Endoscopic Transsphenoidal Pituitary Surgery: Evidence of an Operative Learning Curve

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BACKGROUND: The use of the fiberoptic endoscope is a recent innovation in pituitary surgery.

OBJECTIVE: To investigate the evidence of an operative learning curve after the introduction of endoscopic transsphenoidal surgery in our unit.

METHODS: The first 125 patients who underwent endoscopic transnasal transsphenoidal surgery for pituitary fossa lesions between 2005 and 2007 performed by 1 surgeon were studied. Changes in a number of parameters were assessed between 2 equal 15-month time periods: period 1 (53 patients) and period 2 (72 patients).

RESULTS: There were 67 patients (54%) with nonfunctioning adenomas, 22 (18%) with acromegaly, and 10 (8%) with Cushing's disease. Between study periods 1 and 2, there was a decrease in the mean duration of surgery for nonfunctioning adenomas (from 120 minutes to 91 minutes; $P < .01$). This learning effect was not apparent for functioning adenomas, the surgery for which also took longer to perform. The proportion of patients with an improvement in their preoperative visual field deficits increased over the study period (from 80% to 93%; $P < .05$). There were nonsignificant trends toward improved endocrine remission rates for patients with Cushing's disease (from 50% to 83%), but operative complications, notably the rates of hypopituitarism, did not change. Overall length of hospital stay decreased between time periods 1 and 2 (from 7 to 4 days median; $P < .01$).

CONCLUSION: The improvements in the duration of surgery and visual outcome noted after about 50 endoscopic procedures would favor the existence of an operative learning curve for these parameters. This further highlights the benefits of subspecialization in pituitary surgery.

KEY WORDS: Endoscopy, Operative learning curve, Pituitary surgery, Transsphenoidal

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The past 100 years have seen major advances in the surgical techniques used in pituitary surgery, which is now recognized as a subspecialty in its own right. Since the introduction of the operating microscope in the 1960s, the microscopic transsphenoidal approach has become the gold standard for tackling the majority of pituitary tumors.[1-3] This less invasive approach was shown to be safe, with low morbidity and very low operative mortality.[1-5] Moreover, the clinical outcome in terms of visual recovery and remission rates for endocrine active tumors are well established, and there is also a surgical learning curve, highlighting the benefits of subspecialization.[3,4,6]

ABBREVIATIONS: **ANOVA**, analysis of variance; **NFPA**, nonfunctional pituitary adenoma; **VF**, visual field

The relatively recent introduction of the rigid fiberoptic endoscope is suggested to be a further technical refinement in pituitary surgery.[3,7-20] Although the potential benefits of the endoscope during microscopic pituitary surgery were noted in the early 1960s, the first endoscopic pituitary surgery was described in 1992.[11,15,21,22] There are now several reports of patients operated on via the endoscopic transnasal transsphenoidal route, with claims of benefits for the surgeon and patient in terms of reduced nasal trauma, better optics, and potentially greater tumor removal.[7,8,10-20]

The endoscopic technique is also used to tackle lesions around the pituitary fossa in the so-called extended transsphenoidal approach.[18,19]

As with any new surgical technique, a learning curve can be expected with endoscopic pituitary surgery.[11,14] However, the evidence thus far has been conflicting, with reports in favor and against.[23-25] The reasons for such discrepancies are not entirely clear, but in part may reflect the relatively small numbers of patients studied thus far and differences in the outcome parameters studied with regard to the learning effect. To clarify this issue, we investigated the evidence of an operative learning curve for the first 125 patients who underwent endoscopic transsphenoidal surgery by a single surgeon at our institution.

METHODS

The computerized records of the first consecutive 125 patients who underwent endoscopic transsphenoidal surgery for pituitary fossa lesions by a single surgeon at our institution between 2005 and 2007 were reviewed. For each case, the clinical presentation, endocrine profile, visual field (VF) changes, magnetic resonance imaging findings, operative details, complications, endocrine outcome, tumor residuum/recurrence, the need for adjuvant radiotherapy, and the length of hospital stay were noted.

The duration of surgery was obtained from the computerized theater records. This time period also included the time taken for any surgical planning at the commencement of surgery. For patients undergoing multiple procedures, only the duration of surgery for the first endoscopic procedure was considered. For assessment of changes over the study period, the patients were split into two 15-month time periods: period 1 from April 2005 to June 2006 (53 patients) and period 2 from July 2006 to September 2007 (72 patients).

Surgical Technique

All surgery was undertaken by 1 neurosurgeon who had been performing transnasal transsphenoidal pituitary surgery using the operating microscope for 18 months. The surgeon had also spent 6 months training in endoscopic pituitary surgery before this. There was no input from ear, nose, and throat surgeons in the cases reported. During the initial learning period, the endoscope was used as an adjunct to the microscopic approach, and these early endoscope-assisted cases (N = 6) were not included in the current analysis. On induction of general anesthesia, all patients received hydrocortisone (100 mg), an antibiotic (1.5 g cefuroxime), and a nasal decongestant (cophenylcaine; Aurum Pharmaceuticals Ltd, Romford, United Kingdom). Frameless magnetic resonance-based image guidance (BrainLB UK, Cambridge, United Kingdom) was used for most of the early cases, reoperations, and extended transsphenoidal procedures.

The endoscopic transnasal transsphenoidal approach used was a modification of the techniques previously described.[9,13,14,17,18] The patient was placed in the supine position, with the head neutral in the sagittal plane and the neck flexed and head extended by about 20 degrees each direction (Figure 1). Surgery was performed with the surgeon standing at the head end of the patient (Figure 1). In general, a uninostril approach was used, although in patients with particularly small nasal apertures, both nostrils were used. Most of the surgery was undertaken with a 0-degree fiberoptic rigid endoscope with an outer sleeve that allows for built-in irrigation and suction (Karl Storz Endoscopy, Berkshire, United Kingdom). The endoscope was used free hand, although when bleeding was troublesome, an endoscope holder was used, freeing both hands for the surgeon.

After gentle deflection of the middle turbinate laterally, a modified direct Griffiths technique was used to access the sphenoid fossa.[26] Turbinectomy (partial or total) was not undertaken. In cases in which a firm bony floor to the pituitary fossa was encountered, a high-speed diamond burr (4 mm) was used to breach the bony floor. After tumor removal, a 30-degree endoscope was used to inspect and remove any remaining tumor from the margins to ensure satisfactory clearance of the fossa. The tumor bed was lined with hemostatic gelatin sponge (Spongistan, Ethicon, London, United Kingdom). No nasal packing was used.

At the end of surgery, the Valsalva maneuver was also performed to look for a cerebrospinal fluid (CSF) leak. In patients with a small CSF leak (eg, CSF "weep" or a small visible arachnoid defect), intraoperative repair was undertaken using combinations of hemostatic gelatin sponge (Spongistan; Ethicon), dural substitute (Durafoam, Codman, Wokingham, United Kingdom), and a dural sealant (Duraseal; Confluent Surgical, Waltham, Massachusetts). In those patients with a larger CSF leak associated with a sizable dural and/or bony defect (eg, after extended transsphenoidal approaches), in addition to the above, the repair included the use of fat graft (from a periumbilical incision) and/or a piece of titanium mesh (Matrix, Synthese, United Kingdom) or polyethylene patch (Medpor, Porex Surgical, London, United Kingdom). In such cases, a perioperative lumbar drain was also selectively used to divert CSF, at 5 to 10 mL/h for 3 to 5 days postoperatively. For macroadenomas with a very large suprasellar component, 5 to 15 mL of saline solution was cautiously injected intraoperatively via a lumbar drain to aid the descent of the suprasellar part of the tumor.

Endocrine Assessment

All patients were closely monitored pre- and postoperatively by the endocrine team. Postoperatively, all patients were discharged home on hydrocortisone replacement (10-5-5 mg/d regimen) until basal and dynamic pituitary reserve was assessed 2 to 3 weeks later. Humphrey VFs were reassessed at 4- to 6-week follow-up. Postoperative magnetic resonance imaging was routinely performed at 4 to 6 months, and those with a large tumor residuum and ongoing chiasmal compression were recorded.

The proportion of patients with new anterior and/or posterior hypopituitarism at final follow-up was noted; such patients were not always judged to require replacement therapy. For functioning tumors, disease remission was assumed on return to low or normal levels of the active hormone at final follow-up, together with improvement of the relevant clinical symptoms. Thus, for Cushing's disease, this meant that while off all steroid replacement, the patient demonstrated at least two 8 AM cortisol levels of less than 50 nmol/L.[27,28] In acromegaly, disease remission was assumed, if the mean growth hormone level on a 5-point day curve was less than 1.7 μg/L (5 mU/L) and/or the growth hormone nadir on an oral glucose tolerance test was less than 0.7 μg/L (2 mU/L).[29,30] For prolactinomas, disease remission was assumed if at final follow-up the prolactin levels were consistently within or less than the normal range (ie, 86-324 mU/L in men and 102-496 mU/L in women).

In patients with Cushing's disease and acromegaly, early testing of the active hormone levels was routinely undertaken at 4 to 7 days postoperatively, with a view to offering re-exploratory surgery at 2 to 4 weeks postoperatively for patients with persistently increased hormone levels.[28,30] For those with likely residual disease, an early postoperative magnetic resonance imaging (at 1-2 weeks after surgery) was also undertaken.

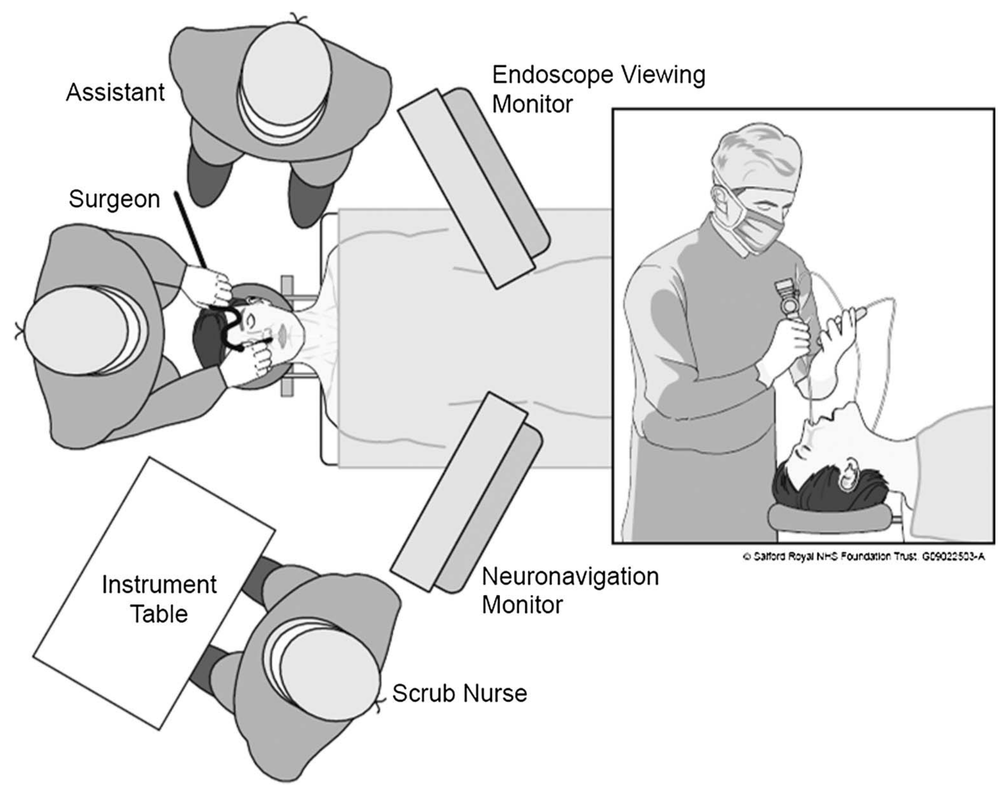

FIGURE 1. *Diagram demonstrating the relative positions of the patient, surgeon, and monitors during surgery.*

Statistical Methods

All data was entered and analyzed using the SPSS statistical package (Statistical Programs for the Social Sciences, London, United Kingdom). Differences between groups were assessed using analysis of variance (ANOVA) post hoc Bonferroni tests for parametric data and using the χ^2 or Mann-Whitney test for nonparametric data. Regression analysis was used to examine the relationship between the duration of surgery and other factors including date of surgery, tumor type, and tumor size.

RESULTS

Demographic Details

The demographic details of the first 125 patients undergoing endoscopic transsphenoidal surgery and the changes over study time periods 1 and 2 are shown in Table 1. There were 70 male patients and 55 female patients, who underwent 144 operations during this time period. Twenty-four patients (all with a nonfunctioning pituitary adenoma [NFPA]) had undergone previous pituitary surgery, 17 via the transsphenoidal route and 7 via a craniotomy. The mean age was 51 ± 16 years (range, 18-85 years), and the mean duration of follow-up was 18 ± 9 months (range, 10-40 months). Surgery was undertaken for a variety of sellar and parasellar pathologies (Table 1). Lesions in the "other" category were Rathke's/other cysts (n = 3) and one each of TSHoma, pituicytoma, and pituitary dermoid and clival chordoma.

There was an increase in the proportion of NFPAs between time periods 1 (42%) and 2 (63%) ($P < .01$; χ^2 test; Table 1). There were 106 (85%) macroadenomas (lesions >1 cm) and 19 (15%) tumors were microadenomas (Table 1). The proportion of macroadenomas increased between time periods 1 and 2 (76% to 92%; $P < .01$; χ^2 test).

Nonparametric tests were used to analyze the length-of-stay data because the distribution curve was skewed to the left, with a minority of patients having a prolonged hospital stay because of postoperative complications. Overall, the median length of hospital stay was 5 days (range, 3-36 days; Table 1). The median length of stay was shorter for NFPAs (4.5 days; range, 3-34 days) than for functioning adenomas (7 days; range, 3-21 days) and extended transsphenoidal procedures (12.5 days; range, 8-36 days) ($P < .01$; Mann-Whitney test). The overall length of stay decreased from time period 1 to time period 2, and this decrease was apparent for NFPAs (median values of 6 and 4 respectively; $P < .01$), but not for functioning adenomas (median values of 7 and 7, respectively; Mann-Whitney test; Table 1).

TABLE 1. Comparison of Patient Demographics and Operative Times Between Different Study Periods (N = 125)[a]

	Period 1	Period 2	Total
No. (%)	53 (42)	72 (58)	125 (100)
Age, y, mean ± SD	49 ± 16	53 ± 15	51 ± 16
Pituitary tumor type, no. (%)			
NFPA	22 (42)	45 (63)[b]	67 (54)
Acromegaly	15 (28)	7 (10)	22 (18)
Cushing's disease	4 (8)	6 (8)	10 (8)
Prolactinoma	6 (11)	3 (4)	9 (7)
Craniopharyngioma	2 (4)	2 (3)	4 (3)
Apoplexy	1 (2)	5 (7)	6 (5)
Other	3 (6)	4 (6)	7 (6)
Tumor size			
Macroadenoma, no. (%)	40 (76)	66 (92)[c]	106 (85)
Duration of surgery, min, mean ± SD			
NFPA (n = 80)	120 ± 35	91 ± 27[c]	101 ± 33[d]
Functioning (n = 41)	137 ± 30	145 ± 30	140 ± 30
Extended transsphenoidal (n = 4)	206 ± 44	251 ± 16	229 ± 36
Duration of hospital stay, d, median (range)	7 (3-36)	4[c] (3-15)	5 (3-36)

[a]SD, standard deviation; NFPA, nonfunctioning pituitary adenoma.
[b]*$P < .05$ vs period 1 (χ^2 test).
[c]$P < .01$ vs period 1 (χ^2 test, Mann-Whitney test or analysis of variance).
[d]$P < .01$ vs functioning adenomas or extended transsphenoidal surgery groups (analysis of variance).

Duration of Surgery

Overall, the mean duration of surgery for the first endoscopic transsphenoidal procedure in this group of patients was 118 ± 42 minutes (range, 46-255 minutes). The duration of surgery was shorter for NFPAs than for functioning adenomas or those undergoing extended transsphenoidal procedures ($P < .001$; ANOVA; Table 1).

Between time periods 1 and 2 there was a decrease in the duration of surgery for NFPAs, but not for functioning adenomas or for extended transsphenoidal procedures ($P < .001$; ANOVA; Table 1). We also analyzed the changes in the duration of surgery for NFPAs after every 25 endoscopic procedures between 2005 and 2007. The respective mean ± standard deviation duration of surgery was 132 ± 40 min (0-25 patient group), 104 ± 20 min (25-50 patient group), 100 ± 24 min (50-75 patient group), 92 ± 32 min (75-100 patient group), and 82 ± 20 min (100-125 patient group). The decrease in duration of surgery became significant after 50 to 75 patients ($P < .02$; ANOVA).

Figure 2 demonstrates the scatterplots for duration of surgery over the study period for NFPA (Figure 2A) and functioning adenoma (Figure 2B) patients. Regression analysis confirmed a significant inverse relationship for NFPA patients ($R = 0.55$; $P < .0001$) but not for functioning adenoma patients ($R = 0.04$; $P = .8$) (Figure 2). In a multiple linear regression model, the only factors significantly related to the duration of surgery were the date of surgery (coefficient = −0.04; 95% confidence interval: −0.05 to −0.01) and tumor type (for functioning adenomas, coefficient = 36; 95% confidence interval: 19-53), but not tumor size (coefficient = −0.03; 95% confidence interval: −21 to 21).

VF Changes

At presentation, 61 (49%) patients had VF deficits in at least 1 eye, and this proportion increased from time periods 1 (38%) to 2 (57%) ($P < .05$; χ^2 test; Table 2). Of the patients with VF deficits, 54 (89%) noted a relative improvement or normalization of the VF at final follow-up. In 5 patients, the VF deficit remained unchanged and in 2 patients, it worsened postoperatively.

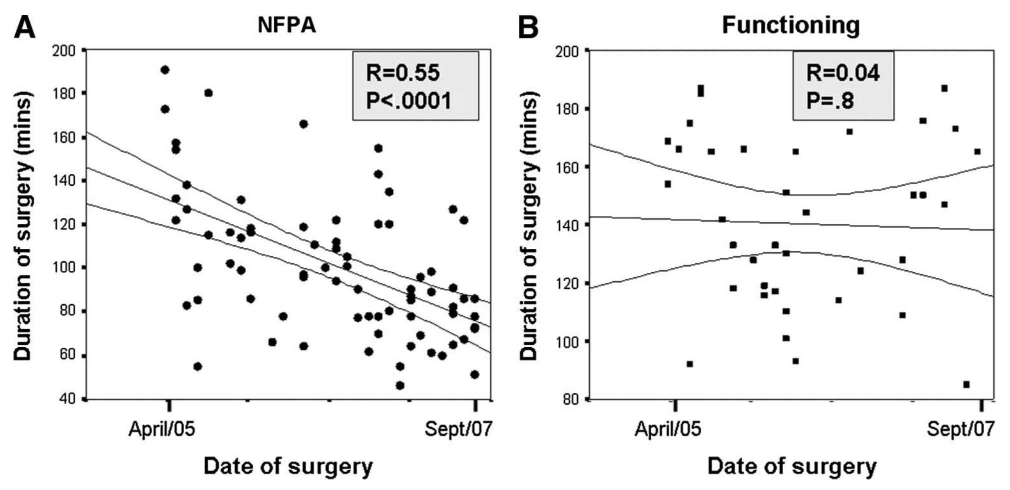

FIGURE 2. *Scatterplots demonstrating the relationship between the duration of surgery and the date of surgery over the study period for nonfunctioning pituitary adenoma (NFPA) patients (**A**) and functioning adenoma patients (**B**). Linear regression lines with 95% confidence intervals are shown.*

TABLE 2. Comparison of Patient Outcome After Endoscopic Pituitary Surgery Between Different Time Periods (N = 125)[a]

	Period 1	Period 2	Total
No.	53	72	125
VF deficits, no. (%)			
Patients	20 (38)	41 (57)[b]	61 (49)
VF improvement	16 (80)	38 (93)[b]	54 (89)
VF unchanged/worse	4 (20)	3 (7)	7 (11)
Endocrine remission, no. (%)			
Acromegaly	12 of 15 (80)	6 of 7 (86)	18 of 22 (82)
Cushing's disease	2 of 4 (50)	5 of 6 (83)	7 of 10 (70)
Large tumor residuum, no. (%)	2 (4)	4 (6)	6 (5)
Adjuvant radiotherapy, no. (%)	13 (25)	24 (33)	37 (30)
Postoperative hypopituitarism, no. (%)			
New anterior hypopituitarism	8 (17)	18 (25)	27 (22)
q*New diabetes insipidus*	2 (4)	4 (6)	6 (5)
Nonendocrine complications, no. (%)	6 (11)	5 (7)	11 (9)
Reoperations (eg, for residual tumor, CSF leak), no. (%)	9 (17)	10 (14)	19 (15)

[a]VF, visual field; CSF, cerebrospinal fluid.
[b]$P < .05$ vs period 1 (χ^2 test).

Between time periods 1 and 2 there was an increase in the proportion of patients with improvement or normalization of preoperative VF deficits (from 80% to 93%; $P < .05$; χ^2 test; Table 2).

Endocrine Outcome

In patients with acromegaly, the overall remission rate was 82% (18 of 22 patients) at final follow-up. The remission rate was 77% (13 of 17) for macroadenomas and 100% (5 of 5) for microadenomas. Six of these patients (4 in time period 1) had early re-exploration for residual tumor at 2 to 4 weeks after the first operation, and disease remission was achieved in 3 of these patients. There was no significant change in the remission rate between time periods 1 and 2 (80% to 86%; $P = .75$; χ^2 test; Table 2).

In patients with Cushing's disease, the overall remission rate was 70% (7 of 10 patients), and there was a trend toward improved remission rate between time periods 1 and 2 (from 50% to 83%; $P = .26$; χ^2 test; Table 2). Three of these patients (2 in time period 1) had early re-exploration for residual tumor at 2 to 4 weeks after the first operation, and disease remission was achieved in 1 of these patients. For prolactinomas, surgery was only undertaken because of a lack of response or intolerance to a variety of dopamine agonists. The overall remission rate was 56% (5 of 9 patients), and in 4 patients surgery was performed primarily to debulk very large tumors with cavernous sinus invasion before adjuvant radiotherapy.

Complications

Overall, in 6 (5%) patients, postoperative magnetic resonance imaging confirmed a large tumor residuum, causing ongoing chiasmal compression (Table 2). Postoperative radiotherapy was given to 37 (30%) patients (Table 2). In total, 27 patients (22%) were noted to have new pituitary hormone deficiency at final follow-up (Table 2). This entire group of patients had deficiencies in 1 or more anterior pituitary hormones, and 6 (5%) from the same group also had newly diagnosed diabetes insipidus. In this respect, there was no difference between time periods 1 and 2 (Table 2).

In total, 11 (9%) patients developed other (ie, nonendocrine) complications, including postoperative CSF leak/meningitis (N = 4), sphenoid sinusitis (N = 2), sickle cell crisis (N = 1), "symptomatic"postoperative pituitary fossa hematoma (n = 2) and significant residual tumor (N = 2) (Table 2). There were no carotid artery injuries or deaths. In total, 19 patients (15%) required further surgery postoperatively for reasons including residual tumor (n = 14; of these, 9 with functioning adenomas underwent planned early transsphenoidal re-exploration for residual disease), pituitary fossa hematoma (n = 2), and transsphenoidal repair of a CSF leak (n = 3) (Table 2). There were no differences in these parameters between time periods 1 and 2 (Table 2).

DISCUSSION

The use of the rigid fiberoptic endoscope in pituitary surgery affords a more panoramic view of the target, enabling the surgeon to look around corners, theoretically aiding tumor removal.[3,7-22] The endoscope also allows access without the need to dilate the nasal passages with a speculum. Thus, nasal trauma is minimized, obviating the need for postoperative nasal packing with this technique.[3,7-20] Despite these benefits, the use of the rigid endoscope does provide several challenges to the neurosurgeon, who may be less familiar with some of the technical demands of performing functional endoscopic sinus surgery. These challenges include operating with a 2-dimensional view, the limitations of using 1 hand to hold the endoscope, the periodic clouding of the endoscope lens by blood, and difficulties controlling significant hemorrhage.[3,7-20] Several strategies have been devised to overcome these difficulties, including the use of ear, nose, and throat surgeons for gaining access; built-in irrigation; and a holder for the endoscope. Nevertheless, the use of the endoscope remains a significant departure for the neurosurgeon accustomed to the microscopic technique, which provides a 3-dimensional view and also enables the operating surgeon to use a 2-handed technique without assistance.

To assess the surgical learning curve of the endoscopic approach, we studied the temporal changes in a number of parameters during the first 125 endoscopic transsphenoidal pituitary operations performed between 2005 and 2007 in our unit. At the outset, it is important to recognize the potential limitations of this study, including its retrospective nature, its being based on a single surgeon's experience, and the risks of type I and II errors related to the need for multiple comparisons and the lack of previous power calculations. The sample size, although larger than hitherto studied, is likely to be inadequate when considering infrequent outcome parameters such as remission rates for functioning adenomas and the postoperative complications. Accepting these limitations, we observed the following in this study.

Duration of Surgery

Overall, the duration of surgery for functioning adenomas was longer than for NFPAs. This may reflect the increased time required to ensure thorough tumor removal that is essential to accomplish disease remission for a functioning adenoma. The relatively few cases of extended transsphenoidal procedures performed took noticeably longer still, which is likely to be related to the greater technical challenges surgeons face with these procedures.[8,13,18,19]

There was approximately a 25% decrease in the duration of surgery between study periods 1 and 2, but this was only apparent for NFPAs and only after about 50 operative cases had been performed. Scatterplots also revealed that this learning effect may be more progressive and is independent of other confounding influences such as tumor size, which also varied over the study period.

In the 2 previous smaller studies to look into the changes in the duration of endoscopic pituitary surgery over time, a 26% to 35% decrease in operating times was noted.[23,24] In these reports, the eventual endoscopic surgery time varied between 95 and 133 minutes, and the decrease in the duration of surgery was also apparent after fewer operative cases than in the current study (ie, n = 17 and 40, respectively).[23,24] Furthermore, it has also been reported that using the endoscopic approach may be quicker to undertake than microscopic transsphenoidal surgery, although this may not be universally true (unpublished personal observations).[14,24] Such variations in surgery time are more likely to reflect the individuality of the surgeons with respect to their speed of operating, learning curves, and training in the different technical challenges posed by the endoscopic and microscopic approaches.

Although the duration of surgery is of interest, other measures such as visual improvement, endocrine remission, and complications are arguably more important in assessing the outcome of pituitary surgery.

Visual Recovery

Over the study period, there was an increase in the proportion of patients with an improvement in their preoperative VF deficits (from 80% to 93%). Postoperative recovery in VF can also be influenced by other factors including the severity and duration of the preoperative VF deficits.[31-33] Although these were not assessed in the current study, another factor, the proportion of patients with a large tumor residuum causing chiasmal compression, did not change over the study period. Moreover, the improved visual outcome over the study period was apparent despite a simultaneous increase in the proportion of patients with NFPAs and the proportion of patients presenting with VF deficits between study periods 1 and 2. The reason for the latter was not clear, but nevertheless the increased numbers of operative cases and therefore by inference the learning experience may have contributed to the better visual outcome noted in the second half of the study period. Overall, our findings further confirm that transsphenoidal pituitary surgery with either endoscopic or microscopic techniques produces an excellent outcome with respect to VF improvement.[31-33]

Remission Rates for Functioning Adenomas

There were nonsignificant trends toward improved endocrine remission rates over the study period for Cushing's disease, but not for acromegaly or prolactinomas. However, the relatively small numbers of cases in each subgroup would preclude any meaningful statistical analysis. It is widely recognized that the surgical outcomes for functioning pituitary adenomas are dependent on a number of factors including tumor size, invasiveness, the biochemical cutoffs used to define endocrine remission, and the surgical expertise.[3,34] In expert hands, the remission rates for acromegaly and Cushing's disease range from 50% to 85%.[3] The overall remission rates for patients with functioning adenomas in our study also compares favorably with those in the published literature for large microscopic and endoscopic series.[3,5,7,8,10]

Moreover, for acromegaly patients, the current results denote a significant improvement in comparison with an earlier study that reported an overall remission rate of only 18% for acromegaly patients treated in Manchester between 1974 and 1997.[34,35] This was despite the adaptation in the current study of stricter modern criteria for disease remission in acromegaly.[29] Such a transformation in outcome cannot be entirely attributed to the introduction of endoscopic pituitary surgery in our unit. A number of other factors, not the least of which was the establishment of a specialist pituitary surgical practice, with a decrease in the number of surgeons performing pituitary surgery, are likely to have been important.[34,35]

Length of Stay and Operative Complications

There was an overall decrease in the length of stay over the study period, which was only apparent for patients with NFPAs, who also had the shortest inpatient stay. This decrease in the length of stay is likely multifactorial, partly reflecting increased proportions of patients with NFPAs during time period 2 and a more efficient discharge policy introduced in our unit during the latter part of the study. Although the degree of nasal trauma seems to be less with the endoscopic technique than with more traditional approaches, the length of stay for pituitary patients is primarily influenced by the need for close postoperative monitoring of the endocrine function. This largely accounted for the greater length of stay for patients with functioning adenomas who underwent early endocrine testing for disease remission as inpatients.

We also failed to note a significant change in the operative complications over the study period, including the rates of postoperative anterior and posterior hypopituitarism. On the other hand, Ciric et al,[4] in a landmark study of neurosurgeons in the United States undertaking predominantly microscopic transsphenoidal surgery, found decreased rates of complications with increased operative workload. They noted that an operative experience of 200 or more cases was associated with reduced risk of death, blindness, carotid artery injury, CSF leak, epistaxis, and anterior and posterior hypopituitarism.[4] Although it must be emphasized that this was a questionnaire study subject to the biases of self-reporting, this and other studies suggest the existence of a learning curve for complications of microscopic pituitary surgery.[6,8] Thus, with larger numbers of patients, a learning effect may also become evident for operative complications in endoscopic pituitary surgery.

Moreover, there have also been suggestions that the complications after endoscopic surgery may be less than with the microscopic approach.[8,13] Although this may be true for local complications related to nasal trauma, such generalized claims remain largely unsubstantiated. Recent comparative studies of endoscopic and microscopic techniques have all had the limitations of small patient numbers and/or lack of randomization.[20,24,25,36-38] We previously outlined the potential difficulties in attempting a meaningful comparative study between the 2 techniques.[3]

CONCLUSION

Operative learning curves exist for a variety of procedures in a number of surgical disciplines.[24,39-41] The gradients of these learning curves and the number of learning cases will vary depending on the surgical procedure, technical difficulties faced, and the adequacy of surgical training, and there will also be individual variations among surgeons.

This study confirms the presence of an operative learning curve for endoscopic pituitary surgery, especially with respect to the duration of surgery and visual outcome after approximately the first 50 operative cases. This further highlights the benefits of subspecialization in pituitary surgery and the need for an adequate training program in the technique.

Disclosure

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