

# Quantitative Ergonomic Comparison of Traditional Versus Endoscopic-Assisted Tonsillectomies: A Prospective Case-Control Study

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## Abstract

Five succinct key points: -Otolaryngologists are at high risk for ergonomic injury, particularly in the neck and cervical spine region. - There is a need to use validated ergonomic assessment tools to quantify the amount of risk in specific otolaryngology procedures and identify alternative methods to decrease that risk. -The physical positioning of the senior author was studied using the RULA score during two different operative approaches to tonsillectomy: one using an endoscope and one using direct visualization without the aid of an endoscope. - The RULA score for the traditional, non-endoscopic approach was 5, with a Neck, Trunk, and Leg Score of 6 and a Wrist/Arm score of 1, demonstrating a high risk and suggesting a need for further investigation and change. The RULA score for the endoscopic-assisted approach was 3, with a Neck, Trunk, and Leg score of 4 and a Wrist/Arm score of 1. -An endoscopic-assisted approach to tonsillectomy allowed for a lower RULA score than traditional tonsillectomy. This study suggests that an endoscopic approach may decrease the potential for musculoskeletal strain and reduce occupational-related pain and injury seen in practicing otolaryngologists.

## Quantitative Ergonomic Comparison of Traditional Versus Endoscopic-Assisted Tonsillectomies: A Prospective Case-Control Study

*Keywords:* Tonsillectomy; Ergonomics; endoscopes

### Five succinct key points:

- Otolaryngologists are at high risk for ergonomic injury, particularly in the neck and cervical spine region.
- There is a need to use validated ergonomic assessment tools to quantify the amount of risk in specific otolaryngology procedures and identify alternative methods to decrease that risk.
- The physical positioning of the senior author was studied using the RULA score during two different operative approaches to tonsillectomy: one using an endoscope and one using direct visualization without the aid of an endoscope.
- The RULA score for the traditional, non-endoscopic approach was 5, with a Neck, Trunk, and Leg Score of 6 and a Wrist/Arm score of 1, demonstrating a high risk and suggesting a need for further investigation and change. The RULA score for the endoscopic-assisted approach was 3, with a Neck, Trunk, and Leg score of 4 and a Wrist/Arm score of 1.

-An endoscopic-assisted approach to tonsillectomy allowed for a lower RULA score than traditional tonsillectomy. This study suggests that an endoscopic approach may decrease the potential for musculoskeletal strain and reduce occupational-related pain and injury seen in practicing otolaryngologists.

*Introduction:* Prior research has demonstrated that otolaryngologists are at high risk for ergonomic injury, particularly in the neck and cervical spine region, manifesting as stiffness and pain (1-3). Some otolaryngologists even report the need to stop during procedures or miss workdays due to the musculoskeletal burden they are consistently subjected to (3). Therefore, there is a need to use validated ergonomic assessment tools to quantify the amount of risk in specific otolaryngology procedures and identify alternative methods to decrease that risk.

The RULA tool, created by Corlett and McAtamney (1993), is a screening tool based on observation to assess exposure to energy use due to neck, trunk, and upper limb posture, muscle use, and forces (4). The administration of this tool is inexpensive and does not require special tools or pre-existing skills. Rodman et al. (2020) used the RULA tool to analyze surgical ergonomics in pediatric otolaryngology. This study demonstrated that 37% of intraoperative observations had a high ergonomic risk, while 16% had a very high risk (2). Furthermore, a recent systematic review and meta-analysis demonstrated the prevalence of work-related MSK discomfort to be approximately 79% among practicing otolaryngologists (5). Thus, given the high prevalence of work-related musculoskeletal discomfort and the unacceptable level of ergonomic risk for common procedures, analyzing the ergonomic risk of alternative techniques and new technologies is needed to reduce and lower the risk of musculoskeletal injury for otolaryngologists.

The tonsillectomy is one of the most frequently performed surgeries by the otolaryngologist. There are several techniques for tonsillectomy, but in general, they are performed macroscopically, requiring the surgeon to look down and flex their cervical spine for the extent of the procedure. However, an alternative to the macroscopic approach is an endoscopic-assisted tonsillectomy, either by having an assistant hold the endoscope or mounted on an endoscope holder. We believe that the ergonomics of the endoscopic-assisted tonsillectomy technique may reduce the neck and cervical spine strain of the performing surgeon. Thus, this study aims to quantitatively evaluate the ergonomics of traditionally performed tonsillectomy versus an alternative endoscopic-assisted tonsillectomy. Further, we compare the additional positive and negative aspects of using the endoscope for tonsillectomy.

*Methods:* A simulation tonsillectomy was conducted using a Airsim advance Bronchi 2 manikin for the subject. A zero-degree Hopkins rod connected to a 4K camera and a Storz video tower was Endoscopic Assisted tonsillectomy and a Welch Allyn headlight attached to a xenon light source was used for traditional tonsillectomy. In both cases an Arthrocare Evac 70 Cobator handpiece was utilized. The physical positioning of the senior author was studied during simulation of two different operative approaches to tonsillectomy: one using an endoscope and one using direct visualization without the aid of an endoscope.

Whole-body postural data was collected and analyzed using the validated Rapid Upper Limb Assessments (RULA) tool to calculate the risk of musculoskeletal injuries. To use the RULA tool, the viewer assigns a numerical rating to the posture of the upper arms, lower arms, and wrists, which equals Score A, together with the stance of the neck, trunk, and legs equals score B. The observer then assigns another numerical rating for extra factors that strain the musculoskeletal system, such as static loading, repetitive action, and force exertion. Thus, Score A + muscle use + force scores for group A equals Score C, and Score B + muscle use + force scores for group B equals Score D.

The numerical ratings are scored and computed to a Grand Score, ranging from 1 to 7. A RULA score of 1 to 2 is negligible the risk with no action required, 3 to 4 is low risk with a potential need for change, 5 to 6 is a high risk suggesting a need for further investigation and change, and 6 or greater is a very high risk with the need for rapid change (2). The otolaryngologist subject of this simulation study is the senior author of this project, making it exempt from IRB review.

*Results:* The RULA score for the traditional, non-endoscopic approach was 5, with a Neck, Trunk, Leg Score of 6 and a Wrist/Arm score of 1(Fig1). The RULA score for the endoscopic-assisted approach was

3, with a Neck, Trunk, Leg score of 4 and a Wrist/Arm score of 1(Fig2). The difference between the two approaches narrowed down to the effect on neck positioning (angle decreased from >20 degrees with traditional to nearly 0 degrees with endoscopic) and trunk positioning (angle reduced from 20-60 degrees with traditional to 0 degrees with endoscopic).

*Discussion:* Our study demonstrated that the endoscopic-assisted approach to tonsillectomy allowed for a lower RULA score, suggesting that there may be potential to reduce the musculoskeletal strain and injuries induced by repetitive MSD. This study is the first to utilize the RULA tool to analyze the ergonomic risk of a traditional tonsillectomy versus an endoscopic approach.

Traditionally, the tonsillectomy is performed macroscopically under the surgeon's direct vision, necessitating sustained neck flexion to look down at the surgical field (6). Rodman et al. found that this procedure carried a RULA score of 5, which indicates that a procedure has a high risk of ergonomic injury, and that further investigation and rapid change are warranted (2). In comparison, the endoscopic-assisted approach to tonsillectomy allowed for a lower RULA score of 3, indicating a lower risk of ergonomic injury. Notably, the endoscopic-assisted approach allows the surgeon is primarily looking up at a screen, a position that is more neutral than the constant flexion of the traditional approach. As a result, the difference between the two approaches narrowed down to the effect on neck positioning, and the angle decreased from >20 degrees with traditional to nearly 0 degrees with endoscopic.

In addition to the ergonomic issues, the traditional tonsillectomy is an approach that is often not amenable for other members of the medical team to have direct visualization due to the small surgical field. In contrast, the endoscopic-assisted tonsillectomy is an approach that uses an endoscope for indirect visualization, projecting the surgical field onto a screen. This alternate approach has been shown to facilitate the education of tonsillectomy techniques while enabling the surgeon to operate with comparable, if not enhanced, precision due to the enlarged view of the operation field (6). Additionally, with the wide-angle of the endoscopic view compared to that offered by microscopy, it is not necessary to move the fixed endoscope during the operation.

Despite the decreased ergonomic risk and the proposed educational advantage, endoscopic-assisted tonsillectomies may carry some disadvantages, including increased cost per procedure and the need for an additional set of hands or an endoscope-holder setup. A previous observational cohort study analyzing the significant expenses for same-day adenotonsillectomy (T&A) found that the mean cost per T&A was approximately \$1506 with a 95% confidence interval, \$1492-\$1519 (7). This study demonstrated that the most significant cost categories included using the Operating Room (31.9%), Same Day Services such as anesthesia and pharmacy (28.1%), and OR supplies (15.6%)(7).

Furthermore, a previous study examining the cost difference between the Endoscopic Stapling Technique for the Treatment of Zenker Diverticulum vs. the Standard Open-Neck Technique demonstrated that endoscopic procedures, although maybe shorter in operative time, add increased cost per procedure when compared to the conventional open approach(8) . This increased price was attributed to specialized equipment, notably the EndoGIA endoscopic stapler. Additionally, the costs associated with reprocessing conventional endoscopes can range between \$ 140 and \$ 280 per endoscope (9). Thus, utilizing the reusable endoscope for routine, same day adenotonsillectomy would undoubtedly add to the OR supply expenses and likely increase the total cost of a procedure. Nevertheless, a possible strategy to decrease the price per endoscopic-assisted tonsillectomy procedure maybe be to use single-use disposable endoscopes. For example, a previous study comparing the Costs of Reusable Versus Disposable endoscopes in Carpal Tunnel surgery demonstrated that the disposable equipment was less costly, resulting in cost savings of \$102 (10). Therefore, perhaps using disposable endoscopes for endoscopic-assisted tonsillectomy may reduce cost. However, a cost comparison between conventional tonsillectomies versus endoscopic-assisted tonsillectomies or reusable endoscopes versus disposable endoscopic-assisted tonsillectomies has yet to be performed and requires further study.

This study is limited by evaluating the ergonomics of a single surgeon on a single day. More studies are required to validate and expand on our findings, by assessing multiple surgeons throughout different stages of their careers.

**Conclusions:** Our study demonstrated that the endoscopic-assisted approach to tonsillectomy allowed for a lower RULA score than the traditional macroscopic tonsillectomy approach. While previous research has shown the educational benefits of increased visualization with an endoscopic procedure, this study suggests that an endoscopic approach may additionally aid in reducing occupational-related pain and injury. Though endoscopes may add considerable cost to tonsillectomies, the rise in low-cost disposable endoscopes may further promote this surgical technique.

## References:

1. Cavanagh J, Brake M, Kearns D, Hong P. Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members. *Am J Otolaryngol.* 2012;33(4):441-6.
2. Rodman C, Kelly N, Niermeyer W, Banks L, Onwuka A, Mason E, et al. Quantitative Assessment of Surgical Ergonomics in Otolaryngology. *Otolaryngol Head Neck Surg.* 2020;163(6):1186-93.
3. Vijendren A, Yung M, Sanchez J, Duffield K. Occupational musculoskeletal pain amongst ENT surgeons - are we looking at the tip of an iceberg? *J Laryngol Otol.* 2016;130(5):490-6.
4. McAtamney L, Nigel Corlett E. RULA: a survey method for the investigation of work-related upper limb disorders. *Appl Ergon.* 1993;24(2):91-9.
5. Ryan MT, Montgomery EA, Fryer J, Yang AW, Mills C, Watson N, et al. Ergonomics in Otolaryngology: A Systematic Review and Meta-analysis. *Laryngoscope.* 2022.
6. Nakaya M, Kimura Y, Onuki Y, Kida W, Shiraishi A, Fujimoto C, et al. Endoscopic-assisted tonsillectomy. *Laryngoscope.* 2013;123(2):360-1.
7. Meier JD, Duval M, Wilkes J, Andrews S, Korgenski EK, Park AH, et al. Surgeon dependent variation in adenotonsillectomy costs in children. *Otolaryngol Head Neck Surg.* 2014;150(5):887-92.
8. Smith SR, Genden EM, Urken ML. Endoscopic stapling technique for the treatment of Zenker diverticulum vs standard open-neck technique: a direct comparison and charge analysis. *Arch Otolaryngol Head Neck Surg.* 2002;128(2):141-4.
9. Ciocîrlan M. Low-cost disposable endoscope: pros and cons. *Endosc Int Open.* 2019;7(9):E1184-e6.
10. Voigt J, Seigerman D, Lutsky K, Beredjiklian P, Leinberry C. Comparison of the Costs of Reusable Versus Disposable Equipment for Endoscopic Carpal Tunnel Release Procedures Using Activity-Based Costing Analysis. *J Hand Surg Am.* 2021;46(4):339.e1-e15.

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