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Comparative Study between Laryngoscopy and Transcutaneous Laryngeal Ultrasonography in Diagnosis of Laryngeal Disorders

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ABSTRACT

Background: Transcutaneous Laryngeal Ultrasonography [TLUSG] can be used as an alternative to fiber optic flexible laryngoscope for evaluating laryngeal function. TLUSG is a non-invasive, comfortable, and painless method, and some studies have shown it to be an effective way to assess laryngeal function.

The aim of the work: The aim of the study was to compare the diagnostic efficacy of laryngoscopy and transcutaneous laryngeal ultrasonography in identifying various laryngeal disorders.

Patients and Methods: This study included 150 patients, with hoarseness of voice and examined by laryngoscope and TLUSG. Findings were compared, and diagnostic statistics of TLUSG were analyzed in reference to laryngoscopy.

Results: No statistically significant difference has been shown in the findings between the laryngoscopy and ultrasound in detection of the different findings; however, the laryngoscopy showed all the lesions and the ultrasound failed to show findings in 15 cases [10%] with statistically significant difference [p= 0.035]. Ultrasound had 100% specificity for detecting all lesions.

Conclusion: Transcutaneous laryngeal ultrasonography is favorable for diagnosing different laryngeal lesions and incredibly advantageous for diagnosing larger lesions. As TLUSG did not show laryngeal lesions in 15% of cases, it is recommended to perform laryngoscopy in cases with negative TLUSG.

Keywords: Laryngoscopy; Transcutaneous; Laryngeal Ultrasonography; Hoarseness of voice.

INTRODUCTION

Transcutaneous laryngeal ultrasonography [TLUS] is now recognized as a valuable tool for investigating the airways in perioperative, emergency, and critical care settings [1].

Two-dimensional [2D] ultrasound imaging has become increasingly utilized for visualizing the laryngeal tract. Transcutaneous laryngeal ultrasonography [TLUS] is a specific application of 2D ultrasound that is used to analyze the anatomy and motion of the airway vocal folds [2].

Although laryngoscopy is still considered the gold standard for evaluating vocal fold function, some studies suggest that TLUSG can be used as an alternative to fiberoptic flexible laryngoscope, providing real-time imaging for examining laryngeal function. TLUSG is a non-invasive, painless, and comfortable method that has been shown to be a reliable way to assess laryngeal function in several studies [4].

COVID-19 is a contagious respiratory illness caused by the novel SARS-CoV-2 virus, which has been declared a global pandemic by the World Health Organization. As of September 24, 2020, the Italian National Health Agency reported that 30,009 healthcare workers had tested positive for SARS-CoV-2 [5]. Due to the nature of their work, otolaryngologists are at a high risk of exposure to aerosol transmission. They perform procedures that generate aerosols, ranging from routine oral examinations to laryngoscopy [6].

As the TLUSG is a simple non-invasive, and less hazardous to the examiner, the current study was conducted to compare between TLUSG and laryngoscopy in the evaluation of laryngeal structures among patients with hoarseness of voice.

PATIENTS AND METHODS

The present cross-sectional study had been concluded at the Department of ENT, Al-Azhar University Hospital [Damietta], Egypt. The study included 150 patients presented with hoarseness of voice and examined by laryngoscopy and TLUSG.

Inclusion criteria: All patients were suffering from hoarseness of voice.

Exclusion criteria: Patients with history of laryngeal operations [total and partial laryngectomy].

Before participating in the study, each patient was informed about the purpose and procedures of the study and gave both verbal and written consent. The study design was approved by the ethics committee of the Faculty of Medicine at Al-Azhar University.

All participants in the study underwent a complete medical history assessment, including general medical history and any associated comorbidities, as well as a clinical examination. Also, all patients underwent both laryngoscopy and TLUSG examinations.

Laryngoscopy: Each patient was examined while awake using both a Hopkins rod rigid laryngoscope [70°; Carl Storz, Germany] and a flexible laryngoscope, which was equipped with a camera [Carl Storz] for photo documentation and video recording purposes.

Laryngeal ultrasonography: The patient was positioned in a supine position with a slightly extended neck for the laryngeal ultrasound examination using a high-resolution ultrasound machine [LOGIQ P5] from General Electric [China]. The examination was conducted using a small linear probe with a frequency of 7.5 MHz and a laser page printer. The examiner first identified the thyroid cartilage externally and then placed the probe transversely on its midsection to begin the examination. The probe was moved up and down to obtain images of various laryngeal structures and lesions. The examination was conducted in two phases: [a] during quiet breathing to assess the vocal cords and any lesions, and [b] during phonation, where the patient was instructed to make the long E sound, to obtain the best sonographic assessment of vocal cord mobility. All Patients were discharged on the same day of examination.

Statistical analysis: The medical history, clinical examination, and outcome measures data were coded, entered, and analyzed using Microsoft Excel software. The data were then imported into Statistical Package for the Social Sciences [SPSS version 21.0] for further analysis. Qualitative data were represented as percentages and numbers, while quantitative continuous data were represented by mean ± SD. To test for differences and associations of qualitative variables, statistical tests such as the Chi-square test [X2] were used. The diagnostic accuracy of TLUSG was calculated using sensitivity, specificity, positive predictive value [PPV], and negative predictive value [NPV].

A p-value of less than 0.05 was considered significant for the results obtained.

RESULTS

The study participants had a mean age of 42.14 ± 14.47 years, with a median age of 41 years, and ages ranging from 15 to 75 years. Of the total participants, 47 were male [31.3%] and 103 were female [68.7%]. Among participants, 137 had GERD, while 53 were smokers. Also, 18 of the participants had previously undergone thyroidectomy, as shown in Table [1].

No statistically significant difference was indicted in the findings between the laryngoscopy and ultrasound in detection of the different findings. However, as the laryngoscopy showed all the lesions and the ultrasound failed to show findings in 15 cases [10%] with statistically significant difference [p= 0.035] as stated in table [2].

Table [3] shows the diagnostic accuracy of ultrasound as compared with laryngoscopy in detection of different findings. Regarding the detection of right vocal cord paralysis, ultrasound revealed 88.9% sensitivity, 100% specificity, 100% PPV, 99.3% NPV and 99.3% accuracy.

Table [1]: Demographic data and risk factors of the studied cases

Items		Study Cases n =150
Age [years]	Mean ± SD Median [min-max]	42.14 ± 14.47 41 [15-75]
Sex	Male Female	47 [31.3%] 103 [68.7%]
Clinical history and risk factors	GERD Smoking Thyroidectomy	137 [91.3%] 53 [35.3%] 18 [12%]

Table [2]: Comparison of the clinical findings as detected by laryngoscopy versus ultrasound

Variable	Laryngoscopy		Ultrasound		P value
	No.	%	No.	%	
Not seen	0	0	15	10	**0.035***
Normal	56	37.3	54	36.1	0.320
Right Vocal cord paralysis	9	6.0	8	5.3	0.826
Left vocal cord paralysis	6	4.0	5	3.3	0.840
Vocal cord polyp [Unilateral]	25	16.7	21	14.0	0.264
Vocal cord polyp [Bilateral]	2	1.3	2	1.3	1
Vocal cord nodule [Bilateral]	29	19.3	25	16.7	0.252
Right Vocal cord mass	7	4.7	6	4.0	0.834
Left vocal cord mass	2	1.3	2	1.3	1
Reinke's edema	14	9.3	12	8.0	0.488

Table [3]: Diagnostic accuracy of Ultrasound compared to laryngoscopy in detection of different findings

Findings	Sensitivity	Specificity	PPV	NPV	Accuracy
Right Vocal cord paralysis	88.9%	100%	100%	99.3%	99.3%
Left vocal cord paralysis	83.3%	100%	100%	99.3%	99.3%
Vocal cord polyp [Unilateral]	84%	100%	100%	96.9%	97.3%
Vocal cord polyp [Bilateral]	100%	100%	100%	100%	100%
Vocal cord nodule [Bilateral]	86.2%	100%	100%	96.8%	97.3%
Right Vocal cord mass	85.7%	100%	100%	99.3%	99.3%
Left vocal cord mass	100%	100%	100%	100%	100%
Reinke's edema	85.7%	100%	100%	98.6%	98.7%

DISCUSSION

The small size and mobility of the larynx in different planes make it difficult to study. While the examination of vocal cords and other internal laryngeal structures is commonly done using an indirect laryngoscope, this method may not be well-tolerated by certain patients, such as children, elderly individuals, patients with sensitive gag reflexes, patients with neck or jaw diseases, and those experiencing stridor [7]. Therefore, ultrasound has been studied extensively as a method for evaluating laryngeal disorders. Ultrasound has been widely used as a diagnostic tool for head and neck disease [8].

In the present study, TLUSG detected 13 out of 15 cases with vocal cord paralysis [8/9 on the right side and 5/6 on the left side]. Compared to fiberoptic laryngoscopy, laryngeal ultrasound has a reported sensitivity of about 90% for evaluating vocal fold motion [9], and its concordance with laryngoscopy findings can exceed 95% [10].

Our study results showed no significant difference between laryngoscopy and transcutaneous laryngeal ultrasonography in diagnosing various types of lesions and polyps, as well as in diagnosing Reinke's edema. Our results were consistent with the study of **Sadek *et al.*** [11] as they stated that no significant differences between direct laryngoscopy [DL] and ultrasonography diagnosis results. By DL, bilateral vocal fold nodule was diagnosed in 14 cases. However, ultrasound diagnosed only 11 cases of them. 16 cases were diagnosed with left or right vocal fold polyp and the ultrasound diagnosed 15 cases of them. 10 patients were diagnosed as glottal mass and the ultrasound diagnosed only 8 cases of them. For vocal fold cyst, four cases were diagnosed by both DL and ultrasound. Also, for Reinke's edema, four cases were diagnosed by both DL and ultrasound. One case was diagnosed as Laryngeocele by both maneuvers. One case was diagnosed as Laryngeoscleroma by DL while it was not diagnosed by ultrasound.

Likewise, **Nasr *et al.*** [12] reported that laryngeal ultrasound was successful in identifying vocal cord nodules in 27.3% of patients, polyps and cysts in all patients, Reinke's edema in 60% of patients, and laryngeal masses in 78.6% of patients. The researchers concluded that laryngeal ultrasound is a useful diagnostic tool for detecting different types of laryngeal lesions.

Regarding diagnostic accuracy in detection of different findings, the detection of right vocal cord paralysis, ultrasound revealed 88.9% sensitivity, 100% specificity, 100% PPV, 99.3% NPV with 99.3% accuracy. Good results were also obtained for various lesions.

Shah *et al.* [13] found that TLUSG was highly effective in assessing vocal cords, with excellent sensitivity, specificity, positive predictive value, and negative predictive value when compared to videolaryngoscopy [75%, 95.1%, 60%, and 97.5%, respectively]. They suggest that TLUSG can be used as a non-invasive and convenient bedside screening tool for evaluating vocal cord palsy after thyroidectomy. These findings are similar to our own results.

While some studies have cautioned against using Laryngeal Ultrasonography as a substitute for video laryngoscopy [14] recent research [15] has shown that TLUSG's ability to assess vocal fold motility is significantly reduced in patients with a BMI of 25 or higher and after surgery. Additionally, **Wong *et al.*** [16] have found that the success rate of visualizing vocal cord movement through ultrasound is lower than that achieved by laryngoscopy, and certain factors such as older age and male sex can make the examination impractical. A multicenter study involving 510 patients also reported a low rate of visualization in men compared to women [17% vs. 83%] and in patients with thyroid cartilage calcification compared to those without [42% vs. 83%].

Despite the limitations of laryngeal ultrasound, we advocate for its use as a screening tool for identifying vocal fold motion abnormalities, particularly during a pandemic situation to prevent healthcare workers from getting infected.

Ultrasound examination can be performed safely by following standard and transmission-based precautions, such as using appropriate protective equipment [face masks, goggles, face protective shields, surgical gowns, and gloves], as well as ensuring proper cleaning and disinfection of the ultrasound transducer [18].

Additional experience with the TLUSG examination could open up new possibilities of laryngeal ultrasound in ENT departments. For instance, it could be used to identify the cricothyroid membrane for cricothyrotomy management [19, 20], evaluate laryngeal pathologies in children with dysphonia and stridor [21], and complement laryngoscopy and tomography as a diagnostic tool for patients with laryngeal cancer [22, 23].

The assessment of vocal folds can be hindered by the calcification of the thyroid cartilage, and another limitation is the air-mucosa interface. Although the free margins of the vocal fold are easily distinguishable, the posterior part of the vocal cord and its free margins may not be clearly visible due to the interface between the glottic air and the surrounding tissues [8].

Conclusion: Transcutaneous laryngeal ultrasonography could be an effective and alternative technique to direct laryngoscopy in diagnosis of different laryngeal lesions. As TLUSG did not show laryngeal lesions in 15% of cases, it is recommended to perform laryngoscopy in cases with negative TLUSG.

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