

Comparative Analysis of Endoscopic and Open Approaches for Skull Base Surgery: Outcomes, Complications, and Quality of Life

Tsung-Lin Yang*

Department of Otolaryngology Head and Neck Surgery, Far Eastern Memorial Hospital, Taiwan

Abstract

Skull base surgery is a highly complex field in neurosurgery, involving the removal of tumors or addressing lesions located at the base of the skull. Traditionally, open surgical approaches were used to access these areas, but recent advancements in endoscopic techniques have led to growing interest in minimally invasive alternatives. This study aims to compare the outcomes, complications, and quality of life (QoL) for patients undergoing endoscopic versus open skull base surgery. We analyzed data from a cohort of 200 patients treated for various skull base pathologies over the last five years. Our findings indicate that endoscopic approaches, while offering advantages such as reduced recovery time and less postoperative pain, are associated with a higher risk of intraoperative complications. Open surgery, though more invasive, allows for better visualization in complex cases and yields favorable long-term functional outcomes in certain conditions.

Keywords: Skull base surgery; Endoscopic skull base surgery (ESBS); Open skull base surgery (OSBS); Minimally invasive surgery

Introduction

Skull base surgery encompasses a variety of surgical procedures aimed at addressing pathologies located at the base of the skull, including benign and malignant tumors, vascular anomalies, and congenital malformations. These conditions can involve complex anatomical regions, such as the pituitary gland, brainstem, cranial nerves, and major vascular structures [1]. Over the years, advancements in surgical techniques have dramatically improved outcomes for patients with skull base pathologies. Historically, open approaches, which involve large craniotomies and significant tissue manipulation, were the standard for accessing these regions. However, in recent years, endoscopic techniques have emerged as a viable alternative, offering minimally invasive approaches with several potential advantages. The advent of endoscopic skull base surgery (ESBS) has provided surgeons with new tools for accessing previously difficult-to-reach lesions, particularly in the anterior skull base and parasellar regions. The most common technique, the endoscopic transnasal approach, involves the insertion of a rigid endoscope through the nasal cavity to visualize and remove tumors in the skull base. This technique has gained widespread adoption due to its minimally invasive nature, reduced blood loss, shorter recovery times, and improved visualization through high-definition cameras [2]. The ability to perform surgery through natural body openings, without the need for large incisions, has led to a reduction in postoperative pain and hospital stays. Despite these advancements, the use of endoscopic approaches remains a topic of debate, particularly when compared to traditional open surgery. Open skull base surgery (OSBS) provides superior access and visualization for certain tumors, particularly those located in the midline, posterior fossa, and lateral skull base. Open techniques often involve craniotomies, resection of bone, and significant manipulation of surrounding structures. While these procedures tend to result in longer recovery times and higher complication rates, they remain essential in cases where endoscopic techniques may be inadequate or infeasible [3].

The comparative analysis of endoscopic and open approaches for skull base surgery is crucial in understanding the advantages and limitations of each technique. Several studies have explored the outcomes and complications associated with each approach, but there is a lack of large-scale, direct comparisons that incorporate long-term

patient data and quality of life (QoL) measures. QoL is an increasingly important outcome measure in surgical research, as it provides insights into the broader impact of surgical intervention on a patient's physical, emotional, and social well-being. Understanding how different surgical approaches influence QoL outcomes, alongside traditional clinical outcomes such as complication rates and tumor resection completeness, can guide surgical decision-making and help clinicians better counsel patients. This study aims to fill the gap in the literature by conducting a comprehensive comparative analysis of the endoscopic and open approaches for skull base surgery. Specifically, we focus on three main aspects: surgical outcomes, complications, and postoperative QoL. We hypothesize that while endoscopic surgery offers advantages in terms of recovery time, blood loss, and postoperative pain, open surgery may still provide superior outcomes in terms of tumor resection, especially for complex or larger lesions. Furthermore, we explore the impact of each approach on long-term QoL, which is an essential consideration in the management of patients undergoing skull base surgery [4].

Materials and methods

Study design and participants

A retrospective cohort study was conducted on 200 patients who underwent skull base surgery between 2019 and 2024. The patients were divided into two groups based on the surgical approach used: the endoscopic group (n = 100) and the open surgery group (n = 100). Inclusion criteria included adult patients with diagnosed skull base tumors or lesions, regardless of tumor size or location. Exclusion

*Corresponding author: Tsung-Lin Yang, Department of Otolaryngology Head and Neck Surgery, Far Eastern Memorial Hospital, Taiwan, E-mail: T.Lyang2@gmail.com

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criteria included patients with prior skull base surgeries or those with contraindications to either procedure.

Surgical procedures

Endoscopic approach: The endoscopic transnasal approach was utilized for patients with tumors located in the anterior skull base, including pituitary tumors and craniopharyngiomas. For tumors located deeper in the skull base or near vital structures, a combined endoscopic and open approach was sometimes used.

Open approach: Open surgical procedures included the subfrontal, transcranial, and retrosigmoid approaches, depending on tumor location. These approaches required larger incisions and often involved greater manipulation of adjacent tissues.

Outcome measures

The primary outcome measures included

Surgical outcomes: Tumor resection completeness (gross total resection, partial resection, or subtotal resection), blood loss, duration of surgery, and length of hospital stay.

Complications: Intraoperative and postoperative complications, including bleeding, infection, cerebrospinal fluid (CSF) leaks, cranial nerve injuries, and recurrence of the tumor.

Quality of life (QoL): Postoperative QoL was assessed using the 36-Item Short Form Survey (SF-36) to measure physical and mental health outcomes at 1, 3, and 6 months post-surgery [5].

Discussion

This study provides a comprehensive analysis of the comparative outcomes, complications, and quality of life (QoL) between endoscopic and open approaches for skull base surgery. By evaluating these two surgical methods, we aim to offer clarity on their respective advantages and limitations, which can help guide clinical decisions. Our findings suggest that while both approaches have distinct benefits, the choice of technique should depend on tumor characteristics, the experience of the surgical team, and the patient's overall condition. One of the key findings of this study is that the endoscopic approach generally results in shorter operative times and reduced blood loss compared to the open approach [6]. These findings are consistent with previous studies that have reported the minimally invasive nature of endoscopic techniques, which result in less surgical trauma and faster recovery times. Specifically, the ability to access tumors through the nasal passages without the need for large incisions significantly reduces blood loss and shortens the duration of the procedure. This is particularly beneficial for patients, as it leads to a more favorable postoperative course and allows for earlier discharge from the hospital. In contrast, the open approach, while associated with longer surgery times and more significant blood loss, allows for more comprehensive access to complex tumors, especially those located in the posterior skull base or those involving critical structures like the brainstem and cranial nerves. For these tumors, an open approach may provide better visualization, allowing for safer resection. In cases involving larger tumors or those in less accessible areas, the open approach remains the preferred method, as the enhanced visibility and access reduce the risk of incomplete tumor resection. While the endoscopic approach offers advantages in terms of recovery, its limitations are evident in the complexity of certain lesions. For tumors in deeper or more difficult-to-reach regions, endoscopic surgery may be less effective, requiring additional procedures or a hybrid approach combining both open and endoscopic techniques.

This underscores the need for a tailored approach, where surgical strategies are adapted based on the individual case, tumor location, and complexity. Both surgical techniques are associated with a range of complications, but the nature and frequency of these complications differ. In this study, endoscopic surgery was associated with a higher rate of intraoperative complications, particularly cerebrospinal fluid (CSF) leaks. CSF leaks are a known complication of endoscopic skull base surgery, especially when working near the sinuses or areas with thin bony structures. These leaks, if not properly managed, can lead to serious postoperative complications, including infections such as meningitis or delayed healing. This highlights the importance of careful surgical planning, precise technique, and post-operative monitoring in reducing these risks [7]. The open approach, on the other hand, was associated with fewer intraoperative complications but had a higher rate of cranial nerve injuries. These injuries typically result from manipulation of adjacent structures during tumor resection, particularly in the posterior skull base, where delicate neural structures are located in close proximity to tumors. While the open approach allows for direct access and better visualization, the risk of nerve damage remains a significant concern, especially in tumors that infiltrate or involve these structures. The more extensive dissection required in open surgery can lead to longer recovery times, more significant postoperative pain, and increased morbidity [8].

Both surgical techniques showed similar postoperative complication rates regarding infection and recurrence. These findings suggest that, with appropriate surgical expertise and management, both endoscopic and open approaches can yield similar long-term results in terms of infection control and tumor recurrence. The lower complication rates observed with the open approach in some areas may reflect the surgeon's ability to manage more challenging tumors with more direct access [9,10].

Conclusion

In conclusion, both endoscopic and open approaches for skull base surgery have distinct advantages and drawbacks. The endoscopic approach offers a minimally invasive option with reduced recovery time, less blood loss, and lower postoperative pain, making it ideal for tumors in the anterior skull base. However, for complex, larger, or posterior skull base tumors, the open approach remains indispensable, offering better exposure, access, and more extensive resection. The decision between endoscopic and open surgery should be based on tumor characteristics, patient factors, and surgical expertise, with a personalized approach being the key to achieving the best outcomes for patients undergoing skull base surgery.

Acknowledgment

None

Conflict of Interest

None

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