


Development of a Surgical Video Atlas for Resident Education: 3-Year Experience

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Abstract

Objective. To create a high-quality annotated online surgical video atlas of key indicator otolaryngology cases and assess its use and overall journal trends over time.

Methods. Videos are recorded from multiple viewpoints within the operating room and compiled into a single stream. Postediting includes chaptering videos and overlaying relevant text annotations. Videos are published online and viewership trends analyzed.

Results. Over 3 years, 29 otolaryngology videos were published out of 161 journal publications (18%). Eight of the 14 key indicator procedures are included (57%). From the beginning of 2017 to the end of 2019, viewership of otolaryngology pages increased from 548 to 11,139 views per month, totaling >150,000 views. These now represent 10% of the total journal monthly views and 10% of the overall views. Users originate from the United States and from >10 other countries.

Discussion. Residents and faculty face challenges of providing the highest standard of clinical care, teaching, and learning in and out of the operating room. Inherent difficulties of surgical training, high-fidelity surgical simulation, and imposed work hour restrictions necessitate additional, more efficient and effective means of teaching and learning. Surgical videos demonstrating key anatomy, procedural steps, and surgical dexterity with hand positioning are increasing in their popularity among learners.

Implications for Practice. Surgical video atlases provide a unique adjunct for resident education. They are enduring and easily accessible. In a climate of work hour restrictions or elective case reduction, they may supplement how residents learn to operate outside the operating theater.

Keywords

video, education, resident training, PS/QI

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The frequently evolving aspects of patient care pose unique challenges in graduate medical education, particularly for surgical residents. They must expand their foundational knowledge of the pathophysiology of disease processes, learn to care for patients on the wards and in the clinic, and navigate the complexities of appropriate documentation and administrative work. Although formal structured teaching sessions aim to improve a resident's theoretical knowledge, surgical trainees must also acquire the ability and confidence to perform surgical procedures.¹

Surgical proficiency is not an inherent ability but rather a skill learned with dedication, repetition, and time. Multiple barriers to its development exist. The operating room (OR) itself poses a challenge to surgical teaching, based on the nature of the work, time constraints, and the requirement to uphold patient safety first and foremost. Students and residents must adapt to the physical environment of the OR, learning skills and techniques, familiarizing themselves with the culture, and coping with the emotional impact of surgery as work.² Their instructors also face the demanding tasks of providing the highest standard of clinical care, conducting research, as well as taking time to teach in and out of the OR.

The structure of residency training has not changed significantly since its conception despite evolving societal expectations, advancements in technology, and the development of subspecialties.³ An increasing concern for patient safety and resident well-being led to the formal adoption of decreased duty hours for residents. Work hour restrictions that were implemented in 2003 and 2011 have affected

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Figure 1. Screenshots from surgical videos demonstrate the (a) viewpoint and annotations as well as (b) the chaptering and structure highlights.

training across all graduate medical programs, but surgery and its subspecialties have been uniquely affected. Residents have expressed their frustration at having less time for the observation of surgical technique.⁴ Studies have provided objective data demonstrating a decrease in operative cases performed throughout residency.⁵ Nearly 75% of graduating residents seek additional fellowship after completing general surgery residency.³ Furthermore, a survey of fellowship directors regarding general surgery residents found that 21% felt that new fellows arrived inadequately prepared for the OR.⁶

While computer technology continues to evolve with ever-improving virtual reality gaming, high-fidelity simulation for use in surgical education is still a nascent art form. In otolaryngology, such virtual reality-based surgical skill training approaches are the subject of research and development in only a few academic centers. At this time, there is no validated, non-cost-prohibitive, high-fidelity simulation educational tool available to teach otolaryngology residents a surgical operation. One may practice specific skills on a task trainer, but this is not the same as practicing an entire operation. However, it is intuitive that at least seeing an operation and being aware of its key points aids in increasing the educational yield of participating in an operation the first few times. However, current surgical videos on platforms such as YouTube are of subpar quality and lack educational content in the form of written or verbal commentary.⁷

The inherent difficulties of surgical training, the lack of high-fidelity simulation, and the imposed work hour restrictions necessitate innovative and effective means of teaching

and learning. Residents must know the relevant surgical anatomy, as well as the sequence of steps involved in the procedure, if they hope to assist or perform cases. This is often obtained through the use of surgical atlases, with text descriptions accompanying still photographs. This study describes the creation of a surgical video atlas and the trends of its use over a 3-year period.

Methods

This study was found to be exempt by Duke University Institutional Review Board (Pro0007360).

Case Identification

Based on the current key indicator procedures published by the American College of Graduate Medical Education,⁸ we sought to produce a “core” curriculum as well as an “advanced” curriculum for more complicated cases.

Video Production

Videos were produced and published from 2017 through 2019. The intention of these videos is to provide simultaneous exposure of the surgical field and the surgeon's hand positioning throughout surgery. Multiple cameras positioned in various angles in the OR accomplish this. In otology and rhinology cases, the high-definition footage from the microscope/endoscope is superimposed over the view of surgeon's hands (**Figure 1a**). For other cases, a first-person viewpoint is obtained via GoPro (GoPro Inc) and loupe-mounted cameras (NanoCam). Another camera is used to obtain a panoramic perspective of the operating theater and

surgical instrumentation setup. The primary surgeon wears a microphone on the surgical mask to facilitate real-time narration with high-quality audio, minimizing excess noises of the OR.

After all angles are synchronized, footage is reviewed and condensed by the first author (C.S.B.), separating key parts of the procedure into searchable “chapters” (**Figure 1b**). This allows viewers to quickly move among specific parts of the case depending on their focus or intended area of improvement (eg, incision, mastoidectomy, margins, closure). If the surgeon describes a particularly relevant aspect of the dissection, a text annotation is displayed concurrently on the screen (**Figure 1a**). Key anatomic structures can also be highlighted. Videos are further processed by editors at the *Journal of Medical Insight (JOMI)*, reviewed a second time, and then published online. Videos are accessible online through an individual account or by subscription to the journal. Accompanying text is provided describing the patient presentation, indications for surgery, options/rationale for treatment, and required surgical equipment. When the text portion is completed, the videos are reviewed by an additional 2 otolaryngologists to determine if the video is suitable for publication.

Time and Cost

The first author was intimately involved in the case identification, video filming, and editing process. Time investment (case setup, filming, editing, approval) ranged from 8 to 12 hours per project but does not include the time spent by members of the *JOMI* team. Anyone may submit videos to the journal for consideration of publication (criteria available at <https://jomi.com/publish>). While this reduces some of the associated costs, others can enlist the staff at *JOMI* for all elements of the production process, including filming within their institution.

Viewership Assessment

Each view of the specific video webpages was recorded. For analysis of viewership trends, these were combined into monthly views. When users sign up for the journal, they are asked to identify themselves (eg, surgical attending, surgical resident, medical student, other) but are not required to do so. Views were therefore analyzed by user type when that information was available. Descriptive statistics on viewership was performed to generate the associated graphs and tables.

Results

Since the publication of the first otolaryngology video in October 2016, 29 videos have been produced. Four additional videos are included in this section due to overlap with other surgical specialties (eg, parathyroidectomy performed by general surgeon). Within the 29 case videos, we have published 57% (8/14) of the “key indicator” procedures required for graduating residents. As of January 2020, 161 videos are available for access via the online journal across specialties. The otolaryngology section accounts for 18% of

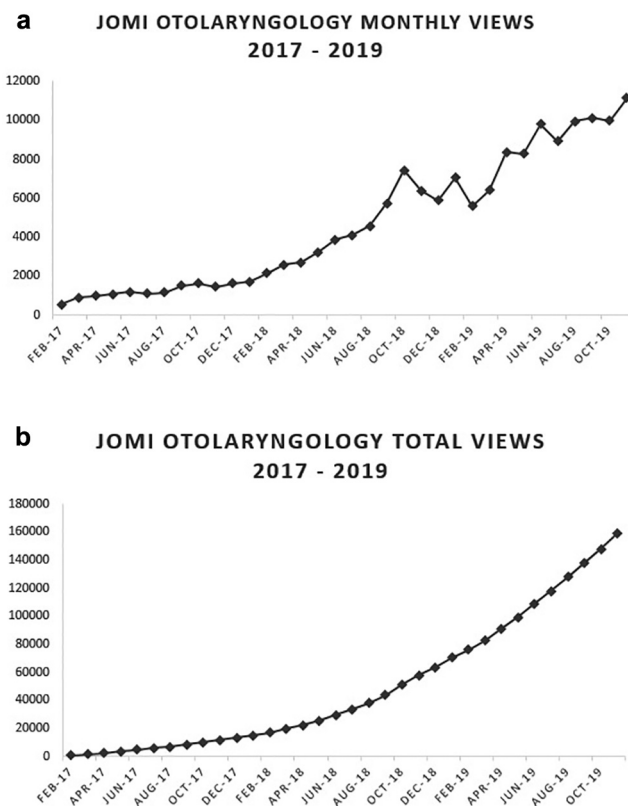


Figure 2. Viewership trends of otolaryngology videos. (a) Views per month of otolaryngology videos. (b) Overall number of otolaryngology video viewership. *JOMI*, *Journal of Medical Insight*.

the video content in the journal. **Figure 2** illustrates viewership trends over this period. Although there is some fluctuation from month to month, the trend has been an increase in monthly views. When viewership data were first recorded in February 2017, there were 548 views per month of otolaryngology videos, as compared with November 2019, when 11,139 views were recorded. In terms of the amount of content available at those times, the increase was from 91.3 views per month per otolaryngology video to 384. Of all views by registrants who identified as surgical residents, 15% have been of the otolaryngology videos. While a subscription is not required to watch the videos, institutions such as medical schools, medical libraries, and surgical technologist institutions have subscribed and provided monetary support. Additionally, institutions from >10 countries outside the United States have subscribed.

Discussion

Here, we present the development of an annotated, narrated, and multiperspective surgical video atlas and its rapidly increasing viewership over 3 years. To safely perform operations, surgical trainees must have absolute knowledge of relevant surgical anatomy, understand the rationale of performing the procedure as well as the steps, and demonstrate correct usage of instruments. While surgical anatomy can be learned initially through anatomic diagrams and photographs,

the 3-dimensional relationships are often more difficult to conceptualize. Within otolaryngology, the small operative field in many procedures prevents medical students and sometimes residents from visualizing the procedure.⁹ With a surgical video that displays the first-person view of the operative surgeon, trainees are provided an immersive experience that they otherwise would not be able to achieve. Surgical atlases display image A and image B, requiring trainees to infer how the second step was achieved from the first. Surgical videos overcome this limitation by depicting the necessary steps to accomplish each aspect of the procedure.

While understanding surgical anatomy remains a pivotal foundation for surgical residents, surgery also requires the ability to explain the rationale for performing procedures. The same surgical procedure could be performed for multiple reasons, such as a mastoidectomy for cochlear implant, vestibular schwannoma excision, or cholesteatoma. At the beginning of each video, the attending surgeon explains the patient presentation and indications for surgery. Accompanying text may include features such as radiography and audiometry to supplement the experience. Mota et al found that residents valued didactic illustrations and procedural narration when using videos for surgical preparation.¹⁰

An important barrier to surgical training for residents and medical students is the ability to demonstrate their knowledge and correct usage of instruments.² Within otolaryngology, substantial variation exists in subspecialty instrumentation. This vast array of instrumentation poses a challenge to operating efficiently for early learners. Many surgical videos available on websites such as YouTube or in textbooks such as *Cummings Otolaryngology*¹¹ contain a single view of the operative field, frequently zoomed in where only the tips of instruments are visible¹² (**Figure 3**). Understanding procedure steps conceptually is crucial prior to operating. The ability to master these skills requires knowledge of hand positioning as well as dynamic movements of the hands and arms. This proficiency often comes with repetition and practice. Our video provides multiple viewpoints of the procedure, with microscopic or endoscopic footage superimposed over a view of the surgeon's hands (**Figure 1**). This may accelerate a trainee's use of hand positioning to become more efficient with additional cases. Techniques learned from one case will often carry over to other procedures (eg, tympanomeatal flap, mastoidectomy, skin closure).

The model for teaching and learning continues to evolve over time. The dramatic rise of multimedia technology over the past 20 years has greatly changed the way that information is disseminated. This in particular has affected learning methods for millennials, who have been shaped by this profound expansion of information technology, enhanced social networking, and a connected global culture.¹³ Medical students participate in video lectures, and there has been a recent increase in the favorability of presenting surgical procedures in the form of real-time video display instead of photographs only.¹⁴ This transition affects medical students, residents, and attending physicians, as evidenced by the

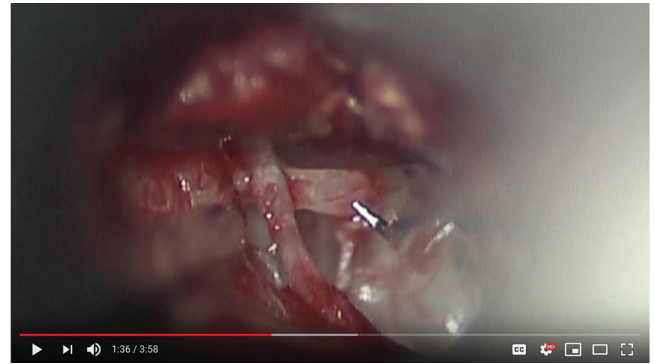


Figure 3. Typical view of online surgical videos from a single vantage point. Screenshot obtained at 1:36 from <https://www.youtube.com/watch?v=FasI4u-h7Mg>.

American Academy of Otolaryngology–Head and Neck Surgery tasking its educational committees with the creation of surgical video libraries. While this study is limited in its lack of any specific educational outcome measure, Mendez et al found that video teaching modules result in fewer errors and less “staff takeover” from residents.¹⁵ These libraries of high-quality videos endure through time and are accessible from computers, tablets, and mobile phones. Until such time that high-fidelity virtual reality technology evolves to the point of allowing learners to fully immerse themselves in a virtual operation, video libraries present an invaluable form of learning operations from start to finish. Given that over half of the key indicator cases have been published, programs could incorporate them into didactic sessions for disease processes or require junior residents to watch them prior to their first exposure in the OR.

Implications for Practice

The unique features of these videos (high definition, multiple camera angles, annotation) make them a valuable educational asset to residents and medical students. We believe that annotated surgical videos in this format serve as an adjunct to surgical atlases for the training of residents as self-learning as well as didactic supplements. In the context of the 2020 global pandemic, with significant restrictions placed on trainee involvement in the OR, such an atlas could allow for a different form of exposure to surgery in otolaryngology.

Author Contributions

C. Scott Brown, substantial contributions to the conception or design of the work, drafting the work or critically revising it, final approval, and agreement to be accountable for all aspects of the work; **Calhoun D. Cunningham III**, substantial contributions to the conception or design of the work, drafting the work or critically revising it, final approval, and agreement to be accountable for all aspects of the work; **Walter T. Lee**, substantial contributions to the conception or design of the work, drafting the work or critically revising it, final approval, and agreement to be accountable for all aspects of the work; **Liana Puscas**, substantial

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Disclosures

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