Single-stage endoscopic-assisted eye sparing resection with primary orbital reconstruction for sinonasal malignancy*

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To the Editor:

One of the difficulties faced when treating sinonasal malignancies (SNM) is the invasion of the tumour into important structures such as the orbit and the skull base. Invasion of the orbit negatively affects both overall prognosis and disease-free survival [1-3].

Endoscopic techniques have revolutionised the surgical management of SNM; combined transnasal endoscopic and transorbital approaches can facilitate complete tumour resection in cases with bony orbital erosion and invasion [4]. However, resecting the bony orbital walls can have adverse sequelae, such as a risk of hypoglobus or enophthalmos due to loss of support for orbital contents. Reconstruction of the bony orbital defects may reduce the risk of these complications [2].

Whilst several studies focus on orbital sparing surgery, only one reports on functional outcomes and reconstruction techniques following resection of SNM. Unfortunately, this paper includes only open resection techniques [2, 5-7].

This study aims to report our experience of SNM with orbital invasion, where we utilised endoscopic-assisted eye-sparing surgery (EAESS) with single-stage reconstruction and subsequently proposed an orbital reconstruction algorithm.

We undertook a retrospective study of 13 consecutive patients with SNM. We included patients treated with EAESS with/without transorbital approach, orbital reconstruction, and if indicated with adjuvant radiotherapy ± chemotherapy between 2017 and 2022. Indication for orbital reconstruction in our institution is a significant disruption to the periorbital layer and/or defect of the orbital floor confirmed clinically or based on preoperative imaging.

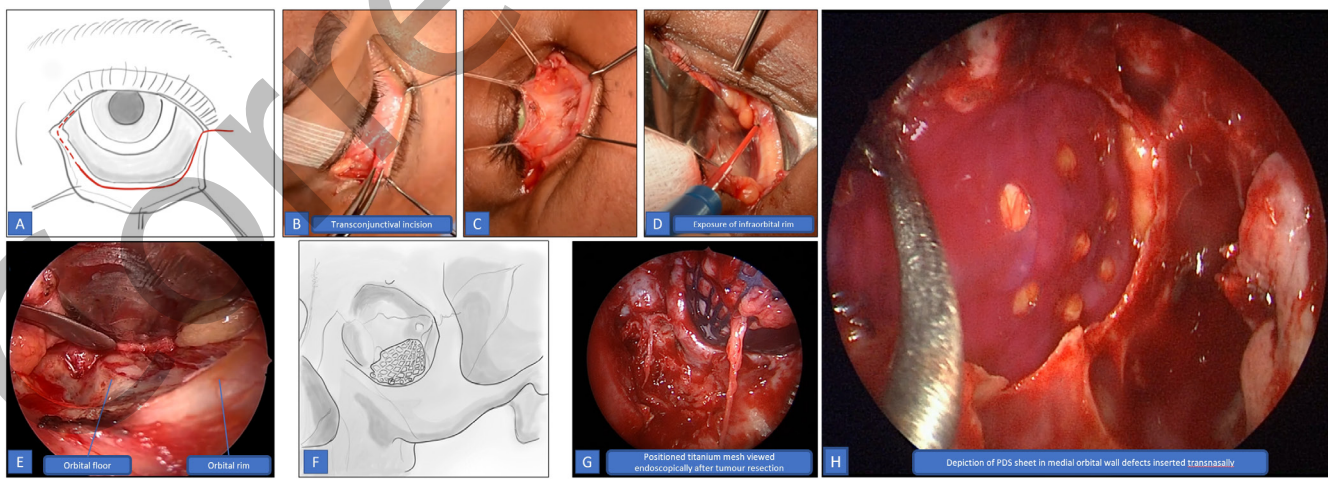

Figure 1. Stepwise depiction of titanium mesh transorbital placement in inferior orbital wall defects. A: Transconjuctival incision with lateral canthotomy; B & C: Initial incision and dissection; D: Exposure of infraorbital rim; E: Exposure of inferior orbital wall; F: Anatomical depiction of titanium mesh placement; G: Positioned titanium mesh viewed endoscopically after tumour resection; H: Depiction of PDS sheet in medial orbital wall defects inserted transnasally.

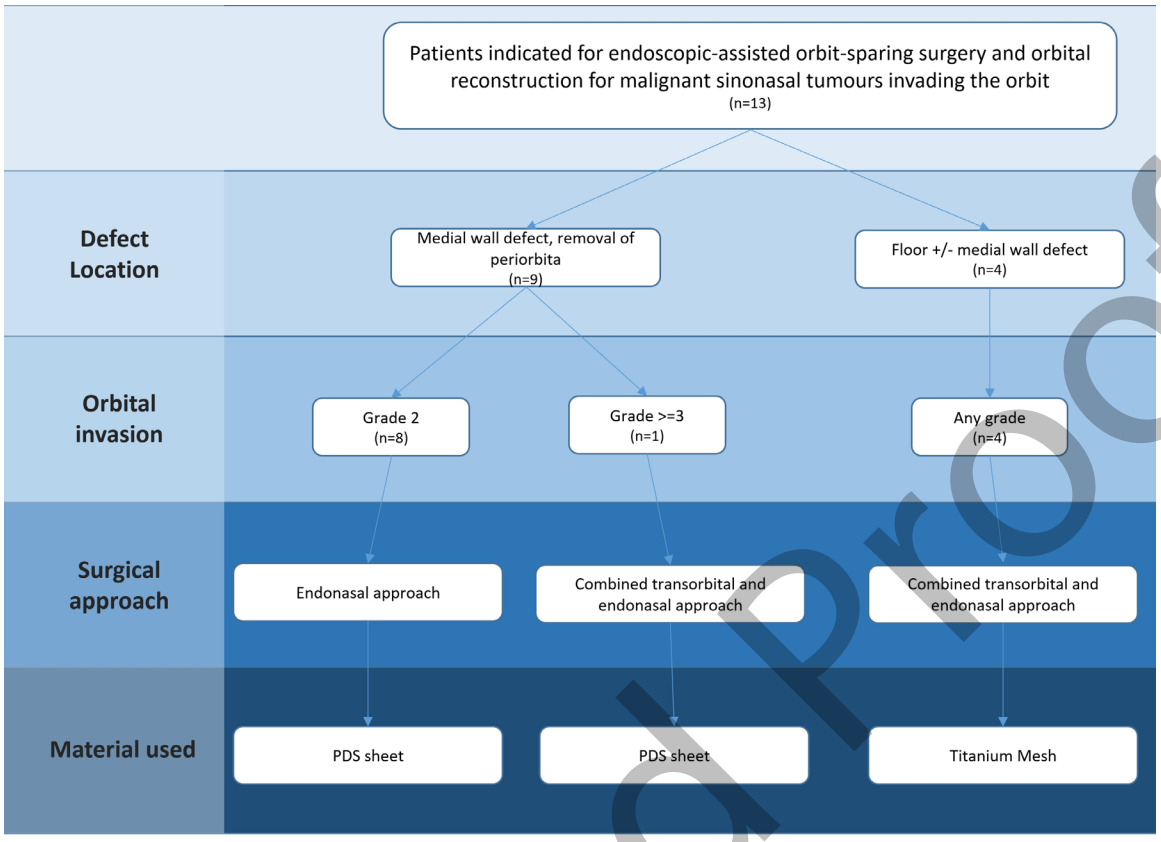

Figure 2. Orbital defect management algorithm.

All included patients underwent preoperative contrast-enhanced MRI and CT scans of sinuses. The classification proposed by Iannetti was used to stage orbital invasion based on imaging [8]. In addition, we used a grading system by Imola and Schramm to assess the overall function in the preserved eye [2] (Appendix 1). Survival data was also analysed.

Tumours were resected via an EAESS. We assessed the completeness of resection using marginal incisions depicted on anatomical diagrams that facilitated multidisciplinary team discussion. In the case of medial orbital wall invasion, the lamina papyracea and periorbita were removed. Medial wall defects were reconstructed using a perforated polydioxanone implant (PDS) to prevent fat prolapse. In cases of minimal periorbital resection, PDS was inserted transnasally. In cases of substantial orbital involvement, we used a transorbital approach in addition to a transnasal approach. Transorbital approach via transcaruncular incision allowed early identification of the lateral extent of the tumour and clear demarcation of uninvolved tissue planes at the orbital interface, allowing for a more controlled operative field (Figure 1).
Orbital floor defects with/without medial wall involvement were an indication for using preformed titanium mesh inserted via a transorbital approach using a transconjunctival incision with lateral canthotomy.
In orbital floor defects, where the risk of hypoglobus is increased, we decided to use titanium mesh due to its robust nature; In medial wall defects where the prevalence of orbital complications is lower, we decided to use a PDS sheet that is easier to insert and manipulate.
The reconstruction material was not covered and thus was allowed to re-mucosalise. The patient started a post-operative nasal irrigation regimen of Neilmed® sinus rinse four times a day for one month. A debridement was undertaken at six weeks if necessary.
Appendix 1 and Figure 1 describe in detail the surgical technique, and Figure 2 depicts our proposed reconstruction algorithm.

A single-stage resection and reconstruction was performed in 12 patients; in one patient (case 1), the reconstruction was performed as a second-stage procedure. Following resection, nine patients (69%) had an isolated medial wall and periorbital defect, subsequently reconstructed using a PDS sheet. The remaining four patients (31%) had a deficient orbital floor following tumour resection therefore titanium mesh was the reconstruction material of choice.

Table 1. Patient demographics including histology, classification and treatment.

Case	1	2	3	4	5	6	7	8	9	10	11	12	13
Age, Gender	61Y, F	60Y, M	30Y, F	84Y, F	57Y, M	66Y, F	28Y, M	68Y, M	62Y, M	59Y, F	83Y, F	57Y, M	78Y, M
Histology	ACC	ITAC	ACC	SCC	IPSCC	IPSCC	IPSCC	IPSCC	NON-ITAC	NON-ITAC	ITAC	SCC	SNARCB1 def SNUC
Origin	E	E	E	MS	E	MS	E	E	2 foci*	E	E	E	E
Classification - AJCC	T4b-N0M0	T3 N0M0	T3 N0M0	T3 N0M0	T2 N0M0[%]	T3 N0M0	T2 N0M0[%]	T4a N0M0	T4a N0M0	T3 N0M0	T3 N0M0	T2 N0M0[%]	T3 N2bM0
Ianetti Classification	3	2	2	3	2	3	2	3	2	2	2	3	2
Orbital involvement	FL, MW, LP, F	MW, LP	FL, MW, LP	FL, MW, LP, F	MW, LP	MW, LP, F	MW, LP	FL, MW, LP	MW, LP	MW, LP	MW, LP	MW, LP, F	MW, LP
Treatment	ER + TO[$]	ER	ER + TO	ER + TO[$]	ER	ER + TO	ER	ER + TO	ER	ER	ER	ER	ER
Adjuvant Treatment	PORT	PORT	-	PORT	-	PORT	-	PORT	PORT + CTx	-	-	PORT	PORT + CTx
Orbital reconstruction	Ti Mesh[&]	PDS	Ti Mesh	Ti Mesh	PDS	PDS	PDS	Ti Mesh	PDS	PDS	PDS	PDS	PDS
Recurrence (Y/N)	N	N	N	Y (at 21m)	N	N	N	N	N	N	N	N	N
Clear margins (Y/N)^	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Disease free years (months	44	42	25	21	41	23	10	14	7	17	10	7	10
Eye function (I-III)	II	I	I	I	I	I	I	I	I	I	I	I	I

[&] Second stage reconstruction; * Two separate foci - right maxillary sinus and left ethmoidal complex; [%] Final staging was downstaged based on histologically negative periorbita and lamina papyracea; [$] Treatment aim in these two patients was palliative; ^ Clear margins were defined as negative frozen sections and marginal biopsies.

ACC=adenoid cystic carcinoma, ITAC=intestinal type adenocarcinoma, SCC=squamous cell carcinoma, IPSCC=inverted papilloma associated squamous cell carcinoma, NON-ITAC=non-intestinal type adenocarcinoma, SNUC=sinonasal undifferentiated carcinoma, FL=orbital floor, MW=medial orbital wall, LP=lamina papyracea, F=fat, E=ethmoidal complex, MS=maxillary sinus, ER=endoscopic endonasal resection, TO=transorbital approach, PORT=post-operative radiotherapy, CTx=chemotherapy.

We observed local recurrence in one patient at 21 months post-operatively. The remaining patients are disease-free. Post-follow-up period all patients were alive.

Twelve patients (92%) had post-operative eye function grade I, all of whom had undergone single-stage resection and reconstruction. One patient had eye function grade II (Case 1). In this patient, we performed titanium mesh reconstruction as a second stage procedure nine months after completion of initial treatment. This led to improvement of enophthalmos, but diplopia persisted. None of the patients had extrusion or infection of the implant during the follow-up period, there has been no morbidity associated with exposed reconstruction materials. In addition, we have not observed reduced sensitivity of the cheek due to infraorbital nerve damage related to reconstruction.

In a large-scale study [(4)] describing management of patients with sinonasal malignancy invading the orbit following EAESS, 33% of patients had some ophthalmologic impairment and 4% had a non-functional eye. Results did not mention utilisation of primary reconstruction or offer details on the staging of orbital invasion in patients with ophthalmological sequelae. Although our study is smaller, only 8% of patients had a post-operative ophthalmological impairment, suggesting that primary reconstruction may be beneficial.

Previously in our institution, it was a standard of care to undergo resection without primary reconstruction. The single case who did not have a primary reconstruction of an orbital floor defect remained disease-free, with significant visual symptoms. Subsequently, a second stage reconstruction was undertaken. The reconstruction was challenging due to scarring, and whilst it

was possible to improve the enophthalmos, diplopia persisted. Emerging evidence that primary reconstruction may improve functional outcomes, alongside our experience in this case, led to a change in our practice for all subsequent cases. A previous study describes a similar experience, concluding that it is crucial to reconstruct extensive orbital defects primarily as defects are refractory to correction in the second-stage once they have become established [2].

There remains a debate about indications for reconstruction following EAESS. It is accepted that removal of the lamina papyracea, or even the medial wall of the orbit, does not affect globe position and movements, and therefore does not have to be reconstructed [2, 9]. However, in our institution, significant disruption to the periorbital layer and/or defect of the orbital floor is deemed an indication for reconstruction.

This study presents a proposed algorithm for single-stage reconstruction of the orbit after endoscopic tumour resection based on our single-institution experience. The key strength of this paper is that all patients were managed according to a set protocol. We present functional outcomes and complication data throughout follow-up, thus sufficient to demonstrate the safety and durability of the reconstructive techniques. The key limitation of this study is the sample size and follow-up duration for presented oncological outcomes.

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Authorship contribution

Conception and design of the paper: PS, CH and AT. Data Collection & Case Ascertainment: PS, RN, AF, RO, and AT. Data analysis: PS and JC. Drafting of manuscript: JC. All involved authors have commented and reviewed the paper.

Conflict of interest

No conflicts of interest.

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SUPPLEMENTARY MATERIAL, APPENDIX 1

We used the classification proposed by Iannetti to stage the orbital invasion based on imaging [9].

- Grade 1 - erosion or destruction of medial orbital bony wall (lamina papyracea)
- Grade 2 - invasion of the periorbital layer and/or focal invasion of the extraconic periorbital fat
- Grade 3 - invasion of the orbital contents (anterior 2/3 of the orbit), including extrinsic ocular muscles, optic nerve, ocular bulb, and the skin overlying the eyelids
- Grade 4 - involvement of the orbital apex.

Tumours were also restaged following the AJCC Staging System (8th edition) [10], and the histologic diagnosis was in accordance with the 4th edition of the WHO Classification of Head and Neck Tumours [11].

Overall function in the preserved eye was graded in accordance with classification described by Imola and Schramm [2]:

- Grade I - functional without impairment
- Grade II - functional with impairment
- Grade III - non-functional.

CT chest and contrast-enhanced MRI neck were used to evaluate for systemic spread. In all patients, biopsies were obtained following the imaging to define the tumour histology. Subsequently, the case was discussed at the regional head and neck MDT, and options for treatment were decided with input from the wider specialty multidisciplinary team.
We adhered to the STROBE guidelines for reporting cohort studies and patient series.

Orbital floor reconstruction using preformed titanium mesh
Here, we present details of Orbital floor reconstruction using preformed titanium mesh (DePuy synthesis matrixORBITAL)

Step 1: Fitting of preformed titanium mesh is performed using transconjunctival approach combined with lateral canthotomy and transcaruncular incision. Prior to endonasal tumour resection, we inserted the mesh intraorbitally and adjusted the shape with the aid of a forming instrument to follow orbital walls that were planned for resection. We also pre-drilled holes on the zygomatic arch.

Step 2: Titanium mesh was removed and silicon elastomer (Silastic®, Dow Corning Corporation, USA) was inserted transorbitally. As described by Amin et al. [5] we used a U-shaped piece cut to an appropriate size for the anticipated defect, and inserted it rolled as a cone via the same transconjunctival incision, adjusting final position based on anticipated resection. The clear sheet allows for visualization during the transnasal endoscopic portion of the tumour removal especially when landmarks are difficult to identify and can help identify the lateral margin of the tumour excision. This also allows the periorbita to be removed, while preventing orbital fat from prolapsing into the nasal cavity.

Step 3: Endoscopic tumour resection.

Step 4: Reconstruction stage was initiated by insertion of titanium mesh intraorbitally whilst Silastic sheet was still in situ and preventing orbital fat prolapse. Once the titanium mesh was secured in place with screws, Silastic was removed.

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