Using a 4K 3-Dimensional Exoscope for Upper Airway Stimulation Surgery: Proof of Concept

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Abstract

Objective: Demonstrate the potential of a 4K 3-Dimensional Exoscope during upper airway stimulation surgery (UAS)
Methods: A proof of concept was performed to evaluate the feasibility of utilizing the ORBEYE 4K-3D Video Microscope (OVM) during 3 consecutive UAS.
Results: The OVM was employed during UAS including cuff electrode, implantable pulse generator, and sensing lead placement. All 3 cases were successfully completed, with a mean operative time of 200 minutes (range 188-218 minutes) and reduction in operative time with consecutive OVM usage. The mean operative time with OVM was slightly longer than published reports of 179 minutes with traditional microscopic technology. The OVM allowed for 3-Dimensional visualization of the entire operative field by the operating surgeon, assistant surgeons, surgical technologists, and nursing staff. No adverse events or complications were attributed OVM usage.
Conclusion: In this initial experience, the OVM provided notable advantages over traditional binocular microscopy including improved ergonomics, unobstructed surgical field access, wide depth of field visualization, and ease of use. Additionally, it allowed all surgical personnel to have a similar field of view to the primary surgeon, facilitating the ability to assist and anticipate procedure progression. In an academic institution, it also served as an educational tool allowing the supervising surgeon to safely follow all aspects of the operation. In the setting of UAS, which requires clear delineation of the functional breakpoint within the hypoglossal nerve in order to provide optimal implant functionality, this unique visualization device has the potential to become a valuable tool in the sleep surgeon's armamentarium.

Introduction

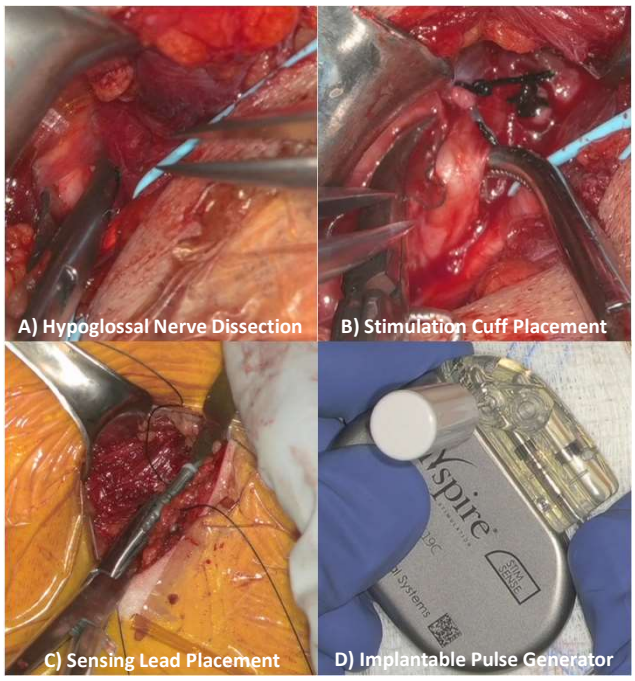
Upper airway stimulation (UAS) surgery is a relatively novel procedure designed to address obstructive sleep apnea (OSA), which is often performed through close collaboration via a dedicated sleep specialist team comprised of sleep physicians, technicians, and surgeons. Currently, UAS surgery is performed under surgical loupe magnification and/or binocular microscopy to allow for precise targeting and selective stimulation of hypoglossal nerve fibers. Recent developments in next-generation imaging technology have led to the advent of the extracorporeal video telescope, or "exoscope," which is suspended above the surgical field and produces a latency-free image. The exoscope's longer focal length (220mm-550mm) allows for the entire system to be positioned farther from the surgical field, increasing the working corridor for surgeons. Given these advantages, the exoscope has been successfully utilized in a variety of surgical procedures in neurosurgery and otolaryngology[1-6]. The exoscope may improve surgical ergonomics, operative efficiency, and medical education.

Methods & Results

Three patients undergoing UAS surgery met inclusion and exclusion criteria; all patients received polysomnography and drug induced sleep endoscopy preoperatively and underwent hypoglossal nerve stimulator placement with the use of the exoscope. The exoscope was employed during cuff electrode, implantable pulse generator, and sensing lead placement. All cases were successfully completed with the exoscope, with a mean operative time of 200 minutes (range 188-218 minutes) and reduction in operative time with consecutive exoscope usage. Notably, the exoscope allowed for visualization of the entire operative field by the operating surgeon, assistant surgeons, surgical technologists, and nursing staff. No adverse complications were attributed to exoscope. All patients had successful testing of the stimulator cuff with appropriate protrusion of the tongue. Finally, both authors subjectively found the tool to be comfortable and favored the ergonomics of the exoscope as opposed to alternative visualization methods for all cases in this cohort.

Watch the video by using the camera app on your phone to view this link:

Exoscope Deployment During UAS Surgery



Discussion

Operating surgeons were able to perform all critical portions of the procedure safely and efficiently without the need for traditional visual adjuncts. Notable advantages of the exoscope include improved communication and instrument exchange between team members, superior ergonomics for operating surgeons, and unique feasibility as a teaching utility platform which affords a high-quality view. Future studies with a more systematic assessment of the exoscope's image quality, ergonomics, and impact on surgical workflow could be of significant benefit in the evaluation of these systems in otolaryngologic surgery.

Conclusions

This clinical pilot study aims to share our initial experience and demonstrate the potential viability of the exoscope for UAS surgery; it is a safe, innovative, and effective alternative or adjunct to existing operative modalities. Future technological modifications could allow for the exoscope to become a promising next-generation tool in the armamentarium of the contemporary sleep surgeon, which will allow for high-precision surgery with the ability to obtain optimal surgical outcomes.

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