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Original Article

Multiple analyses of factors related to complications in endoscopic sinus surgery

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Abstract

Background: This study was undertaken to evaluate whether endoscopic sinus surgery (ESS) with a microdebrider had an impact on complication rates, and to facilitate the determination of factors associated with complications in patients who underwent ESS at a tertiary referral center in Taiwan.

Methods: This investigation was a retrospective study and literature review. We analyzed 997 consecutive patients who underwent ESS at Mackay Memorial Hospital in Taipei, Taiwan from January 2006 through February 2010. All data including those of patient medical information, and peri- and postoperative complications were provided by the surgeons involved in patient medical care. We analyzed the complication rates using the following 10 variables by univariate analysis and multivariate logistic regression: sex, age, Lund–Mackay score, polyp grading, previous sinonasal surgery, surgeon skill, adjunctive sinonasal surgery, mesenteric type of anterior ethmoid artery, Keros skull base type, and the use of a microdebrider.

Results: Of the 997 patients in our study, 78 (7.8%) had complications. Major complications occurred in five patients (0.5%): two with cerebrospinal fluid rhinorrhea, one with medial rectus muscle damage, and two with retrobulbar hematoma. Minor complications were found in 73 patients (7.3%), which included 32 patients with perioperative estimated blood loss > 15% of the total estimated blood volume, 26 with lamina papyracea damage, two with orbital cellulitis, and 13 with postoperative bleeding. Univariate analysis showed that risk factors related to complication rate were advanced Lund–Mackay scores (scores 19–24), advanced polyp grading (Grades 2 and 3), inexperienced surgeon (resident), and microdebrider usage. However, multivariate analysis revealed that complication rate was linked to advanced Lund–Mackay scores (Scores 19–24), mesenteric type of anterior ethmoid artery, and inexperienced surgeon.

Conclusion: Overall, the results of our study showed that the ESS complication rate was 7.8%, with risk factors including advanced Lund–Mackay scores (19–24, odds ratio 10.4) and inexperienced surgeon. It was also noted that ESS with a microdebrider had no impact on complication rates, although the presence of a mesenteric type of anterior ethmoid artery proved to be a protective factor.

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Keywords: complications; endoscopic surgery; frontal sinus; rhinosinusitis

Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

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1. Introduction

Since endoscopic sinus surgery (ESS) was first introduced by Messerklinger in 1978,[1] and further advanced in the mid-1980s by Kennedy et al[2,3] and Stammberger,[4] it had also become the primary surgery to solve medication-refractory chronic rhinosinusitis and nasal polyps around the globe. In Taiwan, in excess of 10,000 ESS procedures are performed every year, according to claims data from the National Health Research Institutes. These patients will encounter potential risks because the operation field is close to the orbit and anterior cranial fossa.[5] In his 1929 publication, Mosher[6] described that endonasal ethmoidectomy is the easiest way to kill a patient. However, numerous advances have been made since then to reduce this potential risk. In the mid-1990s, the advent of the microdebrider was among the most important surgical instrument inventions in the field, advancing the treatment of sinonasal disease in a more visible field through its suction-based rotating blade; the innovative device became widely used in Taiwan.[7] However, Stankiewicz et al[8] cautioned that patients are most at risk when the microdebrider can easily suction and sever periorbital and dura, which can then be misdirected into the orbit or brain. On the contrary, Hopkins et al[5] said that a microdebrider was not a risk factor for complications in ESS. There was a lack of evidence from comparative studies focusing on the use of microdebriders and complication rates in Taiwan. This study was carried out to evaluate the impact of a microdebrider on complication rates, determine the complication rates of ESS in our institution, and analyze factors associated with ESS complications.

2. Methods

This study was retrospective by means of reviewing charts. Information was collected from patients who underwent ESS in our hospital from January 2006 to February 2010. All medical information was acquired under the approval of Mackay Memorial Hospital Institutional Review Board, Taipei, Taiwan (Institute Review Board No. 14MMHIS187). Complications in these patients were identified from the medical records at the time of surgery. Major complications included orbital, intracranial, and great vessel injuries. Minor complications were defined as perioperative bleeding with over 15% loss of total estimated blood volume, postoperative bleeding requiring treatment, infection, and breach of the lamina papyracea with orbital fat exposure.[9]

Data on 10 variables were collected: sex, age, Lund–Mackay score, polyp grading, previous sinonasal surgery, surgeon skill, adjunctive sinonasal surgery, mesenteric type of anterior ethmoid artery (AEA), Keros skull base type, and the use of a microdebrider. The Lund–Mackay score of patients was calculated based on computed tomography (CT), and the score ranged from 0 (complete lucency of all sinuses) to 24 (complete opacity of all sinuses).[10] The polyp grading system we employed had a four-point classification system under a rigid endoscope (0 = no polyp, 1 = confined to middle meatus, 2 = below middle turbinate but not causing total obstruction, and 3 = causing total obstruction). Based on the surgical skill, surgeons were classified as resident and experienced. Septomeatoplasty was undertaken in the event adjunctive sinonasal surgery was necessary. Keros skull base type was subdivided into Type I (1–3 mm), Type II (4–7 mm), and Type III (8–16 mm) according to the depth of the olfactory groove.[11] A mesenteric type of AEA is identified on coronal CT image as a suspended band between the cribriform plate and lamina papyracea (Fig. 1).

The complication rates in this study were presented as a percentage according to each variable. Stata 11 statistics software (StataStastical Software, College Station, TX, USA) was used for univariate analysis and multivariate logistic regression model, in order to quantify the influence of these variables on complication rates. We considered $p < 0.05$ to indicate a statistically significant result.

3. Results

This study recruited 997 consecutive patients under the care of consultants for medical conditions associated with the ear, nose, and throat. Of the total 997 patients, 78 suffered complications (7.8%). Five patients presented major complications (0.5%), of which two reported to have cerebrospinal fluid rhinorrhea, one medial rectus muscle damage, and two retrobulbar hematoma. Minor complications were reported in 73 patients (7.3%), including 32 patients with perioperative estimated blood loss of over 15% of total body blood volume, 26 with a breach of the lamina papyracea, two with orbital cellulitis, and 13 with postoperative bleeding.

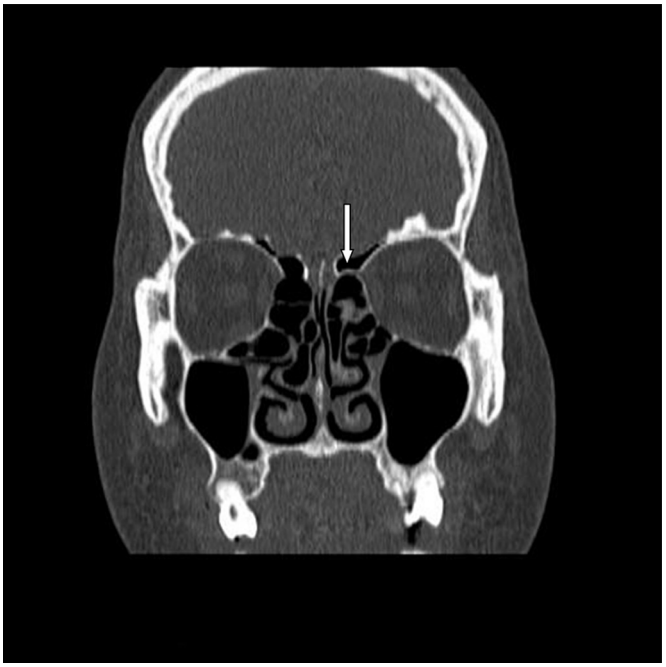

Fig. 1. Coronal computed tomography image. A suspended band between the cribriform plate and lamina papyracea is characteristic of a mesenteric type of anterior ethmoid artery.

We found that the complication rate was statistically increased in the groups with an advanced Lund–Mackay score [19–24, odds ratio (OR) 10.4], advanced polyp grading (2 and 3, OR 2.2 and 6.0, respectively), and microdebrider usage (OR 1.43) in univariate analysis. The univariate profile is listed in Table 1. If the surgeons involved were deemed to be at the "experienced" level, the complication rate statistically decreased in univariate analysis (OR 0.17). Furthermore, we calculated the overall effects of the use of the multivariate logistic regression model on complication rate (Table 2). We found that patients with an advanced Lund–Mackay score (19–24) were more likely to suffer complications [adjusted OR 6.0, 95% confidence interval (CI) 2.11–17.05]. Patients with mesenteric AEA contrarily had a reduced level of complication rate compared to those without mesenteric AEA (adjusted OR 0.422, 95% CI 0.2–0.89). Surgeons whose skill reached the experienced level were associated with lower complication rates than residents (adjusted OR 0.10, 95% CI 0.03–0.272). Overall, the use of a microdebrider was not associated with complication rates (adjusted OR 1.28, 95% CI 0.64–2.55).

Table 1
Complication rates according to variables.

Variables	No. of patients	Complication rate (%)	Odds ratio (95% CI)	*p*
Sex				
Male	386	6.5		
Female	611	8.8	1.03 (0.9–2.3)	0.180
Age (y)				
<18	80	3.75		
19–40	340	7.65	2.12 (0.63–7.20)	0.226
41–60	447	8.50	2.38(0.72–7.92)	0.156
>60	130	9.23	2.61 (0.71–9.55)	0.147
Lund–Mackay score				
0–6	250	4.0		
7–12	285	3.2	0.8 (0.3–2.0)	0.600
13–18	309	4.5	1.1 (0.5–2.6)	0.758
19–24	152	30.3	10.4 (5.1–21.4)	<0.001*
Polyp grading				
0	294	4.1		
1	104	1.9	0.5 (0.1–2.1)	0.316
2	481	8.5	2.2 (1.1–4.2)	0.020*
3	118	20.3	6.0 (2.9–12.5)	<0.001*
Keros type				
I	41	7.3		
II	693	7.9	1.1 (0.3–3.7)	0.886
III	188	8.5	1.2 (0.3–4.3)	0.802
Mesenteric type of AEA				
No	552	9.0		
Yes	370	6.5	0.7 (0.4–1.2)	0.161
Previous sinonasal surgery				
No	806	7.8		
Yes	190	8.4	1.1 (0.6–1.9)	0.781
Surgeon skill				
Resident	537	12.67		
Experienced	458	2.40	0.17 (0.089–0.325)	<0.001*
Adjunctive sinonasal surgery				
No	842	8.4		
Yes	144	5.6	0.57 (0.24–1.32)	0.190
Microdebrider				
No	510	2.8		
Yes	487	5.1	1.43 (1.2–3.3)	0.004*

*$p < 0.05$.
AEA = anterior ethmoid artery; CI = confidence interval.

4. Discussion

We had an overall complication rate of 7.8%, with major and minor complication rates of 0.5% and 7.3%, respectively. However, there were still 7.3% of minor complications. The most common minor complication was excessive perioperative bleeding. This complication may be related to the severity of disease on CT image, especially the presence of a high Lund–Mackay score. A comparison with other recently published complication studies of ESS is provided in Table 3. The prospective study conducted by Hopkins et al[5] in 2006 reported their overall, major, and minor complication rates of 7.0%, 0.4%, and 6.6%, respectively. Asaka et al[12] reported in 2012 that the overall, major, and minor complication rates were 5.8%, 0.1%, and 5.7%, respectively. Stankiewicz et al[8] also reported a complication rate of 3.1% in a retrospective study based on 25-year experience published in 2011. The most common complications were hemorrhage ($n = 41$), orbital complications ($n = 29$), and cerebrospinal fluid leak ($n = 19$). Dalziel et al[7] had conducted a systemic review in 2006 with total complication rates ranging from 0.3% to 22.4%, major complication rates ranging from 0% to 1.5%, and minor complication rates ranging from 1.1% to 20.8%. Conclusively, the rate of major complications of ESS has generally been low, and our result was consistent with this broader finding.

Table 2
Multivariate analysis of risk factors.

Variables	Adjusted odds ratio (95% CI)	*p*
Sex	1.03 (0.52–2.04)	0.924
Age	1.1 (0.9–1.3)	0.232
Lund–Mackay score		
0–6		
7–12	0.741 (0.25–2.22)	0.593
13–18	1.21 (0.42–3.49)	0.72
19–24	6.00 (2.11–17.05)	<0.001*
Polyp grading		
0		
1	0.4 (0.21–1.98)	0.319
2	1.15 (0.45–2.94)	0.768
3	1.29 (0.41–4.05)	0.657
Keros type		
I		
II	5.93 (0.67–53.00)	0.11
III	4.24 (0.40–45.00)	0.23
Mesenteric type of AEA	0.422 (0.20–0.89)	0.023*
Previous sinonasal surgery	0.80 (0.35–1.83)	0.593
Surgeon skill		
Resident		
Experienced	0.10 (0.03–0.272)	<0.001*
Adjunctive sinonasal surgery	0.44 (0.16–1.22)	0.113
Microdebrider	1.28 (0.64–2.55)	0.485

*$p < 0.05$.
AEA = anterior ethmoid artery; CI = confidence interval.

Table 3
Comparison with associated complication rate studies.

Authors (date)	Study design	No. of patients	Complication rate (%)	Complication no. and rate (%)	
				Major	Minor
Soyka & Holzmann (2005)[13]	Retrospective	410	39.7	Grade C 2/0.5	Grade A 155/36.8 Grade B 10/2.4
Hopkins et al (2006)[5]	Prospective	3128	7.0	11/0.4	207/6.6
Dalziel et al (2006)[7]	Systematic review	12,395 (42 publications)	0.3–22.4	0–1.5	1.1–20.8
Asaka et al (2012)[12]	Prospective	706	5.8	1/0.1	40/5.7
MMH data (2010)	Retrospective	997	7.8	5/0.5	73/7.3

Complications are always an important issue when rhinologists are in the process of performing ESS due to the vital structures around the sinuses, which sometimes can lead to irreversible morbidity and mortality. The ESS procedure has evolved over decades as surgeons' skills and innovative instrumentation have improved, reducing disastrous complications. Except for analyzing the patient variables, we enrolled operative variables to clarify the impacts of these factors for ESS. We found that the presence of mesenteric AEA and involvement of experienced surgeons were protective factors of ESS. In other words, residents were more likely to contribute to the development of complications. We later determined that the use of a microdebrider had no impact on complication rate after adjustment of potential confounding factors.

Hopkins et al's[5] and our study summarized that sex, age, previous sinonasal surgery, extent of operation, adjunctive sinonasal surgery, and microdebrider use were not related to complication rate. In Hopkins et al's[5] study, Lund–Mackay score and polyp grading were designated to be risk factors.[10] In Asaka et al's[12] analysis, polyp score and asthma were risk factors, but not the Lund–Mackay score, because they proposed that a mucosal lesion was the key to identifying a surgical landmark than a mucus lesion in the sinus. Nevertheless, our result excluded polyp grading, which could arise from different distributions of polyp grading in our race. In Hopkins et al's[5] study, 48.3% of patients had advanced polyp grading (2 and 3), whereas we had 60.0%. Perhaps, our surgeons had conducted more polyp cases and had more experience than their counterparts in the Soyka and Holzmann,[13] Hopkins et al's,[5] and Asaka et al's[12] studies. "Declared surgeon skill" was not one of their risk factors, merely stating that the more experienced the surgeon, the more challenging operation they would undertake that would result in potential complications for such experienced surgeons. In our multivariate analysis, a resident was apt to make more decisions involving complications than experienced surgeons. The result was different from a previously reported study. Residents always need more time and practice to enhance their surgery skills and anatomical knowledge under the supervision of experienced surgeons. Usually, the greater the time a surgeon spends in the operating room, the greater the blood loss. In those instances, complications such as excess blood loss might occur.

There has been no prior study addressing the impact of mesenteric AEA. In our study, mesenteric AEA was considered a protective factor of ESS. The p value of the mesenteric type of AEA shows a statistical significance in multivariate analysis. The existence of a mesenteric type of AEA on preoperative sinus CT may perhaps be a valuable reminder for surgeons that it should be handled with caution. Therefore, the relative anatomical structure and major vascular damage could be avoided without massive bleeding during operation. Ultimately, a mesenteric type of AEA is generally considered to be a protective factor.

The higher the Lund–Mackay score and polyp grade, the higher the need for application of a microdebrider. It is well understood around the globe that a microdebrider precisely resects tissues, minimizing inadvertent tissue trauma, and involves stripping. Christmas and Krouse[14] reported that surgical bleeding was reduced by more than half in the microdebrider group. A shorter operating time, relatively bloodless surgery, and a clearer visual field were reported when surgeons operated with a microdebrider.[15] Therefore, these elements lead to the conclusion that enhanced safety can be offered during operation. Hopkins et al,[5] Hackman and Ferguson,[16] and Ecevit et al[17] demonstrated that the use of a microdebrider did not increase the risk of complications. By contrast, Stankiewicz et al[8] indicated that the use of a microdebrider leads to increased complications. Of note, both Hopkins et al[5] and Ecevit et al[17] provided statistical evidence in their studies, while Stankiewicz et al[8] did not. So far, there is no current statistical evidence suggesting increased complications by using a microdebrider.[9]

In conclusion, the overall complication rate in our study of ESS was 7.8%. Risk factors of ESS were advanced Lund–Mackay score (19–24, OR 10.4) and inexperienced surgeon. The protective factor was the presence of a mesenteric type of AEA. ESS with a microdebrider had no impact on complication rates.

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