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RESEARCH ARTICLE

ENDOSCOPIC TRANS-SPHENOIDAL SURGERY IN MANAGEMENT OF SELLAR TUMORS: EXPERIENCE AT BANHA NEUROSURGICAL DEPARTMENT.

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Abstract

Aim:- Endoscopic transsphenoidal approaches to sellar tumor have undergone several refinement over the last 100 years, we report the results of our early experience of a consecutive series patients who underwent sellar tumor excision via endoscopic endonasal approach and the results of the evaluation of the efficacy and safety of this approach and recognized the learning curve for this procedure.
Material And Methods:- 20 patients undergoing sellar region surgery between March 2014 and March 2016 were assessed retrospectively and prospectively in our department.
Results: The preoperative clinical presentation of the patients, visual assessment, hormone profile, computed tomography and magnetic resonance imaging findings, were evaluated and revealed the importance of the parameters for surgery. Surgical technique, tumor characteristics, postoperative clinical condition of the patients, hormone profile, complications and follow-up period were reviewed.
Conclusion: Endonasal endoscopic pituitary surgery is a minimal invasive, safe and effective surgical technique.

Introduction:-

The transsphenoidal approach for resection of sellar tumors was first performed by **Herman Schloffer** in1906, Later, **Hirsch** in 1910 described a direct endonasal transsphenoidal approach, a procedure that involved resection of the middle turbinate and part of the nasal septum. In the same year**, Halstead** described the sublabial gingival via ***(1).*** In 1963, **Guiot et al**. first proposed the use of the endoscope as part of the transnasorhinoseptal microsurgical approach to explore the sellar contents. However, this idea remained unrecognized until the further contribution of **Apuzzo et al**. in 1977 ***(2).*** In 1970, **Messerklinger** developed the endoscopic technique. After it, the endoscope started to be used in skull base surgery and in sellar and parasellar region. In 1992, **Jankovski et al**. introduced the endoscope in the pituitary surgery, describing the use of the endonasal transsphenoidal endoscopic technique for removal of three pituitary adenomas ***(3).***

The development of the endonasal endoscopic approach to the resection of pituitary adenomas has been one of the most remarkable advances for the treatment of these tumors in the last decades. Since 1997, after the initial reports of large series of endoscopic pituitary surgery by **Jho and Carrau** and **Cappabianca** the technique has been disseminated worldwide and represents, nowadays, the main surgical approach for sellar lesions in different

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neurosurgical centers ***(1).*** Following the steps of **Jho and Carrau** in the University of Pittsburgh, **Kassam and snyderman** began to take the advantages of the utility of the endoscope and neuronavigation around 1998. They described bilateral endonasal team approach to the sella turcica, in which both hands are used for instrument maneuver while another surgeon drives the scope in and out. In recent years they have also reported on the use of the pure endonasal endoscopic technique for the treatment of various pathologies of the skull base ***(4).*** Although there are complications such as hypopituitarism, diabetes insipidus, cerebrospinal fluid (CSF) leakage, meningitis, carotid artery injuries, hypothalamic injuries and loss of vision **(Ciric et al., 1997),** Several authors have advocated the endoscopic endonasal approach as a method to increase the extent of resection and decrease pituitary deficiency after surgery based on the increased visualization afforded by the panoramic and angled views provided by the endoscopes ***(5).***

The endoscopic technique requires a sharp learning curve, because it is necessary for the neurosurgeon to become confident with the non familiar anatomy of the nasal cavities and with the specific endoscopic dexterity. These are the reasons for the longer operative time, during the first procedures. Nevertheless, after an adequate experience, the operating time becomes the same or shorter than that required for transsphenoidal microsurgery, especially in case of recurrences. ***(5).***

Patients and methods:-

The study was conducted on twenty patients with sellar tumors between March 2014 and May 2016 in the Department of Neurosurgery at Banha University Hospitals. Sellar tumors were diagnosed based on the clinical characteristics, confirmation of sellar tumors on CT and/or MRI. Preoperative visual field analysis and anterior pituitary hormone analysis (ACTH, early morning cortisol level, urine cortisol, PRL, TSH, T3, T4, GH, IGF-1, FSH, LH, E2, and free testosterone) were evaluated. The endoscopic endonasal trans-sphenoidal surgical approach was used for tumor removal in all patients. In patients with pituitary apoplexy, glucocorticoid replacement therapy was given together with thyroxine replacement therapy. In patients with prolactinoma, treatment started with medical therapy in the form of dopamine agonist e.g. Parlodel or dostinex.

Surgical technique:-

Patients were placed supine on the operating table, under general anesthesia and orotracheal intubation. The back was elevated by about 10º, and the head was tilted 10º to the right. Vertical tilting of the head varied according to the site of the lesion.The head was slightly flexed for tumors that preferentially involved the sphenoidal sinus and the clivus; the head was placed in a neutral position or slightly hyperextended for tumors involving the suprasellar region and the sphenoidal plane. The otorhinolaryngologist was to the right of the patient and the neurosurgeon was to the left. The assistant and instruments was also to the right of the patient. The anesthesiologist was to the left and next to the patient’s feet. The videoendoscopic surgery equipment (monitor, camera, light source and documentation equipment) was placed behind the patient’s head in such a way that both the neurosurgeon and the otorhinolaryngologist could comfortably look at the monitor. Aqueous chlorhexidine gluconate at 0.2% was used for antisepsis of the face and abdomen, after which sterile drapes were placed. Rigid, 4mm diameter, 18 cm length, 0° and 30° angle endoscopes (Karl Storz, GmbH and Co, Tuttlingen, Germany) was used, with video output to one monitor. Under endoscopic view, long cottonoids imbibed in adrenalin at a 1:1000 concentration were placed in both nasal fossae between the middle turbinate and the nasal septum for vasoconstriction and decreased perioperative bleeding, and a cleaner surgical field. The cottonoids were removed after about five minutes and the middle turbinate was gently displaced laterally, avoiding fractures close to its insertion. The first step of this surgery consisted of opening the sphenoidal sinus ostium. The most important landmarks to locate the sphenoidal sinus ostium are the choanal arch and the tail of the superior turbinate. The sphenoidal sinus ostium was located close to the tail of the superior turbinate, along the sphenoethmoidal recess, about 1.5cm above the choanal arch. A delicate Kerrison-type forceps or specific Stammberger sphenoidal sinus forceps was used to open the sphenoidal sinus ostium, moving initially downwards and medially to avoid injury to important anatomical structures placed superior and lateral to the sinus, such as the optic nerve and the internal carotid artery. The next step was wide removal of the anterior wall of the sphenoidal sinus. A similar procedure was done through the contralateral nasal fossa to attain a bilateral ample sphenoidotomy. About 1.0 to 1.5 cm of the posterior nasal septum was removed for simultaneous access to the sphenoidal sinuses through both nasal fossae. A Kerrison or a reverse cutting forceps was used to this end. The intersinus septum was carefully removed with cutting forceps to avoid accidental fractures of the sellar floor. There may be other always incomplete vertical or oblique septa in the sphenoidal sinus, other than the intersinus, sagittal and generally paramedian bone septum that completely separates the right and left sphenoidal sinuses. There septa were removed with cutting forceps only when it became necessary to improve the access to the sellar region, and only after a careful analysis of image exams (computed tomography and/or magnetic resonance imaging) that revealed the anatomical relations between these septa and adjacent structures. The dura is incised in a midline position, in a linear or cross fashion and a fragment of dura can be drawn for histological examination, if it appears infiltrated. Careful exploration of the sella with the 30º endoscope to find tumor remains and holes in the sellar diaphragm that could result in cerebrospinal leaks is done after removal of the tumor. Post-procedure, all patients transferred to ICU for 24 hours with close follow up and monitoring especially to vital signs (HR, Bl.P), Serum electrolyte (Na, K), urine output, conscious level and visual assessment. All patients underwent **CT brain** immediately postoperatively and an **MRI** three months later to evaluate the extent of resection; this was then repeated annually.

Results:-

Our patient population in this study included 20 patients, 11 males (55 %) and 9 females (45 %). The average age was 38.5 years, with a range of 18–70. From the point of view on the type of tumor; 1 patient was inflammatory pseudotumor, 5 patients (30 %) had non-functioning pituitary adenomas. While most of patients; 14 (70 %) had functioning pituitary adenomas that showed significant symptoms of pituitary dysfunction. Among the patients harboring the functioning adenomas, 8 patients had prolactinomas (40%), 5 patients had GH secreting pituitary adenoma (25%),and 1 patient had Cushing disease (5%). 10 cases of these series showing criteria of pituitary apoplexy, 9 cases of pituitary apoplexy were haemorrhagic type and 1 patient was pituitary infarction.

Upon examination of visual functions, 11 patients (55%) had deterioration of their visual acuity. Other visual manifestations seen were; 15 patients (75%) presented with visual field defect, most common defect was bitemporal hemianopsia, found in 10 patients (50%), while 4 patients (20%) had sever bilateral constricted field and one patient presented with Homonomus hemianopia. Four patients (20%) had ocular palsies at time of presentation.

The transnasal endoscopic technique was done in the entire sample regardless of age, anatomical variants, tumor characteristics and etiology and previous surgery. There was no need to correct septal deviation for surgical access in any of the cases. The medial turbinate was removed in 6 cases at early experience. The image intensifier was used to confirm the trajectory of surgical instruments in 5 cases that had a conchal type sphenoidal sinus and misdirection during procedure.

Table 1:- Technical difficultie.s

	Removal of middle turbinate	Removal of septal deviation	Image intensifier	total
Yes	6 (30.0)	0 (0.0)	5 (25.0)	11 (55.0)
No	14 (70.0)	20 (100.0)	15 (75.0)	9 (45.0)
Total	20 (100.0)	20 (100.0)	20 (100.0)	20 (100.0)

There was no perioperative bleeding that required the surgical procedure to be interrupted. No patients required blood transfusion.

Gross total resection of tumor was achieved in 9 out of 20 Cases (45%), with eight (40%) radical subtotal and 3 (15%) subtotal. Calculations of the extent of tumor removal were done by measuring the size of the residual tumor in the MRI in the three dimensions and comparing that to the original size of the tumor in the preoperative MRI.

Out of our 20 cases, 4 cases received post-operative stereotactic radiosurgery (Gamma Knife), because of failure of endocrinological remission and unsatisfactory symptoms due to residuals three months following surgery. 3 of them that showed uncontrolled hormonal level after surgery became controlled with adjuvant gamma knife, and the other one with large residual tumor became controlled as regard size of tumor on follow up.

Outcome:-

Visual outcome:-

Overall, endoscopic transnasal transsphenoidal decompression resulted in an improvement of the visual acuity deficits in 87.5%, visual field deficits in 86.7%. Results of visual outcome were correlated to the extent of tumor resection surgery, as shown in Table 2 . Improvement of visual field was best seen in cases were gross total resection and radical subtotal resection was achieved (100%). Similarly, out of the 8 cases that showed diminution in their visual acuity at time of presentation, 4 showed improvement following gross total transsphenoidal decompression and 2 improved after radical subtotal resection. Whereas 1 case not improved after subtotal excision (Table 2).

Table 2:- Showing the correlation between time of surgery and visual outcome.

Extend of removal Post op results	Subtotal	Radical subtotal	Gross total	FET	P
Post op field (15) Improved Not improved	 1(33.3) 2(66.7)	 7(100) 0(0.0)	 5(100) 0(0.0)	 5.81	 0.029*
Post op acuity(8) Improved Not changed	 1(50.0) 1(50.0)	 2(100) 0(0.0)	 4(100) 0(0.0)	 2.83	 0.50

(A *P* value <0.05 was considered statistically significant (S) while >0.05 statistically insignificant P value <0.01 was considered highly significant (HS) in all analysis.)

Endocrinological outcome and follow up:-

We evaluated the endocrine symptoms of our 20 patients. The endocrinological disorder was alleviated, although acromegaly was not improved significantly. After 3 months follow up, blood hormone levels of 11 patients returned to normal. In this group of patients. 1 patients who showed hypopituitarism before surgery, needed long-term replacement therapy in form of steroids and thyroxine. 3 patients with prolactinomas and one patients with GH-secreting adenomas did not show hormonal remission 3 months following surgery and needed further medical treatment with dopamine agonists and further management. 1 patient who showed cushing disease complicated post-operative with transient hypoadrenalism and needed short term of thyroxine and steroids. Results of hormonal status was correlated to both timing of surgery and extent of tumor resection. Improvement achieved in 8 cases out of the 14 cases of our series that showing hormonal oversecretion, with no significant differences seen in results of cases operated early than those operated late. In cases were gross total resection was reached, there was only a slight difference in results, with better results achieved in cases where radical subtotal resection was performed.

Table 3:- Showing correlation between extent of tumor resection and hormonal condition following surgery.

Extend of removal Post op results	Subtotal (3)	Radical subtotal (6)	Gross total (5)	FET	P
Hormones (14) Controlled Not	 1(33.3) 2(66.7)	 4(66.7) 2(33.3)	 3(60.0) 2(40.0)	 0.933	 0.627

(A *P* value <0.05 was considered statistically significant (S) while >0.05 statistically insignificant P value <0.01 was considered highly significant (HS) in all analysis.).

In our series the 8 cases of prolactinoma; 5 cases of them improved after surgery and PRL level was controlled, but the remaining 3 cases not controlled and need medical treatment to all and radiotherapy for 2 of them. The 5 patiens of acromegaly; 4 cases of them improved post-operative as regard GH level but the remaining 1 patient did not and need radiotherapy. The only case of cushing disease in our series; had post-operative transient hypoadrenalism which need medical treatment (thyroxin and steroid) until improvement.

Radiotherapy:-

3 patients with residual functioning adenomas (2 prolactinoma – 1 acromegaly) which did not show endocrinological remission and gave unsatisfactory symptoms and one patient with residual non functioning adenoma were subjected to stereotactic radiosurgery, 3 months after surgery. Following the radiation therapy, 3 functioning cases showed improvement in their hormonal levels after 6 months follow up and needed no additional medical treatment.

Complications:-

In this study, no cases had shown deterioration in their visual acuity when compared to the condition before surgery, while 6 patients showed no improvements. 1 patient with inflammatory pseudotumor showed no improvement of his visual field defects, but was not worse, and need another surgery for decompression which done transcranial. 3 cases suffered diabetes insipidus, which occurred immediately postoperative, and the symptoms were relieved by the treatment with vasopressin and/or minirin for a short period .Only 1 case had to use long term minirin until condition was controlled. Only 1 case developed cerebrospinal fluid leakage, and antibiotics were used to prevent infection together with conservative measures for 6 days until spontaneous cure. In this study, there were no carotid artery rupture, hypothalamic injury, intracranial hemorrhage or other serious complications.

Results of post-operative complications were correlated to extent of tumor resection. 3 patients of our 20 cases complicated with DI 2 of them after subtotal excision. And the only patient complicated with CSF leakage also after subtotal excision.

Table 4:- Showing correlaton between extent of tumor resection and complications following surgery.

Extend of removal Post op results	Subtotal	Radical subtotal	Gross total	FET	P
DI Yes No	 2(66.7) 1(33.3)	 0(0.0) 8(100)	 1(11.1) 8(88.9)	5.55	0.046*
CSF rhinorrhea Yes No	 1(33.3) 2(66.7)	 0(0.0) 8(100)	 0(0.0) 9(100)	3.83	0.15

(A *P* value <0.05 was considered statistically significant (S) while >0.05 statistically insignificant P value <0.01 was considered highly significant (HS) in all analysis.)

Discussion:-

Old transsphenoidal approaches to the sella that dates back to ancient Egyptians have been recently revived the endonasal transsphenoidal approach which is now very popular and widely used for surgery in and around the sella **(6, 7). Guiot et al.** introduced endoscopes into sellar region surgery as an accessory tool for the microscope to improve visualization. **Jankowski et al.** later used it in place of the microscope as the only tool for visualization of the sphenoidal sinus directly in a transnasal approach. **Jho and Carrau** systematized this approach and used it in 48 procedures with no need to detach the nasal septum, which meant that the access route became less invasive **(1, 3, 6).**

The advantages of the endoscopic approach in respect to traditional microscopic one are well known **(8).** Endonasal endoscopic sellar surgery enables the surgeons to verify the diagnosis, and to reduce considerably the size of all the tumors to be amenable to alternate complimentary treatment modalities such as radiosurgery or hormonal therapy **(9, 10)** Furthermore, the endoscopic approach provides a more mobile, panoramic, and close-up view of the anatomical structures with the ability to check the recesses and the lateral extensions of the tumor when using different angled lenses. This is not possible with the operating microscope, which works in a straight field **(11)**.

In our work we used the **pure endoscopic endonasal transsphenoidal** approache for surgical decompression of sellar tumors seen in 20 patients admitted to our department. **White et al.** compared 50 patients undergoing sublabial transseptal transsphenoidal surgery from 1996 to 1999, as well as 50 patients undergoing endoscopic surgery from 2000 and 2002. There was no difference in the intraoperative blood loss and the incidence of diabetes insipidus between the two groups. However, they showed that endonasal complications were much lower in the endoscopic group compared to the sublabial group **(12).**

Our endonasal approach was made through a Para septal route medial to the middle turbinate. The surgical landmark leading to the sella was the inferior margin of the middle turbinate. The line drawn along the inferior margin of the middle turbinate extends to 1 cm inferior to the floor of the sella & through a small anterior sphenoidotomy hole, the posterior wall of the sphenoidal sinus was exposed. The middle turbinate has been removed in only one case, in which the tumor was mainly invading the right cavernous sinus, in order to facilitate the operation.

Many authors have reported partial or total removal of the middle turbinate to facilitate the approach to sphenoidal sinus **(13, 14).** The middle turbinate has been removed in only 6 cases in the early experience but later on there is no need for such step which is aligned with the intention of other groups that always seek to preserve the middle turbinate whenever possible **(5, 15).** Topical use of cottonoids with adrenalin at 1:1000 may have helped to locate the ostium of the sphenoidal sinus. Intense vasoconstriction and decreased mucosal edema resulting from the use of adrenalin facilitate the approach to the sphenoethmoidal recess without the need to remove the middle turbinate partially or totally.

The bilateral transnasal endoscopic approach was used in 6 cases of the surgical procedures in this series. One of the reasons for this choice is the increased comfort in using surgical tools in one nostril and the endoscope in the other. The decisive factor, however, was the simultaneous presence of the otorhinolaryngologists (responsible for handling the endoscope) and the neurosurgeon (responsible for handling the surgical tools) in the surgical field during the procedure, one on each side of the patient. This arrangement of the team would conflict if the unilateral approach were used.

The benefits of placing the team in this arrangement are significant. One of the criticisms of endoscopic surgery is that it is done with only one had, as the other is busy holding the endoscope. The surgeon, for instance, cannot aspirate the surgical field while removing the tumor **(16)**. With the abovementioned arrangement, the otorhinolaryngologist holds the endoscope with one of his or her hands and a surgical instrument (generally the nasal aspirator) with the other. The neurosurgeon used one or both hands to manipulate the surgical tools through the other nasal fossa. This procedure requires integration between team members; with practice, however, it can be said that the hands operate as if belonging to the same person **(16)**.

In our series we did not use endoscope holders, as one of the most important advantages of the endoscope is its mobility; it can be rapidly repositioned without having to be released and refixated. The holding mechanism may not be sufficiently precise to hold the endoscope exactly in the desired position **(17)**. One of the ways in which a notion of depth is obtained with an endoscope is to move it constantly backwards and forwards, using fixed anatomic landmarks as references.

A further disadvantage of using endoscopes, in our series, is that they may hinder the movement of the neurosurgeon's surgical tools. Curettes and dissectors may be partially guided towards undesirable positions by the external contour of the endoscope; they may roll over the tip of the endoscope and result in abrupt movements. Finally, at times it becomes necessary to clean the tip of the endoscope, which may become covered by condensation or blocked by blood; if the endoscope is fixed, time will be lost during the procedure. Some authors routinely used a cleaning system for the tip of the endoscope - irrigation with saline - to try to solve this problem (**13, 15).**

The last difficulty found in the surgical approach we studied was the need for image intensifiers to confirm the trajectory of surgical tools. It is used routinely in sellar region surgery with microscopes and by some authors that use the endoscopic approach **(15).** We required image intensifiers to confirm the trajectory of surgical tools in 5 cases only. This finding is similar to those of **Cappabianca et al.,** who only use this recourse in cases of pre-sellar or conchal sphenoidal sinuses. Other authors have underlined the usefulness of navigation systems to help locate anatomical landmarks, particularly in cases of tumor recurrence **(18).**

Reconstruction of the sellar floor was made by means of gel foam and bone harvested from the bony septum or the sphenoid rostrum of the patient .We used a fat graft to pack the sella after surgery, in 4 out of 20 trying to avoid CSF leakage and sagging of the arachnoid membrane or the chiasm.

The primary goals of sellar tumor management are to reduce the size of the tumor, reduces visual manifestations, and control endocrinologic dysfunction. In cases with giant or large adenoma gross total resection (GTR) is not the goal for such large tumors because of neurovascular structures involvement and the recent success of adjuvant therapies **(19)**. Thus, the extent of resection is difficult to evaluate as an outcome for large and giant pituitary adenomas (19). Moreover, there is no general consensus on the definition for near total (NTR), subtotal (STR), and partial resection (PR), as also noted by Chabot et al. **(19)**. Overall, the reported rate of GTR in the modern purely endoscopic series published after the systematic review by Komotar et al. ranges from 14% in our series to 60% in the Naples series13 (average of 36.7%) **(20).**

One patient of our series was diagnosed as inflammatory pseudotumor hypphysitis which was difficult to be resected with trans-sphenoidal approach only and need another set transcranial surgery later on within one week interval due to non improvement of visual problem this situation is co insistent with **Ray et al,** who said that the disease had proven difficult to resect with tans-sphenoidal approach and following the withdrawal of corticosteroid therapy symptoms returned and mass enlargement was observed. Subsequently, the patient underwent gamma knife treatment, corticoid therapy was stopped and symptoms did not recur **(21)**.

In the present series, postoperative endocrinological control was achieved in 11out of the 14 patients with secretory adenoma 3 months postoperatively (78.57%). Likewise, postoperative visual field improvement was noted in 14 out 15 patients (93.3%) of those who had preoperative field deficit.

In cases with acromegaly (5 patients) in our series, GH level was controlled in 4 patients of them post-operative and one patient did not and need radiotherapy furthermore, the early analysis of GH level post-operative was a good predictor of the long term cure, these finding co insistent with **Kim et al,** and **Pinaki et al, (22, 23)** whome found that GH levels measured 6 h after surgery had the highest predictive value (AUC 0.892) for long-term cure. In addition, duration of the disease, the tumor volume had no effect on the prediction of cure. Postoperative IGF-1 measured 3 months after surgery had a better predictive value (AUC = 0.99) than GH levels measured 6 h (with threshold of 1.5 ng/ml, AUC = 0.89) **(23).**

As regard complications of procedure in our series, 3 patients (15%) developed DI post-operative which was transient and managed medically, these ratio is similar to complications rates reported by **Tabaee et al., 2009 (24)** but not correlated with **Gondium et al., 2014** who consider transient DI is a common complication in the immediate post-operative period with a reported incidence of 24.1%–53.6% of the patients. It is considered to occur as a result of direct surgical manipulation, especially associated to hypothalamic injury **(1).**

Only 1 patient (5%) had CSF leak that managed conservatively. These results support the safety and efficacy of the approach and agree with the complication rates reported by **Tabaee et al.,(24),** also in our series we did not operate any case with cavernous sinus extension which less manipulations and decreased incidence of arachnoid violations as seen with **Chabot et al., (19)**, whom reported higher incidence of CSF leake (10.6% - 27.6%) due to use of extended approach with large and giant pituitary adenoma. Only 1 patient from 20 of our series developed post-operative transient hypopituitarism which needs adjuvant medical treatment (thyroxin and steroid), this result correlated with **Nakao, Itakura and Juraschka et al.**(25, 26) whom reported lower rates of new postoperative hypopituitarism, the endocrine outcomes seems to correlate inversely with the greater extent of resection and therefore with the greater surgical manipulation provided by the endoscope **(25, 26**). A few authors have reported higher rates of postoperative cerebrospinal leaks compared to our study. **White et al, (12)** reported a 12% rate of postoperative cerebrospinal leaks and a 2% rate of meningitis. Most authors, however, have reported lower rates of this complication compared to our series. **Sonnenburg et al, (27)** reported a 4.44% rate of postoperative cerebrospinal leaks a 2.22% rate of meningitis. **Nasseri et al, (28)** reported a 4.4% rate of postoperative cerebrospinal leaks, and **Cappabianca et al, (7)** reported a 2.3% rate of this complication in their series.

The concept of a learning curve with novel surgical procedures is recognized in many areas of surgery. It can be broadly defined as the number of cases necessary to perform for outcomes to tend toward the long-term mean rate. The existence of a need to adapt technique and learn new skills has been recognized by the pioneers of endoscopic transsphenoidal surgery, with suggestions made as to means of easing the procedural transition **(6).** The use of the endoscope as an adjunct during microscopic resection has been advised as a “halfway house” position to gain familiarity with the two-dimensional view and endoscope handling. All procedures were undertaken after visiting a center already practicing endoscopic skull base surgery and in full conjunction with an ENT surgeon experienced in functional endoscopic sinus surgery (FESS) techniques. Despite these measures, it is clear that a learning curve does exist for this procedure; our results improved significantly between the early and late cases in all respects. Not all published series have examined this aspect, but most series that have agree with our findings of a definite improvement of outcome as experience improves **(29, 30).** Some disagree, finding no incremental improvement of results with time **(27).**

Overall, and especially in comparison with the final group of 8 patients, we feel endoscopic results at least equal and may well surpass those obtained from the microscopic technique. Certainly there would appear to be a trend toward better hormonal control in secretory tumors. We are moving away from using the microscopic technique and now use an endoscopic approach whenever possible logistically.

Conclusion:-

Transsphenoidal surgery is an effective and safe treatment for most patients with pituitary adenoma and sellar tumors. It could be considered the first-choice therapy in all cases except for prolactinomas responsive to dopamine agonists. It shows excellent results with tumors confined to the sella and tumors with suprasellar extension in the midline. We found that there is no big difference between results of gross total resection versus radical subtotal resection, especially with use of post-operative radiotherapy (GKS) controlling size of residuals or hormonal imbalance. We believe that the endoscopic endonasal pituitary surgery eventually will replace the microscopic techniques once the surgeons get used to it in the near future.

References:-

1. **Gondim JA, Almeida JP, Albuquerque LA, Schops M, Gomes E, Ferraz T, et al: 2014,** Endoscopic endonasal approach for pituitary adenoma: Surgical complications in 301 patients. Pituitary. 14:174–83.
2. **Apuzzo MLJ, Heifetz M, Weiss MH, Kurze T: 1977,** Neurosurgical endoscopy using the side-viewing telescope: Technical note. **J Neurosurg** 16:398–400.
3. **Jankovsky R, Auque J, Simon CMJC, Hepner H, Wayoff M: 1992, Endoscopic** pituitary surgery. Laryngoscope. 102:198–200.
4. **Doglietto F, Prevedello DM, Jane JA Jr, Han J, Laws ER Jr: 2005**, A brief history of endoscopic transsphenoidal surgery—from Philipp Bozzini to the First World Congress of Endoscopic Skull Base Surgery. Neurosurg Focus. 19(6):E3.
5. **Cappabianca P, de Divitis E and Esposito F**: **2007,** endoscopic skull base instrumentation, in anand vk, Schwartz TH practical endoscopic skull base surgery. San diego CA plural publishing.
6. **Jho HD and Carrau RL: 1997,** Endoscopic endonasal transsphenoidal surgery: experience with 50 patients. J Neurosurg**;** 87:44- 51.
7. **Badie B, Nguyen P, Preston JK: 2000,** Endoscopic-guided direct endonasal approach for pituitary surgery. Surg Neurol 2000;53(2):168–172, discussion 172–173
8. **Al-Mefty O, Pravdenkova S, Gragnaniello C: 2010,** A technical note on endonasal combined microscopic endoscopic with free head navigation technique of removal of pituitary adenomas. Neurosurg Rev; 33(2):243–248, discussion 248–249
9. **Schulder M, Sernas TJ, Carmel PW: 2003,** Cranial surgery and navigation with a compact intraoperative MRI system. Acta Neurochir Suppl (Wien); 85:79–86
10. **Laws E. R., Kanter A. S., Jane J. A., Jr., Dumont A. S: 2005,** Extended transsphenoidal approach. J. Neurosurg. 102, 825–828. doi: 10.3171/jns. 102.5.0825.
11. **Gnanalingham KK, Bhattacharjee S, Pennington R, Ng J, Mendoza N: 2005,** The time course of visual field recovery following transphenoidal surgery for pituitary adenomas : predictive factors for a good outcome. **J Neurol Neurosurg Psychiatry 76** : 415-419.
12. **White D R, Sonnenburg R E, Ewend M G, Senior B A: 2004,** Safety of minimally invasive pituitary surgery (MIPS) compared with a traditional approach. Laryngoscope; 114:1945–1948.
13. **Har-El G: 2011,** Endoscopic transnasal transsphenoidal pituitary surgery--comparison with the traditional sublabial transseptal approach. Otolaryngol Clin North Am; 38(4) p.723-35.
14. **Thomas RF, Monacci WT, Mair EA: 2002,** Endoscopic image-guided transethmoid pituitary surgery. Otolaryngol Head Neck Surg ;127:409-16.
15. **Rudnik A, Zawadzki T, Galuszka—Ignasiak B, Bazowski P, Duda I, Wojtacha M, et al: 2012,** Minim Invasive Neurosurg ;49:10-4.
16. **van Lindert EJ, Ingels K, Mylanus E, Grotenhuis JA: 2010,** Variations of endonasal anatomy: Relevance for the endoscopic endonasal transsphenoidal approach. Acta Neurochir (Wien) 152:1015–20.
17. **de Divitis E and Cappabianca P: 2004,** Enodoscopic pituitary surgery. Anatomy and surgery of the transsphenoidal approach to the sellar region. Tuttligen Endo press.
18. **Lasio G, Ferroli P, Felisati G et al: 2002,** Image-guided endoscopic transnasal removal of recurrent pituitary adenomas. Neurosurgery; 51: 132-137.
19. **Chabot JD, Chakraborty S, Imbarrato G, Dehdashti AR: 2015,** Evaluation of outcomes after endoscopic endonasal surgery for large and giant pituitary macroadenoma: a retrospective review of 39 consecutive patients. World Neurosurg; 84(4):978-88. doi:10.1016/j.wneu.06.007
20. **Komotar RJ, Starke RM, Raper DM, Anand VK, Schwartz TH: 2012,** Endoscopic endonasal compared with microscopic transsphenoidal and open transcranial resection of giant pituitary adenomas. Pituitary. 2012;15(2):150-9. doi:10.1007/s11102-011-0359-3

21. **Ray DK, Yen CP, Vance ML, Laws ER, Lopes B and Sheehan JP: 2010,** Gamma knife surgery for lymphocytic hypophysitis. J Neurosurg 112: 118-121.
22. **Kim HU, Kim S, Kang S et al: 2001,** Surgical anatomy of the natural ostium of the sphenoid sinus. Laryngoscope**;** 111: 1599-1602.
23. **Pinaki Dutta , Márta Korbonits , Naresh Sachdeva , Prakamya Gupta , Anand Srinivasan , Jagtar Singh Devgun , Ankur Bajaj , Kanchan Kumar Mukherjee*: 2016,*** Can immediate postoperative random growth hormone levels predict long-term cure in patients with acromegaly?**.** Neurology india; vol 64: 252-285.
24. **Tabaee A, Anand VK, Barrón Y, et al: 2009,** Endoscopic pituitary surgery: a systematic review and meta-analysis. J Neurosurg; 111(3):545–554
25. **Nakao N, Itakura T: 2010,** Surgical outcome of the endoscopic endonasal approach for non-functioning giant pituitary adenoma. J Clin Neurosci; 18(1):71-5. doi:10.1016/j.jocn.2010.04.049
26. **Juraschka K, Khan OH, Godoy BL, Monsalves E, Kilian A, Krischek B, et al: 2014,** Endoscopic endonasal transsphenoidal approach to large and giant pituitary adenomas: institutional experience and predictors of extent of resection. J Neurosurg; 121(1):75-83. doi:10.3171/2014.3.JNS131679
27. **Sonnenburg RE, White D, Ewend MG, Senior B: 2004,** The learning curve in minimally invasive pituitary surgery. Am J Rhinol; 18(4):259-63.
28. **Nasseri SS, Kasperbauer JL, Strome SE, McCaffrey TV, Atkinson JL, Meyer FB: 2001,** Endoscopic transnasal pituitary surgery: report on 180 cases. Am J Rhinol ; 15(4):281-7.
29. **O'Malley BW, Jr, Grady MS, Gabel BC, Cohen MA, Heuer GG, Pisapia J, et al: 2008,** Comparison of endoscopic and microscopic removal of pituitary adenomas: Single-surgeon experience and the learning curve. Neurosurg Focus. 25:E10.
30. **Koc K, Anik I, Ozdamar D, et al: 2006,** The learning curve in endoscopic pituitary surgery and our experience. Neurosurg Rev.; 29:298–305.