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Retrospective analysis of a concurrent series of microscopic versus endoscopic transsphenoidal surgeries for Knosp Grades 0–2 nonfunctioning pituitary macroadenomas at a single institution

Clinical article

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Object. The object of this study was to compare surgical outcomes and complications in a contemporaneous series of patients undergoing either microscopic or endoscopic transsphenoidal surgery for nonfunctioning pituitary macroadenomas without imaging evidence of cavernous sinus invasion.

Methods. This is a retrospective analysis of a prospectively collected database from a single institution. Data were collected from patients whose surgery had occurred in the period from June 2010 to January 2013. Patients who underwent microscopic or endoscopic surgery for Knosp Grade 0, 1, or 2 nonfunctioning pituitary macroadenomas were included in the study. Patients who had clinically secreting or Knosp Grade 3 or 4 tumors and patients who were undergoing revision surgery were excluded from analysis. Eligible patient records were analyzed for outcomes and complications. Statistical analyses were performed on tumor volume, intraoperative factors, postoperative complications, and degree of resection on 1-year postoperative MRI. The results were used to compare the outcomes after microscopic and endoscopic approaches.

Results. Forty-three patients underwent microscopic transsphenoidal surgery, and 56 underwent endoscopic transsphenoidal surgery. There were no statistical differences in the intraoperative extent of resection or endocrinological complications. There were significantly more intraoperative CSF leaks in the endoscopic group (58% vs 16%); however, there was no difference in the incidence of postoperative CSF rhinorrhea (12% microscopic vs 7% endoscopic). Length of hospitalization was significantly shorter in patients undergoing an endoscopic approach (3.0 days vs 2.4 days). Two-month follow-up imaging was available in 95% of patients, and 75% of patients had 1-year follow-up imaging. At 2 months postprocedure, there was no evidence of residual tumor in 79% (31 of 39) and 85% (47 of 55) of patients in the microscopic and endoscopic groups, respectively. At 1 year postprocedure, 83% (25 of 30) of patients in the microscopic group had no evidence of residual tumor and 82% (36 of 44) of those in the endoscopic group had no evidence of residual tumor.

Conclusions. The microscopic and endoscopic techniques provide similar outcomes in the surgical treatment of Knosp Grades 0–2 nonfunctioning pituitary macroadenomas.
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Key Words • **microscopic** • **endoscopic** • **transsphenoidal** • **nonfunctioning pituitary macroadenoma** • **pituitary surgery**

Neurosurgeons have traditionally used a sublabial or transseptal incision with an operating microscope to access the sphenoid sinus and sella turcica for the resection of pituitary tumors.[9] Over the past decade, however, the endoscopic endonasal transsphenoidal approach has become an increasingly popular method of removing pituitary tumors and other lesions of the sella.[2,3,7,12,20]

Among the arguments proposed for the use of endoscopy for transsphenoidal surgery are that it provides a superior view of the sella and its surrounding structures by allowing panoramic visualization, and it offers improved lighting. Angled endoscopes allow visualization into recesses within the sphenoid sinus and sella that is not offered by the operating microscope. The enhanced visualization during endoscopic procedures theoretically can improve the extent of resection of very large pituitary tumors, in particular those extending laterally or superiorly beyond the direct vision of the operating microscope. On

Abbreviations used in this paper: GTR = gross-total resection; SIADH = syndrome of inappropriate antidiuretic hormone secretion.

the other hand, proponents of the microscopic approach emphasize the enhanced precision of dissection under the direct vision of the operative field with the microscope. Theoretically, however, there is less benefit with the endoscope for tumors contained within the sella.

Both the Hardy and Knosp classification systems are used to grade pituitary tumors based on their size and gross degree of invasiveness.[10,13] The Knosp classification system assigns a grade from 0 to 4 based on the lateral extent of the tumor in relation to the intracavernous segment of the internal carotid artery on coronal MRI sections.[13] Tumors with Grades 0–2 are contained within the lateral carotid artery tangential, while tumors that extend beyond the carotid artery tangential are Grades 3–4. In their report, Knosp et al. found that many Grade 2 tumors had surgical evidence of cavernous sinus wall invasion, and tumors with Knosp Grades 3–4 were generally thought to grossly invade the cavernous sinus. However, a high rate of successful biochemical remission occurs with hormone-secreting Knosp Grade 2 tumors, suggesting that many tumors within the 0–2 grades are surgically curable.[11] The Knosp classification is not without its limitations, however. Several studies have shown that MRI is not sensitive enough to detect microscopic invasion of the surrounding dura and cavernous sinus wall, especially with small tumors.[6,14,16]

There is no consensus on one surgical approach over the other in terms of the extent of resection possible for variously sized tumors or of complications. Starke et al. recently compared microscopic and endoscopic approaches in growth hormone–secreting tumors.[24] The results of that study suggest that there is no difference between these approaches in achieving biochemical remission or in complication rates. Previous comparisons suggest that patients who undergo the endoscopic approach have shorter operative times, less operative blood loss, shorter hospitalizations, and fewer postoperative complications.[4,5,18,22] However, most of these studies have compared a prior microscopic series to a more recent endoscopic series or have included only small numbers of patients. No study has addressed whether one approach is superior for moderate-sized tumors without radiographic evidence of lateral extension into the cavernous sinus or has compared the outcomes of the two surgical approaches over the same interval.

Methods

Data Collection

The institutional review board at the University of Virginia approved this study. We retrospectively reviewed our prospectively collected database for sequential patients undergoing endoscopic and microscopic transsphenoidal surgery at the University of Virginia in the period from June 2010 to January 2013. Patients were not randomized to either microscopic or endoscopic surgery. One attending neurosurgeon performs microscopic surgery (E.H.O.) and another performs endoscopic surgery (J.A.J.). Patients referred directly to an attending underwent surgery by that attending. Patients referred to the pituitary center are seen by the attending with the soonest available clinic opening. Patients harboring nonfunctioning macroadenomas with a Knosp grade of 0, 1, or 2 were included in our analysis. Patients with hormonally secreting tumors and those with Knosp Grade 3 or 4 tumors were excluded. Moreover, patients undergoing revision surgery for recurrent tumors were also excluded. Knosp grades were determined by the operating surgeons and verified by another surgeon (R.D.) before data analysis. Data were collected from a retrospective chart review: patient demographics, tumor dimensions, intraoperative findings, postsurgical MRI, and postoperative outcomes. New endocrinological deficiencies were considered transient if a patient received new replacement therapy after surgery but discontinued that therapy during follow-up; deficiencies were considered permanent if a patient received new replacement therapy after surgery and that medication was not discontinued at the last follow-up. Extent of tumor resection was estimated during surgery and with MRI at 2 months and 1 year after surgery.

Operative Methods

Both attending neurosurgeons attempt to remove tumor by using the pseudocapsule as a surgical plane when possible.[19] Intraoperative video-fluoroscopy is routinely used during the microscopic technique, whereas intraoperative image guidance is selectively used during endoscopic surgery in the setting of a presellar sphenoid sinus. Lumbar drainage is used in the majority of microscopic surgeries, whereas it is used selectively in endoscopic surgeries.[18] An otolaryngologist participated in the exposure in 55% of the endoscopic procedures. Otolaryngological expertise is particularly used in patients with deviated nasal septi, preexisting sinus disease, or large tumors in which a nasoseptal flap may be necessary for reconstruction.

Data Analysis

Data were analyzed using commercially available statistical software (MedCalc software). Univariate analysis and chi-square tests were performed for data comparisons. A p value < 0.05 was considered significant.

Results

Patient Information

Ninety-nine patients met the study criteria. Forty-three patients underwent a sublabial microscopic approach, and 56 underwent an endoscopic approach. There was no significant difference in patient age or sex between the two treatment groups (Table 1).

Most patients presented with either visual field deficits or an endocrinopathy, but some presented after an incidental finding from intracranial imaging studies performed for other reasons. In the microscopic group, 51% of patients had visual field deficits, and 65% had tumors compressing the optic chiasm according to coronal postcontrast MRI. In the endoscopic group, 39% of patients had visual field deficits, and 70% of tumors were compressing the optic chiasm. The most common visual field deficit was an incomplete bitemporal hemianopia. There was no statistical difference between the two treatment

TABLE 1: Summary of demographics in 99 patients treated for nonfunctioning macroadenomas*

Parameter	Microscopic TSR	Endoscopic TSR	p Value
no. of patients	43	56	
mean age at surgery in yrs†	56.7 ± 16.9	56.2 ± 12.8	0.85
M/F	24/19	27/29	0.45
no. w/ preop visual field defect (%)	22 (51)	22 (39)	0.24
no. w/ optic chiasm compression (%)	28 (65)	39 (70)	0.63
no. w/ preop endocrinopathy (%)	19 (44)	25 (45)	0.96
panhypopituitarism	3	4	
hypogonadism	10	11	
amenorrhea	4	3	
other	2	7	

* TSR = transsphenoidal resection.
† Values expressed as mean ± standard deviation.

TABLE 2: Summary of tumor information

Parameter	Microscopic TSR	Endoscopic TSR	p Value
Knosp Grade 0 tumor			
no. (%)	3 (7)	11 (20)	0.04
vol in cm^3	2.6	2.1	0.78
diameter in mm	21.0	17.7	0.57
Knosp Grade 1 tumor			
no. (%)	18 (42)	23 (41)	0.93
vol in cm^3	5.3	4.1	0.48
diameter in mm	24.8	20.8	0.29
Knosp Grade 2 tumor			
no. (%)	22 (51)	22 (39)	0.23
vol in cm^3	6.0	7.2	0.38
diameter in mm	24.7	26.9	0.77
overall average tumor vol in cm^3	5.6	5.0	0.38

groups in the number of patients presenting with visual field deficits or in the number with tumors compressing the optic chiasm. There was a statistical correlation between Knosp grade and MRI evidence of optic chiasm compression in both groups ($p = 0.02$), although there was no correlation between Knosp grade and visual field deficit. Forty-four percent of patients in the microscopic group and 45% of patients in the endoscopic group had preoperative hypopituitarism of some degree. The most common form was hypogonadism, followed by panhypopituitarism. These patients typically presented with fatigue. There was no statistical difference in preoperative endocrinopathies between the two groups.

Knosp Grade and Calculated Tumor Volume

Preoperative postcontrast MR images in the coronal plane were used to determine the Knosp grade for each tumor. Grades were assigned by the operating surgeon, dictated in the operative notes, and subsequently verified by another neurosurgeon (R.D.) before data analysis. In the microscopic group, a majority of patients had tumors with Knosp Grades 1 or 2 (42% and 51%, respectively). Only 7% of patients had a tumor with a Knosp grade of 0. There were significantly more patients with Knosp Grade 0 tumors in the endoscopic group ($p < 0.05$; Table 2).

Tumor volume was estimated by measuring greatest tumor dimensions in the coronal, sagittal, and axial planes on preoperative postcontrast imaging. Tumor volumes were calculated by multiplying these values and dividing by 2. There was a positive correlation between tumor volume and Knosp grade for both treatment groups. Knosp Grade 0 tumors had calculated volumes of 2.6 and 2.1 cm^3 in the microscopic and endoscopic groups, respectively. Knosp Grade 2 tumors had calculated volumes of 6.0 and 7.2 cm^3, respectively. Calculated tumor volumes for Knosp Grade 2 tumors were significantly larger than those for Knosp Grade 0 tumors for both treatment groups ($p < 0.05$). As expected, Knosp Grade 1 tumors had intermediate tumor volumes. When comparing microscopic versus endoscopic groups, there was no statistical difference in tumor volume in patient sets with similar Knosp grades (Table 2). The overall estimated tumor volume was not statistically different between the two treatment groups, and there was no correlation between preoperative Knosp grade and endocrinopathy.

Intraoperative Data

Operative reports were analyzed for intraoperative differences between the microscopic and endoscopic approaches. Both surgeons predicted that most patients had undergone a gross-total resection (GTR; 93% microscopic vs 96% endoscopic).

To reduce the incidence of intraoperative CSF leaks, lumbar drains were placed preoperatively in 70% of patients undergoing microscopic resection compared with only 1.7% of those who had an endoscopic resection ($p < 0.05$). Lumbar drains were placed in patients with tumors that had suprasellar extension.[15] Cerebrospinal fluid leaks were noted intraoperatively in 16% of microscopic cases. Significantly more intraoperative CSF leaks were noted in endoscopic cases (58%, $p = 0.002$). Seventy-nine percent of intraoperative CSF leaks in the endoscopic group were categorized as "weepy" without a clearly evident hole in the sellar diaphragm. There was no significant difference in the number of "large" or "small" intraoperative CSF leaks between the treatment groups. An abdominal fat graft was harvested and used for the prevention of postoperative CSF leakage in 7% of microscopic resections and in 30% of endoscopic resections ($p < 0.05$). In the microscopic group, 12% of patients had lumbar drains either inserted postoperatively or left in place after surgery for the management of CSF leaks, compared with none in the endoscopic group. An otolaryngologist was present in only one microscopic surgery, whereas 55% of endoscopic cases were assisted by an otolaryngologist (Table 3).

Hospitalization and Complications

Medical records were reviewed for postoperative endocrine and surgical complications. Patients who under-

TABLE 3: Summary of intraoperative data*

Parameter	No. (%) Microscopic TSR	No. (%) Endoscopic TSR	p Value
extent of resection			
GTR	40 (93)	54 (96)	0.45
STR, >80%	3	2	
preop lumbar drain	30 (70)	1 (1.7)	<0.05
postop lumbar drain	5 (12)	0	0.01
abdominal fat graft harvest	3 (7)	17 (30)	<0.05
nasoseptal flap	0	1 (1.7)	0.38
cases w/ otolaryngologist present	1 (2.3)	31 (55)	<0.05
cases w/ op CSF leak			
total	7 (16)	29 (58)	<0.002
large	3 (7)	1 (1.7)	
small	0	5 (9)	
weepy	4 (9)	23 (41)	

* STR = subtotal resection.

went an endoscopic approach had a significantly shorter hospitalization (3.0 vs 2.4 days, p = 0.04; Table 4).

The rate of postoperative CSF leaks was 12% and 7% in the microscopic and endoscopic groups, respectively, but there was no statistical significance in this difference (p = 0.55; Table 4). There was no correlation between the development of a postoperative CSF leak and Knosp grade. In the microscopic group, 4 of the postoperative CSF leaks were unrecognized at surgery and only 1 was unrecognized in the endoscopic group. Five patients in the microscopic group and 4 patients in the endoscopic group had postoperative CSF leaks. Lumbar drainage was attempted in all patients with CSF leaks in the microscopic group, but none in the endoscopic group. This reflects methodological differences between the two surgeons. Four patients in the microscopic group had resolution of their CSF leak with lumbar drainage alone, and 1 patient returned to the operating room for repair. All 4 patients with postoperative CSF leaks in the endoscopic group returned to the operating room for surgical repair.

TABLE 4: Summary of hospitalization and complications data

Parameter	No. (%) Microscopic TSR	No. (%) Endoscopic TSR	p Value
mean length of stay in days	3.0 ± 1.7	2.4 ± 0.76	0.04
endocrine			
transient diabetes insipidus	6	10	0.83
permanent diabetes insipidus	1	0	0.23
SIADH	7	5	0.52
transient hypocortisolism	3	5	0.76
permanent hypocortisolism	3	3	0.66
surgical			
postop CSF leak	5 (12)	4 (7)	0.55
vision changes	0	2	0.21
sinusitis	1	5	0.64
epistaxis	1	6	0.11
porex graft removal	0	3	0.12

There were no significant differences in newly diagnosed postoperative endocrinological complications, including transient diabetes insipidus, permanent diabetes insipidus, syndrome of inappropriate antidiuretic hormone secretion (SIADH), transient hypocortisolism, and permanent hypocortisolism between the treatment groups. In the microscopic group, 6 patients experienced transient diabetes insipidus, 7 developed postoperative SIADH, 3 had transient hypocortisolism, and 3 had permanent hypocortisolism after surgery. In the endoscopic group, 10 patients had transient diabetes insipidus, 5 had SIADH, 5 had transient hypocortisolism, and 3 had permanent hypocortisolism.

One patient in the microscopic cohort required permanent treatment for diabetes insipidus. In the microscopic group, all 3 patients with new permanent hypocortisolism had had hypogonadism preoperatively, and 2 of these patients had low insulin-like growth factor–1 levels. In the endoscopic group, 2 patients with new permanent hypocortisolism had had hypogonadism preoperatively. In sum, 5 of 6 patients who developed permanent hypocortisolism postoperatively had had partial hypopituitarism preoperatively. There was no statistical difference in the development of a newly diagnosed transient or permanent endocrinopathy between the two treatment groups (Table 4). There was no correlation between tumor Knosp grade and the development of a new endocrinopathy after surgery (Table 5).

There were no differences in surgical complications postoperatively. Notably, 1 patient who underwent microscopic surgery with a persistent CSF leak developed meningitis and was treated with intravenous antibiotics. Six patients who had undergone endoscopic surgery and 1 patient who had undergone microscopic surgery had moderate–severe epistaxis within the first few days of surgery; this was not a statistically significant difference (p > 0.05, chi-square test). One patient in the microscopic group received therapeutic anticoagulation for a symptomatic pulmonary embolism and subsequently had

TABLE 5: Complications stratified by Knosp grade

Parameter	No. of Cases Knosp Grade 0	Knosp Grade 1	Knosp Grade 2	p Value
postop CSF leak				
microscopic TSR	0	1	4	0.4
endoscopic TSR	0	2	2	0.69
transient endocrinopathy				
microscopic TSR	2	4	9	0.34
endoscopic TSR	5	10	5	0.11
permanent endocrinopathy				
microscopic TSR	0	2	2	0.96
endoscopic TSR	0	1	2	0.33

severe epistaxis that required sphenopalatine artery embolization. Two patients with epistaxis in the endoscopic group had nasal packing to control bleeding. Two patients in the endoscopic group had vision changes after surgery; both patients had transient diplopia that resolved with conservative management. Three patients who underwent endoscopic surgery had dislodged polyethylene implants used in the sellar reconstruction. Two patients returned to the operating room to have the implants removed.

Follow-Up

Postoperative radiographic and medical records were analyzed for patient follow-up and extent of resection (Table 6). After transsphenoidal surgery, our patients have 2-month and 1-year follow-up appointments with the multidisciplinary neuroendocrine team. Patients typically have an MRI study before their appointment. Ninety-five percent of the patients in our study had 2-month follow-up imaging, and 75% had 1-year follow-up imaging.

The 2-month MRI follow-up showed definite evidence of residual tumor in 4 (10%) of 39 patients in the microscopic group and in 5 (9%) of 55 patients in the endoscopic group (Table 6). Postsurgical change versus residual tumor was noted in 4 (10%) and 3 (5%) patients in the microscopic and endoscopic groups, respectively. At the 1-year MRI follow-up, 83% of the patients (25 of 30) in the microscopic group and 82% (36 of 44) in the endoscopic group had no evidence of residual tumor. Among the 4 patients in the microscopic group who had potential residual tumor versus surgical change at the 2-month postoperative imaging, 2 of them had residual tumor and 2 had no residual tumor at the 1-year MRI follow-up. In the endoscopic group, among the 3 patients with potential tumor versus surgical change at 2 months, 1 patient had residual tumor and 1 had no residual tumor at the 1-year MRI follow-up; one did not have 1-year postoperative MRI. There was no statistical difference in GTR at the 1-year MRI follow-up ($p = 0.54$), and there was no correlation between Knosp grade and extent of resection at this time point (Table 7).

TABLE 6: Follow-up data in 99 patients surgically treated for nonfunctioning macradenomas

Parameter	No. of Cases (%)		p Value
	Microscopic TSR	Endoscopic TSR	
radiographic follow-up			
none	4 (9)	1 (1.7)	
2-mos MRI	39 (91)	55 (98)	
GTR	31 (79)	47 (85)	0.46
definitive residual	4 (10)	5 (9)	
surgical changes vs residual tumor	4 (10)	3 (5)	
1-yr MRI	30 (70)	44 (79)	
GTR	25 (83)	36 (82)	0.54
residual	5 (17)	8 (18)	

TABLE 7: Gross-total resection rate stratified by Knosp grade

Parameter	GTR Rate		p Value
	Microscopic TSR	Endoscopic TSR	
Knosp Grade 0			
2-mos follow-up	100	91	0.83
1-yr follow-up	100	90	0.85
Knosp Grade 1			
2-mos follow-up	93	90	0.60
1-yr follow-up	91	82	0.44
Knosp Grade 2			
2-mos follow-up	71	68	0.40
1-yr follow-up	76	75	0.62

Discussion

Previous reports have compared microscopic and endoscopic approaches for transsphenoidal surgery.[4,24] Most have featured sequential series,[5,18] included very small numbers of patients,[4,22] or had other limitations that compromise the ability to compare the two approaches. Starke et al. recently compared a large series of microscopic and endoscopic approaches for growth hormone–secreting tumors and found no difference in remission rates or postoperative complications.[24]

The present study focuses on nonfunctioning macroadenomas generally accepted to be potentially surgically curable (Knosp Grades 0–2).[11] No other study clearly compares these surgical approaches according to tumor size in a concurrent series at a single institution. Most previous studies have included a heterogeneity of tumor types, grouping together both functional and nonfunctional tumors.[5,18,22] Given that one of the principle arguments for using an endoscopic approach is that it allows a panoramic view of the sella and closer inspection of the posterior and superior recesses, it is important to compare the surgical outcomes for variously sized tumors. With this argument in mind, one might expect to see a correlation between the extent of tumor resection and Knosp grade or tumor volume. In this study, there was no difference in the extent of resection between the two treatment groups when comparing MRI at 2 months and 1 year after treatment. Furthermore, there was no correlation between Knosp grade and extent of resection. Patients with Knosp Grade 2 tumors were as likely as those with Knosp Grade 0 or 1 tumors to have GTR ($p = 0.23$ and 0.33, respectively, chi-square test). This is an important observation since Knosp Grade 2 tumors are generally thought to be the largest potentially surgically curable tumors.

Few studies have stratified resection rates based on the Knosp classification, but overall the rate of complete resection is higher for small, noninvasive tumors than for those that invade the cavernous sinus. Messerer et al. reported a GTR rate of 88.2% for Knosp Grade 2 tumors and 67.9% for Knosp Grade 3 tumors after using a fully endoscopic approach.[17] Gondim et al. studied cases of macroadenomas larger than 4 cm in diameter and reported a 100% rate of complete resection for Knosp Grade 0

tumors, 57.1% for Knosp Grade 1, and 35.7% for Knosp Grade 2.[8] For growth hormone–secreting tumors, Starke et al. showed a remission rate of 86.7% in patients with Knosp Grades 0–2 tumors following microscopic transsphenoidal surgeries and 80.8% for those who had undergone endoscopic surgeries.[24] The 1-year postoperative MRI results in the present study are consistent with results in these previous studies.

Reported CSF leak rates following transsphenoidal surgery range from 0.5% to 15%, with most reports documenting rates of < 6%. One of the factors most predictive of a postoperative CSF leak is an intraoperative CSF leak.[15] Other factors, including revision surgery and the resection of nonadenomatous lesions, have also been shown to increase the risk of postoperative CSF leaks. Two studies documented an increased rate of CSF leakage with larger lesions;[1,21] however, Shiley et al. did not find a difference in the rate of CSF leaks between micro- and macroadenomas.[23] The overall rate of postoperative CSF leak at 9% in the present study is within the range of previously reported rates, and there was no correlation between tumor size and postoperative CSF leak.

There was no significant difference in the rate of postoperative CSF leak between the two surgical approaches. There were 5 (12%) postoperative CSF leaks in the microscopic group and 4 (7%) in the endoscopic group. There was a higher rate of intraoperative CSF leak in patients who had undergone the endoscopic transsphenoidal approach. In the cohort of 56 patients, 29 (58%) were noted to have leaks during the operation compared with 7 (16%) of 43 patients in the microscopic group. Most of the intraoperative CSF leaks in the endoscopic group (23 [79%] of 29) were classified as weepy along the dura. Reconstruction with an abdominal fat graft or sellar reconstruction alone was sufficient to prevent postoperative CSF leaks in patients noted to have a weepy sellar diaphragm. Of the 23 cases with intraoperative CSF leaks, only 2 developed postoperative CSF leaks. One patient in the endoscopic group had an unrecognized intraoperative CSF leak that required reoperation and postoperative lumbar drainage. A second patient had a recurrent CSF leak and required a nasoseptal flap for repair. Overall, there were 4 postoperative CSF leaks in the endoscopic group, all of which underwent reoperation with abdominal fat grafting for repair.

In the microscopic group fewer intraoperative leaks were noted; however, there were 4 patients in whom an intraoperative CSF leak was not noticed at the time of surgery, although there was a postoperative CSF leak. During the time frame of this study, many of the patients with macroadenomas with suprasellar extension who had undergone microscopic surgery had intraoperative CSF drainage with a lumbar drain or high-volume lumbar punctures just before the surgery to limit the incidence of intraoperative CSF leaks. This reduced the need for intraoperative repair of a CSF leak using a fat graft in the microscopic group (7%) as compared with that in the endoscopic group (30%; $p < 0.05$).[15] Although more patients in the microscopic group required postoperative measures to treat CSF leakage (5 patients [12%] had postoperative CSF drainage and bed rest for 2–3 days) than in the endoscopic group (1 patient [2%] had additional surgery for surgical repair), more patients in the endoscopic group underwent surgical placement of a fat graft to prevent postoperative leakage of CSF that was evident at surgery.

In regard to an association of CSF leaks with tumor size, there was no correlation between intraoperative CSF leak and Knosp grade or tumor volume for either cohort ($p = 0.23$ and 0.20). In addition, there was no correlation between Knosp grade or tumor volume and postoperative CSF leaks.

There are limitations to this study, including the biases of a retrospective study design and the cohort size of 99 patients, which may not be powerful enough to detect small differences in the two treatment methods. However, a prospective study comparing these two surgical techniques would be difficult to perform. In this study, most patients had 1 year of postsurgical radiographic follow-up. These patients must be followed up for a long period of time since there is a known recurrence rate even for tumors that have had what appears to have been a complete resection. It is possible that with longer periods of follow-up, there is a difference in recurrence rates. There are methodological differences between the surgeons in terms of operative management for very large tumors and postoperative CSF leaks. In the microscopic cohort, the surgeon preferred to place a lumbar drain preoperatively in cases in which there was suprasellar extension of the tumor; the surgeon who performed endoscopic surgery does not routinely do this. Similarly, in select cases of postoperative CSF leaks, the surgeon who performed microscopic surgery will address postoperative leaks with lumbar drainage before repeating surgical repair. On the other hand, the surgeon who did endoscopic surgery prefers to perform repeat surgical repair with abdominal fat grafting without attempting a trial of lumbar drainage beforehand.

Conclusions

This report compares microscopic and endoscopic transsphenoidal surgery performed for nonfunctioning macroadenomas at one institution during the same time period. There were similar rates of GTR and postoperative complications for the two procedures. Patients who underwent the endoscopic approach had shorter hospitalizations. Overall, our data suggest that there is little difference in outcomes based on the surgical approach for resecting Knosp Grades 0–2 nonfunctioning pituitary macroadenomas.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Jane, Oldfield. Acquisition of data: Jane, Dallapiazza. Analysis and interpretation of data: Jane, Dallapiazza, Payne, Oldfield. Drafting the article: Jane, Dallapiazza, Oldfield. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Jane. Statistical analysis: Bond. Administrative/technical/material support: Dallapiazza.

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