

ONCOLOGICAL OUTCOME ANALYSIS OF TRANS-NASAL MINIMALLY INVASIVE ENDOSCOPIC RESECTION OF SINO-NASAL MALIGNANCY NOT TRANSGRESSING THE DURA: A SINGLE CENTRE STUDY

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ABSTRACT:

Objective: To evaluate the oncological results and efficacy of trans-nasal minimally invasive endoscopic resection of nose and para nasal sinus malignancy.

Methods: A retrospective observational study including 29 cases of nose and paranasal sinus malignancy stage I-IV of varied histopathological types operated from January 2006 to July 2016. All the patients underwent trans-nasal laser/microdebrider assisted endoscopic resection of the primary tumor with adequate margins. Neck dissection was carried out in 8 cases. All stage III/IV cases and 5 cases of stage-II including olfactory neuroblastoma received post-operative radiotherapy/ Chemo-radiotherapy and one case of malignant melanoma referred for post-operative immunotherapy. Average follow up period was 7 months. Data was analysed using Kaplan Meier method to estimate the overall and disease specific survival rate along with the median survival time wherever applicable. Statistical analysis was carried out using STATA 13.

Results: The age range was 39-64 years with a mean of 49.4yrs. 67 % of the patients were males. Overall, there were 2cases (7.1%) in T1, 8 (28.5%) in T2, 12(42.8%) in T3 and 6 cases (21.4%) in T4 stage. 22 patients (75.8%) were N0, 5(17.2%) were N1 and 2(6.8%) were N2 to begin with. 24/ 29 patients had no disease on their last follow up. One case of olfactory neuroblastoma in Kadish stage B had no recurrence on last follow-up after 18 months. 5 cases had local recurrence of which T1 and T2 cases had no contribution. Out of the 2 cases of recurrence in T3, one at 14 months was managed with endoscopic re-excision and the other at 28 months with external resection. 3 recurrences in T4 were observed and open approach adopted for 2 cases at 16 and 34 months respectively and one case refused treatment at 19 months. 2 patients had lung metastasis after 3 years. 15 out of the 18 patients followed up for 2 years were disease free. The study showed an overall survival rate of 82.7% while the 2 year disease specific survival rate was found to be 83.33%.

Conclusion: Endoscopic resection of paranasal sinus malignancy has provided an efficient tool to the skull base surgeon for providing good oncological results with favourable cosmesis avoiding the potential morbidities of open approaches.

Keywords: Endoscopic resection, paranasal sinus malignancy, microdebrider, skull base.

INTRODUCTION:

Sino-nasal malignancies comprise 3-4 % of all head and neck oncology workload. They have been traditionally attributed to poor prognosis owing to close anatomical proximity to anterior skull base, orbit, cranial nerves, carotid vessels and morbid surgical

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approaches¹. The landmark open craniofacial resection (CFR) by Ketcham in 1963, Moore's lateral rhinotomy and Weber-Fergusson's approach with its modifications have been the standard options for surgical resection of sinonasal malignancies for a long time^{1,2}. However, the recent advances in endoscopic surgical instrumentation, intra-operative image guidance technology, powered instruments, optical gadgets and training programmes in endoscopic sinus surgery have revolutionised the concept of trans-nasal endoscopic resection of sinonasal tumours³. Benign sinonasal tumours were managed earlier using endoscopic approach and the excellent results provided an impetus to tackle malignant lesions with oncological results comparable to open approaches. The changing paradigms in the management of sinonasal malignancies were based on the results of various studies comparing the endoscopic and open approaches^{2,3}.

The two major advantages of open approaches are an en-bloc resection and easy reconstruction of anterior skull base defect. Endoscopic resection includes a piecemeal excision of the lesion due to the complex anatomic location and access⁴. This piecemeal resection with microscopically clear margin provides similar oncological results as an en-bloc resection. The recent techniques in endoscopic skull base reconstruction has made it possible to reconstruct defects with precision^{4,5}. With the advances in instruments and training workplaces, endoscopic surgeons have continued to improve their knowledge of the complex paranasal sinus and skull base anatomy. Endoscopic resection provides the major advantage of minimal morbidity, shortened intra-operative time, faster post-operative recovery and cosmetically superior with similar oncological safety^{6,7}.

MATERIALS AND METHODS:

A retrospective observational analysis of data was conducted at our tertiary care centre with a total of 31 cases of biopsy proven sinonasal malignancy; those have undergone trans-nasal endoscopic resection. Out of these, 29 cases are included in this study for analysis. 1 case each of rhabdomyosarcoma and metastatic malignant eccrine spiradenoma of nape of neck were excluded in this study due to incomplete/palliative treatment. Patients undergoing external approach for facial and cranial access, aided with endoscopy were

excluded. Cases with tumour transgressing dura requiring resection were carried out by craniotomy instead of trans-nasal neurosurgical intervention and hence excluded from the study. Various histopathological sub-types of sinonasal malignancies in stages I-IV operated from January 2006 to July 2016 were included in the study. The cases had undergone purely endoscopic resection of the sinonasal mass with microscopically negative margins. The primary site of origin in all cases was located in maxillo-ethmoidal complex with variable local spread. Stringent inclusion and exclusion criteria were formalised for the selection of patients. All the subjects had undergone routine head and neck clinical examination followed by nasal endoscopy and contrast enhanced CT scan for assessment of the lesion. Minimum follow-up period was 7 months.

Records were evaluated for patient age, sex, diagnosis, tumour staging, histopathological findings, operative procedure, operative time, estimated blood loss, complications, hospital stay, intensive care unit (ICU) stay, postoperative course, follow-up, recurrence rates, and metastasis, mortality and survival rates. Olfactory neuroblastoma was staged according to the Kadish staging system⁸. Other malignant tumours were staged according to the tumour, node, and metastases (TNM) staging system for nasal cavity and ethmoid sinus malignancy of the seventh edition of the American Joint Committee on Cancer (AJCC)⁹. Staging was based on preoperative examination, computed tomography (CT) and magnetic resonance imaging (MRI). Management of neck was individualised depending on the nodal status. Adjuvant radiotherapy was provided to all stage III/IV cases and those with poor histology. Patients with tumours deemed unresectable endoscopically due to its extension into orbit, intradural and intracranial compartments, nasal bones, hard palate were excluded. Cases with massive involvement of the frontal sinuses, lateral bony wall of the maxillary sinus and lacrimal apparatus were managed with combined approach resection. Patients with recurrent or residual lesions and also the radio-residual ones were not part of the study group. None of the patients were subjected to palliative resection or debulking procedure thus strictly following oncological protocols. Cases requiring cribriform plate resection were included and the defect

was repaired after complete tumour excision. Data was analyzed using Kaplan Meier method of estimation to estimate the overall survival and 2 year disease specific survival rate along with the median survival time wherever applicable. Statistical analysis was carried out using STATA 13.

Surgical technique:

Goffart et al (2000)¹⁰ and Casiano et al (2001)¹¹ popularised the technique of endoscopic resection of sinonasal tumours. The addition of navigation and powered instruments has provided a helping hand to the skull base surgeon.

Some surgical landmarks which are of prime importance:

- Superior turbinate and Ostium of the sphenoid sinus.
- The maxillary sinus roof is used as a robust landmark to allow safe dissection and debulking of pathology.
- Maxillary ostium guides the removal of pathology.

An alternative way is by proceeding posteriorly to enable a safe entry to the sphenoid sinus, and thus the true skull base, when normal structures such as the superior turbinate and sphenoid ostium are not available.

The primary aim in endoscopic tumour excision is radical removal of the lesion with safe margins, as in traditional procedures. The cornerstone of oncological surgery i.e. 'enbloc' resection to avoid the risk of tumour spillage is outdated and is replaced by the concept of 'disassembling' of the lesion, having under view the limits between normal and diseased mucosa^{10,11}. Surgical technique varies slightly from one patient to another according to the site of origin and extent of the lesion. We used a powered instrument like microdebrider or/and KTP-532 laser for reducing the bulk of the primary tumour for better manipulation and visualisation of margins and assessment of extent of resection. Bony cuts were then made with osteotome/drill from the healthy area with a good margin.

Some basic steps are followed during the resection which can be modified depending on type of disease and extent: (Fig 1, 2, 3, 4, 5)

- Disassembling tumour using powered instrumentation and/or cutting instruments which reduces the bulk of the tumour and helps to visualise the margins clearly
- Removal of the posterior nasal septum & sphenoid rostrum.
- Draf type IIb frontal sinusostomy in the case of Unilateral mass with frontal sinus extension and Draf type III median frontal sinusostomy is performed if the lesion involves both sides by identifying the cribriform plate.
- Centripetal Removal: Exposure of antero-superior and posterior inferior margin.
- Endoscopic medial maxillectomy type III
- Nasoethmoidosphenoidal complex is isolated and pushed towards the central part of the nasal fossa (centripetal technique) and removed¹².
- Skull Base Removal: Can be extended to resect anterior cranial base.
- Reconstruction: Endoscopic multilayer technique.

Reconstruction of skull base defect was done by using fascia lata. The second layer was followed by superiorly based local septal mucosal reflected from other side of the septum or a pedicled nasoseptal flap

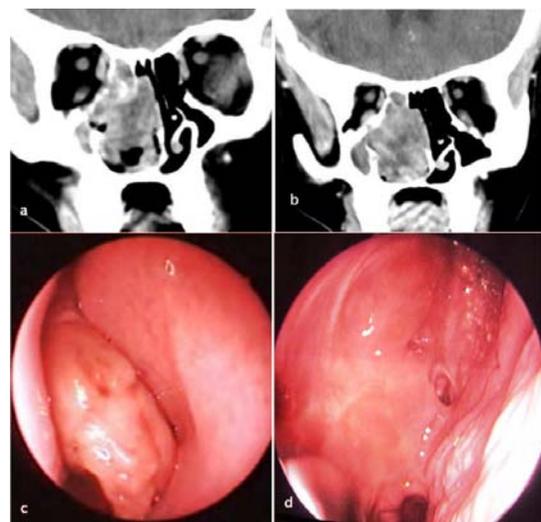


Figure-1: Adenocarcinoma (a&b) CT scan paranasal sinus showing the tumour extension, (c) intra operative endoscopic picture before resection (d) post operative endoscopic picture after one year post operative period with no evidence of disease.

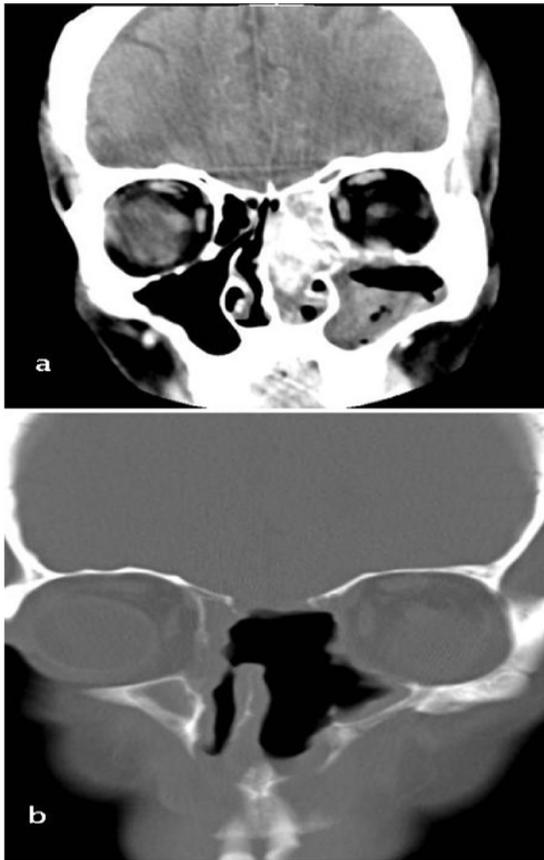


Figure-2: Squamous Cell Carcinoma (a) pre operative & (b) post operative CT scan.

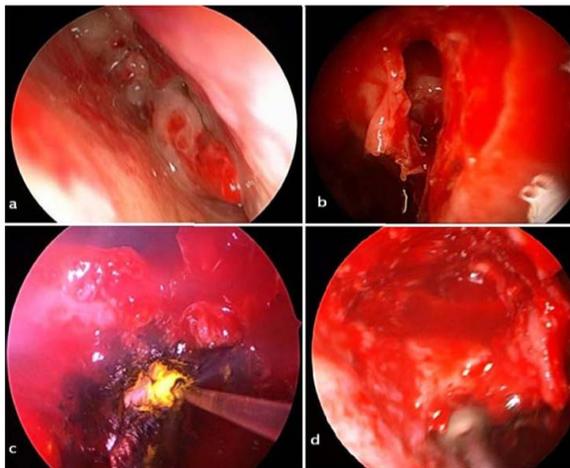


Figure-4: Inverted Papilloma with Transitional Cell Carcinoma (a) Showing the lesion (b) A Draf-II procedure in progress (c) Showing resection of soft tissue attached to tumour that was extended to the nasopharynx with KTP laser from skull base after a posterior septectomy (d) Additional drilling of bone is being done for clearance from sphenoid sinus floor and nasopharynx).

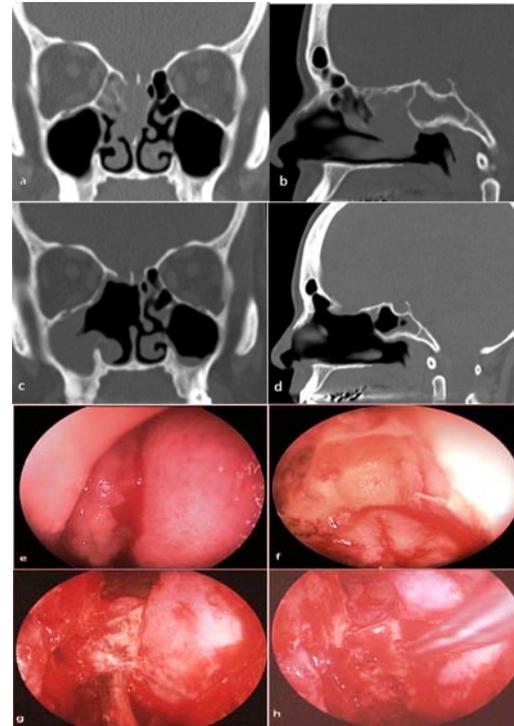


Figure-3: Olfactory Neuroblastoma (a,b)– pre operative CT), (c, d)– post operative CT), (e) showing the lesion occupying the superior aspect of nasal cavity, (f) showing exposure of skull floor of frontal sinus anterior to 1st olfactory neurone. Note the tumour along with healthy mucosal margin has been separated (g) A Draf-II sinusostomy has been performed to identify the skull base & the tumour has been resected completely from dura after removal of adjacent bone, (h) Showing reflection of septal flap from opposite side to cover the dura.

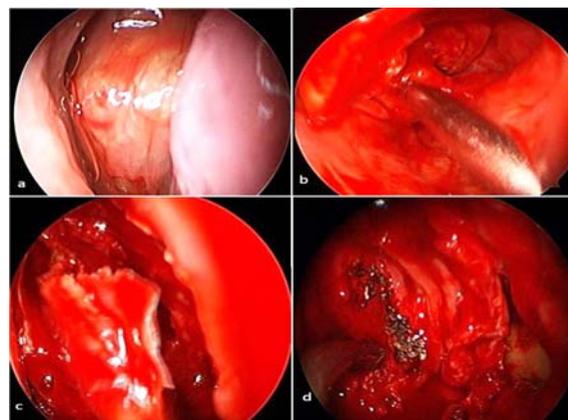


Figure-5: Residual Chordoma following neurosurgical resection in nasal cavity extending into the sphenoid sinus and nasal cavity (a) Showing the lesion, (b) Resection of tumour from nasal cavity ethmoid and sphenoid sinus, (c) showing posterior septectomy being done to facilitate tumor removal from the floor of the sphenoid sinus and clivus (d) – Showing the removal of the tumor from the roof of nasopharynx.

(Haddad flap) for support¹³. Nasal packing was done with moistened absorbable nasal packs. All cases anticipated for CSF leak, were provided complete bed-rest keeping the head in a 20 degree elevated position until the 3rd post-operative day. Intravenous third-generation cephalosporin therapy was started the day before surgery and continued for at least 7days. Nasal irrigation and cleaning with normal saline solution was started after 2-3 days with topical antibiotic ointment. Regular nasal endoscopic cleaning of the nasal cavity was done and looked for suspicious lesions. All patient with T3 and T4 disease and 5 cases of stage II disease received post operative adjuvant Radiotherapy/Chemo-Radiotherapy.

RESULTS:

The age range was 39-64 years with a mean of 49.4yrs. 67 % of the patients were males. The histological subtypes of the sinonasal malignancies managed via endoscopic approach are given in Table 1.

Table 1: Histological Subtypes^{14,15,16} (Includes tumours treated with endoscopic approach only)

HISTOPATHOLOGY	NUMBER (n=29)
Malignancy of Salivary gland origin (4 Adenocarcinoma, 6 Adenocystic carcinoma)	10
Squamous cell carcinoma (scc) (poorly differentiated – 4)	7
Inverted papilloma with malignancy (scc, tcc)	2
Undifferentiated	1
Malignant melanoma	3
Olfactory neuroblastoma (high grade)	1
Chordoma	1
Hemangiopericytoma	1
Transitional cell ca (tcc)	1
Smooth muscle tumour of uncertain malignant potential	1
NHL	1

Malignancy of Salivary gland origin (Adenocarcinoma and Adenocystic carcinoma) comprised the majority (34.4%) of cases followed by squamous cell carcinoma (24.1%), malignant melanoma (3.4%) and others. 1 case of olfactory neuroblastoma belonging to Kadish stage B was a part of the study group. The remaining 28 cases were stage-wise categorised as given in Table 2. Adjuvant radiotherapy was advised in stage III/IV cases and in cases with aggressive tumour behaviour. One patient of malignant melanoma received immunotherapy. A case of smooth muscle tumour of unknown malignant potential was treated with endoscopic resection only.¹⁴ 24 of the 29 patients had no disease on their last follow up. 5 cases had loco-regional recurrence of which stage I and II cases had no contribution. We had 2 recurrences in stage III out of which one at 14 months was re-excised using endoscopic technique and the other one at 28

Table 2: Stage Wise Classification Of Cases.

STAGE	NO. OF CASES N=29	Recurrence/Distant metastases(DM)/ Total maxiilo-ethmoidectomy+ sphenoidotomy+ Draf(TMESD)/ Death on last follow up
T1	02	No recurrence
T2	08	No recurrence
T3	12	02 (1-TMESD. 1- Re-excision)
T4	06	03 (2- TMESD, 1- refused treatment)
N0	22	01 (Re-excision)
N1	05	01 (TMESD)
N2	02	03 (2-TMESD, 1 Refused treatment)
M1	00	2 cases (lung) after 3 years
Stage-I	02	No recurrence
Stage-II	05	No recurrence
Stage-III	15	02 (1-TMESD. 1- Re-excision)
Stage-IV	06	03 (2- TMESD, 1- refused treatment)
1 case of olfactory neuroblastoma Kadish B had no recurrence.		

months was managed with an external total maxillo-ethmoidectomy. In stage IV with extension of disease into sphenoid or frontal sinuses, 3 cases had loco-regional recurrences, two of which at 16 and 19 months respectively were managed with external approach using total maxillo-ethmoidectomy and sphenoidotomy or external frontoethmoidectomy procedure. One patient with recurrence at 34 months, refused any further treatment. 2 patients had lung metastasis after 3 years (1 death at 42 months).

No significant complication was noted intra-operatively and during post-operative recovery. Epistaxis was noted in 3 cases and was managed conservatively during post-operative period. Hyposmia was observed in 2 patients who are still on regular follow-up. We did not encounter any CSF leak probably due to the multi-layered skull base defect closure technique and vigilant post-operative care. The overall survival rate for the study population was found to be 82.7%. 15 out of the 18 patients followed up for 2 years were found to be disease free and hence the 2 year disease specific survival rate was 83.33% (Fig.6)

DISCUSSION:

The extensive use of endoscopic approach for dealing with chronic sinusitis made the skull base

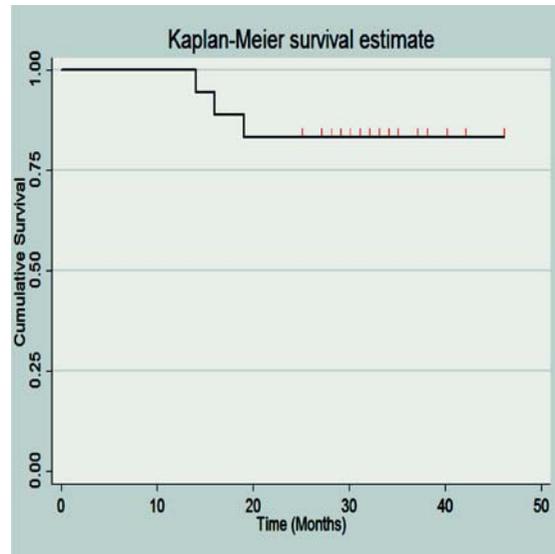


Figure 6b: Kaplan-Meier graph showing 2 –year specific survival rate.

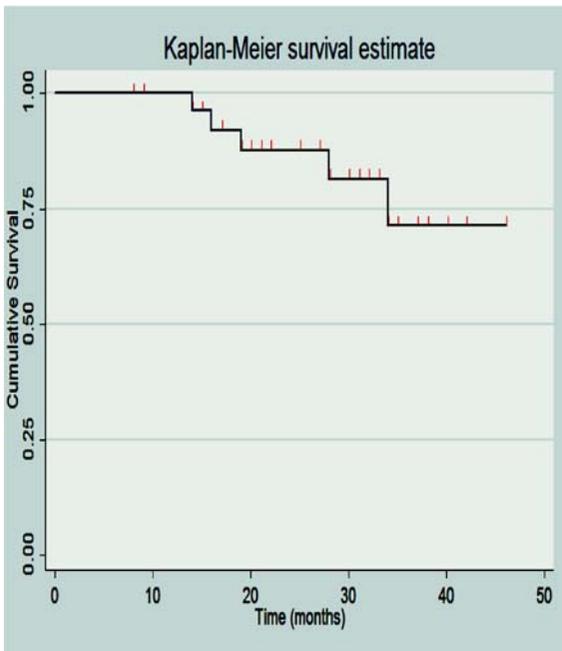


Figure 6a: Kaplan-Meier Graph showing Overall survival rate.

surgeons all over the globe realise the possibility of managing sinonasal tumours with this approach⁴. While there have been many reports describing its use in benign tumours, there has been a dearth in literature on its efficacy in managing malignant lesions¹⁷. In addition to the excellent visualization owing to better optics and imaging advances, endoscopic approaches have significantly reduced the need for craniofacial soft-tissue dissection, skeletal disassembly, and cerebral retraction for tumor access and resection^{17,18}. The endoscopic approach facilitated better access to difficult areas such as the frontal recess, sphenoid sinus, orbital apex, pterygomaxillary space and inferior part of the septum while avoiding dissection of vital non-involved structures thus providing an added advantage over open techniques¹⁸. The lack of external incisions and improved cosmesis makes it a patient friendly and compliance inducing approach. Dave et al¹⁹ stated the advantages including, avoidance of craniotomy, facial, gingival, and bi-coronal incisions, extensive facial osteotomies, lumbar drains, tracheotomy, and frontal lobe retraction in this endoscopic technique. Other potential advantages include decreased operative time, reduced anesthetic risk, shorter hospital stay, less postoperative pain, and fewer complications^{4,18,19}. These advantages probably provided an impetus for the increased adoption of endoscopic approaches for surgical management of selected sinonasal malignancies.

With respect to oncological results, Nicolai et al²⁰ reported the largest series to date, with 184 patients with naso-ethmoidal malignancies of which one hundred thirty-four patients (72.8%) were managed exclusively by an endoscopic approach, whereas 50 required an adjunct craniotomy with mean follow-up of 34.1 months. The overall rates of disease-free survival, alive with disease, died of disease, and died of other causes were 80.9%, 4.4%, 11.4%, and 2.2%, respectively. Ehab et al¹⁷ concluded that out of his 120 patients, 18 (15%) experienced local recurrence, with local disease control of 85%. The 5- and 10-year disease-specific survival rates were 87% and 80%, respectively. The 5- and 10-year overall survival rates were 76% and 50%, respectively. Lund et al²¹ in their work, reported a 49-patient prospective cohort that underwent endoscopic resection as an alternative to CFR. Overall survival was 88% at 5 years, with 36 patients free of disease, seven patients with residual disease, and six patients died of disease. Ganly et al²² reviewed pooled data on 334 patients from 17 institutions and noted overall survival and recurrence-free survival of 48% and 46%, respectively. Dulguerov et al²³ retrospectively reviewed 220 patients of olfactory neuroblastoma from 1975 to 1994 with a minimum 4-year follow-up. The 5-year actuarial survival rate was 63% with 57% local control rate. Batra et al¹⁸ studied 31 patients and calculated overall survival was 86.2% and 58.6% at 2 and 5 years respectively. They also found the disease-free survival to be 64% and 51.7% at 2 and 5 years respectively.

Literature has witnessed better oncological results with Esthesioneuroblastoma compared with other sinonasal malignancies and hence results on only these tumors cannot be extrapolated on other pathological types^{22,24}. The pathology of primary tumor was noted to be an important predictor of survival in the international collaborative study⁴. The 5-year disease-free survival rates for Esthesioneuroblastoma, SCC, and melanoma were 75%, 50%, and 27%, respectively. This is very comparable to the 5-year disease-specific rates of 88%, 51%, and 18% for the same three pathologies reported by Bentz et al²⁴. This comparison must be viewed keeping in mind the small sample size in each subgroup. We had 1 case of olfactory neuroblastoma which was disease free on their last follow-up. Our 3 cases of malignant melanoma were managed endoscopically and adjuvant radiotherapy was taken by one patient. One case received immunotherapy post-

surgery. Proper selection of cases amicable to endoscopic resection forms the backbone of success in endoscopic resection of sinonasal tumors. Accurate clinical and radiological assessment of the lesion with neurosurgical back-up is an added advantage^{25,26}. Tumors with involvement of dura, orbital contents, palate and those with intra-cranial extension were better managed with open approaches²⁶.

On the other hand, various concerns have been raised regarding the safety and efficiency of this technique as well. En-bloc resection of tumour was not possible in most cases using this technique but literature suggests that piece-meal resection has no oncological disadvantage^{4,18,19}. Generous margins are often not possible even in external approach owing to the close proximity to critical structures and the delicate ethmoid septations which prevent the specimen from being intact. Moreover, multiple endoscopic series employing the piecemeal approach have not demonstrated compromise in survival^{17,18,19,24}. The anterior skull base reconstruction was also an area of concern. However, use of local flaps and free non-vascularised flaps with fat and absorbable nasal packing material in multi-layered technique provided excellent results¹³. Whereas the endoscopic approach allows clear visualization through different angled endoscopes, an external approach relies primarily on tactile discrimination, direct visualization and preoperative anatomic imaging during tumour resection. The lack of tactile sensation in endoscopic resection is compensated by the advanced optics, powered instruments, magnified view and navigation system^{17,18,19}. The addition of intra operative frozen section examination has undoubtedly improved resection margins and oncological results, but is only optimal when combined with adequate visualization using an endoscope^{18,19}.

Despite the debate on the surgical approach, the oncological objective of complete tumour removal with adequate margins must be balanced with minimal morbidity and better quality of life. At this juncture, data from multiple reports suggests that the endoscopic approach provides similar surgical objectives while decreasing intra operative complications and minimizing long-term patient morbidity compared to the open techniques^{1,4,17}. Our study is a single institutional one, with a small sample size which needs further addition over the next few years. Local recurrence, poor outcomes, and decreased survival are

all associated with positive surgical margins^{4, 18}. In our series, there were no positive margins. Some of the cases with significant inferior extension to the floor of the nose, anterior extension onto the facial soft tissues, lateral extension to the maxillary sinus, orbit, pterygomaxillary space, or Infratemporal fossa were taken up for a combined endoscopy –assisted open approach and are not included in this study. We had 3 cases (10%) of post-operative epistaxis which were managed conservatively and 2 cases (6%) of hyposmia on regular follow-up. Nicolai et al. noted mean hospitalization time of 3.7 days for the exclusive endoscopic group while it was 4.2 days for our patients. Moreover, major complication noted in the exclusive endoscopic approaches (6% CSF leaks), following dural resection and repair. Successful separation of the intracranial and sinonasal compartments and multilayer reconstruction provides the best opportunity for water tight closure for large skull base defects^{4,5}. Reconstruction was not a major problem in this series as tumours transgressing the dura were not in the study. In accordance with the work by Bentz et al²⁴, adjuvant radiotherapy was provided in tumors that had higher T stage, high-grade pathology, positive margins, large volume of disease, or extensive local invasion, bone invasion, positive nodal status. Atrophic rhinitis, blindness, frontal lobe necrosis, and radiation induced malignancies were some adverse effects of radiotherapy at this site noted in literature.

The challenges in endoscopic management of sinonasal tumors begin with a proper case selection using strict endoscopic and radiological parameters for successful outcome and to prevent mishaps intra-operatively^{4,5}. The operating surgeon must be well-versed in both; endoscopic nasal surgery and surgical oncology principles which needs a prolonged learning curve. The hospital should be dedicated and equipped for managing critical patients with a good neurosurgical support. A tailor-made, incremental, systematic approach to increasing complex cases may improve outcomes and decrease risk of complications. Relative contraindications for endoscopic resection include highly vascular tumors, extensive bilateral disease, and significant orbital or Infra temporal fossa involvement^{25,26}. The surgeon must be well equipped with skills and instruments to convert the planned endoscopic procedure into an open approach if need arises. Adjuvant radiotherapy using Intensity

modulated radiotherapy has improved the outcomes with minimal toxicity¹⁸.

CONCLUSION:

Endoscopic resection of malignant sinonasal tumours has made a path-breaking change in the management of these cases. Providing similar oncological safety with minimal morbidity and improved cosmesis forms the corner-stone of this technique. We uphold the fact that endoscopic approaches are not a replacement to conventional open techniques which have to be the choice in advanced cases. However, with proper case selection, we could provide the patient in selected cases with this alternative option of endoscopic resection provided; the surgeon is oncologically skilled and equipped to manage the expected complications. Adequate expertise in skull base reconstruction is also mandatory prior to embarking on such surgical voyages, especially when dural breach is noted, necessitating resection and reconstruction. Endoscopic technique of resection and reconstruction is indeed a boon to the new generation of skull base surgeons in providing patient friendly results with improved compliance.

DISCLOSURES:

- (a) Competing interests/Interests of Conflict- None
- (b) Sponsorships - None
- (c) Funding - None
- (d) No financial disclosures
- (e) Animal rights-Not applicable

REFERENCES :

1. J. A. Eloy, R.J. Vivero, K. Hoang et al. Comparison of transnasal endoscopic and open craniofacial resection for malignant tumors of the anterior skull base. *Laryngoscope*, 2009;119:834–840.
2. T.Z. Shipchandler, P.S. Batra, M.J. Citardi et al. Outcomes for endoscopic resection of sinonasal squamous cell carcinoma. *Laryngoscope*, 2005;115:1983-1987.
3. Thaler ER, Kotapka M, Lanza DC, Kennedy DW. Endoscopically assisted anterior cranial skull base resection of sinonasal tumors. *Am J Rhinol* 1999;13:303–310.
4. McCutcheon IE, Blacklock JB, Weber RS, et al. Anterior transcranial (craniofacial) resection of tumors of the paranasal sinuses: surgical technique

- and results. *Neurosurgery* 1996;38:471-479.
5. Har-El G, Casiano RR. Endoscopic management of anterior skull base tumors. *Otolaryngol Clin North Am* 2005;38:133-144.
 6. Y. Bi, SHe, T.Guo. Modified transnasal endoscopic maxillectomy: a novel surgery style of maxillary malignant tumor. *Int J Clin Exp Med* 2016;9(6):11361-11366.
 7. S.K.Singhal, N.M.Nagarkar, A.Dass et al. Endoscopic removal of tumours of nose and paranasal sinuses- our experience. *Clinical rhinology: an international journal*, jan-april 2011,4(1), 27-37.
 8. C. Walch, HStammler, W. Anderhuber et al. The Minimally Invasive Approach to Olfactory Neuroblastoma: Combined Endoscopic and Stereotactic Treatment. *Laryngoscope* 2000;110:635-640.
 9. Edge SB, Compton CC. The American Joint Committee on Cancer: the 7th edition of the AJCC cancer staging manual and the future of TNM. *Ann Surg Oncol*. 2010 Jun;17(6):1471-4.
 10. Goffart Y, Jorissen M, Daele J. Minimally invasive endoscopic management of malignant sinonasal tumours. *Acta Otorhinolaryngol Belg*. 2000;54:221-232.
 11. Casiano RR, Numa WA, Falquez AM (2001) Endoscopic resection of esthesioneuroblastoma. *Am J Rhinol* 15:271-279.
 12. P. Castelnuovo, M. Turri-Zanoni, P. Battaglia et al, Endoscopic Endonasal Approaches for Malignant Tumours Involving the Skull Base; *Curr Otorhinolaryngol Rep* 2013; 1:197-205.
 13. Hadad G, Bassagasteguy L, Carrau RL et al, A novel reconstructive technique after endoscopic expanded endonasal approaches: vascular pedicle nasoseptal flap. *Laryngoscope* 2006;116:1882-1886.
 14. D.R.Nayak, A.D.Ghanpur, A.N.Reddy et al, Smooth muscle tumor of uncertain malignant potential in the nasal cavity: an incidental finding. *BMJ Case reports*, Nov 2016.
 15. D.R.Nayak, A.M.Bhandarkar, A.Gudiseva et al, Paranasal Sinus Malignancies A 6 Year Tertiary Hospital Experience. *Indian Journal of Applied Research* 4(2):2014 · February 2014 Doi: 10.15373/2249555x/feb2014/123.
 16. R Kudva, S Sharma, R Gurijala, D R Nayak, Sinonasal Type Hemangiopericytoma of Nasal Cavity: A Rare Neoplasm, *RRJMHS*, Volume 3, Issue 3, July - September, p 31-36, 2014
 17. E.Hanna, F. DeMonte, S. Ibrahim et al, Endoscopic Resection of Sinonasal Cancers with and Without Craniotomy. *Arch Otolaryngol Head Neck Surg*. 2009;135(12):1219-1224.
 18. P.S. Batra, A. Luong, S.J.Kanowitz et al, Set Outcomes of Minimally Invasive Endoscopic Resection of Anterior Skull Base Neoplasm. *Laryngoscope* 2010;120:9-16, 2010
 19. S.P. Dave, A.Bared, R. R. Casiano et al, Surgical outcomes and safety of transnasal endoscopic resection for anterior skull tumors. *Otolaryngology-Head and Neck Surgery* (2007) 136, 920-927.
 20. Nicolai P, Battaglia P, Bignami M, et al. Endoscopic surgery for malignant tumors of the sinonasal tract and adjacent skull base: a 10-year experience. *Am J Rhinol* 2008;22:308-316.
 21. Lund V, Howard DJ, Wei WI. Endoscopic resection of malignant tumors of the nose and sinuses. *Am J Rhinol* 2007; 21:89-94.
 22. Ganly I, Patel SG, Singh B, et al. Craniofacial resection for malignant paranasal sinus tumors: Report of an International Collaborative Study. *Head Neck* 2005;27:575-584.
 23. Dulguerov P, Calcaterra T. Esthesioneuroblastoma: the UCLA Experience 1970-1990. *Laryngoscope* 1992; 102:843-849.
 24. Bentz BG, Bilsky MH, Shah JP, Kraus D. Anterior skull base surgery for malignant tumors: a multivariate analysis of 27 years of experience. *Head Neck* 2003;25: 515-520.
 25. Roh HJ, Batra PS, Citardi MJ. Endoscopic resection of sinonasal malignancies: a preliminary report. *Am J Rhinol* 2004;18:239-246.
 26. Stammler H, Anderhuber W, Walch C, et al. Possibilities and limitations of endoscopic management of nasal and paranasal sinus malignancies. *Arch Otolaryngol Head Neck Surg* 1999;53:199-205.