**ABSTRACT**

**OBJECTIVE**

* To Describe the Pre-operative and Post-operative Voice Handicap Index Scores and Praat voice analysis results of patients with Spasmodic Dysphonia who underwent Thyroplasty Type II.

**METHODOLOGY**

This is a retrospective cross sectional study of charts of patients diagnosed with Adductor Spasmodic Dysphonia and who underwent Thyroplasty Type II from June 2018 to November 2019 in a tertiary government hospital. Age, sex, pre-operative and post-operative Filipino Voice Handicap Index Scores and Praat voice analysis results were reviewed and recorded.

**RESULTS**

 This study included 8 patients with Adductor Spasmodic Dysphonia who underwent Thryoplasty Type II from June 2018 to November 2019. Pre-operatively, the Filipino Voice Handicap Index Scores revealed severe voice handicap. On the other hand, post-operatively, the scores revealed mild voice handicap. In addition, pre-operative Praat software revealed high vocal jitters, high vocal shimmers, and low harmonic to noise ratio. In comparison, post-operative voice analysis revealed low jitter percentage, high vocal shimmers, and high harmonic to noise ratio.

**CONCLUSION**

In conclusion, patients with Adductor Spasmodic Dysphonia were more common in middle-aged female. The Pre-operative Voice Handicap Index scores of patients with Adductor Spasmodic Dysphonia had significant Voice Handicap scores with high vocal jitters, high vocal shimmers, and low harmonic to noise ratio as determined objectively by the Praat software. Patients who underwent Thyroplasty Type II have mild Voice Handicap scores post-operatively. In addition, the Praat software determined that the patients have low jitter percentage, high vocal shimmers, and high harmonic to noise ratio post-operatively.

**DEFINITION OF TERMS**

**Thyroplasty –** phonosurgical technique designed to improve the voice by altering the thyroid cartilage of the larynx, which houses the vocal cords in order to change the position or the length of the vocal cords.[8,9,10]

**Filipino Voice Handicap Index** – A validated Filipino version the Voice Handicap Index questionnaire by Jacobson et. al. that measures the influence of voice problems on a patient's quality of life.

**Praat Voice Analysis –** open-software tool for the analysis of speech.

**INTRODUCTION**

Dysphonia is described as impaired voice production as recognized by a clinician. This term is often used interchangeably with hoarseness; but, hoarseness is a symptom of altered voice quality reported by patients.[13]

According to World Health Organization (WHO) International Classification Functioning, Disability and Health (ICF) and Philippine’s National Council on Disability Affairs, chronic voice disorders such as spasmodic dysphonia (SD) is classified as a disability, covering impairments, activity limitations, and participation restrictions.

According to Ludlow, there are two kinds of Spasmodic Dysphonia. Adductor spasmodic dysphonia (ADSD) affects close to 90% of spasmodic dysphonia patients and is characterized by voice breaks during vowels during speech ensuing a strained-strangled voice due to intermittent hyperadduction of the vocal folds. The second type is Abductor spasmodic dysphonia (ABSD), which is relatively rare and involves intermittent voiceless breaks resulting in a breathy voice due to prolonged voiceless consonants before initiation of the following vowel. The prevalence was noted to be higher among middle-aged (45-65 years old) women than men with a prevalence rate of 0.98% based on a retrospective study by Cohen et.al.

 Management of adductor spasmodic dysphonia is directed at the relief of vocal spasm and to improve patient symptoms. Patients may be managed conservatively using percutaneous injection of botulinum toxin into the thyroarytenoid muscle.[1] However, due to its temporary effects, a patient is required repeated injections after 3 to 4 months.[1] On the other hand, surgical management may considered and would offer a more immediate and more permanent result compared to medical and botox injection. Current surgical management for Spasmodic Dysphonia would include laryngeal nerve sectioning, thyroarytenoid myectomy and Isshiki Thyroplasty Type 2.[3,7]

Isshiki Thyroplasty Type 2 provides an immediate, and more permanent improvement of the voice and is a reversible procedure.[9] The surgical technique innovated by Dr. Nobuhiko Isshiki provides long term relief of the symptoms of adductor spasmodic dysphonia.[9] Its principle is to release the tightness of the vocal cords during adduction by separating only the laryngeal framework, in this case, the thyroid cartilage and creating a more relaxed anterior glottal gap.[10] The incised and separated thyroid cartilage would be maintained using a surgical keel. In the past, several materials such as cartilage, rib graft, silicone have been used as a keel to maintain the interthyroidal cartilage space of the incised thyroid cartilage.[9] At present, a specially pre-fabricated titanium bridge is being used to maintain the inter-thyroidal cartilage gap. The latter method of separation is proven to be much more effective. [9]

Therefore, the aim of this paper is to present the preoperative and postoperative voice handicap index scores and voice analysis results of patients with Adductor Spasmodic Dysphonia who underwent Thyroplasty Type II using titanium bridge and titanium mesh.

**General Objectives**

* To Describe the Pre-operative and Post-operative Voice Handicap Index Scores and Praat results of patients with Spasmodic Dysphonia who underwent Thyroplasty Type II.

**Specific Objectives**

* To describe the demographics of patients with Adductor Spasmodic Dysphonia
* To describe the pre-operative Filipino Voice Handicap Index Scores of patients with Adductor Spasmodic Dysphonia
* To describe the post-operative Filipino Voice Handicap Index Scores of patients with Adductor Spasmodic Dysphonia
* To describe the pre-operative Praat results of patients with Adductor Spasmodic Dysphonia
* To describe the post-operative Praat results of patients with Adductor Spasmodic Dysphonia

**METHODOLOGY**

 This is a retrospective cross sectional study where the charts of 8 patients diagnosed with Adductor Spasmodic Dysphonia, previously treated with botulinum toxin injection into the vocal cords, and eventually underwent Thyroplasty Type II from June 2018 to November 2019 in a tertiary government hospital. Subjective voice evaluation was done using the validated Filipino Voice Handicap Index Questionnaire, which is a self-administered 30-item questionnaire that determines the functional, physical and emotional impact of voice disorders. On the other hand, objective voice evaluation was done using the Praat Voice analysis software, which evaluates voice acoustic parameters such as jitter, shimmer, and harmonics to noise ratio. Age, sex, co-morbidities, pre-operative, and post-operative Filipino Voice Handicap Index Scores and Praat voice analysis results, were reviewed and recorded.

 **Surgical Technique**

Isshiki Thyroplasty Type II was performed by the same surgeon in the operating room under local anaesthesia (Figure 1). Patient was placed on a supine position with the neck extended. Several landmarks such as thyroid prominence, cricoid cartilage and anterior border of the sternocleidomastoid muscle were identified and marked.(Figure 2) A 4cm horizontal curvilinear incision at mid thyroid cartilage level was marked. Infiltration of local anesthesia was done. Sterile water, lidocaine and epinephrine was used as local anesthetic with the dilution of 10:10:0.1. Cross hatched markings were then placed on the lines of incision. Incision was then made up to the sub-platysmal level. Superior flap was developed up to the level of the hyoid followed by the development of the inferior flap up to the level of the cricoid cartilage. Strap muscles were then exposed and separated in the midline and were lateralized using tissue hook retractor. Thyroid cartilage was then exposed and dimensions were measured and recorded (Figure 3). A vertical midline incision on the thyroid cartilage was done using a surgical blade and a hand-piece motor with a fine tip drill (Figure 4). The thyroid cartilage was then separated with a thyroid cartilage spreader. (Figure 5) Intra-Operative Voice Calibration was done to determine ideal inter-thyroidal cartilage gap based on the patient’s voice which was assessed subjectively and objectively intra-operatively. Subjective evaluation was done by asking the patient to phonate while the thyroid cartilage was being separated. Patient was asked to say the vowels “e” and “a” for 10 seconds and recite the numbers 1-10. The inter-thyroidal gap was noted on the best voice that the patient has produced. Regression of phonatory breaks were noted during patients’ phonation as well as the regression in the sensation of strangulation. Patient’s voice was also recorded using a portable recording computer with high definition speakers (Figure 10) intra-operatively and was analyzed using the Praat software. The titanium bridges (Figure 6) were anchored to the thyroid cartilage using 2-O nylon suture placed on the superior (Figure 7) and inferior edge of the plates (Figure 8). After final evaluation of patient’s voice the surgical site was closed layer by layer. Strap muscles were re-approximated and sutured. Subcutaneous layer was closed with Vicryl 3.O suture and the skin was closed with 3.O nylon suture. (Figure 9) Sterile strip was then applied to incision site. Patient was returned to the room and regular diet was resumed. Patient was instructed to refrain from talking, whispering nor shouting for one week.

**RESULTS**

This study included 8 patients with Adductor Spasmodic Dysphonia who underwent Thryoplasty Type II. Pre-fabricated titanium bridges were used for 7 out of the 8 patients, while a titanium mesh was used for 1 patient w­ho underwent Thyroplasty Type II from June 2018 to November 2019. It was observed that the mean age of the patients who were diagnosed with Adductor Spasmodic Dysphonia is 34.25 years old with a range of 24 to 69 years old. In addition, 5 were female and 3 were male. It was also noted that only 1 of the 8 patients had hypertension as co-morbidity.

1. Subjective Voice Evaluation

The validated Filipino Voice Handicap Index is a self-administered 30-item questionnaire that determines the functional, physical and emotional impact of voice disorders. The functional subscale items described the impact of a person’s voice disorders on daily activities. On the other hand, the physical subscale items included statements representing self-perceptions of laryngeal discomfort and voice output characteristics.[6,7] The emotional subscale items consisted of statements representing patient’s affective response to voice disorders.[6,7] The total assessment of handicap is measured by obtaining the mean of the scores on all 30 statements, which is the total VHI score. A score of 0-30 is a low score and indicates a minimal amount of handicap associated with the voice disorder.[6,7] A score of 31-60 indicates a moderate amount of handicap due to dysphonia. A score of 61-120 represents a significant and serious amount of handicap due to dysphonia.[6,7]

 In the functional domain of the voice handicap index, it was determined that mild handicap scores were noted on both pre-operative and post-operative states of patients. Pre-operative scores collected ranged from 18 to 27 (appendix A) with a mean score of 24.65 and post-operative scores ranged from 2 to 10 (Appendix B) with a mean score of 7.

 In the physical domain of the voice handicap index, moderate amount of voice handicap was noted pre-operatively where the scores collected ranged from 26 to 34 (Appendix A) with a mean of 30.75. On the other hand, scores garnered post-operatively were from 0 to 10 (Appendix B) with a mean score of 5.25 (Appendix B) translating to minimal voice handicap.

 In the emotional domain of the voice handicap index, the pre-operative scores of the response collected were from 17 to 33 (Appendix A) with a mean score of 22.375 indicating minimal amount of voice handicap and 2 to 8 (Appendix B) with a mean score of 4.875 (Appendix B) and with a scale of mild handicap post-operatively.

 The Overall Voice Handicap Index Scores showed that persons suffering from adductor spasmodic dysphonia had a severe voice with scores ranging from 74 up to 93 (Appendix A) and a mean score of 77.75 pre-operatively and 4 up to 27 (Appendix B) with a mean score of 17.5 (Appendix B) or mild voice handicap, post-operatively.

1. Objective Voice Evaluation

Praat voice analysis evaluates voice acoustic parameters such as jitter, shimmer, and harmonics to noise ratio.[7] It showed that vocal jitters ranged from 2.427% to 10.125% with mean pre-operative score of 6.626875% (Appendix C) which is considered abnormal. On the other hand, post-operative vocal jitters ranges from 0.533% up to 3.443% with a mean score of 1.33525% (Appendix D) which is still considered abnormal.

Vocal shimmers has a mean of 12.85975% ranging from 2.613% up to 17.876% pre-operatively (Appendix C) which is not considered pathological. At the same time, post-operative results showed a range from 4.432% up to 16.552% with a mean score of 10.49375% (Appendix D) post-operatively, which is also considered non-pathological.

Lastly, Harmonic to Noise Ratio (HNR) show that pre-operative HNR is less than 7 dB denoting an asthenic or dysphonic voice where a mean score of 4.797dB and a range of 3.142 dB up to 12.841 dB were collected (Appendix C). In contrast, post-operative scores were from 3.678 dB up to 15.393 dB with a mean score of 8.973375 (Appendix D) indicating a more sonorant and harmonic voice.

**DISCUSSION**

Spasmodic Dysphonia is a rare neurologic disorder that is characterized by uncontrolled contractions of laryngeal muscles.[1] Usually, when an individual with adductor spasmodic dysphonia attempts to speak, the resultant voice is described as strained, strangled-voice usually because of forceful adduction of the vocal folds. [5] It is recognized as a neurological disorder, focal dystonia, which affects the muscle tone in one part of the body to an unknown neurobiologial mechanism and is said to be more prevalent in females.[3] In our study, adductor spasmodic dysphonia was noted to be present in 5 females out of 8 total subjects.

The validated Filipino Voice Handicap Index is a self-administered 30-item questionnaire that has 3 divisions for subjective voice evaluation. The physical subscale, which includes statements representing self-perceptions of laryngeal discomfort and voice output characteristics.[6,7] Functional subscale, which describes the impact of a person’s voice disorders on daily activities. Lastly, Emotional subscale, which consists of statements representing patient’s affective response to voice disorders. This tool has been used to assess effectiveness of voice rehabilitation, medical and surgical treatment.[6,7] The total assessment of handicap is measured by obtaining the mean of the scores on all 30 statements. A score of 0-30 is a low score and indicates a minimal/mild amount of handicap associated with the voice disorder.[6,7] A score of 31-60 indicates a moderate amount of handicap due to dysphonia. A score of 61-120 represents a significant and serious/severe amount of handicap due to dysphonia. [6,7] In our study, pre-operative Voice Handicap Index Scores were noted to be ranging from 74 up to 93 with a mean score of 77.75 (Appendix A) and post-operative scores of 4 up to 27 with a mean score of 17.5 (Appendix B) or mild voice handicap. In the pos-operative VHI evaluation, the response with the lowest score was “sinusubukan ko na ibahin ang tunog ng aking boses” where all response garnered a score of 0 in the physical domain. In the functional domain, the response with the lowest score was *“sinusubukan ko na ibahin ang tunog ng aking boses”* where all response garnered a score of 0. Lastly, on the emotional domain, the response with the lowest score was *“Ikinababahala ko ang aking boses”.*

The Praat voice analysis software is a computer software developed by Paul Boersma and David Weenink of the Institution of Phonetics Sciences of the University of Amsterdam. [7] It evaluates voice acoustic parameters such as jitter, shimmer, and harmonics to noise ratio.[7] Measurements of these parameters has been proven to be useful in describing vocal characteristics which are crucial in measuring the severity of a Spasmodic Dysphonia.[8,9]

Jitter is a parameter defined as frequency of variation from cycle to cycle.[7] It is affected by lack of control of vibration of the cords hence the voices of the patients with pathologies often have a higher percentage of jitter.[7] Various sources consider 0.5 to 1% jitter for sustained phonation as normal.[8] In our study, pre-operative Jitters ranged from 2.427% up to 10.125% with a mean of 6.626875%.

On the other hand, vocal shimmers relates to amplitude variation of the sound wave.[7] It changes with glottal resistance mass lesions on the vocal cords and correlates breathiness of voice.[9] It is considered shimmers less that 3% for adults as pathological.[7,8,9] Results showed pre-operative vocal shimmers had a range of 2.63% up to 17.876% and a mean score of 12.85975%. (Appendix C)

Lastly, Harmonic to Noise Ratio is the assessment ratio between periodic components and non-periodic components comprising a segment of speech.[10] A voice sound with a high HNR is associated with a sonorant and harmonic voice. Therefore, HNR measures the efficiency of speech.[10] A low HNR that is less than 7dB denotes an asthenic voice or dysphonia.[8] Our results show that pre-operative HNR ranged from 2.145% up to 12.841% with 4.797% (Appendix C).

Medical management of spasmodic dysphonia is done by administering botulinum toxin injection directly to the vocal cords to temporarily relieve the dysphonia.[9] Another option is surgical management, which would offer a more immediate and permanent relief from the dysphonia. Isshiki Thyroplasty Type 2 has been proven to be very effective for spasmodic dysphonia patients.[3] It provides an immediate, more permanent improvement of the voice and is reversible.[3]

Post-operatively, Praat voice analysis was done and results showed vocal jitters with a range of 0.525% to 3.443% with a mean of 1.33525% this connotes normal phonation.

Moreover, vocal shimmers with a range of 4.105% to 16.552% with a mean of 10.49375%. This result is more than 3% yielding abnormal phonation.

The vocal harmonics-to-noise ratio ranged from 3.678 dB to 15.393 dB with a mean of 8.973375 dB. The mean resulted in more than 7db HNR ratio which depicts normal phonation.

**CONCLUSION**

In conclusion, patients with Adductor Spasmodic Dysphonia were more common in middle-aged female.

The pre-operative Voice Handicap Index scores of patients with Adductor Spasmodic Dysphonia had significant or severe Voice Handicap.

Thepre-operative Praat voice analysis had high vocal jitters, high vocal shimmers, and low harmonic to noise ratio.

The post-operative voice handicap index scores were mild voice handicap.

The post-operative Praat voice analysis revealed low jitter percentage, high vocal shimmers, and high Harmonic to Noise Ratio.

**RECOMMENDATION**

We recommended to add more subjects to improve the study since we currently have only 8 patients. In addition, we recommend referring the patient to a speech pathologist to further improve the outcome of the patient’s voice post-operatively. We also recommend doing a prospective study to determine the success rate of Isshiki Thyroplasty Type II in treating Adductor Spasmodic Dysphonia in Filipinos. Moreover, this study may be used to establish recommendations in managing Filipinos with Adductor Spasmodic Dysphonia.

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