharyngeal walls contracted significantly towards the midline forming an "upside down V shape" creating a very narrow pharyngeal tube lifting the soft palate and narrowing the VP port considerably. Movement of the lateral pharyngeal wall compensates the limited movement of the often scarred, fibrosed and short velum in a cleft palate child as highlighted by Woo (2012). Through this study, we can cautiously assume that this mechanism from the act of singing itself produces a desirable effect in hypernasality reduction.

Another postulated theory in decrease of hypernasality during singing compared to speech is in accordance with the recent study by Nair et al. (2016). Through MRI images, this study could demonstrate that the act of the low mandible manoeuvre performed in singing which increases resonance maintains a more sustained and closer contact of the velum to the posterior and lateral pharyngeal walls.

5.3.2 Effect of Vowel production on the VP Complex during Singing

The most salient difference between speaking and singing is vowel duration. Melodies in songs are carried by vowels. Jones (1971) discovered that when the VP port is open during singing, the quality of the vowel produced is altered and is less preferred than those produced when the VP port is closed. This study emphasized a high affiliation between closure of the VP port and the preference in quality of singing. Austin (1997), emphasized that when singing the VP port is closed longer and tighter.

5.3.3 Vowel Height

As speech rate increases, vowel height decreases and the closure of the VP port becomes less firm as it is difficult to achieve closure of the VP with inadequate height (Moll, 1962). This is known as velar fatigue and speakers would start to sound hypernasal. Singing exaggerates consonants and sustains vowels at a greater height for a longer duration as compared to speaking (Cohen, 1994). According to a theory by Finkelstein et al. (1993), if there's more effort placed to achieve a tighter VP closure, there is progressive muscle recruitment to obtain a better seal at the VP complex as seen in this study.

5.3.4 Tone and Pitches in Singing

Singing naturally occurs at a higher tone compared to speaking. Previous studies have reported that velar elevation increases as the frequency of the pitch increases (Austin, 1997; Birch et al., 2002; Yanagisawa et al., 1991).Austin (1997) mentioned that by increasing the fundamental frequency (F0), nasal resonance is removed and the sound produced is of greater quality. Fowler and Morris (2007) suggested that untrained singers should lift their velum higher whenever they could not achieve the targeted musical tone.

As one sings, they learn to control their breath to sing the lyrics following the variable pitches in a song. Singing involves rapid and forceful inspirations, followed by extended expirations to sustain notes, leading to higher vocal intensity and vocal control than speaking (Natke, Donath, & Kalveram, 2003; Tonkinson, 1994). This explains the reduction of frequency of audible nasal emission demonstrated in this study.

Singing also stimulates musculatures involved in phonation, respiration, articulation as well as resonance (Wan, Rüüber, Hohmann, & Schlaug, 2010). By singing songs at different tempos and by exaggerating consonants, abnormal speech rates as well as speech intelligibility improves (Cohen, 1994). This indirectly reduces hypernasality and audible nasal emission perceptible in cleft palate patient as described in this study.

Another reason that could perhaps explain these findings is based on a study by Warren, Dalston, and Mayo (1993) who discovered that subjects with cleft palate compensate for the loss of pressure through the VP orifice by increasing the intraoral pressure through increasing their lung output. This helps improve speech intelligibility. Singing utilizes great respiratory pressure which is produced by diaphragmatic-intercostal breathing which expands the lower back ribs to aid the diaphragm to produce the required tone (Haneishi, 2001).

In singing, similar to speech, movements have to be precise, quick and accurate as discussed by Hardin-Jones et al. (2006). The actions of each muscle, structure and phoneme is influenced by another muscle, structure and phoneme which form a continuum (Kollia, Gracco, & Harris, 1995). Therefore, there must be good synchronization between every component involved. Songs are led by tunes and melodic schema, which require harmonization in maintaining rhythm as well as accurate pronunciations of the lyrics. Thus, the integrity of the VP in singing cannot be overemphasised.

A highly significant difference was also seen in audible nasal emission of cleft palate children on singing as compared to speaking. Frequency of audible nasal emission also seems to be reduced in singing as compared to speaking. This is because audible nasal emission is usually present in short utterance but in order to maintain the melody of a song, the utterance is longer and the respiratory output is more thus reduces the need to take more breaths to replenish air that is lost (Kuehn & Moller, 2000; Peterson-Falzone, Hardin-Jones, & Karnell, 2010).

5.4 Assessment Tool

The VAS scoring system, which was used in this study, has been beneficial since it gives flexibility to the listeners. It has led to a wider range of statistical analysis options with higher power and reliability (Grant et al., 1999; Reips & Funke, 2008). VAS was shown to be easy to use by the untrained lay person and managed to yield bountiful information for this study.

5.5 Limitations of this Study

This study was carried out under various limitations. The most significant of all was time constraint and patient compliance. If the study was carried out for a longer time period, singing training could be provided to the participants of the study and they could be categorized based on their voice range. Measurements of the differences of hypernasality and audible nasal emission during the act of speaking and singing also could not be measured objectively due to lack of sophisticated equipment in this country such as the one third octave spectral analysis and vocal low tone high tone ratio measuring instrument.

The issue of patient compliance was due to the various commitments of school going children and parents were also a hindrance in obtaining a larger sample. Therefore, a closer collaborative effort together with the CLAPAM organization could be done with other on-going cleft clinics and speech therapy sessions to reach out to these cleft children. Perhaps listener training, which was not provided in this study, could also be done to calibrate ratings among trained listeners and untrained listeners. Intra-rater listener reliability testing for trained listeners can also be carried out to produce more accurate and reliable ratings in assessment of hypernasality and audible nasal emission.

As no imaging tools such as radiographs or videofluoroscopy were used in this study, the patterns of closure of the VP complex of the cleft children while they were singing compared to when they were speaking cannot be determined. With these additional investigations in future research, expected outcomes can be further strengthened.

CHAPTER 6: CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This is a preliminary pilot study, which assesses hypernasality in singing among cleft palate individuals, and the results have fulfilled the objectives. This study demonstrates a reduction in hypernasality when a subject with cleft palate sings as compared to speaking. However, the theories behind the reduction of hypernasality and the actual mechanism involved can only be speculated as this study is based merely on auditory-perceptual judgement.

6.2 Recommendations

Yules (1970) believed that training palatal muscles might be beneficial in treating VP incompetence in certain individuals. Cole (1971) suggested that muscle training of the palate and/or pharyngeal muscles go hand in hand with surgical and prosthodontic management and advocates 3 types of muscle training which are direct, semidirect and indirect training. Direct muscle training includes electrical stimulation of the muscles at the VP port, semidirect muscle training include non-speech activities of the VP muscles and indirect muscle training involve the VP complex but the actual treatment does not focus on the VP muscles.

In the past, blowing, swallowing, whistling and playing a wind instrument has long been advocated as a semi direct muscle training therapy, with hopes of speech improvement (Moser, 1942). However, previous studies has proven that these exercises are ineffective as it is not speech related (Moll, 1965). Singing on the other hand, has never been incorporated as one of these exercises. It can be categorised as a form of speech as it does consist of speech components such as glottal stops, plosives, and fricatives entirely different as compared to non-speech activities (Kummer, 2011).

As the VP complex consists of muscles and muscles require regular training to build and become toned, findings from this study could be utilized in composing an easy-to-follow children's song consisting of mainly oral phonemes. By using music and songs, the attention of a child can be diverted away from boring monotonous speech exercises. The song can then be taught to parents, teachers and the children themselves for daily practice. This would be a fun yet effective way of speech therapy in correction of VP mislearning. Different songs similar to the composition of the speech passage used in regularly in speech therapy practices can be composed with the assistance of a speech therapist and musician.

Singing combines different frequency range according to one's desired rhythm and melody as it is a natural pathway for human expression. This provides an avenue for people with limited or abnormal vocal resonance such as cleft palate to expand their vocal range (Cohen, 1994). Rhythm, which is presented in a musical format, like a melodic phrase, may be easier to imitate and maintain than the rhythm of isolated speech. People with abnormal rates of speech might benefit from practicing song lyrics at a tempo, which approximates their desired speech rates. An individual must have sufficient vocal intensity to project both speech and song in an intelligible manner. For most individuals, a song sung would have the capacity to project farther than a spoken sound due to the periodic vibration and duration of the vowel sounds.

Regular singing opportunities could help to increase the vocal volume of patients who speak too softly. This a common feature of cleft children as they confidence and often being isolated due to their deformity. A person's diction must be executed correctly if the words are to be understood. For song lyrics to be intelligible, the consonants must be exaggerated over what is required for normal speech. People with insufficient verbal intelligibility, such as children with cleft palate might benefit from vocal exercises that emphasize consonant articulation.

On a side note, nothing like vocal training can boost one's self-esteem and confidence, which is lacking among cleft children. Singing can serve as an alternative or supplement speech therapy as it provides a different form of communication (Ogden, 1982). As singing requires a much lower speech and language capability compared to speech, anyone can pick up a musical tune and master it (Goldstein, 1948).

Nevertheless, there is still much to be learnt regarding hypernasality and the VP complex system in singing. A thorough understanding of its movements and coordination system would be beneficial in managing this clinical problem. For future study, an MRI assessment of the function of cleft palate individuals would be invaluable for visualization for the VP in function and comparison of measurements of the velar stretch as well as amounts of constrictions of the pharyngeal walls on singing as compared to speaking. Usage of quantitative acoustic measuring tools such as 1/3 octave spectral analysis and vocal low tone high tone ratio, can be also considered to supplement perceptual judgement in assessment of hypernasality and audible nasal emission (Vogel et al., 2009).

APPENDIX A

<u>ASSESSMENT FORM</u>

Study Title: Hypernasality in singing; A preliminary study

Subject number: ______________________

Task: ☐ Speaking ☐ Singing (Please mark accordingly)

Please listen to the speech and singing samples for the subject stated above NOW. You may listen the recordings for each sample up to 3 times. You should listen for BOTH hypernasality and audible nasal emission as you listen to the samples.

First, please rate the Severity of Hypernasality below. Please move the block on the line to indicate your ratings somewhere between 1 = Normal (no hypernasality) and 100 = Severe Hypernasality.

Severity of Hypernasality

Normal (1) Severe (100)

Now, please rate the frequency of audible nasal emission (including nasal turbulence) for the same sample. Please move the block on the line to indicate your ratings somewhere between 1 = Absent (none) and 100 = Very frequent

Frequency of Audible nasal emission

Absent (1) Very Frequent (100)

APPENDIX B

THE *'KAMPUNG'* PASSAGE

Semasa saya masih kecil saya tinggal di kampung bersama nenek. Ayah dan emak tinggal di bandar. Abang dan adik saya tinggal bersama ayah dan emak. Setiap minggu saya dan nenek pergi ke rumah ayah.

Jika kami tidak ke sana, ayah, emak, abang dan adik datang menziarahi kami di kampung. Saya gembira apabila mereka datang kerana saya boleh bermain bersama-sama abang dan adik. Di belakang rumah nenek ada sebatang sungai. Abang sangat suka mandi di sungai, begitu juga saya tetapi adik tidak boleh bermain di sungai. Dia masih kecil dan belum boleh berenang.

Setiap pagi, abang dan saya pergi ke sungai. Kadang-kadang kami lupa makan dan minum. Di tebing sungai itu ada sebatang pokok rambai. Abang suka memanjat ke dahannya yang rendah lalu terjun ke dalam air. Semasa dia dalam air, saya bimbang dia akan lemas. Mujurlah kepalanya sentiasa berada di atas permukaan air. Apabila melihat abang demikian, saya ketawa kegembiraan.

APPENDIX C

PATIENT INFORMATION SHEET

Please read the following information carefully. Do not hesitate to discuss any questions you may have with your doctor.

Study Title
Hypernasality in singing among cleft palate children– A preliminary study

Introduction
All children born with cleft palate are commonly known to have a speech defect known as hypernasality (too much airflow through nose) upon speaking. This is caused by their velopharyngeal dysfunction. The velopharyngeal region is situated in the throat. It is at the junction where your soft palate (velum) touches the back of your throat (pharynx). Its function is to close tightly to create oral pressure so your voice will not escape through your nose. This is called a Velopharyngeal Function (VPF).

Children who have velopharyngeal dysfunction may sound like they are "talking through their noses." Though the cleft palate in your child has been surgically repaired, this hypernasal speech phenomenon is known to persist. In most cases, your child would be undergoing speech therapy to further correct his/her speech.

However, it has been observed that this hypernasal voice which is present in a child upon speaking seems to become less apparent upon singing. To date, no studies have been done to prove this.

What is the purpose of this study?
This study is aimed to document the differences of hypernasality among cleft patients during speech and singing and also to improve our understanding of hypernasality in which may contribute in treating this clinical problem.

What are the procedures to be followed?
Firstly, your child will be screened and his/her voice range will be determined with glissando scales and repeated pitches after stimulation with a piano. Next, he/she will be grouped according to their voice group; soprano, mezzo. alto and base; Each participant will be guided through a series of phonatory exercise which includes sustained vowels, the reading text "The Kampung Passage" and singing the song 'Negaraku" at different octaves and sustained /a/ singing vowel. Professional digital audiotape recordings will be made of all subjects.

Who should not enter the study?
Patients excluded from this study are patients who:

- Have other medical conditions (except cleft palate) that effect speech and pharyngeal space
- Have a residual fistula post repaired cleft palate surgery
- Are mentally incapable/syndromic
- Have hearing loss
- Are non Bahasa Malaysia or English speaking patients

- Not able to follow simple musical notes

What will be the benefits of the study:

(a) To your child/you as a subject?
You will be able to have a baseline of the severity of your child's hypernasality upon speaking and singing while undergoing speech therapy.

(b) To the investigator?
This study will prove if there are any difference in hypernasality in a cleft palate child when compared during speaking and singing.

What are the possible drawbacks?

There are none.

Can I refuse to take part in the study?

Yes, you may refuse to take part or withdraw from this research and it will not affect your speech therapy.

Who shall I contact if I have additional questions during the course of the study?

Main and other investigators:

(1) Doctor's Name/Supervisor: Prof Dato Dr Zainal Ariff bin Abdul Rahman
Tel. No.: 0379674807
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(2) Doctor's Name/Supervisor: Dr Yap Jin Han
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(5) Doctor's Name/ Student: Dr Sabrina a/p Peter
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BORANG MAKLUMAT KEPADA PESERTA/ IBU/ BAPA/ PENJAGA

Sila baca maklumat berikut dengan teliti, dan sekiranya ada apa-apa soalan, sila bincangkan dengan doktor berkenaan.

Tajuk Kajian:

Hypernasality dalam nyanyian kanak-kanak rekah lelangit- kajian awal

Pengenalan:

Setiap kanak-kanak yang dilahirkan dengan masalah rekahan lelangit atau lelangit sumbing mengalami masalah suara sengau (terlebih udara memasuki rongga hidung) ketika suara dikeluarkan. Ini adalah disebabkan oleh keadaan ketidakupayaan *velopharyngeal* individu tersebut.

Velopharyngeal adalah terletak di tekak anda. Ia adalah di persimpangan di mana lelangit lembut anda (*velum*) menyentuh bahagian belakang tekak anda (*pharynx*). Fungsinya adalah untuk ditutup rapat bagi mewujudkan tekanan udara dalam mulut supaya suara anda tidak terlepas melalui hidung anda apabila bercakap. Ini dipanggil Fungsi *Velopharyngeal* atau *Velopharyngeal Function* (VPF).

Kanak-kanak yang mempunyai ketidakupayaan *Velopharyngeal* ini, akan kedengaran sengau. Meskipun masalah rekahan lelangit anak anda telah dirawat dengan pembedahan, sering kali didapati suara sengau anak anda akan masih lagi kedengaran dalam pertuturan harian. Dalam kebanyakan kes, anak anda akan diminta untuk menjalani latihan percakapan untuk memperbaiki pertuturannya.

Namun demikian, adalah didapati masalah suara sengau kanak-kanak ini yang jelas kedengaran semasa percakapan, didapati berkurangan semasa kanak-kanak tersebut menyanyi. Sehingga kini, tiada kajian yang pernah dibuat untuk membuktikan fenomena ini.

Apakah tujuan kajian ini?

Kajian ini bertujuan untuk merekodkan perubahan suara sengau pesakit rekahan lelangit semasa bertutur dan menyanyi dan juga meningkatkan pemahaman kita mengenai keadaan suara sengau ini agar kita dapat merawat masalah klinikal ini dengan lebih efektif.

Apakah langkah-langkah perlu diikuti?

Anak anda perlu disaring terlebih dahulu dan julat kumpulan suaranya akan ditentukan mengunakan skala 'glissando' dan ulangan kenyaringan. Ini akan dilaksanakan menggunakan stimulasi sebuah piano.

Kemudian, anak anda akan diklasifikasikan mengikut kumpulan suaranya sama ada soprano,mezzo, alto atau base. Setiap peserta akan dipimpin melalui sebuah siri latihan pertuturan termasuk bertutur bunyi vokal secara berterusan, bacaan text " The Kampung passage" dan menyanyi lagu "Negaraku" mengikut "octave" yang berbeza dan juga menyanyi bunyi vokal /a/ secara berterusan. Recording digital professional akan dibuat untuk setiap subjek.. Penilaian-penilaian tambahan ini tidak akan mengganggu peraliran rawatan latihan percakapan anda.

Siapakah tidak layak diterima untuk kajian?

Pesakit dikecualikan daripada kajian ini adalah pesakit yang:

- Mempunyai masalah kesihatan atau ketidaknormalan yang lain kecuali rekahan bibir dan lelangit yang member kesan kepada pertuturan dan ruang pharyngeal

- mempunyai masalah pemahaman/ mental
- kehilangan deria pendengaran
- tidak bertutur secara baik dalam Bahasa Malaysia dan Bahasa Inggeris yang mudah
- tidak dapat menyanyi nota muzikal yang mudah

Apakah manfaat kajian ini:

(a) Kepada anak anda/ anda sebagai pesakit?
Anda akan memperolehi rekod asas tahap permasalahan suara sengau anak anda dalam pertuturan dan nyanyian sambil menjalani rawatan latihan percakapan.

(b) Kepada penyelidik?
Kajian ini akan membuktikan jika terdapat apa-apa perubahan suara sengau pesakit rekahan lelangit semasa bertutur dan menyanyi.

Apakah halangan kajian ini?
Tiada

Bolehkan saya menolak dari menyertai kajian ini?
Ya, anda boleh menolak untuk mengambil bahagian atau menarik diri daripada kajian ini dan ia tidak akan menjejaskan rawatan latihan percakapan anak anda.

Siapakah patut saya berhubung sekiranya ada soalan tambahan sepanjang masa kajian ini?
Penyiasat utama dan penyiasat-penyiasat lain:

(1) Doctor's Name/Supervisor: Prof Dato Dr Zainal Ariff bin Abdul Rahman
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(2) Doctor's Name/Supervisor: Dr Yap Jin Han
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(4) Doctor's Name/Supervisor: Ms. Puspa Maniam
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Email address: mirrsha_83@hotmail.com

(5) Doctor's Name/ Student: Dr Sabrina a/p Peter
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KEIZINAN OLEH PESAKIT UNTUK PENYELIDIKAN KLINIKAL ***FAKULTI PERGIGIAN, UM, K.L.***

Saya, ………………………………………… No. Kad Pengenalan... ....

(Nama pesakit)

beralamat……………………………………………………………………………………………………

(Alamat)

dengan ini bersetuju menyertai dalam penyelidikan klinikal (pengajian klinikal/pengajian soalselidik/percubaan ubat-ubatan) disebut berikut:

Tajuk Penyelidikan : *Hypernasality* dalam nyanyian kanak-kanak rekah lelangit– Kajian awal

yang mana sifat dan tujuannya telah diterangkan kepada saya oleh

Dr………………………………………………….…...... mengikut terjemahan

(Nama & jawatan doktor)

…………………………………………………….... yang telah menterjemahkan kepada saya dengan

. *(Nama & jawatan penterjemah)*

sepenuh kemampuan dan kebolehannya di dalam bahasa/loghat…………………………………

Saya telah diberitahu bahawa dasar penyelidikan klinikal dalam keadaan metodologi, risiko dan komplikasi (mengikut kertas maklumat pesakit). Selepas mengetahui dan memahami semua kemungkinan kebaikan dan keburukan penyelidikan klinikal ini, saya merelakan/mengizinkan sendiri menyertai penyelidikan klinikal tersebut di atas.

Saya faham bahawa saya boleh menarik diri daripada penyelidikan klinikal ini pada bila-bila masa tanpa memberi sebarang alasan dalam situasi ini dan tidak akan dikecualikan dari doktor yang merawat.

Tarikh …………………………… Tandatangan/Cap jari…………………………………

(Pesakit)

DI HADAPAN

Nama …………………………………………………,

No. K/P ……………………………………………., Tandatangan ……………………………

(Saksi untuk tandatangan pesakit)

Jawatan …………………………………………........ Tarikh ....

Saya sahkan bahawa saya telah menerangkan kepada pesakit tentang sifat dan tujuan penyelidikan klinikal tersebut di atas.

Tarikh …………………………….... Tandatangan ………………………………………………

(Doktor yang merawat)

KEIZINAN OLEH PESAKIT UNTUK PENYELIDIKAN KLINIKAL

No. Pend.
Nama
Jantina
Umur
Unit

CONSENT BY PATIENT FOR CLINICAL RESEARCH ***FACULTY OF DENTISTRY, UM, K.L.***

I, ………………………………………………………Identity Card No. ………………………………
(Name of patient)

of………………………………………………………………………………………………………
(Address)

hereby agree to take part in the clinical research (clinical study) specified below :

Title of Study : Hypernasality in singing among cleft palate children - a preliminary study

The nature and purpose of which has been explained to me by Dr………………………………………
(Name & designation of doctor)

and interpreted by……………………………………… to the best of his/her ability in
(Name & designation of interpreter)

………………………. language/dialect.

I have been told about the nature of the clinical research in terms of methodology, possible adverse effects and complications (as per the patient information sheet). After knowing and understanding all the possible advantages and disadvantages of this clinical research, I voluntarily consent of my own free will to participate in the clinical research specified above.

I understand that I can withdraw from this clinical research at any time without assigning my reason whatsoever and in such a situation shall not be denied the benefits of usual treatment by the attending doctors.

Date …………………………… Signature or thumbprint……………………………………
(Patient)

IN THE PRESENCE OF

Name ………………………………………………,
I/C No. …………………………………………… Signature ……………………………………
(Witness for signature of patient)
Designation ………………………………………... Date ....

I confirm that I have explained to the patient the nature and purpose of the above mentioned clinical research.

Date …………………………..... Signature …………………………………………………..
(Attending doctor)

CONSENT BY PATIENT FOR CLINICAL RESEARCH	R.N. Name Sex Age Unit

KEIZINAN OLEH IBUBAPA PESAKIT UNTUK PENYELIDIKAN KLINIKAL

FAKULTI PERGIGIAN, UM, K.L.

Saya,………………………………No. Kad Pengenalan... ………………………………

(Nama ibu/bapa pesakit)

beralamat……………………………………………………………………. dengan

(Alamat)

ini membenarkan anak/tanggungan saya yang bernama ……………………………………………… untuk menyertai dalam penyelidikan

(Nama pesakit)

klinikal (pemeriksaaan klinikal dan latihan pertuturan) seperti tersebut di bawah:

Tajuk Penyelidikan : Hypernasality dalam nyanyian kanak-kanak rekah lelangit-kajian awal

Saya telah diterang mengenai dasar penyelidikan klinikal dari aspek metodologi, risiko dan komplikasi (mengikut borang maklumat pesakit). Selepas mengetahui dan memahami semua kemungkinan kebaikan dan keburukan penyelidikan klinikal ini, saya merelakan/mengizinkan anak saya menyertai penyelidikan klinikal tersebut di atas.

Saya faham bahawa anak saya boleh menarik diri daripada penyelidikan klinikal ini pada bila-bila masa.

……………………………….	……………………………………
Tarikh	**Tandatangan ibu/bapa**

CONSENT BY PATIENT'S PARENT FOR CLINICAL RESEARCH

FACULTY OF DENTISTRY, UM, K.L

I, …………………………… Identity Card No. ………………………………

(Name of patient's parent)

of ……………………………………………………………… hereby agree

(*Address)*

to allow my daughter/son named ………………………………………….. to

(Name of Patient)

take part in the clinical research (clinical examination and questionnaire) specified below:

Title of Study: Hypernasality in singing among cleft palate children- a preliminary study .

I have been told about the nature of the clinical research in terms of methodology, possible adverse effects and complications (as per the patient information sheet). After knowing and understanding all the possible advantages and disadvantages of this clinical research, I voluntarily consent of my own child to participate in the clinical research specified above.

I understand that my child can withdraw from this clinical research at any time.

……………………………   ……………………………………

Date   **Signature of Parents**

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