Outcomes of Endoscopic Sinus Surgery in Treating Paranasal Sinus Mucoceles with Orbital Complications

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Abstract

Objective: Mucoceles, benign cystic lesions within the paranasal sinuses, often progress slowly, leading to bone erosion and potential orbital complications such as subperiosteal abscesses, posing severe intracranial risks. This study investigates the effectiveness of endoscopic sinus surgery in managing mucoceles accompanied by orbital complications.

Methods: We conducted a retrospective analysis of 68 patients diagnosed with paranasal sinus mucoceles, focusing on mucocele location, associated orbital complications (manifesting as ophthalmic symptoms and optic neuropathy), onset timing, surgical interventions, and visual outcomes. Data were collected from patients treated at the Ear Nose Throat Ho Chi Minh City hospital.

Results: Among 68 patients, 76 mucoceles were identified with orbital complications. Notably, 28.9% were secondary mucoceles post-prior surgeries, 21.1% linked to previous facial trauma, and 50% primary mucoceles. Predominant mucocele locations included the frontal ethmoid region (47.4%), frontal sinus (10.5%), ethmoid sinus (13.2%), maxillary sinus (17.1%), maxillary-ethmoidal sinus (6.6%), and sphenoid sinus (5.3%). Clinical symptoms included bulging eyes (48.5%), double vision (16.2%), reduced vision (13.2%), and limited eye movement (11.8%). Most cas (93.4%) underwent endoscopic sinus surgery, with 6.6% requiring a combined approach.

Conclusion: Early identification of mucoceles and associated complications, especially those affecting ocular health, is vital. Raising awareness among medical professionals about paranasal sinus mucoceles is crucial for prompt diagnosis and intervention. Endoscopic sinus surgery proves effective in managing both simple and complex mucoceles, offering promising outcomes for patients.

Keywords: Paranasal sinus mucoceles, orbital complications, endoscopic sinus surgery

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INTRODUCTION

Sinus mucocele, although benign, can lead to severe complications by eroding sinus wall bones and compressing nearby organs.[1] Therefore, early detection is paramount to prevent potentially serious consequences. Advancements in diagnostic modalities such as endoscopy, computed tomography (CT), and magnetic resonance imaging (MRI) have significantly improved the timeliness and efficacy of mucocele diagnosis and treatment. Endoscopic imaging reveals varying presentations based on tumor size and location, enabling early detection of nasal sinus wall changes due to tumor compression and aiding in differentiation from other nasal cavity tumors.[2] Computed tomography scans facilitate precise localization, sizing, assessment of surrounding structure invasion, and bone destruction extent. Magnetic resonance imaging helps delineate the mucocele's relationship with adjacent soft tissues, particularly the optic nerve and assists in distinguishing it from other soft tissue neoplasms.[3]

Surgical intervention constitutes the primary treatment for mucoceles.[4] The choice of surgical approach depends on the tumor's location and degree of surrounding structure invasion. Endoscopic sinus surgery is preferred for most sinus mucoceles with minimal invasion or those not invading surrounding tissues. External surgery is reserved for cases of recurrent or orbital- or intracranially-invading frontal sinus mucoceles. A combination surgery is employed in cases where both endoscopic and external approaches are necessary, typically for frontal sinus mucoceles or those invading the orbit beyond endoscopic control.[5]

With the growing utilization of endoscopic techniques in sinus surgery and their perceived benefits in reducing invasiveness and ensuring precise lesion excision, there exists a need for more empirical data regarding the efficacy of endoscopic approaches in cases involving orbital complications within the Vietnamese context. This study seeks to address this gap by evaluating and optimizing treatment strategies for paranasal sinus mucoceles accompanied by orbital complications to enhance patient outcomes and quality of life.

METHODS

Design of the Study

This retrospectively observational study was conducted from January 2022 to October 2023 at Ear Nose Throat Ho Chi Minh City Hospital, Vietnam. Each participant provided written informed consent prior to enrollment. The study's protocol received approval from the Ear Nose Throat Ho Chi Minh City Hospital Ethical Board (No.126/TMH-HDDD).

Study Population

A total of 68 patients diagnosed with paranasal sinus mucoceles were enrolled in this study, focusing on various parameters, including mucocele location, orbital complications (manifesting as ophthalmic symptoms and optic neuropathy), onset timing, surgical interventions performed, and ultimate visual outcomes. Eligible patients meeting the inclusion criteria were invited to participate, undergoing comprehensive clinical examinations and providing information regarding their condition. Clinical manifestations of mucoceles typically include prominent symptoms such as bulging eyes, double vision, reduced vision, limited eye movement, severe vision loss, and accompanying sinusitis symptoms such as nasal congestion, rhinorrhea, and headaches.

Computed tomography was employed to precisely delineate mucocele location, size, extent of surrounding structure invasion, and bone erosion. Computed tomography data were used for the image-guided surgery (IGS) system in cases requiring repeated procedures. Magnetic resonance imaging was utilized to assess the relationship between mucoceles and adjacent soft tissues, particularly the optic nerve, aiding in differentiation from other neoplastic lesions.

Main Points

- *The effectiveness of Endoscopic Sinus Surgery (ESS) in treating paranasal sinus mucoceles with orbital complications is significant, showing substantial improvement in ocular symptoms and minimal surgical complications.*
- *Among the 68 patients studied, 76 mucoceles were identified, with secondary mucoceles post-surgery (28.9%) and those linked to facial trauma (21.1%) being significant contributors. Primary mucoceles accounted for 50% of the cases.*
- *Clinical manifestations predominantly included bulging eyes (48.5%), double vision (16.2%), reduced vision (13.2%), and limited eye movement (11.8%), with severe vision loss observed in 10.3% of the patients.*
- *Early detection of mucoceles and their complications is crucial, aided by advancements in diagnostic modalities like endoscopy, CT, and MRI, which have improved the timeliness and accuracy of diagnosis and treatment.*
- *The majority of patients underwent ESS (93.4%), with a small subset requiring a combined surgical approach (6.6%). The use of intraoperative navigation systems (IGS) in 65.8% of cases enhanced surgical precision and safety, resulting in improved patient outcomes.*

Surgical Protocol

The selection of an appropriate surgical method for treating paranasal sinus mucoceles depends on their location and the extent of invasion into surrounding structures. In this study, all patients underwent endoscopic marsupialization under general anesthesia. Endoscopic sinus surgery was predominantly employed for cases where the mucocele had not significantly invaded surrounding tissues or exhibited low levels of invasion. An extended frontal sinus approach, such as the modified Lothrop procedure, was performed for mucoceles located within the frontal sinus. When mucoceles were found within the frontal sinus or invaded the orbit beyond the capabilities of endoscopic surgery alone, a combined surgical approach involving both endoscopic and external routes was employed.

Statistical Analysis

The data analysis was conducted using SPSS 25.0 software (IBM SPSS Corp.; Armonk, NY, USA). The Chi-square test was employed to assess the association between the localization of mucoceles and orbital complications, as well as between orbital wall bone defects and orbital complications. Statistical significance was defined as $P < .05$.

RESULTS

In our study, the gender distribution revealed that 47.1% of participants were male, while 52.9% were female. The mean age was 53.4 years, ranging from 30 to 88 years. The majority of patients originated from the southern provinces, constituting 77.9% of the total sample. The prevalent medical histories among participants included a history of previous sinus surgery (23.5%), facial trauma (20.6%), and chronic rhinosinusitis (11.8%). The average duration of illness among participants was calculated at 2.8 years, with durations ranging from 2 months to 26 years.

The distribution of mucoceles across various paranasal sinuses is presented in Table 1. Among the 68 patients in the study, 8 patients exhibited bilateral paranasal sinus mucoceles (total 76 mucoceles). Secondary mucoceles following prior surgeries accounted for 28.9% of cases, while 8.8% were associated with previous facial trauma resulting in bone fractures, and 72.1% were primary mucoceles. The distribution of mucoceles revealed predominant occurrences in the frontal ethmoid region (47.4% on both sides), followed by the maxillary sinus (17.1%), ethmoid sinus (13.2%), the frontal sinus (10.5%), maxillary-ethmoidal sinus (6.6%), and sphenoid sinus (5.3%). Notably, 30.3% of cases exhibited defects in the orbital wall bone, attributed to compression by the mucocele, involving either the lamina papyracea or inferior orbital wall bone.

Table 1. Distribution of Paranasal Sinus Mucoceles

Location	Previous Surgery n = 22	Facial Trauma n = 16	Primary n = 38	Total N = 76 (%)
Ethmoid-frontal	8	11	17	36 (47.4%)
Frontal	2	3	3	8 (10.5%)
Ethmoidal	5	1	4	10 (13.2%)
Maxillary	2	1	10	13 (17.1%)
Maxillary-ethmoidal	3	0	2	5 (6.6%)
Sphenoid	2	0	2	4 (5.3%)

Table 2. Patients' Ocular Symptoms

Ocular Symptoms	Before Treatment (%)	After Treatment (%)
Bulging eyes	48.5	0
Double vision	16.2	2.9
Reduced vision	13.2	2.9
Limited eye movement	11.8	0
Severe vision loss	10.3	4.4

Upon referral to an ophthalmologist, all patients were presented with ocular abnormalities (Table 2). The most prevalent physical eye symptom was bulging eyes, observed in 48.5% of patients, followed by double vision (16.2%), reduced vision (13.2%), and limited eye movement (11.8%). Notably, severe vision loss, with patients only able to discern hand movements, was evident in 10.3% of cases.

All patients with mucocele-induced bone defects were identified on CT scans, with the ethmoid bone being the most commonly affected site (88.2%), followed by critical areas such as the optic nerve canal (10.5%) and skull floor (6.6%) (Figure 1). Magnetic resonance imaging findings revealed cystic lesions with fluid contents, displaying well-defined borders, low signal intensity on T1-weighted images, and high signal intensity on T2-weighted images, with no contrast enhancement observed post-injection except for one case exhibiting rim contrast enhancement. The medial rectus muscle and optic nerve were frequently compressed structures identified on MRI, accounting for 50% and 39.5% of mucoceles, respectively.

Endoscopic sinus surgery was the predominant treatment modality, administered to 93.4% of mucoceles, with no instances of standalone external surgery. A small subset of cases (6.6%) necessitated a combined approach involving both endoscopic and external surgical techniques for complete lesion removal. Most surgeries (65.8%) were performed with the assistance of the IGS navigation system, facilitating precise and targeted interventions.

After surgery, orbital complications' symptoms improved significantly. All patients no longer had bulging eyes and limited eye movements, double vision decreased to 2.9%, only 4.4% of patients had severe vision loss. No complications were recorded during surgery.

DISCUSSION

In our study, the predominant medical antecedent observed was a history of prior sinus surgery, identified in 16 cases, constituting 23.5% of the patients. This finding aligns with previous reports on mucocele, where a substantial proportion of patients also report a history of sinus surgery. For instance, A. Sama's investigation noted this antecedent in 67% of cases,[6] Ulrike Bockmühl's study reported it in 66%,[7] and Obeso's study documented it in 35%.[8] Consequently, a history of sinus surgery emerges as a potential risk factor predisposing individuals to mucocele formation, likely attributable to the formation of fibrous scar tissue obstructing sinus ostia.[9] Notably, in Ulrike Bockmühl's research, out of 255 patients, 197 had undergone sinus surgery, with 78.7% having undergone Lynch–Howarth or Caldwell–Luc procedures or both. In contrast, only 4% of patients had undergone endoscopic sinus surgery.[7] This discrepancy underscores the drawback of external surgical approaches, as they are more prone to inducing soft tissue scarring, thereby impeding sinus drainage.

Ocular symptoms constituted a significant portion of our study findings, with 48.5% reporting swelling and bulging eyes. These symptoms are primary drivers prompting patients to seek medical evaluation and uncover underlying mucoceles. The directional deviation of the eyeball observed in our cases was predominantly downward and outward, a consequence of the anatomical proximity of the frontal and ethmoid sinuses to the orbit. Other studies have indicated that fronto-ethmoidal mucoceles commonly induce downward and outward eye displacement. A study by Lund et al[10] on ocular manifestations associated with fronto-ethmoidal mucoceles reported a high rate of eyeball displacement at 91%, with displacement ranging from 1 to 17 mm.

Additionally, our study's incidence of reduced vision was notable at 13.2%. In contrast, severe vision loss, where patients could only discern finger counting, was observed in 7 cases, accounting for 10.3% of the patients. These results indicate substantial ocular compromise due to enlarged mucoceles impacting the eyes and optic nerve. The mechanism underlying vision impairment in mucocele cases is presumed to stem from compression of the eye socket by the enlarged mucocele, leading to compromised blood supply to the optic nerve.[11] In our study, double vision was reported by 16.2% of patients, while 11.8% experienced limited eye movement. Bockmühl et al[7] documented a similar incidence of double vision at 13%. Moreover, according to Zainine, mucoceles can induce

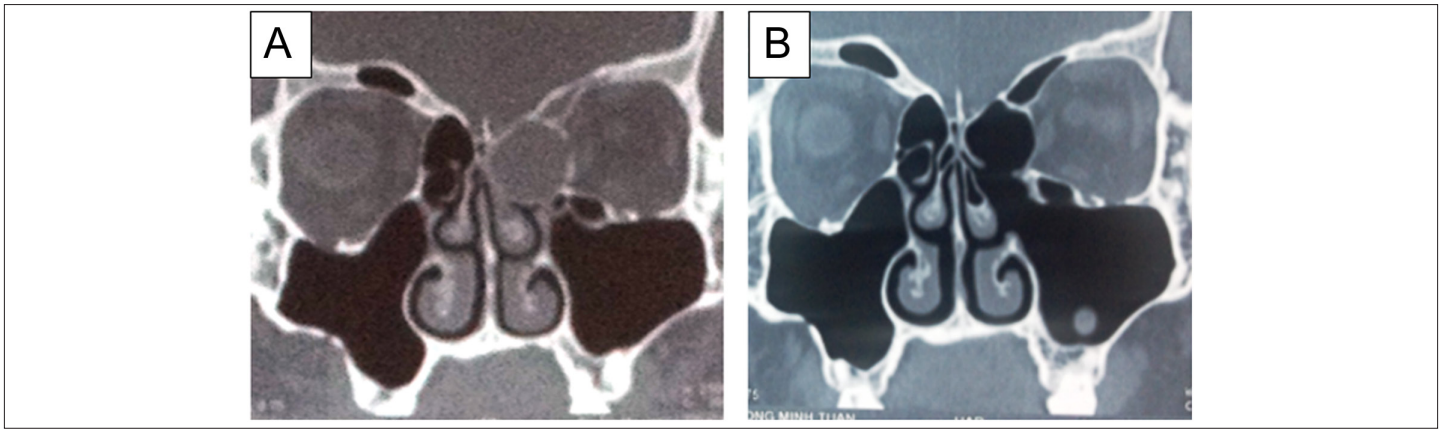

Figure 1. Computed tomography of patient before and after Endoscopic Sinus Surgery (ESS). A. Before ESS, B. after ESS.

oculomotor disturbances by impeding oculomotor nerve function as these nerves traverse the superior aspect of the orbit.[2]

Our observations revealed that all mucoceles exhibited compression of adjacent anatomical structures, which is consistent with previous investigations. Scangas et al. reported a compression rate of 87%,[12] while Ta-Jen Lee's[13] study demonstrated a compression incidence of 100%. These results underscore the insidious progression of mucoceles over extended periods, often leading to compression of neighboring structures by the time of diagnosis. Notably, orbital compression was the most prevalent form observed, accounting for 80% of cases. Given the proximity of fronto-ethmoidal mucoceles to the orbital wall, this area commonly experiences compression. Furthermore, in our study, mucoceles were found to compress vital structures, notably the brain (in 5% of patients) and the optic nerve (in 12.5% of patients). While the occurrence of brain compression incidents may exhibit variability across different studies, these findings emphasize the potential for mucoceles, despite their non-malignant nature, to exert significant pressure on and cause damage to critical anatomical structures.

Visual depiction of optic nerve compression on CT scan elucidates the mechanism underlying vision loss in mucocele patients. Consequently, CT scans not only aid in diagnosing mucoceles but also in precisely delineating their location and assessing adjacent bony structures.[12] This information is invaluable for surgeons, as a thorough understanding of bone defects facilitates anticipation and mitigation of potential intraoperative complications, such as orbital hematoma from fascial damage, cerebrospinal fluid leakage from meningeal injury, or blindness from optic nerve injury. Additionally, in our study, 20 patients underwent MRI scans, corroborating the mucocele locations identified on CT scan. While MRI lacks the capacity to evaluate bone integrity, it offers distinct advantages in distinguishing mucoceles from other tumors and ruling out small tumors as causative agents of sinus obstruction leading to mucocele formation. Importantly, no concomitant tumors were detected in cases where MRI was employed. Moreover, MRI surpasses CT in assessing the extent of mucocele spread and its relationship with surrounding soft tissues, providing comprehensive insights into disease progression and aiding treatment planning.

The predominant surgical approach employed in our study was endoscopic sinus surgery, constituting 93.4% of mucoceles. This modality stands as the preferred method for managing sinus mucoceles, offering numerous advantages, including simplicity, gentleness, preservation of sinus mucosa, minimal facial scarring, low complication rates, and low recurrence rates. During endoscopic sinus surgery, the emphasis lies on creating an opening in the capsule to facilitate mucocele drainage and restore sinus drainage clearance rather than excising the entire mucosal capsule. This approach is justified by the fact that the sinus mucosa tends to recover when sinus drainage and ventilation are adequately restored. Moreover, bone defects resulting from mucoceles typically undergo spontaneous regeneration post-drainage surgery, as demonstrated by Terranova's findings, where 66.6% of such defects regenerated without the need for reconstructive surgery.[14] This phenomenon can be attributed to the removal of the causative factor, allowing the mucosal layer to foster bone tissue regeneration.

However, additional interventions may be required when mucoceles cannot be effectively drained by conventional endoscopic sinus surgery. These interventions may encompass scenarios where mucoceles are situated beyond the confines of the frontal sinus or are accompanied by bone proliferation in challenging anatomical regions, such as the forehead. Additionally, secondary mucoceles arising from malignancy may necessitate alternative approaches.[15] In our study, 5 cases necessitated a combination of endoscopic surgery and Jacques surgery, particularly for frontal sinus mucoceles with challenging frontal recess bone or those situated beyond the frontal sinus, where endoscopic access was limited. Notably, this included cases of mucocele recurrence after previous Jacques tract surgery, as well as cases stemming from frontal sinus trauma. Additionally, 5 cases presented with complex bone fractures, while one case featured a frontal sinus mucocele located externally to the frontal sinus.

In our study, intraoperative navigation systems, specifically IGS, were employed in 65.8% of cases. Given the prevalent bone destruction, invasion of adjacent structures (e.g., eye socket, brain, optic nerve), and the frequent occurrence of revision surgeries altering anatomical landmarks, the guidance provided by IGS proves invaluable in identifying critical structures, enhancing surgical precision, and ensuring safer operative outcomes.

CONCLUSION

Early detection of mucoceles and their associated complications is imperative, especially concerning ocular health and vision impairment. The localization of the mucocele and the presence of orbital bone wall defects emerge as significant risk factors for orbital complications associated with mucoceles. Consequently, raising awareness among healthcare practitioners regarding paranasal sinus mucoceles is imperative for prompt diagnosis and intervention. Endoscopic sinus surgery has demonstrated efficacy in managing both uncomplicated and intricate mucoceles.

Limitations

Our study has some limitations. First, the retrospective nature could introduce inherent biases and limitations associated with data collection and analysis. Additionally, the sample size might be different from the broader population, potentially limiting the generalizability of the findings. Furthermore, the reliance on medical records for patient information may lead to incomplete or inconsistent data, impacting the accuracy and reliability of the results. Finally, while efforts were made to comprehensively assess mucocele characteristics and treatment outcomes, unforeseen confounding variables or unmeasured factors could influence the observed associations and conclusions drawn from the study.

Ethics Committee Approval: The study's protocol received approval from the Ear Nose Throat Ho Chi Minh City Hospital Ethical Board (No.126/TMH-HDDD); at January 9, 2023.

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

Peer-review: Externally peer-reviewed.

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