Speech Production Disorders Related to Cleft Palate and Velopharyngeal Inadequacy

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إضطرابات النطق الناتجة عن أنشقاش سقف الفم وقصور البناء البلعومي اللهاتي دراسة حالة

المستخلص

يُظهر المتكلمون المعتلون بإنشقاق سقف الفم إضطرابات لفظية مختلفة في النطق نتيجة للعوق العضوي الحاصل في سقف الفم وفي بناء المنطقة اللهاتية البلعومية. حيث تشمل هذه الإضطرابات الصوت والرنين والنطق. وتهدف هذه الدراسة لبحث الاداء اللفظي لطفلين عراقيين في سن التعليم الأبتدائي معتلين بإنشقاق سقف الفم، اذ لم تُبين حالات النطق الناتجة عن إنشقاق سقف الفم باللغة العربية إلا نادرا جدا (هاردن-جونز، ٢٠٠٩). إنَ هذا البحث يدرس أخطاء النطق المختلفة التي تظهر لدى الاطفال العرب المعتلين بإنشقاق سقف الفم نتيجة للعوق العضوي. وتصف هذه الدراسة أيضا أنماط النطق التعويضية التي يلجأ إليها هؤلاء المعتلون لتعويض القصور الحاصل في البناء اللهاتي البلعومي. فضلا" عن ماتقدم فهذه الدراسة تقارن هذه الأنماط مع تلك المستخدمة من قبل المتكلمين باللغة الانكليزية والمعتلين بإنشقاق سقف الفم وتقدم النتائج والملاحظات النهائية.

Abstract

Speakers with cleft palate show different speech production disorders due to the structural defect of the palate and the velopharyngeal mechanism. These disorders involve voice, resonance and articulation. The present study aims at investigating the speech performance of two school-age, Iraqi Arabic speaking children with cleft palate. Arabic cleft palate speech data are rare (Hardin-Jones, 2009, personal communication). Thus, this paper intends to study the different speech errors demonstrated by Arabic cleft palate speakers including resonance and articulation. It

describes the 'compensatory articulation patterns ' used by them to compensate for velopharyngeal inadequacy. In addition, it compares these patterns with the patterns used by English cleft palate speakers and offers some findings in addition to observations.

1. Introduction

Speech is a complex process that requires normal structure and function of speech articulators. Abnormal oral structure and function can affect speech development and speech intelligibility and results in different speech disorders. Cleft palate is among the most common craniofacial anomalies that may impair speech intelligibility. The handicap imposed by cleft palate is an abnormal mechanism that prevents normal speech and language. The area involved by this oral cleft is the alveolar ridge, hard palate and soft palate.

Normal production of speech sounds requires the coordinated activity of a number of articulators inside the vocal tract such as the lips, the tongue and the jaw. Of no less importance as an articulator is the *velopharyngeal mechanism***.** This mechanism plays a significant role in the process of coupling (connecting) and decoupling (disconnecting) the oral and nasal cavities; a process known as 'velopharyngeal valving’ (Hardin-Jones et al., 2001 : 69). Oral speech sounds require oral-nasal decoupling; while nasal speech sounds require oral-nasal coupling. Normal velopharyngeal closure for speech is an important aspect in developing correct speech sounds. Speakers with cleft palate, however, fail to achieve normal velopharyngeal closure for speech because of the opening in the roof of the mouth which prevents the soft palate to close off the space between the nasal and oral cavity. Failure to achieve normal velopharyngeal closure for speech has a direct impact on speech learning, speech production, speech intelligibility and speech quality. Consequently, speakers with cleft palate exhibit speech and language disorders of different types. In this study, however, the emphasis is on the speech production problems associated with cleft palate including resonance and sound articulation.

2. Theoretical Background: Physiology of the Palate and Velopharyngeal Mechanism

2.1 *The Palate* :

The palate is the roof of the mouth. It consists of two main parts: the hard palate and the soft palate (see figure 2.1). The hard palate forms the roof of the oral cavity and the floor of the nasal cavity (Cassell and Elkadi ,1995: 46). The outer part of the hard palate is called *the alveolar ridge.*

The soft palate lies behind the hard palate. It stretches across the nasopharynx to seal off the nasal cavity from the oral and pharyngeal cavities throughout most of the sequences involved in speech production. The anatomical name for the soft palate is *velum*. It is composed of several muscles and fibers all of which are attached to the posterior edge of the hard palate. The soft palate plays a decisive role in speech production. Fritzell (1979: 93) states that the primary function of the soft palate is dependent on the *levator veli palatini* muscle. The levator veli palatini arises from the skull and passes onto the upper surface of the soft palate. This muscle is primarily involved in the elevation of the soft palate (Cassell and Elkadi, op.cit: 49). Consequently, the movement of the levator veli palatini has a close relationship with the production of oral sounds and this relationship has been confirmed visually as well as electromyographically.

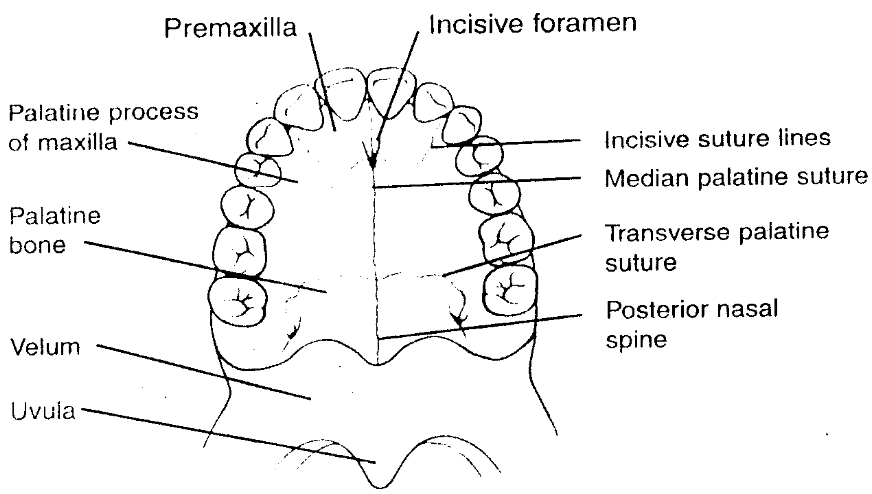

Figure 2.1. ***The bony structures of the hard palate. From Kummer (2001).***

Some speech pathologists (Dickson and Dickson, 1972; kuehn, 1979; Kriens, 1990) describe the palate as consisting of two main portions: the *primary palate*, or *premaxilla*, which

Fusion of these bones begins at the front (the premaxilla area) and extends backwards forming the roof of the mouth and the soft palate (see figure 2.2). Cleft palate results when the two halves of the palate fail to fuse with each other or with the premaxilla (Crystal and Varely, 1988: 212).

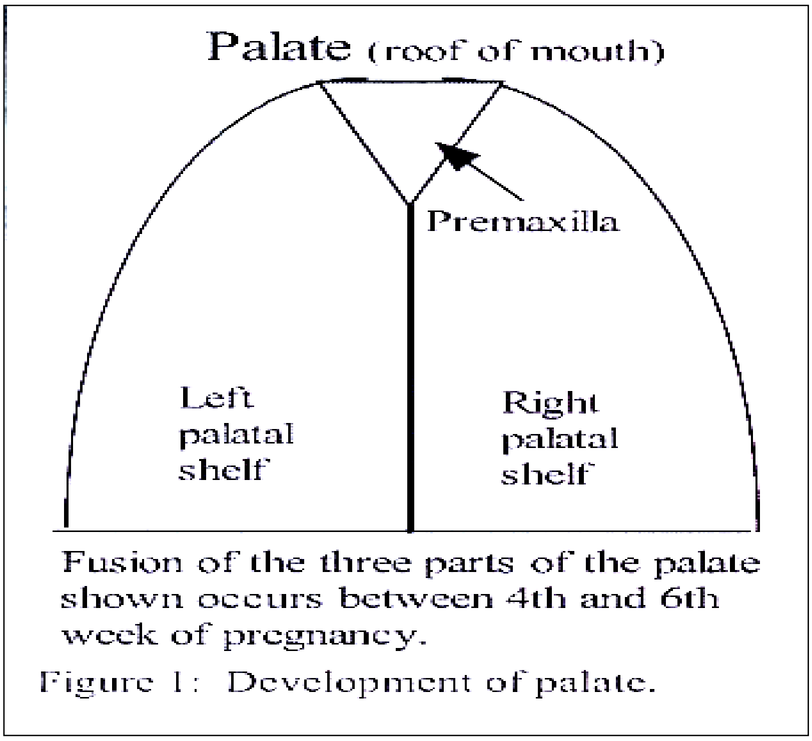

Figure 1: Development of palate.

Figure 2.2. ***Fusion of the palate.From Kenneth (2002).***

2.2 <u>Anatomy of the Velopharyngeal Mechanism</u>

By 'velopharyngeal mechanism' it is meant "the ***muscular valve that extends from the posterior surface of the hard palate to the posterior pharyngeal wall***." (Moon and Kuehn, 1997: 45). This mechanism involves the velum, the lateral pharyngeal wall and the posterior pharyngeal wall. It is situated in that portion of the vocal tract referred to as the *velopharynx*.

The pharynx is divided into two sections: the oropharynx and the nasopharynx. The oropharynx is that portion of the pharynx which lies at the level of the oral cavity; while the nasopharynx stretches above the oral cavity and posterior to the nasal cavity (Kummer, 2001: 12). The back wall of the pharynx is called *the posterior pharyngeal wall* and its side walls are called *the lateral pharyngeal walls*. The velopharynx acts as a valve closing off the nasal part of the upper respiratory tract, a function that it does during respiration. However, it plays a prominent role in the production of nasal and oral sounds by regulating the movement of air through and between the oral and nasal cavities (Cassell and Elkadi, op.cit: 45).

2.3 Physiology of the Velopharyngeal Mechanism :

Understanding the main physiological aspects of the velopharyngeal mechanism is necessary in the study of the effects of this mechanism on speech sounds production. The velopharyngeal mechanism consists mainly of three main parts: the velum, the lateral pharyngeal wall and the posterior pharyngeal wall.

2.3.1 The Primary Velopharyngeal Movements for Speech:

Normal velopharyngeal closure of speech is accomplished by the coordinated movements of the velum, the lateral pharyngeal walls and the posterior pharyngeal wall (Moon and Kuehn, op.cit). The velum plays an important role in the production of speech sounds. Its primary goal is that of closing and opening the nasal cavity for the production of oral and nasal sounds. Moon and Kuehn (ibid) report that there are two main velar movements relative to normal speech articulation. These movements include: velar elevation and velar lowering.

Elevation, or raising, of the velum comprises an important part in the production of most speech sounds. With this movement, the velum is raised to close off the nasal cavity for the production of oral sounds. In the lowering movement, the velum is moved away from the posterior pharyngeal wall to open the velopharyngeal mechanism for the production of nasal sounds. In addition, the velum has a rest position during normal breathing through the nose. Speakers with cleft palate, however, fail to achieve the two basic movements of the velum (raising and lowering) due to a deficiency in the velum muscular activity. The three positions of the velum are shown in Figure 2.3 below.

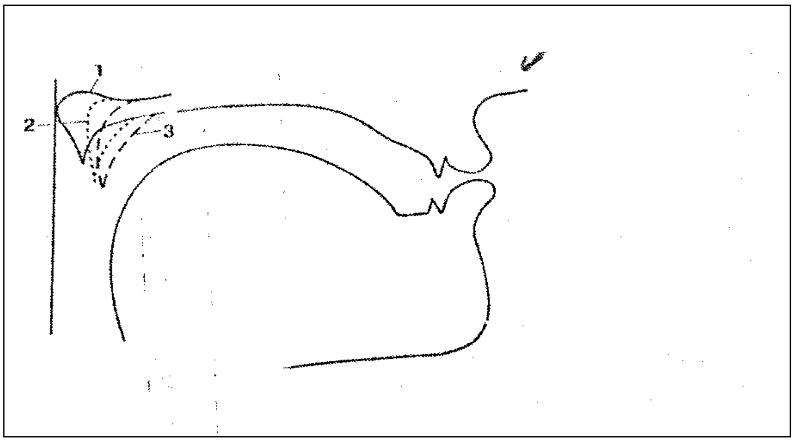

Figure 2.3. ***The movements of the velum presented by three positions: (1) for oral sounds, (2) for nasal sounds and, (3) for normal breathing. The velopharyngeal port is open for the positions (2) and (3). From Shriberg and Kent (1995).***

B. Movements of the Pharyngeal Walls:

Normal velopharyngeal function depends strongly on the combined activity of both the velum and the pharyngeal walls. The pharynx is a muscular tube extending from the base of the skull to the larynx (Dickson and Dickson, op.cit: 373). Two sides of the pharynx play a pervasive role in velopharyngeal closure: the lateral pharyngeal wall and the posterior pharyngeal wall (Hardin-Jones et al, op.cit; Bzoch, op.cit).

1. The Lateral Pharyngeal Wall Movement:

The lateral pharyngeal wall has been of interest to searchers largely for its contribution in the attainment of normal velopharyngeal closure. Shriberg and Kent (op.cit) claim that it is the combined activity of the velum elevation and the inward movements of the lateral pharyngeal wall of the pharynx that assist in velopharyngeal closure for speech (figure 2.4 A).

2. <u>The Posterior Pharyngeal Wall Movement</u>:

The posterior pharyngeal wall, on the other hand, has been assumed motionless during speech of normal people. Moon et al. (1994: 54) argue that in normal individuals, velopharyngeal closure for speech is achieved by elevating and constricting the walls of the velopharynx without the movements of the posterior pharyngeal wall.

However, the posterior pharyngeal wall is said to play a major role in the speech of individuals with cleft palate. Zemlin (1998, as cited in Hardin-Jones, op.cit:77) maintains that in individuals with cleft palate, there appear to be a ' compensatory movement ' of the posterior pharyngeal wall to meet the soft palate. Hagerty and Hill (1961) carried out an Iaminographic X-ray study on cleft palate speakers similar to that of Haerty and his colleagues (op.cit). They allege that there is a tendency for more movement of the posterior pharyngeal wall to compensate for the reduced velar movement in the attainment of the velopharyngeal closure.

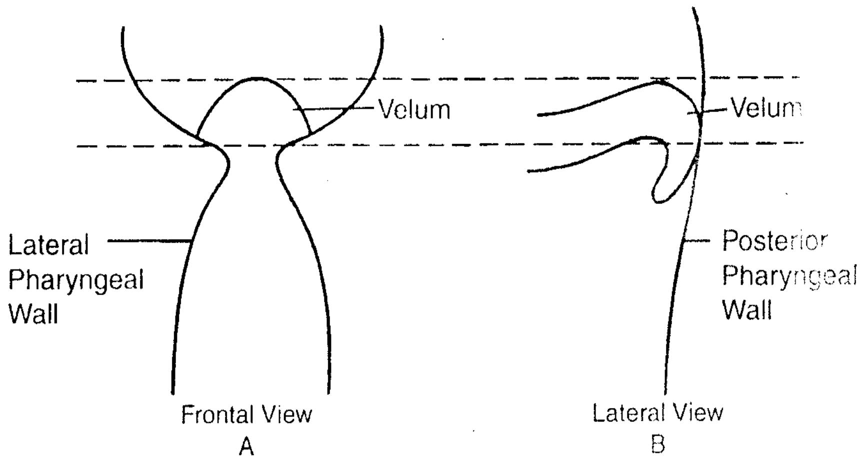

Figure 2.4. A. ***Frontal view of the lateral pharyngeal walls. The lateral pharyngeal walls move medially to close against the velum on both sides. B. Lateral view of the posterior pharyngeal wall – velum contact movement. (Kenneth, op.cit)***

2.3.2.. The Primary Velopharyngeal Functions for Speech:

Studies on the velopharyngeal functions for speech date back to Greek and Roman times when the first studies on speech oratory have been documented. Later attempts of the velopharyngeal functions remarkably progressed in the Renaissance age, when Leonardo de Vinci has first described the velopharyngeal region anatomically. Gradually, the study of the velopharyngeal mechanism advanced rapidly with the invention of two important instrumental techniques; namely the fluoroscopy in the 1950s and the endoscopy in the 1970s (Bzoch, op.cit).

In actual fact, the study of the velopharyngeal functions for speech was the subject of numerous investigations. Researchers and speech scientists have stressed the role of the velopharyngeal mechanism as an important element of the normal articulation mechanism. The velopharyngeal mechanism, as described by Bzoch (ibid: 509) is " ***a valve whose actions act to separate the oral and nasal cavities***." Normal functions of the velopharyngeal mechanism are critical to the development and production of correct speech sounds.

Different theories and views have emerged regarding the nature of the velopharyngeal functions for speech. One of these theories is the ' **binary theory** ', which is initiaied by Moll and Shriner (1967). According to this theory, the velum acts in a binary form: the 'on' and 'off' forms. When the velum is ***on,*** it is elevated to close off the nasal cavity for the production of oral sounds. When it is ***off***, however, it is lowered to open the nasal cavity for the production of nasal sounds. Another theory has been proposed by Kent et al. (1974 : 471) which is known as ' **the coordinated structures**' theory of the velopharyngeal function. In this theory, Kent et al. (ibid) stress the importance of the coordinated function of several velopharyngeal muscles with other speech movements. Actually, this theory is based, in part, on a study by Moll and Daniloff (1971) in which they observed that the velum is elevated during nasal consonants when followed by oral consonants, e.g. the /nt/ cluster in words like '*contact*'. This fact leads Kent et al. (op.cit) to hypothesize that the velopharyngeal mechanism works in coordination with other speech articulators because it does not simply close for oral sounds and then open for nasal ones. Rather, the velopharyngeal mechanism closes to different degrees, depending on different variables such as voicing, vowel height and proximity to nasal consonants (Hardin et al., op.cit).

Warren (1986, as cited in Hardin-Jones et al. op.cit) offers a rather different view concerning the velopharyngeal functions for speech. He claims that the velopharyngeal functions are programmed in accord with a speech regulating system that controls its performance depending on certain aerodynamic commands. Warren's assumption, in fact, is based on the fact that speakers with cleft palate usually attempt to articulate pressure consonants at the larynx or the pharynx and not within the vocal tract. This phenomena is known as ' **compensatory articulation** ' (Bzoch, op.cit; Hardin-Jones et al., op.cit). Warren's aerodynamic theory has best accounted for the velopharyngeal closure for oral consonants and its opening for nasal consonants since management of oral air pressure and nasal air flow is necessary for normal speech production (Hardin-Jones et al., ibid).

Normal anatomy and function of the velopharyngeal mechanism is an important aspect of speech production. Failure to seal off the nasal and oral cavities during speech results in abnormal sounds articulation. The inability to achieve velopharyngeal closure for speech is referred to as ' velopharyngeal inadequacy '.

2.4 *Velopharyngeal Inadequacy:*

2.4.1 *Terminology:*

Terminology concerning the velopharyngeal dysfunction for speech varies from writer to writer. There are several reports that deal with terminological differences related to velopharyngeal disorders (Trost, 1981; Kuhen and Dalston, 1988 among others). Kuehn and Dalston (op.cit) contend that different terms such as velopharyngeal **impairment**, **inadequacy, insufficiency**, **incompetency**, **dysfunction** and others, have been used to describe various aspects of velopharyngeal disorders. Still, there appears to be no universal agreement among writers as to the definitions of these terms.

Trost (op.cit), for instance, suggests that the term 'velopharyngeal inadequacy' should be used as a generic term, keeping the term 'velopharyngeal insufficiency' to refer to an insufficiency of tissues, and 'velopharyngeal incompetency' to refer to the velopharyngeal inadequate movement patterns. Contrastingly, Loney and Bloem (1987) consider the term velopharyngeal insufficiency as a general term. They preserve the term velopharyngeal incompetency to refer to speakers who are incapable of moving the palate adequately for speech regardless of whether the palate structure is normal or not. On the other hand, they use the term velopharyngeal inadequacy to refer to persons who have difficulty in sealing off the velopharyngeal port for speech due to a deficiency in the velopharyngeal structure.

Trost-Cardamone (1989), for her part, considers the term velopharyngeal inadequacy as a general categorical term that encompasses velopharyngeal disorders regardless their etiology. She points out that the term 'velopharyngeal inadequacy' is more adequate than either velopharyngeal insufficiency or velopharyngeal incompetency. According to her, the term velopharyngeal inadequacy applies to individuals with cleft palate, who, because of the abnormal palatal structure, fail to achieve adequate velopharyngeal closure for speech.

Kummer (op.cit: 152) also defines velopharyngeal inadequacy as "a ***physiological deficiency, that results in poor movement of the velopharyngeal structures***." This physiological defect may cause an inadequate velar elevation during speech (figure 2.5 below).

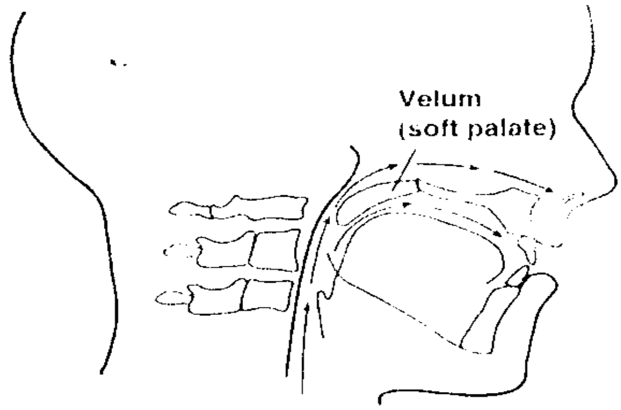

Figure 2.5. *Velopharyngeal Inadequacy. The velum does not move well enough to achieve velopharyngeal closure during speech. From Kummer (op.cit).*

On the other hand, she (ibid) describes velopharyngeal insufficiency as "a ***structural defect that causes the velum to be short relative to the posterior pharyngeal wall."*** It is necessary that the velum is long enough to achieve adequate contact with the posterior pharyngeal wall. A short velum causes velopharyngeal insufficiency. Figure 2.6 below illustrates velopharyngeal insufficiency.

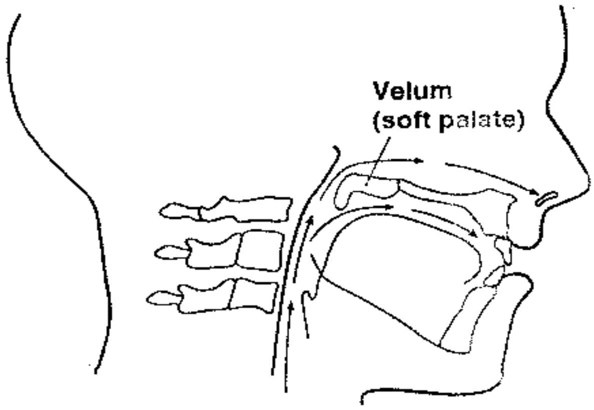

Figure 2.6. ***Velopharyngeal insufficiency. In this case, the velum is too short to achieve velopharyngeal closure during speech. From Kummer (ibid).***

In this study, however, the term velopharyngeal inadequacy is used in its general sense to mean "***any failure of the velopharyngeal mechanism to open or close in a normal fashion for speech.***" (Hardin-Jones et al.,op.cit: 274).

2.4.2 Causal Factors: Cleft Palate

Speech-language pathologists have investigated the different causal factors that might results in velopharyngeal inadequacy for speech (Bzoch, 1959; Hardin-Jones et al., op.cit). There are different congenital physiological factors that result in inappropriate oronasal valving, usually in the form of a failure to sufficiently close off the oronasal passageway during the production of oral consonants. Cleft palate is the main factor that results in velopharyngeal inadequacy for speech.

A **cleft** is a separation on a body structure. The majority of body clefts occur in the oral-facial region. A major type of oral-facial clefts is cleft of the palate. According to the National Organization for Rare Disorders (NORD), cleft palate is a common malformation that is noticeable at birth (i.e. congenital). Crystal and Varely (op.cit: 212) describe cleft palate as "a ***congenital fissure in the midline of the palate which may extend throughout the whole of the palate, or affect only uvula and / or soft palate in varying degrees.***"

Cleft palate is the major factor that leads to velopharyngeal inadequacy for speech. Khan (2005: 1) states out that patients with clefts have a deficiency of tissues and not merely a displacement of normal tissues. Cleft palate results from developmental variations that occur during the embryonic periods and the early fetal periods (9 weeks and beyond). Graber (1949) briefly describes cleft palate formation as follows:

The palate begins forming during just the first few weeks of gestation, before even a woman knows that she is pregnant. During this time, the sides of the mouth, the lateral palatal segments, eventually unite in most infants. In rare cases, however, the sides of the mouth do not fuse together properly creating a notch or a cleft. (p. 359).

Cleft palate creates a condition that interferes with basic biological functions such as breathing and swallowing. More importantly, it can inhibit severely the child's speech and language development.

3. The Experimental Design

The present study focuses on identifying and describing the nature of speech production errors related to cleft palate and velopharyngeal inadequacy. For this purpose, the researcher conducted two speech production tests. These include resonance test and articulation test. Upon determining the nature of speech disorders in cleft palate speech, the researcher presents analyses of the results obtained and discussion of the whole findings.

***3.1 Methodology*:**

***3.1.1 Subjects*:**

The subjects who participated in the present study are two Iraqi Arabic speaking children; a male and a female. The first subject, A (a female), is 9 years and six months; while the second subject, B (a male), is 9 years and two months. Both subjects have complete (soft and hard) cleft palate. Subject A had her palate repaired at the age of 18 months. Subject B, on the other hand, had received two palatal surgery; one at the age of 20 months and the other at the age of 2; 4 (years, months). Unfortunately, for both subjects the palate was not repaired in a proper way and velopharyngeal inadequacy is clear for both, and thus they continued to have speech and language problems.

3.1.2 Procedure:

The procedure followed in the present study involves conducting a case history assessment which includes obtaining background information concerning the subjects' medical and developmental status. Medical assessment involves obtaining diagnostic information from an otolaryngologist to identify the nature and type of the cleft and other important information concerning the adequacy/inadequacy of the velopharyngeal mechanism and the surgical repairing each subject had received.

Moreover, the researcher makes two informal, non-instrumental perceptual tests that assess the subjects' articulation and resonance. Assessment data were tape-recorded for later analysis and evaluation.

3.1.3 Data Collection:

Speech Data was collected in two sessions. Each data collection session lasted approximately for one hour. Audiotape recordings were obtained for both subjects' speech and were made in the researcher's home. Following Bzoch (1997), the researcher conducted two non-clinical perceptual tests in order to have sufficient reliable perceptual judgments regarding the presence of abnormal speech patterns in the subjects' overall speech system as well as the nature of such abnormalities. This includes resonance and articulation tests.

It is necessary to mention that these errors can be investigated formally and/or informally. A formal investigation involves the use of clinical techniques such as nasopharyngoscopy, videofluroscopy, nasometry and radiography. Informally, the cleft palate speech can be investigated by means of certain non-instrumental perceptual tests. The researcher of the present study investigated the speech performance of two school-age children informally using two perceptual tests to assess articulation and resonance. The investigation involves the production of consonants only. Vowels are not within the scope of the investigation. Two dimensions of speech were investigated: articulation and resonance.

No clinical assessment was employed in this study. This is primarily because Iraqi hospitals, particularly Basrah hospitals provide only radiographic, X-ray techniques to assess the velopharyngeal shape and movements during speech. The researcher excludes the use of such clinical examination to avoid radiation exposure and other risky factors associated with the test.

Most speech pathologists agree to the fact that informal perceptual testing can yield a good deal of data about speech production skills although more reliable information can be obtained via formal ones. Kummer (op.cit: 394) proposes that "instrumental ***assessment is not***

required for identification of velopharyngeal dysfunction in most cases because it can be determined through a perceptual assessment."

3.1.4 Speech Production Tests:

A. Resonance Test:

The aim of conducting this test is to determine the effect of the velopharyngeal inadequacy for the production of oral sounds. The significance of such test stems from its strong relation to speech physiology and phonetic science. If the velopharyngeal mechanism is able to close the nasal cavity for the production of oral sounds, air should not flow through the nose under the condition of this test. If the velopharyngeal works inadequately, sounds resonance will be affected and there should be a perceived resonance disorder.

Resonance is assessed auditorily by using the nostril-pinching technique. Words that contain non-nasal sounds (the same words that are used in appendix A excluding words with nasal sounds) were used for this test since they normally cause a sustained velopharyngeal closure for speech. This traditional technique involves having each subject recite the non-nasal words while pinching their nostrils closed.

In normal situations, there should be no perceptual difference in the quality of the sounds since the nasal cavity is normally closed. A perceived difference in voice quality with the pinching of the nares indicates the presence of resonance disorders. The researcher listened for the change in the perceived quality of the sounds. If excessive nasal pressure is felt, or if nasopharyngeal 'snorting' is heard, this indicates the presence of hypernasality.

B. The Single-Word Articulation Test:

In order to adequately understand the nature of sound errors exhibited by speakers with cleft palate, it is necessary that their sounds articulation skills are tested. The researcher designed a single-word articulation test to assess the subjects' articulation of all Arabic consonants in three sound-positions; namely initially, medially and finally (vowels were excluded). The test simply involves asking each subject to recite the words in question one after the other. The subjects' productions were audio-taped for later analysis and transcription. Each word was transcribed as a whole word using the International Phonetic Alphabet and the compensatory articulation notations described by Trost (op.cit). The single-word articulation test helps the researcher identify and readily transcribe the sound errors demonstrated by the subjects as the sounds are produced in discrete and identifiable units. The stimulus items used for this test appear in appendix A.

3.2 Data Analysis:

*A. **Analysis of Resonance :***

Resonance is "***the quality of the voice that results from sound vibrations in the pharynx, oral cavity and nasal cavity.***" (Kummer, op.cit:503). Normal resonance may be influenced by certain structural factors. Structurally, the resonating cavities must be normal and free from obstructions, the soft palate must function adequately to achieve complete velopharyngeal valving and the other articulators must function normally. Any physiological abnormality in the structure of the vocal tract may have the potential to cause resonance disorders.

The resonance test shows that all oral consonants are produced with nasal air emission. Consequently, nasal emission of air is consistence in all oral sounds. Moreover, nasal air emission in both subjects appears in the form of a nasal snort. It can be best described as a noisy, sneeze-like sound. Moreover, the resonance test shows that both subjects exhibit a hypernasal speech due to velopharyngeal inadequacy. Hypernasality, simply speaking, is a resonance disorder in which there is an incomplete velopharyngeal closure which causes too much air to escape through the nose (Judith, op.cit). However, this test shows that not all oral sounds sound hypernasal. Hypernasality appears only on voiced sounds rather than voiceless ones. In addition, it increases noticeably in connected speech (e.g. conversation and passages reading). This is due to the fact that rapid speech is often associated with additional demands on the velopharyngeal mechanism (Kummer, op.cit: 158).

B. Analysis of Articulation Patterns:

The subjects' articulation test results were analyzed in terms of two main categories: compensatory articulation patterns and phonological processes.

1. Compensatory Articulation Patterns:

Normally, speakers with cleft palate demonstrate a typical articulation patterns due to velopharyngeal inadequacy. Hutters and Bronsted (1987) report three ways which are used utilized by cleft palate speakers as a reaction for velopharyngeal inadequacy for speech. The first strategy is a passive one called 'do-nothing' strategy. Speakers who adapt this strategy make no effort to reduce the effects of velopharyngeal inadequacy.

The other two strategies are active; they are termed 'camouflage' and 'compensation' strategies. Hardin-Jones et al., (op.cit: 165) define camouflage as the speaker's attempt " ***to mask the perceptual consequences of velopharyngeal inadequacy through the use of weak articulation – including breathy phonation or the frequent substitution of /h/ for pressure consonants***." The strategy of compensation, on the other hand, is the most widely used strategy by speakers with cleft palate. By 'compensation' it is meant "***the speaker's attempt to substitute sounds produced with constrictors inferior to the velopharyngeal valve (i.e. glottal and pharyngeal articulation) for pressure consonants to reduce the effect of velopharyngeal inadequacy on pressure consonants production.***" (Hardin-Jones et al., ibid.).

The subjects' speech data was first analyzed in terms of compensatory articulation patterns. Speech data indicates that the majority of compensatory articulation patterns exhibited by the two subjects involve errors of place of articulation. The following table displays the production patterns of the subjects and the compensatory articulation patterns used as substitutions (vowels were excluded).

Type of Compensatory Articulation	**Phonetic Symbol**	**Target Replaced**
Glottal stop replacement	[ʔ]	/ ḍ, , ʃ, dʒ, z, χ, ʁ,q /
Velar stop replacement	[K]	/ ṣ, s, t ,d/
Nasal stop replacement	[m]	/ f, b/ / l, r /

Table 4.1. ***The compensatory articulation patterns demonstrated by the subjects*.**

As the table shows, the compensatory articulation patterns demonstrated by the two subjects include: the glottal stop [ʔ], the velar stop [k] and the nasals [m] and [n]. These patterns are consistent in all word positions. Still, one of the subjects (the female)shows an inconsistent glottal compensation. In other words, she uses the glottal stop [ʔ] only initially (not medially or finally).

The glottal stop is a sound produced by a brief closure at the vocal folds (Shriberg and Kent, 1995: 76). The glottis; a chink between the vocal folds, is the main articulator that is involved in the articulation of glottal stops. Abercrombie (1978: 53) maintains that the glottal stop is an important sound in the standard form of many languages. In Arabic, for instance, a glottal stop is a sound of frequent occurrence. It occurs in all word positions, i.e. initially, medially and finally, e.g. / ʔænæ / 'I'; /ræʔæ/ ' saw', and /mæri:ʔ/ ' esophagus'. In B.B.C. English, on the other hand, the glottal stop is not normally included within its phonemic inventory; it "***is not a significant sound in the RP system.***" (Gimson, 1989 : 169) argues. However, it exists in the speech of other English regional accents, Cockney and Scottish in particular.

Hardin-Jones et al. (op.cit) remark that this laryngeal sound is used by speakers with cleft palate as a substitution for oral stops as well as fricatives and affricates. Williams et al. (1997) argue that the use of glottal stop substitutions by speakers with cleft palate results from loss of intraoral air pressure and weak articulation which is, in turn, the result of illvelopharyngeal function. This study shows that the glottal stop is the most common type of compensatory articulation patterns demonstrated by cleft palate speakers. This finding assists other studies on cleft palate speech which finds that glottal stop occurs frequently as a substitution for most oral sounds. (Trost, op.cit, Hardin-Jones et al., op.cit).

2. Phonological Processes:

By definition, the term ‘phonological process’ refers to “***a systematic sound change that affects classes of sounds or sound sequences and results in a simplification of production***” (Lowe, 1996: 5). As the definition suggests, phonological processes are but strategies of sounds modification used by children to simplify adult speech. For example, a child who is unable to produce alveolar sounds may replace them by velar sounds (a process known as backing) to simplify the production of these sounds. The intent of a phonological process analysis is to determine whether the speaker’s speech sounds production errors constitute a pattern. Children with severe articulation errors (like cleft palate children) often demonstrate speech errors that affect a complete class of sounds and thus constitute a pattern of misarticulations.

The researcher re-played the tape recorder and listened again to the subjects’ misarticulations in order to identify the patterns or phonological processes that are present and may influence entire classes of sounds. In other words, the researcher aimed at determining whether the misarticulated sounds share place or manner of articulation or certain distinctive features. A phonological process analysis of the subjects’ speech reveals that backing is the prevailing phonological process that dominates most of the sounds in their phonological system. Backing is the process of replacing sounds that are produced anteriorly with sounds produced posteriorly (Brooks and Hedge, 2000 : 90). In this study, both subjects replace anterior sounds (e.g alveolar, bilabial) with sounds produced further back in the mouth (e.g the glottal stop/ʔ/ and velar fricative /k/). This process of replacing sounds produced anteriorly with sounds produced posteriorly is known as backing of speech sound.

The following table summarizes the final remarks as to the characteristics of the subjects’ speech sound production data.

Target Sound	Substituted Sound	Articulation Pattern
/ b /	[m]	nasal emission
/ t /	[k]	Backing (velar stop)
	[ʔ]	Backing (glottal stop)
/ d /	[k]	Backing (velar stop)
/ ḍ /	[ʔ]	Backing (glottal stop)
/ k /	/ k /	normal production
/ q /	/ ʔ /	Backing(glottal stop)
/ ʔ /	/ ʔ /	normal production
/ m /	/ m /	normal production
/ n /	/ n /	normal production
/ f /	[p]	bilabial stoping
/ θ /	/ θ /	normal production
/ ð /	/ ð /	normal production
/ ð̣ /	/ ð̣ /	normal production
/ s /	[k]	Baking (velar stop)
/ ṣ /	[k]	Backing (velar stop)
/ z/	[ʔ]	Backing (glottal stop)
/ ʃ /	/ʃ /	normal production
/ χ /	[ʔ]	Backing (glottal stop)
/ ʁ /	[ʔ]	Backing (glottal stop)
/ ħ /	/ ħ /	normal production
/ ʕ /	/ ʕ /	normal production
/ h /	/ h /	normal production
/ dʒ /	[ʔ]	Backing (glottal stop)
/ r /	[n]	Nasal emission
/ l /	/ n /	Nasal emission

Notice, for instance, that the class of uvular sounds / χ, ʁ, q/ is all affected by one phonological process, namely backing in which the sounds produced with an anterior constriction are replaced by a posterior sound [ʔ]. Thus, it constitutes a pattern of misarticulation.

*3.3 Discussion***:**

Normal speech production and auditory feedback form the basis of normal speech development. Normal speech requires normal oral structure and function as well as normal auditory skills. Children with cleft palate, however, have problems in these two aspects of speech development. They suffer from oral deficiency due to velopharyngeal inadequacy and auditory disorders due to hearing problems. Therefore, cleft palate children are at high risk for speech and language problems.

The present study attempts the phonetic characteristics of the speech of children with cleft palate. Arabic data on cleft palate children are very limited. Children with cleft palate have similar speech disorders across languages. Cleft palate speech characteristics are: weak pressure consonant production, nasal emission of air, hypernasality of speech and compensatory articulation patterns.

Cleft palate speech is characterized by weak, or sometimes omitted, pressure consonants. Because children with cleft palate have inadequate velopharyngeal valving for speech, adequate production of pressure consonants cannot be achieved. High pressure consonants are highly affected by the reduction in the air pressure that results from the opened velopharyngeal port. In this connection, Kummer (op.cit) assumes that:

When air pressure is leaked through the velopharyngeal valve or an oro-nasal fistula, it causes a reduction in the air pressure that is available in the oral cavity for the production of consonants. As a result, consonants may be weak in intensity and pressure or may be omitted completely (p. 160).

This suggests that there exists a direct relationship between nasal air emission and the amount of air pressure for oral sounds production.

Consequently, the greater the amount of air pressure reduction, the weaker the sounds will be (Kummer, ibid).

Nasal emission of air leads to an apparent distortion in the characteristics of oral pressure consonants. Thus, speakers with cleft palate are often perceived as if they were speaking via their noses. Hypernasality is another speech characteristic of cleft palate speakers. It is caused by a failure of the velopharyngeal mechanism to open and close adequately for sounds production. Clinicians often describe hypernasality as an obligatory outcome of speech produced with an opened velopharyngeal port. It is obligatory in the sense that "***the speaker has no choice but to produce distorted speech that is excessively nasalized and underpowered.***" (Trost-Cardamone, 1997:314). "Backing" is a common phonological process demonstrated by cleft palate children. Children with cleft palate tend to use the back of their tongue too much, resulting in producing most speech sounds far back in the mouth. They are subconsciously attempting to achieve valving at a point inferior to the velopharyngeal mechanism in an attempt to make a plosion or a friction before pressure is lost in the velopharyngeal open port. With a cleft palate, the normal closing action of the soft palate does not take place, resulting in air escaping into the nasal passages causing nasal sounding speech (Hardin-Jones et al., op.cit). In addition, cleft palate speakers have difficulty impounding intraoral pressure due to miscoupling of the oral-nasal cavities. This abnormality in velopharyngeal function affects not only the production of single speech sounds, but it also affects the selection of words. Estrem and Broen (1989: 20) maintain that cleft palate children use more words with nasals and glides and fewer with pressure consonants.

In addition to the patterns of sound substitution discussed previously, the researcher noticed another pattern of sound substitution which is the use of /n/ and nasal snort for some oral sounds. For example, /n/ for /r/ in [naaħ]→/raaħ/ *went*,. This is, again, due to the abnormal function of the velopharyngeal mechanism. Cleft palate speakers compensate for oral sounds by sounds that are easily produced like /m/, /n/ and glottal stop. This finding goes in consistent with other reports in the literature such as Counihan (1956), Bzoch (op.cit), among others.

Sounds omission (omission of final consonant) is also noticed in the speech of the two subjects. Articulatory context may increase the occurrence of sound omission. In other words, the effect of phonetic context may cause this reduction or omission of certain sounds in the word. For example, /idʒat/ she comes→ [idʒa], / qamiiṣ/ shirt→[kamii], and /ba・ ・iibaχ/ watermelon→[baʔii].

The use of the glottal stop /ʔ/ for the sounds / ḓ, ・, ʃ, dʒ, z, χ, ʁ,q /and the velar stop /k/ for /t, d, s, ṣ/ may be come out because the subjects are unable to impound an adequate amount of intraoral pressure necessary for the production of oral sounds. In addition, they use these two compensations because they refuse the distorted forms of the misarticulated sounds and think that these two alternatives are more normal. These two sounds /k/ and /ʔ/ are produced further back in the mouth, i.e. above the palatal region. Thus, they are not affected by the palatal defect and the velopharyngeal dysfunction.

Research on English cleft palate speech have also reported the use of the glottal stop /ʔ/ for the stops /t, d, k, g/ and the pharyngeal fricative /ʕ/ for the fricatives /s, z, ʃ, ʒ/ and the affricates /tʃ, dʒ/ (Trost-Cardamone, op.cit:316). Speech pathologists have different views concerning the nature of compensatory articulation in cleft palate speakers. Trost (op.cit), for instance, considers the use of compensatory articulation as an effort to approximate perceptual-acoustic targets. Bradley (op.cit) explains that compensatory articulation is an alteration in the place of articulation rather than the manner of articulation. In other words, the manner of articulation is maintained while the place of articulation is shifted. These compensatory patterns may not be resulted directly from the structural defect, namely cleft palate. They could be strategies adapted by the speech production system to overcome or minimize the effects of this defect. That is why these patterns of misarticulation may persist even after the palatal surgery due to habituation.

These patterns of compensatory articulation develop as a result of years of speaking with an inadequate velopharyngeal function. In addition, recent researches have unveiled the fact that these patterns are present in some cleft palate speakers and absent in others. This fact indicates that compensatory articulation patterns are learned behaviours (Hardin-Jones et al., op.cit). Some children use these compensatory patterns as alternatives to compensate for the lack of normal velopharyngeal function in speech and be more acceptable and more intelligible.

4. Conclusions:

The main conclusions arrived at in this study include:

1. Since the defect is physiological, most speech characteristics associated with cleft palate are universal. These include: weak pressure consonants, hypernasality of speech, compensatory articulation patterns and disordered speech sounds.
2. There are two types of articulation errors demonstrated by cleft palate children: one is passive and is called " obligatory articulation" which is the direct result of velopharyngeal inadequacy (e.g. hypernasality and nasalization of oral sounds). The second type of articulation error is active and is called "compensatory articulation" which is a learned attempt to compensate for the physiological constraints of the cleft palate.
3. Speakers with cleft palate have difficulty producing some fricatives, affricates and stops since these sounds require high intraoral air pressure.
4. Cleft palate speakers show preference for sounds with velar and glottal place of articulation due to the structural defect.
5. Substitution errors occur more frequently than other types of articulation errors (distortion, addition and deletion). In English, however, distortion and deletion are also present in some speech sound productions (Hardin-Jones, op.cit; Kummer, op.cit; Trost, op.cit; among others).
6. The most common phonological process exhibited by cleft palate children is backing; the posterior placement of oral sounds. In Arabic, the glottal stop /ʔ / and the velar stop /k/ are the most common compensatory articulation patterns used by speakers with cleft palate. This is due to the fact that both sounds are not affected by the presence of the cleft as far as place and manner of articulation are involved. In English, on

the other hand, cleft palate children usually use as posterior placement the glottal stop /ʔ/, the pharyngeal stop [],the posterior nasal fricative [ ] and the velar fricative [ ].

Appendix A : *The Stimulus Items Used in the Single-Word Articulation Test*

Sound	Word-initial	Word-medial	Word-final
/ b /	/ bɑ:b / door	/ ħɪ.bɑ:l / ropes	/ dʊb / bear
/ t /	/ tʊ.fɑ:ħæ / apple	/ mɪf.tɑ:ħ / key	/ beɪt / house
/ ・ /	/・ɑ:.jɑ:ræ/ airplane	/ mæ・ær / rain	/ bæ・æ/ duck
/ d /	{/ dʊb /}* bear	/ wær.dæ/ flower	/ wæ.læd / boy
/ ḍ /	/ ḍɪf. ḍæʕ / frog	/ bæj.ḍæ / egg	/ ʔæb.jæḍ / white
/ k /	/ kʊr.sɪ / chair	/sæ.mæ.kæ / fish	/ di:k / cock
/ q /	/ qæ.læm / pencil	/ bæ.qæ.ræ / cow	/wæ.ræq / paper
/ ʔ /	/ ʔæ.sæd / lion	/ ræʔs / head	/ mɑ:ʔ/ water
/ m /	{/ mɑ:ʔ/}* water	{/ sæ.mæ.kæ /}* fish	{/ qæ.læm /}* pencil
/ n /	/ nɑ:r / fire	/ ʕɪ.næb / grapes	/ʔæs.næn / teeth
/ f /	/ fi:l / elephant	/ sæ. fi:.næ / ship	/ χæru:f / sheep
/ θ /	/ θæʕ.læb / fox	/mʊ.θæ.læθ/ triangle	{/mʊ.θæ.læθ/} triangle
/ ð /	/ ðeɪl / tail	/ dʒʊ.ðu:r / roots	/tɪl.mi:ð/ student
/ ð̣ /	/ ð̣æhr / back	/næ.ð̣ð̣ɑ:.ræ/ glasses	/ ħɑ:.fɪð̣ / boy's name
/ s /	/ sɑ:.ʕæ / watch	{/ ʔæ.sæd /}* lion	/ʃæms / sun
/ ṣ /	/ ṣæħ.rɑ:ʔ / desert	/ ħɪ.ṣɑ:n / horse	/ mɪqæṣ / scissors
/ z /	/zæ.rɑ:.fæ / giraffe	/ ʁæ.zɑ:l / deer	/ mæwz / banana
/ ʃ /	/ʃɪb.bɑ:k / window	/fæ.rɑ:ʃæ / butterfly	/ ʕuʃ / nest
/ χ /	{/ χæ.ru:f /}* sheep	/ ʔæχ. ḍær / green	/ bæ・.・i:χ/ watermelon
/ ʁ /	{/ ʁæ.zɑ:l /}* deer	/ ṣæ.ʁi:r / small	/ ṣæbbæʁ/ painter
/ ħ /	{/ ħɪ.ṣɑ:n /}* horse	{/ tʊ.fɑ:ħæ /}* apple	{/ mɪf.tæħ /}* key
/ ʕ /	{/ ʕɪ.næb /}* grapes	/ mɑ:.ʕɪz / goat	{/ ḍɪf.dæʕ /}* frog
/ h /	/ hæ.dɪj.jæ / gift	/ ʔæz.hær / flowers	/ wæ.dʒɪh / face
/ dʒ /	/ dʒæ.zær / carrots	/ dæ.dʒɑ:dʒ/ chicken	{/dæ.dʒɑ:dʒ/}* chicken

* This is an indication of the repetition of stimulus items with more than one target sounds.

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