Introduction

For over two decades investigators have studied the use of ultrasound in the evaluation of laryngeal disorders. The vocal folds have been shown to be amenable to evaluation by ultrasound in both normal and pathologic states. Multiple studies have focused on the use of ultrasound in the pediatric population due to one of the technique’s most notable advantages: its improved tolerability relative to transnasal laryngoscopy. Other advantages of ultrasound include its non-invasiveness, convenience, comfort, increased availability, ability to evaluate dynamic structures, and obviation of topical anesthetics. The use of in-office ultrasound has increased and has been shown to be cost-effective in clinical practice. Otolaryngologists have also been shown to be competent users of this technology, as it may be considered a modern extension of the physical examination of the head and neck. Therefore, it is not surprising that the role for ultrasound in the head and neck continues to grow.

The aim of this study was to determine the ability of transcutaneous laryngeal ultrasound (TCLUS) to diagnose vocal fold (VF) paralysis when compared to the gold standard of fiberoptic laryngoscopy while in the outpatient clinical setting with the otolaryngologist serving as the ultrasonographer.

Methods

19 patients were recruited from a single Voice and Swallow Center. Fiberoptic laryngoscopy (FL) and TCLUDS were performed on all patients. Real time ultrasound video segments were recorded for each patient and FL confirmed the diagnosis of VF mobility or paralysis. The ultrasound videos were then de-identified, randomized and shown to a group of 16 otolaryngology physicians (11 attendings and 5 residents). None of the participants had prior experience in reading TCLUDS. Participants were asked to assess each patient on VF paralysis (distinguishing laterality) vs. mobility.

There were five patients who were more commonly misdiagnosed (>40% of the time). All of the frequently misdiagnosed patients were male, two had VF paralysis, three had previous neck surgery and four were recorded on the first day of data collection.

Results

All 19 patients were recruited from a single Voice and Swallow Center (Loma Linda University). There were 9 male and 10 female patients. 11 patients had unilateral VF paralysis and 8 served as controls (mobile bilaterally). All patients were consented prior to the TCLUDS/FL, and all patients completed a Voice Handicap Index (VHI-10) prior to the procedure. Data collection took place in the ENT clinic on 2 separate days.

Eleven Otolaryngology attending physicians participated in the grading (all subspecialties were represented). The attending physicians made the correct diagnosis 79.4% of the time (p<0.05). There were no significant differences in scoring when comparing different subspecialties amongst the attending group, although the two highest scoring groups were Laryngology and Facial Plastics & Reconstruction. The Head and Neck attendings made up the largest group (n=4). Five Otolaryngology resident physicians participated in the grading (PGY 2-5 represented). The resident physicians were correct 77.9% of the time (p<0.05). There were no significant differences in scoring between PGY 2-5. Both groups were slightly more accurate at diagnosing patients with mobility.

Attending Physicians

<table>
<thead>
<tr>
<th>Group Total</th>
<th>Percent Correct Group Total</th>
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<tbody>
<tr>
<td>Attending Physicians</td>
<td>79.4%</td>
</tr>
<tr>
<td>Resident Physicians</td>
<td>77.9%</td>
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There were five patients who were routinely misdiagnosed by both grading groups. The most common variable among the most frequently misdiagnosed patients was that the subjects were all male. The male thyroid cartilage generally has a more acute angle, and due to the narrow ultrasound beam interpretation can be more difficult. Another common variable was that four of the cases were presumably due to altered anatomy. Another observation was that it is useful to observe the patient in quiet respiration as subtle VF movements can often be seen more clearly. Forceful phonation raises the larynx and can also make interpretation more challenging.

Importantly, the authors who actually performed the ultrasound diagnosis 100% of the time.

Discussion

Vocal fold evaluation was historically performed using the indirect mirror exam. More recently, the use of the fiberoptic laryngoscope has gained greater popularity among Otolaryngologists for routine evaluation of the larynx. Although FL is generally well tolerated, it still requires a cooperative patient as well as application of topical anesthetic and decongestant. Occasionally there are patients who cannot tolerate FL, and TCLUDS would provide a feasible and reliable alternative for ruling out vocal fold paralysis. Another clinical scenario where TCLUDS would be a convenient extension of current ultrasound use would be in the pre-operative evaluation and documentation of vocal fold mobility in patients set for thyroid surgery.

None of the Otolaryngologists in the current study had previous experience reading TCLUDS and both Resident and Attending physicians were relatively accurate at diagnosing VF paralysis. There were no statistically significant differences when comparing accuracy of the Attending physicians to the Resident physicians, although the Attending physicians did have a tendency for a higher correct percentage.

There were five patients who were routinely misdiagnosed by both grading groups. The most common variable among the most frequently misdiagnosed patients were that the subjects were all male. The male thyroid cartilage generally has a more acute angle, and due to the narrow ultrasound beam interpretation can be more difficult. Another common variable was that four of the cases were performed on the first day of data collection. There was a quick learning curve for accurately capturing high quality video segments for reliable interpretation. Patients with previous surgery and/or history of radiation also result in more frequent misdiagnosis, presumably due to altered anatomy. Another observation was that it is useful to observe the patient in quiet respiration as subtle VF movements can often be seen more clearly. Forceful phonation raises the larynx and can also make interpretation more challenging.

Importantly, the authors who actually performed the ultrasound were able to evaluate the TCLUDS in real time and made the correct diagnosis 100% of the time.

Conclusions

TCLUDS can accurately distinguish between VF mobility and paralysis in select patients when graded by both resident and attending otolaryngologists. The more acute angle of the anterior thyroid cartilage in males and previous neck surgery made TCLUDS interpretation slightly more difficult. Furthermore, there is a fast learning curve for performing and reading the TCLUDS. This study illustrates that TCLUDS is a feasible adjunct to laryngeal examination in patients that are not appropriate for fiberoptic exam.