

# Comparison of Functional and Survival Outcomes in Pedicled and Microsurgical Flap Reconstruction for Near-Total and Total Glossectomies

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## Abstract

**Introduction:** Patients with advanced carcinoma tongue end up with near-total/total glossectomy (NTG/TG). We intended to compare functional, oncological, and survival outcomes of patients undergoing pedicled and microsurgical flap reconstruction in NTG/TG patients at our hospital. **Methodology:** A prospective study was conducted for 7 years on 91 patients with carcinoma tongue who underwent NTG/TG at our institute. Patients underwent anterolateral thigh (ALT), free radial artery forearm flap (FRAFF), and pectoralis major myocutaneous (PMMC) flap reconstruction and were followed up for immediate complications and functional outcomes for speech, swallowing, and decannulation after completion of adjuvant treatment and then for survival rates for a period of 60 months and statistically analysed with log rank test and Fisher's exact test for correlation. **Results:** Ninety-one (42.85%) patients underwent NTG, while 57.14% underwent TG. 85% of patients had >5 mm margin, 14% had ≤ of 5 mm, and none were positive. 57% of patients did not have postoperative complications and 10% underwent re-exploration. During follow-up, 85.7% of patients were able to take orally: 52% soft diet and 32% liquid diet. Multivariate analysis of individual flaps, swallowing, and speech intelligibility values were significant. After 5 years of postadjuvant therapy, there was 76% overall survival, 11% local recurrence and 12% had regional recurrence. **Discussion:** Morbidity and functional outcome depends on the extent of resection. PMMC flaps can be done on lack of expertise. FRAFF has better functional outcomes owing to pliability of flap. ALT and other bulky flaps require expertise and are prone to flap-related complications. Planning of reconstruction should be based on the defect size together with counseling of patients regarding the risk of complications and delay in adjuvant therapy.

**Keywords:** Anterolateral thigh flap, free radial forearm flap, near-total and total glossectomies, pectoralis major myocutaneous flap, speech intelligibility

## INTRODUCTION

Carcinoma tongue is one of the common oral cavity malignancies and requires various degrees of resection. In India, most of the patients present with advanced stage and end up with either subtotal/near-total glossectomy (STG/NTG) or total glossectomy (TG). Such surgeries can lead to dramatic impairment of speech and swallowing function and thereby compromised quality of life (QOL). Due to impaired swallowing efforts, some patients have lifetime dependency on the tracheostomy tube.<sup>[1]</sup> Literature suggests that the functional impairment and QOL depends on the extent of resection, with poorer results in patients who have undergone STG/NTG or TG when compared to partial or hemiglossectomy.<sup>[1]</sup> However, with adequate reconstruction, these impairments can be reduced and QOL can be improved.

Initially, pectoralis major myocutaneous (PMMC) flap was used for the reconstruction of the tongue, and at present, due to the refinement of techniques, microsurgical flap reconstruction has gained importance.<sup>[2]</sup> Various studies have quoted that final functional outcome depends on the volume of the reconstructed tongue.<sup>[3,4]</sup> Hence, in this study,

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we intended to compare the functional outcomes of pedicled and microsurgical flaps used in reconstruction for patients undergoing STG/NTG or TG along with its oncological outcome and 5-year survival.

## METHODOLOGY

Between June 2013 and June 2020, 91 carcinoma tongue patients consenting for the study underwent STG/NTG or TG at the Department of Surgical Oncology, Sri Aurobindo Institute of Medical Sciences, Indore. Institutional ethical clearance (SAIMS/IEC/2021/28) was obtained and all procedures performed in the study were conducted in accordance with the ethics standards given in 1964 Declaration of Helsinki, as revised in 2013. Patients underwent clinical and radiological examination and those included were (1) biopsy proven primary tumour located in the tongue or the floor of the mouth (FOM); (2) preoperative magnetic resonance imaging (MRI) showed invasion in the tongue, FOM (3) no distant metastasis, and (4) general condition suitable for surgery. Patients with metastatic disease and those undergoing partial and hemiglossectomy were excluded from the study.

Before ablation of primary tumour, all cases underwent ipsilateral or bilateral neck dissection. According to the literature, we defined TG as Type V glossectomy where the whole mobile tongue including the base of the tongue (BOT) was removed and STG/NTG where the whole tongue was removed with retention of either whole or contralateral BOT.<sup>[5]</sup> If the mandible was invaded by a tumour, segmental resection with the primary tumour was planned; if the tumour had merely spread to the FOM, marginal mandibulectomy was done to achieve R0 margin. There was no pathological evidence of tumour spread to the larynx; therefore, the larynx was preserved in all cases.

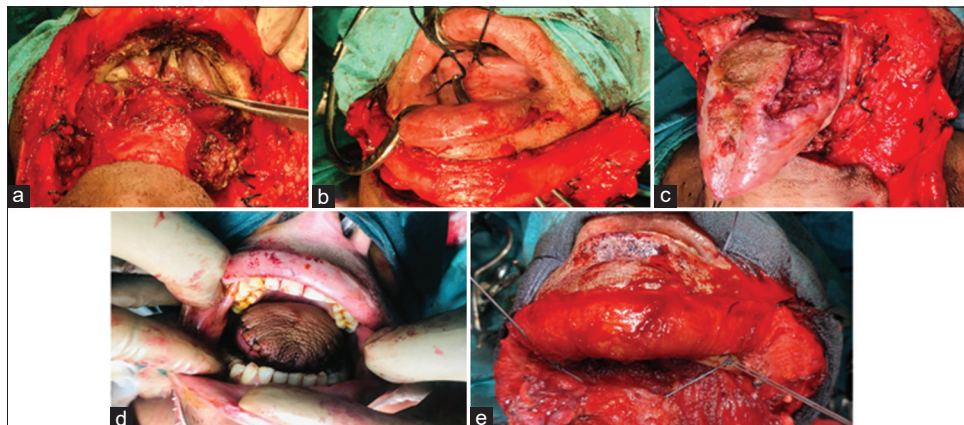
### Reconstruction with flap tissue

In the cases where free flap was planned, surgical oncology team was divided and two teams operated synchronously: one team resected the primary and performed neck dissection,

whereas the other harvested the flap and reconstructed tongue. Pedicled and free flaps were harvested by surgical oncology team. Three types of flap were used for reconstruction: anterolateral thigh (ALT)<sup>[4]</sup> flap, free radial artery forearm flap (FRAFF),<sup>[5]</sup> and pedicled PMMC flap.<sup>[5]</sup> Flap size was determined intraoperatively and was based on the oral cavity defect. The flaps were harvested a bit larger with 30% overcorrection and if required the subcutaneous layer was deepithelialised to add on to the bulk so as to create a dome shape, the dome thus created remains closely in contact with the palate and anteriorly a triangular-shaped protuberance was created [Figure 1]. There was no pathological involvement of larynx and none of the patients required a laryngectomy, hyoid was hitched to the mandible so as to avoid the fall back of the larynx.

### Postoperative follow-up

Patients were in close follow-up for documenting surgical site infection, orocutaneous fistula (OCF), flap status, length of hospital stay, removal of tracheostomy and nasogastric (NG) tube. Patients continued jaw stretching exercises in the wards. Post discharge, patients were followed up based on the NCCN guidelines. Three months after completion of surgery and adjuvant radiotherapy/chemotherapy, all of the 91 patients were referred to the department of rehabilitation for the evaluation and management of swallowing and speech therapy department to assess phonetic functions. Six months after the cancer treatment, swallowing function was assessed by defining the consistency of the diet (soft, liquid, and tube-feeding); the patients could sustain without significant laryngeal leakage or choking. Speech intelligibility was rated on a trinary scale of good, fair, or poor and was evaluated by speech therapists after listening to standardised sentences repeated by the patients. Decannulation of tracheostomy was planned when the patient was able to tolerate liquids after giving a trial. If any signs of aspiration or cough were noted, they were cannulated. Patients were followed up for 5 years to assess the survival and QOL. Speech intelligibility, swallowing, and oncological outcomes were our primary variables, while decannulation and



**Figure 1:** Intraoperative procedure. (a-c) Pull-through technique for glossectomy. (d) Close opposition of (PMMC, FRAFF, and ALT) flap to the palate with anterior triangular shape protuberance. (e) Hyoidolaryngeal suspension. PMMC = Pectoralis major myocutaneous, FRAFF = Free radial artery forearm flap, ALT = Anterolateral thigh

postoperative complications affecting QOL were secondary variables.

**Statistical analysis**

All the flaps used for the reconstruction of glossectomy defect were grouped into PMMC, FRAFF, and ALT and were compared to assess the functional outcomes and their individual complications. Correlation was derived with Fisher’s exact test and  $P < 0.05$  was considered statistically significant. Log-rank test was used to compare the survival between the groups of STG/NTG with TG and primary with salvage surgery.

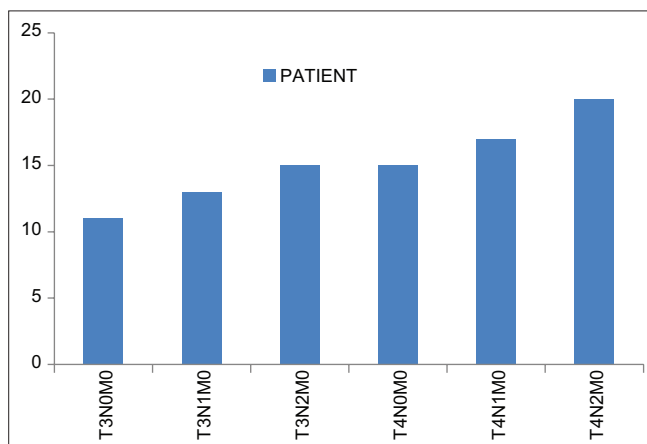
**RESULTS**

Of 91 patients, 64 of them were male and 27 were female with a mean age of 48.1 years (ranged 30–76). In our study subjects, the lesion was found to be evenly distributed in different parts of the tongue with no specific predominance on any part of the tongue [Table 1]. Patients were followed up for a period of 60 months, and 60 (65.93%) patients underwent primary surgery and 31 (34%) underwent postneoadjuvant chemoradiotherapy salvage surgery. Patients underwent metastatic workup, regional contrast-enhanced MRI scan and were staged [Figure 2], 20 patients were of Stage  $T_4N_2M_0$  and 17 patients were  $T_4N_1M_0$ .

Based on histopathological examination (HPE), 79 patients had squamous cell carcinoma while 12 (13%) adenoid cystic carcinoma with 85% patients having margins of  $>5$  mm, 14% had margins of  $\leq$  of 5 mm and none of the margins were involved. Since all the flaps were harvested by surgical oncology team, owing to the learning curve, majority of our flaps were PMMC about 53% and as the finesse improved, based on the remnant volume of the native tongue, FRAFF and ALT flap coverage was done which contributed to 34% and 12% respectively. 52 (57%) patients did not have any postoperative complications, whereas 10 (10%) had to undergo re-exploration owing to kinking of the arterial vessel, and venous thrombosis was seen in 6 and 4 cases of FRAFF and ALT flap, respectively. Four flaps could be salvaged

during re-exploration, while two and four flaps had undergone partial necrosis and complete necrosis, respectively, and had to undergo PMMC reconstruction on a later setting. Nine patients had OCF, which did not require any surgical intervention, were managed conservatively with regular dressings and antibiotic cover which resulted in increase in their hospital stay, morbidity, delayed decannulation and dependency on NG feeds [Table 2]. Of the 91 subjects, 13 and 9 patients were dependent on NG tube and tracheostomy tube, respectively, for more than 21 days, while 14 patients required inpatient care for more than 21 days [Table 3]. This was due to flap-induced morbidity. However, none of the patients had donor site morbidity and there was no mortality.

During follow-up, patients were assessed for the functional outcomes and 85.7% (78/91) of patients were able to take orally, 48 (52%) patients were able to take soft diet and 30 (32%) patients were able to tolerate liquid diet. Based on the Fisher’s exact test, when compared with individual flaps, swallowing ( $P < 0.0001$ ) and speech intelligibility ( $P = 0.015$ ) values were found to be significant. 83.87% (26/31) FRAFF, 54.54% (6/11) ALT, and 32.65% (16/49) PMMC patients constituted 85.7% of patients who tolerate soft diet while 51% (25/49) PMMC, 13% (4/31) FRAFF and 9% (1/11) ALT were among the 32% patients who could tolerate liquid diet. 14% of total patients were dependent on tube feeds where 16% (8/49), 36% (4/11), 3% (1/31) were of PMMC, ALT and FRAFF respectively. On speech intelligibility score, 90% (82/91) of patients were able to communicate. 55% (50/91) of patients had good speech intelligibility, of which 77% (24/31) FRAFF, 54% (6/11) ALT and were 40% (20/49) PMMC respectively. 35% (32/91) had an acceptable speech of which 46% (23/49) PMMC, 27% (3/11)



**Figure 2:** Clinical Staging

**Table 1: Clinical feature of patients**

Patient Characteristics	Number (%)
Age	
$\leq 50$	55 (60.43)
$> 50$	36 (39.56)
Sex	
Male	64 (70.32)
Female	27 (29.67)
Location	
Anterior two third	15 (16.48)
Anterior two third + post third	23 (25.27)
Anterior two third + FOM	15 (16.48)
Post third + extending to BOT	17 (18.68)
Whole tongue + FOM extending to BOT	19 (20.87)
Treatment given	
Primary surgery	60 (65.93)
Salvage surgery	31 (34.06)
Histology	
SCC	79 (86.81)
Adenoid cystic	12 (13.18)

FOM: Floor of the mouth, BOT: Base of the tongue, SCC: Squamous cell carcinoma

**Table 2: Complications and functional outcomes**

	Total (%)	PMMC	FRAFF	ALT	P
Decannulation					
Yes	82 (94.10)	45	30	7	0.017
No	9 (9.89)	4	1	4	
Swallowing capacity					
Soft diet	48 (52.74)	16	26	6	<0.0001
Liquid diet	30 (32.96)	25	4	1	
Tube feed	13 (14.28)	8	1	4	
Speech intelligibility					
Good	50 (54.94)	20	24	6	0.015
Acceptable	32 (35.16)	23	6	3	
Poor	9 (9.89)	6	1	2	
Complications					
SSI	13 (14.28)	7	3	3	0.358
OCF	9 (9.89)	3	1	4	0.009
Re-exploration	10 (10.98)	0	6	4	<0.0001
Flap necrosis	7 (7.79)	1	2	4	0.003
None	52 (57.14)	42	24	7	0.218

SSI: Surgical site infection, OCF: Orocutaneous fistula, PMMC: Pectoralis major myocutaneous, FRAFF: Free radial artery forearm flap, ALT: Anterolateral thigh

**Table 3: Surgery and reconstruction performed**

Surgical features and post-op characteristics	Number (%)
Glossectomy	
Subtotal/near-total	39 (42.85)
Total	52 (57.14)
Margins	
≤5 mm	13 (14.28)
>5 mm	78 (85.71)
Involved	Nil
Reconstruction	
PMMC	49 (53.84)
FRAFF	31 (34.06)
ALT	11 (12.08)
Complications	
SSI	13 (14.28)
OCF	9 (9.89)
Re-exploration	10 (10.98)
Flap necrosis	7 (7.79)
None	52 (57.14)
Length of stay (days)	
≤21	79 (86.81)
>21	14 (15.38)
Duration of NG tube (days)	
≤21	78 (77.92)
>21	13 (14.28)
Locoregional recurrence	
Local	10 (10.98)
Regional	11 (12.08)
None	70 (76.92)

PMMC: Pectoralis major myocutaneous, FRAFF: Free radial artery forearm flap, ALT: Anterolateral thigh, SSI: Surgical site infection, OCF: Orocutaneous fistula, NG: Nasogastric

ALT and 19 (6/31) PMMC while 9% (9/91) had poor speech 18% (2/11) ALT, 12% (6/49) PMMC and 3% (1/31) FRAFF

patients [Table 2]. Postadjuvant therapy, patients were followed up for 5 years, 76% patients were asymptomatic while 11% had local recurrence and 12% had regional recurrence.

**DISCUSSION**

Tongue is a dynamic organ in the oral cavity and involves itself in articulation, mastication, and propulsive function of food in buccal phase of swallowing which is followed by gentle compression of food bolus so as to stretch the receptors in the BOT and pharynx to initiate the involuntary pharyngeal stage of swallowing where uvula contracts and blocks the nasal passage along with contraction of laryngeal muscles closing glottis which is superimposed by closure of epiglottis. This allows the food bolus to be divided into lateral channels to pass through either valleculae and pass down into the oesophagus. Due to its multifunctional role, tongue has a pertinent function in speech and swallowing in humans.

Excision of a part or the whole of the tongue due to oral cancer disturbs its close-knit mechanism in swallowing and speech as the tongue loses its attachments over mandible and pharynx. Intensity of swallowing disturbances due to glossectomy depends on the extent of tissue excision.<sup>[6]</sup> Excision of oral tongue, BOT with or without laryngectomy have the most unfavourable impact on swallowing.<sup>[6]</sup> The most common disturbance occurs in oral stage by limited tongue mobility to form a bolus, impaired glossopalatal seal, and weak glossopharyngeal seal. However, profound impact is seen when there is excision of over 25% of the root of tongue leading to delay of initiation and impaired clearance of residue in pharyngeal stage leading to massive refractory postsurgical aspiration.<sup>[7]</sup> Excision of the adjacent structures in the oral cavity like segmental mandibulectomy affects mastication and increases oral transit time and impairs swallowing.<sup>[8,9]</sup> Suprahyoid muscle excision done in isolation or with segmental mandibulectomy displaces the larynx downward and leads to food retention in pyriform sinus and aspiration.<sup>[10]</sup> The effects are doubled when these patients are subjected to postoperative radiation. Radiation leads to severe mucositis and xerostomia, which further worsens oral and pharyngeal transit time, especially on thicker consistency boluses, greater pharyngeal residue, lower oropharyngeal swallow efficiency, and shorter duration of cricopharyngeal opening.<sup>[11]</sup> The latter effects are the end result of radiation-induced fibrosis of the oropharyngeal musculature, leading to significant reduction in glossopalatal and glossopharyngeal seal.<sup>[12]</sup> All these findings are also seen in patients who have undergone primary chemoradiation, and due to extensive fibrosis and induration, it increases the risk for complications such as poor wound healing, wound dehiscence, and OCF when presented for salvage surgery.<sup>[13]</sup>

In our centre, patients underwent pull-through approach for NTG or TG taking care not to disturb the mandibular integrity, to avoid postoperative pain or any interference in mastication. None of the patients required to undergo segmental mandibulectomy for margin clearance. As the reconstruction was done by surgical oncology team,

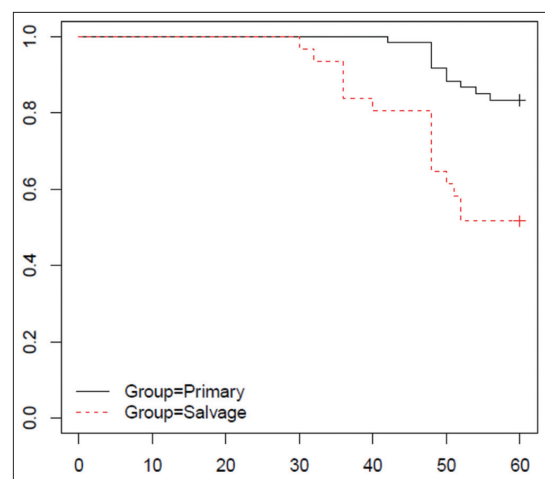


owing to the learning curve, most of the patients received pedicled flap reconstruction, which was then progressed to FRAFF and ALT flap. Considering the fact that flaps undergo shrinkage and fibrosis in due course of time after adjuvant radiation,<sup>[14]</sup> they were harvested in excess of 30% in length and width as suggested by Kiyokawa *et al.*<sup>[15]</sup> Kimata *et al.*<sup>[16]</sup> had suggested flaps to be protuberant or semiprotuberant by deepithelializing the distal ends into arrowhead shape for chewing, swallowing, and especially for speech intelligibility. Furthermore, to bulk the volume in thin patients, Sakuraba *et al.*<sup>[17]</sup> mentioned to insert the deepithelialised portion of skin paddle under the remainder native tissue. There are contrasting studies that re-innervating the flap with hypoglossal nerve reduces muscle atrophy, but its benefits are superseded by adjuvant radiation which negates its effects of functional muscle transfer with fibrosis and contraction.<sup>[18]</sup> Hence, until tongue transplant becomes an option, it is a debate on achieving a better static functional flap reconstruction rather than a dynamic flap.<sup>[19]</sup> Various studies have shown that laryngo-hyoid suspension allowed the larynx to be more in anatomical position by being projected up and forward and reduces its dependency and tension on flap suture line.<sup>[19-22]</sup> In our patients, we followed all these techniques except for the re-innervation. In this study, majority of the patients with FRAFF and PMMC could tolerate soft and liquid diet (85.7%), while the ones who underwent ALT were tube feed depended in spite of following the flap principles, this could be due to the learning curve and also complication like re-exploration and partial flap necrosis did reduce the efficacy of ALT flap. Furthermore, 91% of patients who underwent pedicled and free flap reconstruction were able to communicate. This gives an idea that pedicled and free flaps have comparable functional outcomes in the reconstruction of glossectomy patients. Our center had better results with FRAFF and PMMC flap; this could be due to patients with STG or NTG with remnant native tongue underwent FRAFF reconstruction, giving it as an additional benefit of the remnant native tissue while most of TG patients underwent PMMC and ALT flaps. PMMC flaps requires minimal expertise and can be modified based on the dimensions required and is the workhorse flap in the head and neck reconstruction and can be easily harvested.<sup>[23]</sup> Studies by Hsing *et al.*, Xiao *et al.*, and O'Neill *et al.* showed that PMMC had no significant difference in pain, appearance, swallowing, chewing, and other functional aspects when compared with free flaps, ALT, and FRAFF respectively.<sup>[24-26]</sup> Flap failure rates were minimal in case of FRAFF and PMMC, leading to less patient morbidity. Hence, in the developing countries or in the centers where there is minimal facility, PMMC can be considered for the reconstruction with acceptable cosmetic or functional deficits. In developing countries, tobacco is the main etiology for oral malignancies, and shrinkage of flap or flap fibrosis after adjuvant radiation is often negated with underlying submucosal fibrosis.

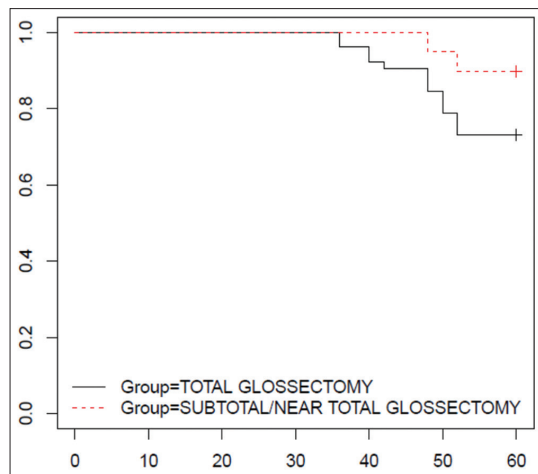
Kaplan–Meier overall survival (OS) curves for the patients for the period of 60 months showed reduced proportion of OS in salvage surgery subgroup and TG subgroup when compared with primary surgery and near-total subgroup, respectively [Figures 3 and 4], probably due to aggressive disease pathology coupled with recurrence and second surgery. None of our patients required total laryngectomy for the margin clearance. Probably, the functional assessment and techniques involved in various flaps for reconstruction would be better if there would have been subgroups with segmental/hemimandibulectomy and laryngectomy. These were the limitations of our study and also we would suggest for future studies comparing the functional outcomes before and after the surgery along with various flap reconstructions, which would give a better understanding in the modifying reconstruction techniques and its outcomes based on the comparison with the pre-morbid state. Subgroup analysis with laryngectomy and in case of salvage surgery would help understand functional outcomes better with various flaps.

## CONCLUSION

Morbidity and functional outcome in glossectomy depends on the extent of resection and remainder of native attachments. Pedicled and free flaps can be used for the reconstruction of the defects. PMMC flaps can be done if there is lack of expertise. FRAFF has better functional outcomes owing to pliability of the flap together with flap inset technique followed in the reconstruction. ALT and other bulky flaps require expertise and are prone to flap related complications, thereby prolonging the morbidity and delay in adjuvant therapy. Planning of reconstruction should be based on the defect size together with better counseling of patients regarding the acceptance of risk of complications and delay in adjuvant therapy based on the expertise offered.



**Figure 3:** Overall survival between primary and salvage surgery group in months



**Figure 4:** Overall survival between total and near-total glossectomy groups in months

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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