LEARNING CURVE IN ENDOSCOPIC TRANSNASAL SELLAR REGION SURGERY

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ABSTRACT

BACKGROUND

The endoscopic endonasal approach for the sellar region lesions is a novel technique and an effective surgical option. The evidence thus far has been conflicting with reports in favour and against a learning curve. We attempt to determine the learning curve associated with this approach.

METHODS

Retrospective and prospective data of the patients who were surgically treated for sellar region lesions between the year 2013 and 2016 was collected, 32 patients were operated by the endoscopic endonasal approach at Vydehi Institute of Medical Sciences and Research Centre, Bangalore. Age, sex, presenting symptoms, length of hospital stay, surgical approach, type of dissection, duration of surgery, sellar floor repair, intraoperative and postoperative complications were noted. All the procedures were performed by a single neurosurgeon.

RESULTS

A total of 32 patients were operated amongst which 21 patients were non-functioning pituitary adenomas, 2 were growth hormone secreting functional adenomas, 1 was an invasive pituitary adenoma, 4 were craniopharyngiomas, 2 were meningiomas, 1 was Rathke's cleft cyst and 1 was a clival chordoma. Headache was the mode of presentation in 12 patients, 12 patients had visual deficits, 6 patients presented with hormonal disturbances amongst which 4 patients presented with features of panhypopituitarism and 2 with acromegaly. Amongst the 4 patients with panhypopituitarism, 2 also had DI, two patients presented with CSF rhinorrhoea. There was a 100% improvement in the patients who presented with visual symptoms. Gross total resection was achieved in all 4 cases of craniopharyngiomas and 13 cases of pituitary adenomas. Postoperative CSF leak was seen in 4 patients who underwent re-exploration and sellar floor repair, 9 patients had postoperative Diabetes Insipidus (DI) which was transient, the incidence of DI reduced towards the end of the study. There was a 25% decrease in the operating time towards the end of the study.

CONCLUSION

An improvement in the duration of surgery and reduction in the incidence of complications as the study evolved demonstrates the presence of a learning curve in endoscopic endonasal sellar region surgeries. With adequate training and a reasonable exposure (n=30 cases) scaling the gradients of the learning curve seems plausible.

KEYWORDS

Endoscopy, Transnasal, Sellar Region Lesions, Learning Curve.

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INTRODUCTION: Transsphenoidal approach to pituitary lesions was first described in the early 1900s by Halstead and Hirsch. The sublabial transseptal approach was perfected and popularised by Cushing, making modifications that reduced morbidity.

Hardy in the 1960s, introduced the operating microscope for better visualisation during transsphenoidal approach, a technical advance that enabled safer extirpation of sellar lesions. Since that time, most skull base surgeons have been trained and are comfortable with the transsphenoidal approach aided by the operating microscope.[1,2,3,4,5] As the endoscopic sinus surgery evolved many surgeons have advocated the use of endoscopy for transsphenoidal exposure of the sella and resection of pituitary lesions. In the 90s, neurosurgeons began to use rigid endoscopes for resection of pituitary tumours.[6,7,8]

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There have been several more case series describing the successful application of the endoscope to the resection of pituitary tumours since then.[9-20] The endoscope has several advantages compared with traditional techniques. Endoscopy provides adequate lighting and a superior field of vision. One can visualise critical anatomy with the use of angled scopes, such as the clival indentation, the optic and the carotid protuberances. It also gives better access to the parasellar and suprasellar extension of pituitary lesions. However, endoscopic resection requires the surgeon to trade the binocular, handless microscope for the monocular, more technically challenging endoscope, a technology with which most neurosurgeons are not as familiar.[21]

As with any new surgical technique, a learning curve can be expected with endoscopic pituitary surgery. However, the evidence thus far has been conflicting, with reports in favour and against. 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. We analysed 32 cases of endoscopically managed sellar, suprasellar lesions in our institute by a single surgeon to analyse the progress in the learning curve of the surgeon and the technical difficulties and the reasons for the same.

METHODS: Retrospective and prospective data were collected on patients who were surgically treated for sellar region tumours at Vydehi Institute of Medical Sciences and Research Centre between 2013 and 2016. Age, sex, presenting symptoms, length of hospital stay, surgical approach, type of dissection, duration of surgery, sellar floor repair, intraoperative and postoperative complications were noted. All procedures were performed by a single neurosurgeon. Initial exposure and corridor up to the sphenoid sinus was achieved by an Otorhinolaryngologist. The tumour pathological type was determined by a pathologist using the appropriate immunostaining. Achievement of resection was determined by obtaining CT scan postoperatively as a part of routine care.

Surgical Approach: All patients were evaluated, diagnosed, and treated by a multidisciplinary team consisting of a neurosurgeon and a senior otorhinolaryngologist. A double nostril, three hand operator technique was used. A 0-degree endoscope was predominantly used for the procedure. The otorhinolaryngologist would create the corridor i.e. after entering the nostril, the inferior turbinate was visualised and lateralised, and a middle turbinectomy was done routinely for all patients (Fig: 1, 2a). Hadad and or reverse Hadad flaps were raised, and then the sphenoid ostia were identified. Posterior septectomy was done and a wide sphenoidotomy was created using Kerrison Rongeurs (Fig: 2b). The mucosa of the sphenoid sinus was peeled off and the intersphenoid septum was excised. The keel of the vomer was preserved to identify the midline (Fig: 2c). The floor of the sella was defined and Kerrison Rongeurs used to open the anterior sellar floor.

If the sellar floor was too thick then a diamond bur was used to thin it out. The dura mater was exposed (Fig: 2d) and a cruciate/U shaped incision was made after cauterisation. Both extracapsular and intracapsular techniques were used for dissection. The lesion would be excised piecemeal and the residual lesion was visualised with the help of a 30-degree scope. Intraoperative cerebrospinal fluid (CSF) leak was checked during the procedure by Valsalva manoeuvre. Haemostasis was achieved with Surgicel and bipolar. The sellar floor repair was then carried out with fat graft and a chip of bone harvested from the septum. Fascia lata graft was harvested from the thigh when required and supplemented with fibrin glue and Surgicel. The sphenoid sinus was packed with Abgel and the Hadad flap turned in place.

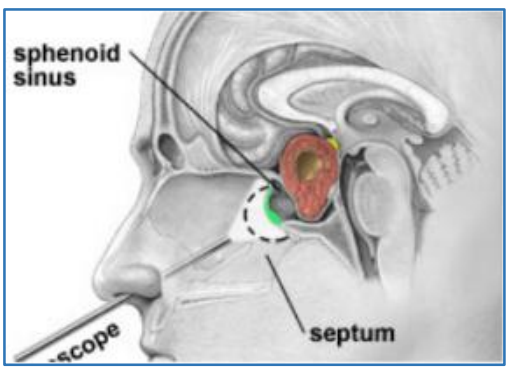

Fig. 1: Trajectory of the Endoscope to Reach the Sphenoid Sinus

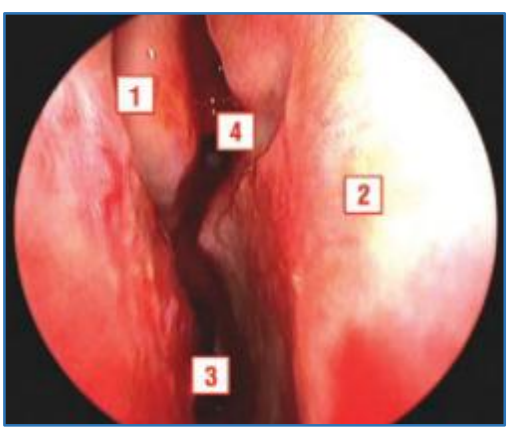

Fig. 2a: Endoscopic view of Nasal Cavity Showing the Septum (2), Middle Turbinate (1), Coana (3) and the Ostium (4)

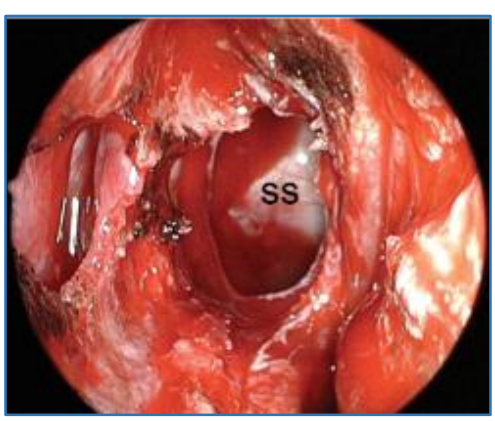

Fig. 2b

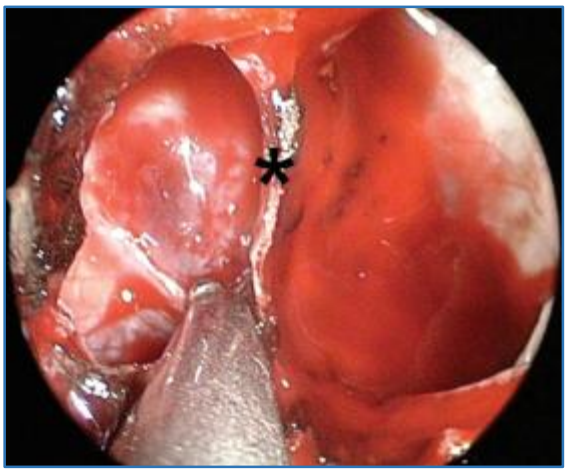

Fig. 2c

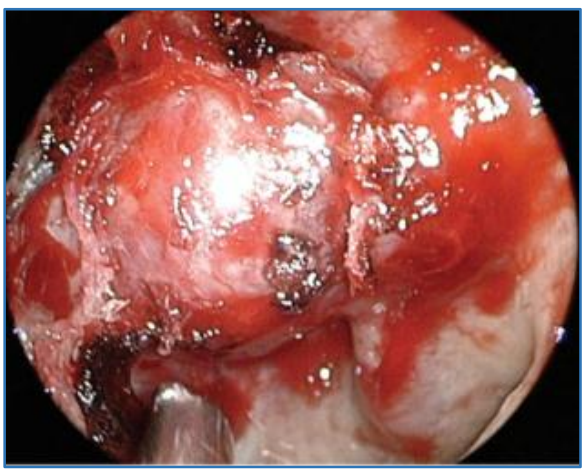

Fig. 2d

Ethics: Ethical committee clearance was taken for the procedures conducted on the patients.

STATISTICS: The patient's age, presentation, type of surgical approach, duration of surgery, intraoperative complications, postoperative complications and the duration of hospital stay were analysed.

RESULTS:

Patient Characteristics and Presentation: 32 consecutive patients seen at Vydehi Institute of Medical Sciences, Bangalore were surgically treated for resection of sellar region tumours between 2013 and 2016 by a single neurosurgeon and otorhinolaryngologist. Amongst the 32 patients, 22 were male and 10 were female. The age group was between 19 yrs. to 62 yrs, mean age group being 43 yrs. Among the 32 patients, 12 patients (37.5%) presented with headache, which was vague dull aching in nature. Twelve patients (37.5%) presented with visual disturbances in the form of lateral field visual loss in 10 the other 2 had blurring of vision and on evaluation had bilateral optic atrophy. 6 patients had hormonal disturbances amongst which 4 patients presented with features of panhypopituitarism and 2 with acromegaly (Chart: 1). Amongst the 4 patients with panhypopituitarism, 2 also had Diabetes Insipidus (DI) for which they were on desmopressin nasal spray preoperatively.

Two patients presented with CSF rhinorrhoea. No patient had features of apoplexy at presentation. The imaging modality of choice for diagnosis was MRI. On MRI, 24 patients had macroadenomas, 4 had craniopharyngioma, 2 had meningioma, 1 had a Rathke's cleft cyst and 1 patient had a clival chordoma.

Operative Data: All the patients underwent raising of Hadad flap and also amongst these 32, 10 patients underwent raising of reverse Hadad flap and 10 other cases underwent bilateral Hadad flaps. The dural incision carried out was cruciate in the initial 10 and in the latter 22 patients underwent a U shaped incision for dura.

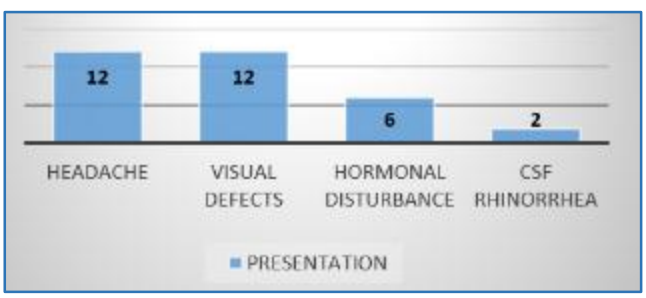

Chart 1

Amongst the 24 cases of pituitary adenomas, initial 19 cases underwent intracapsular dissection and the latter 5 had an extracapsular dissection. All the patients with craniopharyngiomas, one patient with meningioma and the patient with Rathke's cleft cyst had intraoperative CSF leak. Of the 24 patients with pituitary adenomas, 10 patients had intraoperative CSF leak. In the patients who had intraop CSF leak, sellar floor repair was done by bone harvested from the septectomy overlaid on Surgicel and fascia lata graft using a gasket technique, with fibrin glue used for adhesion. In cases without intraoperative CSF leak, the sellar floor was packed with fat graft. The sphenoid sinus was obliterated with fat graft, Hadad flap or both combined together. Duration of surgery was 210 minutes to 300 minutes. Exposure and creating the corridor up to the sphenoid sinus took around 90 minutes to 120 minutes. Excision of tumour took almost 60 minutes to 90 minutes, and closure and sellar floor repair took around 60 minutes. (Chart: 2).

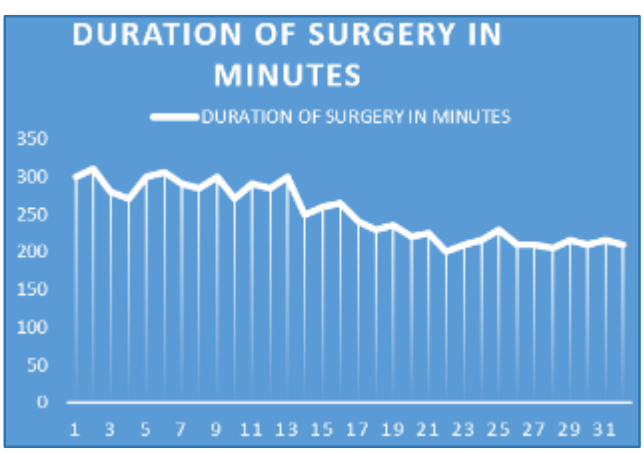

Chart 2

Gross Total Resection: Postoperative evaluation of the resection was done by CT scan. The gross total resection was achieved in all 4 cases of craniopharyngiomas and 13 cases of pituitary adenomas. Subtotal resection was done for Rathke's cleft cyst and both the meningioma cases and 11 cases of pituitary adenomas which were dumbbell shaped. (Chart: 3, 4, 5).

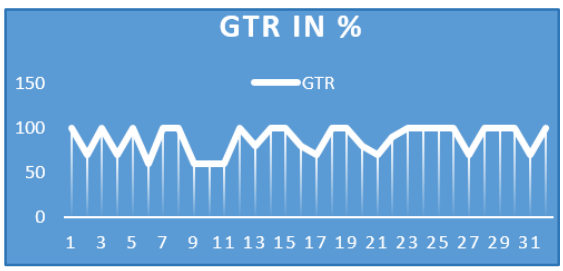

Chart 3

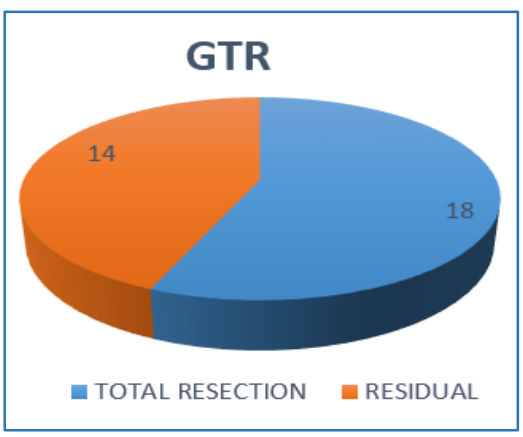

Chart 4

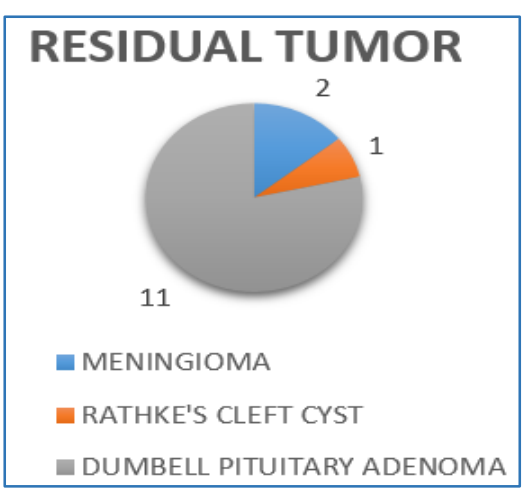

Chart 5

Outcome and Complications: Amongst the 24 patients of pituitary adenomas, 3 had a postop CSF leak which did not settle with a lumbar drain. They were then treated accordingly with re-exploration and closure of the defect. The first patient in the series who had a pituitary macroadenoma had re-exploration twice for sellar floor repair with features of meningitis transiently, which settled with treatment. The patient with Rathke's cleft cyst also had re-exploration twice with a prolonged hospital course.

Diabetes insipidus was noted in 9 patients and all these had a transient DI which lasted for not more than 4-5 days. The 3 patients who had DI preoperatively were not considered while evaluating complications. (Chart: 6).

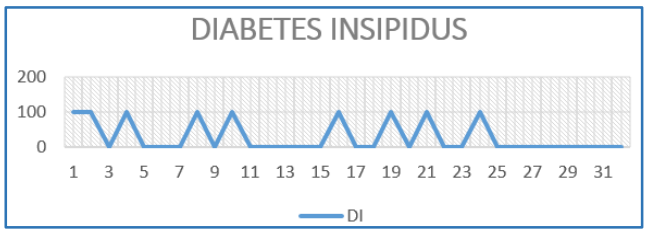

Chart 6

Histopathological Findings: Histopathological examination of the lesions were done by the pathologist with appropriate staining techniques in which 21 (65.6%) were non-functioning pituitary adenomas, 4 (12.5%) were craniopharyngiomas, 2 (6.25%) were growth hormone secreting functional adenomas, 1 (3.12%) was Rathke's cleft cyst, 2 (6.25%) were meningiomas, 1 (3.12%) was a chordoma and 1 (3.12%) was an invasive pituitary adenoma. (Chart: 7).

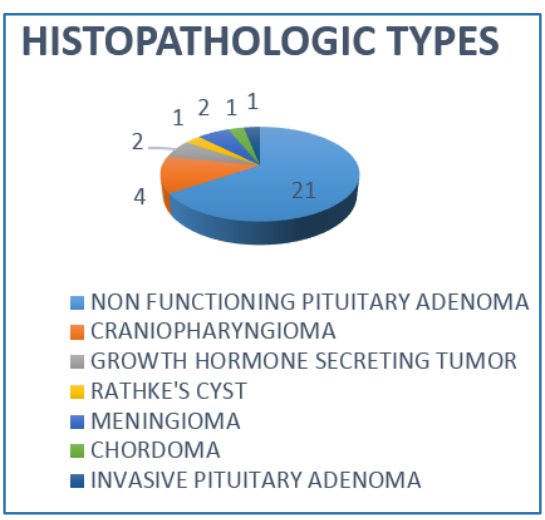

Chart 7

Learning Curve: Endoscopic transsphenoidal surgery like every other surgical technique does have a learning curve. Results are poor in the beginning of the learning curve. This also explains why intra-operative complications were higher, the duration of surgery was longer and the incidence of residual tumour was higher in the beginning.

Followup: Followup at 3 months was considered for the present study. Headache was relieved in all the patients. All the 10 patients with preoperative field defects showed improvement and the 2 patients with preoperative optic atrophy showed no improvement in the postoperative period. Hormonal analysis at 3 months followup showed no change in the hormonal status in any of the patients, but for the two patients with acromegaly who had a drop in the growth hormone value to less than 5 pg/mL indicating a good control. CSF rhinorrhoea was resolved in both the patients who had it preoperatively.

DISCUSSION: It has been shown in multiple reviews that the endoscopic technique is a less invasive procedure, has the potential to decrease operative time and intraop complications, and shorten hospital stay. The field of view is significantly larger when using 0, 30-degree endoscopes than that of what can be achieved with the microscope.[22,23,24] It is less traumatic to nasal mucosa while providing an unparalleled view of the sphenoid.[23,25] 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 endoscopic 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, crowding of instruments and difficulties in controlling significant haemorrhage, and achieving total tumour resection.[26] Several strategies have been devised to overcome these difficulties, including the help of otorhinolaryngologist for gaining access, built-in irrigation, and a holder for the endoscope.

When judging any new surgical technique, it must be compared with the current gold standard on the most important key indicators; oncological and endocrine outcomes, reoperation rates and complications. In a comprehensive meta-analysis of pooled data of over 800 patients from studies published prior to 2006, Tabaee et al. demonstrated both safety and efficacy of the endoscopic approach; showing high rates of gross total removal, normalisation of endocrine function and improved vision as compared to microscopic approach.[27] To assess the surgical learning curve of the endoscopic approach, we studied the changes in a number of parameters during the 32 endoscopic transsphenoidal pituitary operations performed between 2013 and 2016 in our hospital. At the outset, it is important to recognise the potential limitations of this study, including its retrospective nature, it being based on a single surgeon's experience, short followup period and the sample size. The sample size is likely to be inadequate when considering infrequent outcome parameters such as remission rates and postoperative complications. Accepting these limitations, we observed the following in this study:

Amongst the pituitary adenomas, there were total 13 patients who had a complete tumour resection and 11 patients had residual tumour on the postoperative imaging. This is comparable to the results achieved by O'Malley et al who had a 66% gross total resection.[21] Studies claim that GTR is better with endoscopic approach than with microscopic approach. Incomplete tumour resection was seen predominantly in those pituitary tumours which had significant supra and parasellar extension. All the cases of craniopharyngiomas in the current study had a complete tumour excision. The initial part of the study saw cases taking around 300 minutes for the procedure. Subsequently, there was an inconsistently decreasing trend in the operative duration. The surgery for meningiomas and pituitary adenomas with suprasellar extension took a longer time in an attempt to achieve complete resection. Haemorrhage was significantly high in cases of sellar meningiomas which demanded longer duration to achieve haemostasis.

There looked to be a 25% decrease in the duration of surgery towards the end of the study which was on par with the study done by Paul Leach et al. Variations in surgery time are more likely to reflect the individuality of the surgeons with respect to their speed of surgery, learning curves, and training in the different technical challenges posed by the approaches chosen. The degree of nasal trauma is described to be less with the endoscopic technique than with more traditional approaches. It has been recommended that in the initial phase of the learning curve in endoscopic sellar surgeries, middle turbinate excision is of great use.[12] In our series, resection of the lower half of the middle turbinate was done routinely for all the cases for a better access and understanding to the sellar region anatomy. Initial few cases had a bilateral resection of middle turbinates with extensive septal resection which subsequently transformed to a more limited unilateral (predominantly right sided) turbinate resection and a less extensive septal resection.

The length of stay for sellar and parasellar lesions is primarily influenced by the need for close postoperative monitoring of the endocrine function and CSF leak related complications. This largely accounted for the greater length of stay for patients in our study. 9 patients had transient DI who were treated conservatively and 4 patients had CSF leak postoperatively, who underwent re-exploration and sellar floor repair. The incidence of DI and CSF leak was seen less frequently in the later part of the study possibly attributable to the adoption of an extracapsular dissection with a better visualisation of the anatomy. The patient with Rathke's cleft cyst presented to the emergency department with drowsiness, altered sensorium and aphasia after 20 postoperative days due to tension pneumocephalus involving both the lateral ventricles. Similar presentations were noted in other series as well. This patient underwent an EVD and then re-exploration to repair the sellar floor. As the pneumocephalus and CSF leak did not regress and the patient developed ventriculitis, the patient underwent a 2nd re-exploration along with insertion of a lumbar drain. Ventriculitis was treated accordingly with antibiotics and the patient was discharged after a prolonged hospital course. It was perceived from this case that CSF leaks in the postoperative period are better managed by a lumbar drain than an external ventricular drainage which, even if indicated, better be transient.

Barring the two patients who had a preoperative optic atrophy and resultant significant visual loss, all the patients in the study who had preoperative visual abnormalities showed improvement postoperatively indicating adequate tumoural decompression. Madeleine et al. had an 89% improvement in the visual abnormalities. Zhang et al. achieved 70% recovery of preoperative visual disturbances in their series[28]. In the existing literature, the remission rates for acromegaly range from 50% to 85%. The overall remission rates for patients with functioning adenomas in our study also compares favourably with those in the

published literature for large microscopic and endoscopic series. Although relatively small numbers of cases (n=2) would preclude any meaningful statistical analysis.

The development of a new surgical technique often begets criticism due to the possibility of a learning curve. A reason for the learning curve in transnasal endoscopy is the lack of stereoscopic vision. We had a senior otolaryngologist to create the corridor till the sphenoid sinus. As quoted by Cappabianca et al[29] the number of cases for the learning curve was calculated as 70-80 cases, whereas Sonnenberg et al[30] demonstrated that a learning curve does not exist in the endoscopic approach to the sella. They did not identify a learning curve in their 45 cases of purely endoscopic surgery. O'Malley et al postulates that the learning curve for endoscopic resection can be less than or equal to 17 procedures.

It is theorised that, although endoscopes were initially unfamiliar to neurosurgeons, the presence of an experienced otorhinolaryngologist acted to offset any increase in complications. In modern medicine, there is a distinct advantage to a multidisciplinary team approach with otorhinolaryngologists and neurosurgeons working together in the surgical management of these cases. The main disadvantage of endoscopic pituitary surgery is the lack of standard training programs although attending workshops, hands-on cadaveric dissection, practice on models, and observation of live surgeries can reduce the learning curve.[31] The operating surgeon had hands-on cadaveric dissection and attended live surgical workshops for an experience of endoscopic endonasal surgery.

CONCLUSION: Any new procedure taken up in the surgical armamentarium has a certain learning curve, which depends on the procedure chosen and the technical training and skill of the operating surgeon. Endoscopic endonasal sellar region surgery also has a learning curve, as our experience has shown the duration of surgery and the extent of tumour excision improved and the incidence of complications reduced with an increase in the number of surgeries performed. With adequate exposure and commitment towards the field, scaling the gradients of the learning curve seems to be quite possible in endoscopic transnasal surgery.

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