Journal of Surgical Techniques and Procedures

Research Article
Published: 09 Jan, 2024

Effectiveness of Palatoplasty Techniques in Velopharyngeal Incompetence

Perez Cautela Jesus, Perez Nohelia and Muñoz Ruben*

Department of Oral and Maxillofacial, "Dr Angel Larralde" General National Hospital, University of Carabobo, Venezuela

Abstract

Aim: Velopharyngeal Incompetence (VPI) is the term used to refer to the inappropriate closure of the velopharyngeal sphincter during speech, it indicates a lack of separation between the oral and nasal cavities, it is characterized by hypernasal speech or nasal voice and nasal air emission and may be due to velopharyngeal anatomical alterations caused by any structural deficit of the velum or pharyngeal walls. Clefts labiopalatine affecting the palate are a frequent cause of IVF, since the bony and soft palate are compromised; in the secondary palatal cleft the muscles and mucosa of the soft palate are affected, in the submucous cleft, there is an alteration in the velar musculature, but with continuity of the oral and nasal mucosa, which is indicative of surgical correction to obtain an adequate velopharyngeal closure. Objective analyze functional changes to comprehensibility of speech and the functionality of the soft palate in patients diagnosed with velopharyngeal incompetence.

Material and Methods: A retrospective field study of clinical histories was carried out, where the inclusion criteria were taken as pediatric patients who attended the Oral and Maxillofacial Surgery Service of the Hospital General Nacional "Dr. Ángel Larralde" Valencia Venezuela, between the ages of 4 and 8 years, without specifying gender, with IVF. For the analysis of Functional Changes, the preoperative and postoperative recordings were examined, where the patients of the sample repeat a word constituted by occlusive and vibrant phonemes, to verify the effective communication by a Virtual Receiver with Artificial Intelligence (Alexa EchoDot 4th Generation.

Results: Furlow's Palatoplasty Technique is the surgical technique that most benefits patients with Velopharyngeal Incompetence (VPI) since, in the functional analysis parameters, such as comprehensibility and competence gave acceptable and competent results.

Conclusion: It was confirmed that the Furlow palatoplasty technique is ideal for the initial management of patients with velopharyngeal incompetence, showing improvements in their function, accompanied by an improvement in comprehensibility and speech acceptability.

Keywords: Velopharyngeal incompetence; Palatoplasty; Furlow; Veau-Wardill -Kilner

OPEN ACCESS

Correspondence:
Perez Cautela Jesus, Department of Oral and Maxillofacial, Dr. Angel Larralde, General National Hospital, Carabobo University, Naguanagua, Venezuela

Received Date: *18 Dec 2023*
Accepted Date: *05 Jan 2024*
Published Date: *09 Jan 2024*

Citation:
Perez Cautela J, Perez N, Muñoz R. Effectiveness of Palatoplasty Techniques in Velopharyngeal Incompetence. J Surg Tech Proced. 2024; 8(1): 1064.

Introduction

The cleft lip occurs due to the lack of union of the maxillary processes during fetal development. During the 4th and 8th week of gestation, the migration of the mesoderm to this fusion zone is essential for its correct formation, if there is a failure in this migration the cleft occurs as proposed by Veau and Stark in their theory of mesodermal penetration [1]. The velopharyngeal sphincter has a mechanism in charge of controlling the resonance balance between the nasal and oral cavity to control the atmospheric and acoustic pressures of speech. The sphincter remains closed during oral sound production and open for nasal sounds. When velopharyngeal closure does not occur properly during oral sounds, part of the airflow is diverted into the nasal cavity, compromising speech production [2].

Velopharyngeal Incompetence (VPI) is the term used to refer to inadequate closure of the velopharyngeal sphincter during speech and may be due to anatomical velopharyngeal abnormalities caused by any structural deficit of the valvar or pharyngeal walls. In clefts involving the palate, primary surgical correction of the palate prioritizes the establishment of anatomic and functional conditions for adequate velopharyngeal closure; however, some patients may experience symptoms of IVF even after primary surgery [3].

Classification of Severity: Outreach Program Lima Perú (Percy Rossell 2006): Four components are considered: Nasal, lip, primary palate and secondary palate.

Primary palate: Use the cleft width to determine the severity grade for cleft lip and palates. In unilateral cleft lip and palate, the width of the alveolar gap between the medial and lateral segments determines the severity of the cleft. Actually, there is no correlation between the primary palate degree of severity and surgical protocol for unilateral cleft lip and palates. For bilateral cleft lip and palate deformity, the type of cleft is determined by the more severely affected side (based on cleft's width). The width of the alveolar gap is an important element to determine presurgical and surgical management of bilateral cleft lip and palate. It is measured at 1 year of age before cleft palate surgery [4].

Secondary palate: Estimation of the cleft palate is done by comparing the cleft's width and the sum of the width of both palatal segments. This proportion is named as cleft palate index. The same parameter is used for incomplete, unilateral, and bilateral cleft palates. The cleft's width is measured at the posterior border of the palatine bone between the hard and soft palates from the maxillary tuberosity to the posterior nasal spine [4].

PRAAT software is a computer program that analyzes, synthesizes and manipulates vocal sounds. It allows to record sounds with any other audio input device or audio file. It was developed since 1992 by Paul Boersma and David Weenink at the Institute of Phonetic Sciences of the University of Amsterdam. The objective is to analyze different parameters to obtain the Fundamental frequency (F0), disturbance analysis, jitter, shimmer, and Harmonic-to-Noise Ratio (HNR) [5].

Artificial Intelligence (AI) is the science of making machines "think" like humans. Machine learning is a type of AI that focuses on enabling computers to perform tasks independently and improve with experience [6].

Assistive Technology (AT) refers to devices or programs designed to meet and assist people's needs. These devices may support mobility, communication, vision, or cognition [7].

The differences between these devices lie in the price, the software used and the quality of the speakers and microphones. Amazon manufactures the Amazon Echo, which is available in different models, such as Echo Dot, Echo, Tap, Echo Spot and Echo Show, which offer different levels of technology and sound quality. Amazon's personal assistant is called Alexa, and is used as a "trigger phrase" to activate the device and give commands [8].

A useful feature of the Amazon Echo is its ability to recognize the voice of multiple speakers. This allows the device to connect to each individual's personal information, such as messages, emails, online calendars and playlists. In addition, the Amazon Echo can connect to other smart devices in the home, such as smart TVs, lamps and other environmental controls. This allows for hands-free control of the environment, using only voice [8].

A study was carried out comparing the Veau Wardil Killner techniques with the Furlow palatoplasty technique to evaluate from the functional point of view, through the study of speech, using the PRAAT software. In addition, a qualitative assessment was made through the response of a virtual assistant with Artificial Intelligence (AI) to the patient's speech, determining the comprehensibility of speech and speech acceptability.

Materials and Methods

A retrospective field study of clinical histories was carried out, where the inclusion criteria were taken as pediatric patients who attended the Oral and Maxillofacial Surgery Service of the National General Hospital "Dr. Angel Larralde" Valencia Venezuela, with ages between 4 and 8 years old, who presented a diagnosis of Complete Cleft Palate, Secondary Cleft Palate, Sequelae of Palatoplasty and Secondary Cleft Palate. Ángel Larralde" Valencia Venezuela, with ages between 4 and 8 years old, who presented the diagnosis of Complete Palatal Cleft, Secondary Palatal Cleft, Palatoplasty Sequels and who had been operated with the Veau-Wardill-Kilner Palatoplasty Technique and the Furlow Palatoplasty Technique. Since these subjects or patients were minors, their representatives were asked to sign a consent form informing them of the studies to which the patients would be subjected, as well as the possible complications that could arise. The exclusion criteria were patients who had not undergone surgery or who had undergone another palatoplasty reconstruction technique.

For the diagnosis, the severity analysis was used according to the Outreach Surgical Center Lima 2009 - Percy Rossell program, through intraoral and extraoral images of the patient.

For the analysis of Functional Changes, the preoperative and postoperative recordings were examined, where the patients of the sample repeat a word made up of occlusive and vibrant phonemes: "Caracas" established by the service of Oral and Maxillofacial Surgery "Dr. Atilio Perdomo" of the National General Hospital Dr. Angel Larralde; then by means of the Praat software we proceed to check the fundamental frequency (pitch) of the voice of the patients, having as control the recording of a healthy child repeating the same word, with the corresponding age of the patient under study and thus establish the normal parameter.

Likewise, to test the effective communication by a Virtual Receiver with Artificial Intelligence (Alexa EchoDot 4th Generation), by understanding the question: What is a car, obtaining a qualitative rating of: Understandable by the device/incomprehensible by the device.

Results

Based on the retrospective study of the medical records of patients aged between 4 and 8 years with a diagnosis of velopharyngeal incompetence who attended the Oral and Maxillofacial Surgery Service of the University Hospital "Dr. Ángel Larralde", Bárbula, Carabobo State, between 2019-2023, and for the analysis of morbidity, age, gender, diagnosis and surgical procedure used were considered (Table 1).

Functional changes

This factor was analyzed under two parameters with the intention of finding out the postoperative comprehensibility and acceptability of the subject's speech.

Fundamental frequency: Related to the audible spectrum and measured by computerized software, but it is important to consider that the age of the subjects was paramount for the analysis of the quantitative values obtained in this parameter, in addition to handling a range of comprehensibility with the value obtained from the control subject for each gender and age, the closer the value was to that of the control subject, the more effective the analysis was considered.

Table 1: Mobility.

#	Age	Gender	Diagnosis	Technique	Year
1	4	M	SCP	PFT	2019
2	5	M	CCP	PFT	2019
3	5	F	SCP	PFT	2019
4	6	F	SCP	PFT	2019
5	6	F	PS	PFT	2019
6	5	M	CCP	PVWKT	2019
7	7	F	PS	PVWKT	2019
8	4	F	SCP	PFT	2020
9	6	M	SCP	PFT	2020
10	7	F	SCP	PFT	2020
11	8	M	PS	PFT	2020
12	4	M	CCP	PVWKT	2020
13	8	F	PS	PVWKT	2020
14	5	F	SCP	PFT	2021
15	5	F	PS	PFT	2021
16	7	M	PS	PFT	2021
17	8	F	PS	PFT	2021
18	8	F	PS	PFT	2021
19	4	F	CCP	PVWKT	2021
20	4	F	CCP	PVWKT	2021
21	5	F	CCP	PVWKT	2021
22	4	F	SCP	PFT	2022
23	5	F	SCP	PFT	2022
24	5	M	SCP	PFT	2022
25	6	M	PS	PVWKT	2022
26	4	F	SCP	PFT	2023
27	4	M	PS	PFT	2023
28	4	M	CCP	PVWKT	2023
29	6	M	CCP	PVWKT	2023

SCP: Secondary Cleft Palate; CCP: Complete Cleft Palate; PS: Palatoplasty Sequelae; PVWKT: Palatoplasty Veau Wardill Kilner Technique; PFT: Pälatoplasty Furlow Technique; F: Female; M: Male

Speech comprehensibility: To assess this parameter a control subject was taken as a reference, which had the same age and gender of the patient subject at the time of the study, by means of a virtual Artificial Intelligence device, depending on the condition of the patient subject, a response was given to the occlusive and vibrant phonemes, it should be noted that the device responded to fricative phonemes but these are related to the nasal and labial articulatory organ, which were not the object of the study.

Fundamental frequency F0

Measured in Hz and represents the pitch of the sound wave vibrations, classified in three parameters of analysis related to the audible spectrum according to the frequency range: Low audible spectrum with low frequency up to 250 Hz, medium audible spectrum with medium frequencies between 250 Hz to 2000 Hz, high audible spectrum with frequencies higher than 2000 Hz, in the research the change of voice of the subjects submitted to the surgical techniques was compared with a control subject according to the age and gender range (Figure 1).

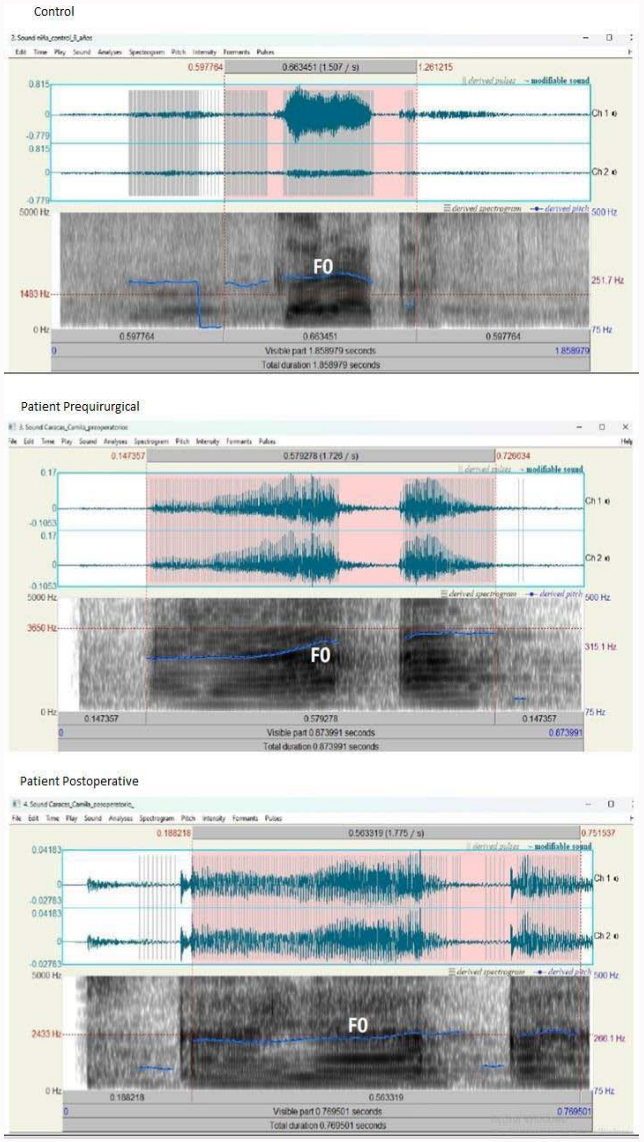


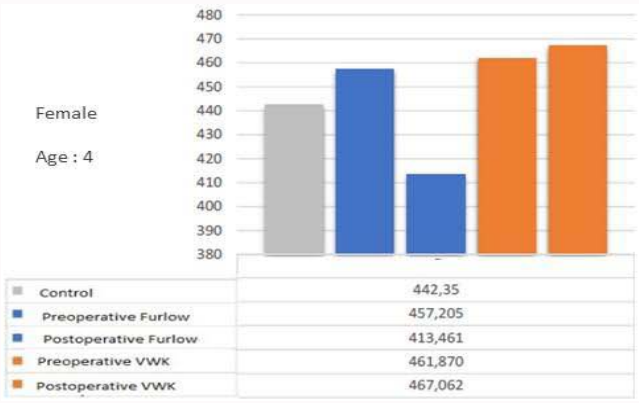
Figure 1: PRAAT Fundamental Frequency Software.

Table 2: Tone range. Fundamental frequency.

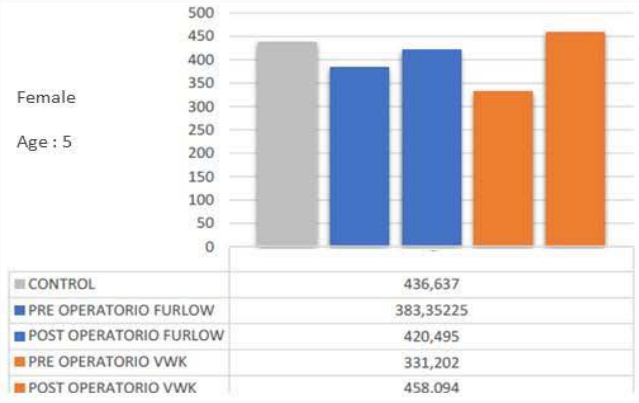
Fundamental frequency F (O)				
		Bass tone Range	Mid-Tone Range	Hight Range
Preoperative	Furlow Technique	1	18	0
	Veau-Wardill-Kilner Tehcnique	0	10	0
Postoperative	Furlow Technique	0	19	0
	Veau-Wardill-Kilner Technique	0	10	0

As a result, the mean tone range was obtained in all patients approaching the tone of the control subject regardless of the palatoplasty technique used, i.e., the F0 was considered within normal values for the age and gender of the patient subject (Table 2).

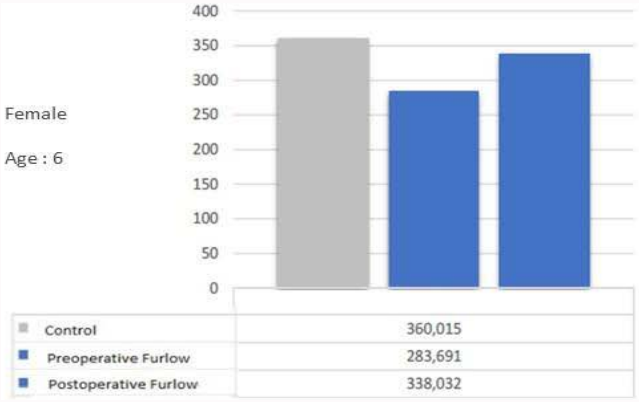
In the fundamental frequency assessment graphs, the evolution of the preoperative and postoperative patients submitted to the Veau-Wardill-Kilner and Furlow surgical techniques was evaluated, analyzing the tonality of the voice through the fundamental frequency quantified in Hz, which was obtained by means of the vibrant and occlusive phonemes obtained from the pronunciation of the word



Graphic 1: Fundamental Frequency.



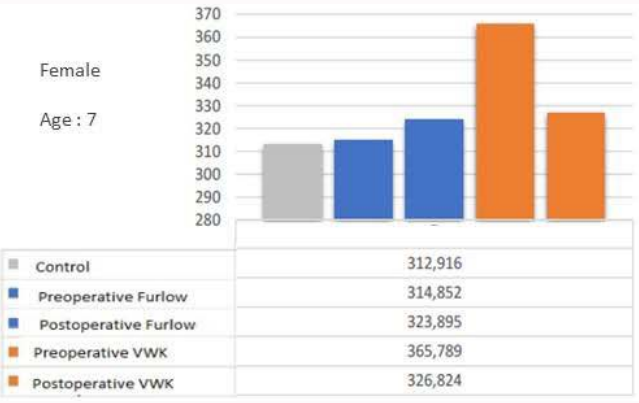
Graphic 2: Fundamental Frequency.



Graphic 3: Fundamental Frequency.

Caracas. These studied patients were divided into groups by gender and subdivided by age. Likewise, in order to obtain a comparative range in this study, the result of the pronunciation of the mentioned phoneme in a healthy control subject of the corresponding age and gender was used, which allowed the comparison of the pre and postoperative period, in order to obtain the data that will allow to evaluate the effectiveness of the treatment used for its postoperative result.

The results of the F0 by gender showed that, in the female gender, the audible spectrum is closer to the acute and medium, especially at younger ages, as opposed to the male patients who present a medium



Graphic 4: Fundamental Frequency.

Graphic 5: Fundamental Frequency.

and severe audible spectrum. We analyzed not only the change and improvement of pre- and post-operative speech comprehensibility, but also the comparison of both techniques used, as previously mentioned (Graphics 1-5).

A satisfactory result was evidenced both in the postoperative change and improvement as well as in the technique. The best results were observed in the Furlow technique at ages 5, 7 and 8 because they were closer to the control value of the subject of the corresponding age. However, comparative assessment could not be performed in 6-year-old subjects due to the lack of female patients operated by Veau-Wardill-Kilner palatoplasty technique in this age range. However, for 4-year-old patients, a number of more significant postoperative changes were observed in the Veau-Wardill-Kilner technique compared to the Furlow technique (Table 3).

In the male gender, as in the female analysis, a satisfactory result was observed for the Furlow palatoplasty technique, especially in patients 4, 5 and 6 years of age, since they presented similar results to the control patient within the age range evaluated. On the other hand, in the graphs of patients 7 and 8 years of age, an effective comparative assessment could not be made due to the lack of patients operated with the VWK palatoplasty technique. In general, a significant evolution was observed in the preoperative and postoperative assessment in any age range and with different techniques in the evaluable results of the operated patients (Graphics 6-10).

Speech comprehension

For the evaluation of speech comprehensibility and acceptability,

Table 3: Data matrix functional changes.

Data				Technique		FO			IA			
PX		Gender							Control		Patient	
#	Age	F	M	Furlow	VWK	Control FO HZ	Pre	Post	U	I	U	I
1	4	x		x		442.4	466.6	448.3	x		x	
2	4	x		x		442.4	496.9	406.0	x		x	
3	4	x		x		442.4	408.1	386.1	x			x
4	5	x		x		436.6	351.8	428.1	x		x	
5	5	x		x		436.6	381.5	402.2	x		x	x
6	5	x		x		436.6	401.2	435.8	x		x	
7	5	x		x		436.6	398.9	415.9	x		x	
8	6	x		x		360.0	248.8	327.8	x			x
9	6	x		x		360.0	318.6	348.3	x			x
10	7	x		x		312.9	314.9	323.9	x		x	
11	8	x		x		278.0	295.9	264.2	x		x	
12	8	x	x	x		278.0	312.2	289.3	x		x	
13	4		x	x		359.2	312.6	334.7	x		x	
14	4		x	x		359.2	372.7	344.3	x			x
15	5		x	x		360.0	382.6	370.2	x		x	
16	5		x	x		360.0	402.9	388.8	x			x
17	6		x	x		283.6	372.8	321.6	x		x	
18	7		x	x		286.8	386.2	336.6	x		x	
19	8		x	x		296.9	308.6	298.2	x		x	
20	4	x			x	442.4	436.9	478.3	x		x	
21	4	x			x	442.4	486.9	455.9	x			x
22	5	x			x	436.6	331.2	458.1	x		x	
23	7	x			x	312.9	365.8	326.8	x			x
24	8	x	x		x	278.0	369.7	294.0	x			x
25	4		x		x	359.2	300.9	292.7	x		x	
26	4		x		x	359.2	322.6	337.8	x			x
27	5		x		x	360.0	409.1	381.9	x		x	
28	6		x		x	283.6	303.5	286.6	x		x	
29	6		x		x	283.6	359.9	299.8	x			x

F: Female; M: Male; VWK: Veau-Wardil Kilner; U: Understandable; I: Incomprehensible; IA: Artificial Intelligence

Table 4: Speech understandability.

		Understandable	incomprehensible
Phonetic analysis	Furlow Technique	13	6
	VKK technique	6	4

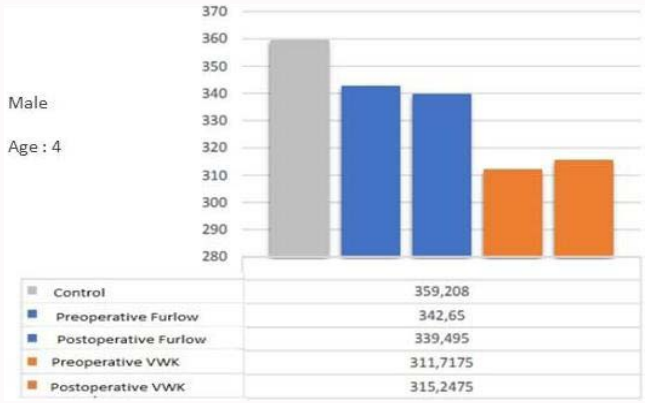
VWK: Veau Wardill Kilner

updated technology was used, through a virtual device with Artificial Intelligence (AI), for which the parameter of comprehensible and incompressible was measured, through the pronunciation of occlusive and vibrant phonemes by the postoperative patient of both surgical techniques. It was evidenced that the patients operated with the Furlow palatoplasty technique, obtained a better speech development, with a comprehensible response by the AI device (Table 4).

Discussion

The purpose of this research was to determine the functionality of the Veau-Wardill-Kilner and Furlow palatoplasty techniques, measuring functional data in patients with velopharyngeal incompetence pre- and post-operatively, allowing a comparative analysis between both palatoplasties in order to determine the effectiveness and better response to incompetence related to the functionality of the soft palate and speech comprehensibility in order to determine the effectiveness and better response to incompetence related to the functionality of the soft palate and speech comprehensibility.

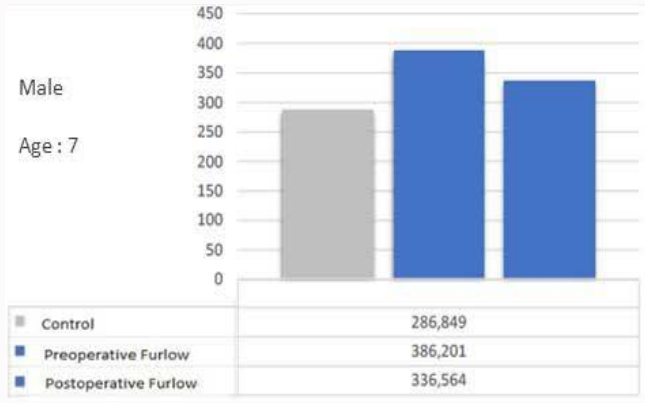
As did Leclerc in 2021, who considered that the movement of the posterior and lateral wall of the nasopharynx is related to the comprehensibility of speech, given that his study focused on the analysis of the Furlow palatoplasty technique and the dimensions that the nasopharynx should have after surgery, It is important to highlight that he considered that this technique does not present favorable results for speech comprehension, since his analysis sample did not have competence in the functionality of the palate, given the transverse length of the palatal cleft, proposing secondary surgical interventions for the correction of the patient's need [9].



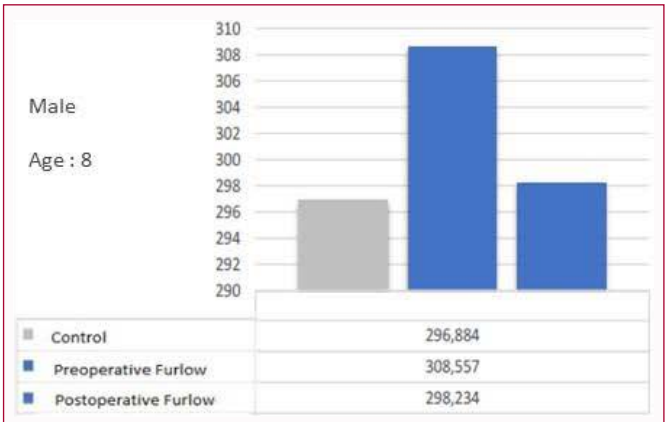
Graphic 6: Fundamental Frequency.

Graphic 7: Fundamental Frequency.

Graphic 8: Fundamental Frequency.



Graphic 9: Fundamental Frequency.



Graphic 10: Fundamental Frequency.

Z-plasty

In the Z Plasty of Furlow, the technique attempts to obturate the defect and retroposition the soft palate by double opposing Z-plasty designed on the soft palate. A significant feature of this technique is that the soft palate is lengthened and retropositioned by the tissue of the soft palate itself, not by the tissue of the hard palate, as in Wardill-Kilner push back. As a result, the interference to the maxillary growth caused by the Furlow procedure could be less than that created by Wardill-Kilner push-back palatoplasty [10].

Veau-Wardill-Kilner or VY recoil palatoplasty

This surgical technique was initially developed by Victor Veau in 1926, raising two mucoperiosteal palatal flaps based on the palatine arteries. Later modified by several authors, Kilner and Wardill added the Push-Back concept in 1937 [11].

Technique: The Veau technique is used to repair the anterior segment of the fissure, resulting in the well-known Veau-Wardill-Kilner palatoplasty technique. This technique is characterized by lateral relaxing incisions, bilateral flaps based on the greater palatine artery, separate mucosal plane closure, hamulus fracture, muscle plane closure and V-Y type elongation of the palate, the design of pedicled peninsular type mucoperiosteal flaps, based on the greater palatine artery, allow tension-free closure of the fissure [4].

Velopharyngeal incompetence analysis

Zhang Yu et al., in August 2023, conducted a study called Automatic detection system of velopharyngeal insufficiency based on acoustic signals from the nasal and oral canals, in the West China Hospital of Stomatology, specifically analyzed the speech function and the predominant characteristics present in patients with this pathology, such as hypernasality and nasal air emission, in addition to swallowing disorders. He exposes the need to use noninvasive instruments that allow direct visualization of the state of palatopharyngeal closure, since techniques such as Nasoendoscopy, Multiview Videofluoroscopy and other medical imaging methods merit that patients meet certain conditions of age and understanding of instructions, so he proposes the use of diagnostic technology assisted with artificial intelligence, with a software computer-assisted detection algorithms VPI based on speech and focusing on automatic detection of speech disorders caused [12]. This study was based on the

use of technology to evaluate the functional changes of patients with velopharyngeal incompetence, specifically a speech analysis software and a virtual device with AI, allowed to analyze the pronunciation of occlusive and vibrant phonemes, obtaining fundamental frequencies of midtone of the audible spectrum for the entire unit of analysis, and data to determine the comprehensibility and acceptability of speech, which concluded in values that allowed to consider the Furlow Palatoplasty technique as the technique that allows to obtain better results related to this parameter.

Other studies reported twenty patients with speech disorders, out of which 10 have cleft palate or cleft lip and palate (experimental group), participated in the perceptual assessment by means of Czermak mirror fogging test for assessing the nasal air escape and Pittsburgh Weighted Speech Scale (PWSS) for assessing the probable nature of the velopharyngeal sphincter. The perceptual speech symptoms and the nasal air escape provide unique insight into the state and role the velopharyngeal sphincter has in speech [13].

Videofluoroscopy is useful to identify anatomical abnormalities in the upper aerodigestive tract and to evaluate the physiology of all phases of swallowing. Using Barium Sulfate in oral suspension as a contrast medium, the function during swallowing can be optimally visualized and the muscular physiology of both the soft palate and the digestive tract can be evaluated. This allows to verify velopharyngeal incompetence and the presence of regurgitation [14].

Conclusion

The diagnosis of velopharyngeal incompetence is made by clinical evaluation and categorization of the diagnosis and treatment used, by means of specific tests that allow evaluating the closure of the velopharyngeal sphincter, for the research a retrospective study of clinical histories of patients with IVF attended in the service of Oral and Maxillofacial Surgery of the University Hospital "Dr. Angel Larralde" during 5 years (2019-2023) was carried out.

It was confirmed that the Furlow palatoplasty technique is ideal for the initial management of patients with velopharyngeal incompetence, since it presents a better palatal conformation, velar elongation and velopharyngeal competence, favoring the swallowing process, avoiding regurgitation and nasalization of the voice and improving its function, accompanied by an improvement in the comprehensibility and acceptability of speech.

Recommendations

It is necessary to continue research on the analysis parameters for the management of IVF, as well as the verification of other surgical techniques used for the correction of this pathology by checking it with the different assessment parameters to improve the response in the field of cleft palate, which affects the social and personal level of the subjects who suffer from it.

The research allows selecting the appropriate treatment for patients who come to the oral and maxillofacial surgery service with complications related to velopharyngeal incompetence, by evaluating the functional changes through different qualitative and quantitative parameters, we can determine the functionality of the soft palate and the comprehensibility and acceptability of speech, with the importance in the optimization of the analysis under the parameters in the diagnosed patients achieving a benefit for their social development and improvement in their quality of life.

References

1. Rosell Perry P. Treatment of cleft lip and palate. Outreach Surgical Center Program. 1st Ed. Lima: Universidad Nacional Mayor de San Marcos Fondo Editorial; 2009.
2. Sadler T. Langman Embriologia Medica. 13th Ed. Barcelona Spain: Wolters Kluwer; 2016.
3. Dudas JR, Deleyiannis FWB, Ford MD, Jiang S, Losee JE. Diagnosis and treatment of velopharyngeal insufficiency: Clinical utility of speech evaluation and videofluoroscopy. Ann Plast Surg. 2006;56(5):511-7.
4. Rossell-Perry P. Atlas of operative techniques in primary cleft lip and palate repair. Lima: Springer Nature Switzerland; 2020.
5. Lopes LW, Do Nascimento Cunha Costa SL, De Almeida Costa WC, Correia SÉN, Vieira VJD. Acoustic assessment of the voices of children using nonlinear analysis: Proposal for assessment and vocal monitoring. J Voice. 2014;28(5):565-73.
6. Chan M, Campo E, Estève D, Fourniols JY. Smart homes - Current features and future perspectives. Maturitas. 2009;64(2):90-7.
7. Steimann F. On the use and usefulness of fuzzy sets in medical AI. Artif Intell Med. 2001;21(1-3):131-7.
8. Amazon. Echo (4th Generation) | Premium sound Wi-Fi and Bluetooth smart speaker with Dolby, smart home hub and Alexa | Charcoal [Internet]. Amazon. 2020.
9. Leclerc JE, Gilbert F, McConnell ÉM, Beaudoin E, Bouchard J, Simonyan D. Furlow palatoplasty: Should we also focus on the size of the nasopharynx? Cleft Palate-Craniofacial J. 2021;58(11):1348-60.
10. Nishio J, Yamanishi T, Kohara H, Hirano Y, Sako M, Adachi T, et al. Early two-stage palatoplasty using modified Furlow's veloplasty. Cleft Palate Craniofac J. 2010;47(1):73-81.
11. Aik-Ming L, Lo LJ. Palatoplasty: Evolution and controversies. Chang Gung Med J. 2008;31(4):335-45.
12. Zhang Y, Zhang J, Li W, Yin H, He L. Automatic detection system for velopharyngeal insufficiency based on acoustic signals from nasal and oral channels. Diagnostics. 2023;13(16):2714.
13. Georgievska-Jancheska T, Gjorgova J, Popovska M. The role of the velopharyngeal sphincter in the speech of patients with cleft palate or cleft lip and palate using perceptual methods. Open Access Maced J Med Sci. 2016;4(4):674-9.
14. Giraldo-Cadavid LF, Leal-Leaño LR, Leon-Basantes GA, Bastidas AR, Garcia R, Ovalle S, et al. Accuracy of endoscopic and videofluoroscopic evaluations of swallowing for oropharyngeal dysphagia. Laryngoscope. 2017;127(9):2002-10.