



Outcome Evaluation of Mandibular Pull-Through Approach for Glossectomies

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Abstract

Patients with advanced carcinoma tongue in the Indian subcontinent have an additional component of submucosal fibrosis (SMF) due to chewing of betel. We intend to evaluate mandibular pull-through approach for total or near-total glossectomy and assessed its functional and survival outcome. Prospective study of 77 patients with carcinoma tongue, who underwent total or near-total glossectomy at our institute, were assessed retrospectively. All the patients who underwent glossectomy through mandibular pull through approach with pedicled or free flap reconstruction were assessed for functional and survival outcomes. Of the 77 patients, 45 (58.44%) patients underwent total glossectomy, while 32 (41.55%) patients near-total glossectomy, 61 (79.22%) cases had operative time ≤ 30 min, 69 (89.61%) patients had margins of > 5 mm, and none of the margins were involved. Flaps were reconstructed with 42 (54.54%) PMMC, 24 (31.16%) FRAFF, and 11 (14.28%) ALT. Five (6.49%) patients had surgical site infections, 6 patients each had to undergo re-explorations and partial flap loss, 7 patients had oro-cutaneous fistula, while 53 (68.83%) patients had no complications/osteoradionecrosis. A total of 94% of patients underwent decannulation, 92% of patients got discharged, and 89% got NG tube removed within 21 POD. Forty patients had reasonably good speech. On the long-term follow-up, 9% of the patients developed local recurrence and 11% of patients had regional/lymph node recurrence. Mandibular pull-through approach had the advantages of good accessibility to the tumour with the least mutilating techniques with shorter operation time, lower rates of postoperative complications, and better aesthetics and based on available data, it is superior to the mandibular lip-spilt surgery for advanced tongue involving BOT and floor of mouth cancers when coupled with SMF surgeries for the Indian scenario.

Keywords Mandibular pull through approach · Submucosal fibrosis · Total glossectomy · Near-total glossectomy

Introduction

In the oral cavity, the tongue is considered to be a dynamic sub-site with varied functions from assisting with mastication, articulation to participation in the initial steps of deglutition. Malignancies involving the tongue invariably has an associated component of the floor of mouth (FOM) either by primary involvement or requires excision for margins. In the Indian scenario, patients with advanced tongue cancer, involving the base of the tongue, the floor of the mouth, and other sites, usually require total or subtotal glossectomy and most of these patients have an associated component of submucosal fibrosis (SMF) leading to trismus due to chewing of tobacco. For treatment with curative intent, it requires achieving adequate safe surgical margins followed by reconstruction for a reasonable functional outcome and cosmesis. All these three factors are required to be considered for the effective long-term survival of the patient. Literature has

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described various approaches for subtotal or total glossectomy, one being the traditional lip-split approach as a primary option for expanded tongue surgery, but this requires splitting of the lip and mandibulotomy, which severely reduces the patient's quality of life [1]. Various other approaches have been described, one such approach is the mandibular pull-through surgery or drop-down technique. In this study, we intended to evaluate this approach for total or subtotal glossectomy and assessed its functional and survival outcome.

Patients and Methods

A prospective observational study was done between June 2013 and May 2019; 77 patients with carcinoma tongue underwent total or near-total glossectomy at our institution. Before surgery, all the patients underwent a thorough clinical and radiological examination and the criteria for inclusion in the study were as follows: (1) primary tumour located in the tongue or the floor of the mouth and pathologically diagnosed as a malignant disease, (2) preoperative magnetic resonance imaging (MRI) showed invasion of more than one-half of the tongue tissue by primary tumour, (3) no distant metastasis, and (4) general condition suitable for surgery.

Surgical Technique

In this technique, the Visor approach was used and an incision was made from the mastoid on one side to that on the other side, usually in continuity with the neck dissection incision. Subplatysmal skin flaps were raised till the inferior

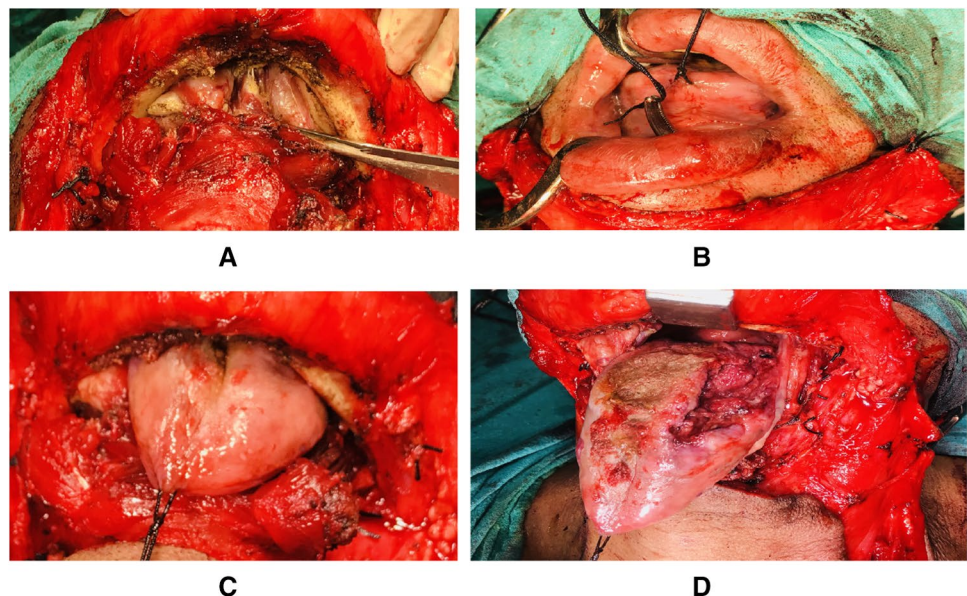
border of the mandible. Bilateral level I regional dissection was performed, and the suprahyoid muscles, i.e., anterior belly of digastric and mylohyoid, were identified and divided 1 cm from its bony attachment to enter into the oral cavity. On the inner aspect of the mandible, the digastric, mylohyoid, geniohyoid, genioglossus (Fig. 1A), and, in turn, the tip of the tongue were held by a suture or Babcock's and continuous traction was given (Fig. 1B). Subsequently, the gingivo-labial sulcus was incised on either side carefully considering for the margins (Fig. 1C) and the tongue was dropped into the neck (Fig. 1D), thereby providing access to all parts of the tongue and oropharynx. Resection and reconstruction were then performed under direct vision and palpation. Reconstruction was done either with pedicled or free flap insertion. Hyoid was hitched to the mandible to avoid the fall back onto the larynx, accurate reattachment of the digastric muscles or remnant genioglossus, and geniohyoid muscles (after subtotal glossectomy) on both sides were sutured to below the flap.

For SMF, excision of fibrotic bands was done with a scalpel and the defect was grafted. If required, an adjunct procedure, like masticatory muscle myotomies, was considered either prior or later after reconstruction [2].

Total and Subtotal Glossectomy

Before ablation of the primary tumour, all cases first required ipsilateral or bilateral neck dissection. According to the literature, we defined total glossectomy as type V glossectomy where the whole mobile portion including the base of tongue (BOT) was removed and subtotal/near-total glossectomy where the whole mobile tongue was removed with either whole or contralateral BOT being preserved respectively

Fig. 1 Intra-op pictures demonstrating the technique. **A** Division of digastric, mylohyoid muscle to access floor of the mouth. **B** Delivery of tongue below mandible with forceps holding the tie. **C** Incision of the gingivo-lingual sulcus. **D** Access to the growth via the pull-through technique



[3]. If the mandible was invaded by a tumour, then segmental resection with the primary tumour was planned but none of the cases had such requirement; if the tumour had merely spread to the floor of the mouth then 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. Patient later underwent ipsilateral modified radical neck dissection (I–V levels) preserving spinal accessory nerve (SAN), internal jugular vein (IJV), and contralateral selective neck dissection (I–III levels) in cases with N_0 neck since the lesion was crossing midline and contralateral modified radical neck dissection (I–V levels) preserving SAN, sternocleidomastoid muscle, and IJV in node positive disease.

Reconstruction with Flap Tissue

In the cases where the free flap was planned, the surgical oncology team was divided and two teams operated synchronously: one team ablated the primary tumour and performed neck dissection, while the other harvested the flap and reconstructed the oral cavity defect. All patients in this study required reconstruction by a flap; three types of flaps were used: free flap including anterolateral thigh (ALT) [4] flap, free radial forearm flap (FRAFF) [5], and vascular pedicle flap including pectoralis major myocutaneous flap (PMMC) [6]. Flap size was determined intraoperatively and was based on the oral cavity defect. On reconstruction, a dome-shaped flap was created to oppose close to the palate.

Post-operative Follow-Up

Patients under the study that were kept in close follow-up, immediate complications like surgical site infection (SSI), oro-cutaneous fistula (OCF), flap status, the length of hospital stay, and removal of tracheostomy and nasogastric (NG) tube were recorded. Patients continued jaw stretching exercises in the wards. Post-discharge, patients were followed up based on the National Comprehensive Cancer Network (NCCN) guidelines. Patients received adjuvant intensity modulated radiotherapy of 56 Gy/28#, 60 Gy/30# in node positive disease with extra capsular nodal spread, and concurrent chemotherapy of weekly cisplatin 30 mg/m² when extra capsular nodal spread. After 3 months of completion of surgery, all of the 77 patients were referred to the Department of Rehabilitation for rehabilitation of speech, swallowing, and phonetic functions. Six months after the cancer treatment, swallowing function was assessed by defining the consistency of the diet, viz., soft diet (patient consumes orally soft and pureed diet), liquid (can consume liquid diet orally and not NG tube dependent), and tube-feeding (NG tube dependent) without significant laryngeal leakage or choking. Speech intelligibility was graded as

good (intelligible speech without repetitions), fair (difficult to understand few repetitions needed), or poor (speech only occasionally understood) based on the trinary scale proposed by Yanai et al. [7], which was evaluated by speech therapists after listening to standardized sentences repeated by the patients. The facial appearance was scored by the patients themselves, and the results were recorded as satisfied, acceptable, or poor. Patients were later followed for 60 months to assess oncological outcomes.

Results

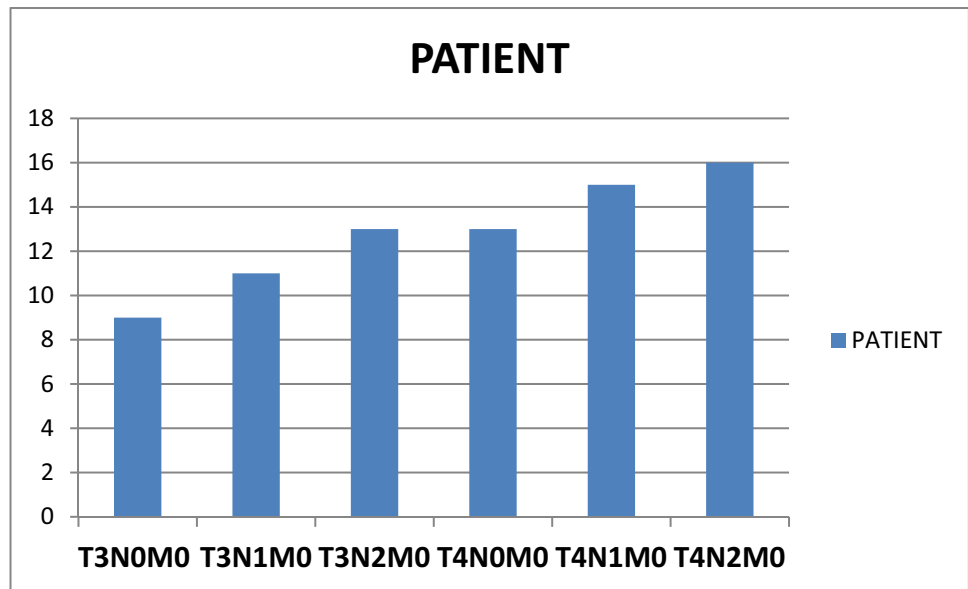
Patient Characteristics

A total of 77 patients were included in our study with 56 (72.72%) males and 21 (27.27%) females in the study with the mean age being 41 years (range 23–64 years). Exactly 21 (27.27%) patients had growth in the anterior two-third extending into the posterior third, while 17 (22%) patient had growth involving the whole tongue, extending to BOT with FOM (Table 1). TNM classification of the growth based on AJCC 7th edition as in Fig. 2, with 16 patients who belonged to $T_4N_2M_0$ and 15 patients who were of $T_4N_1M_0$. All the patients belonged to T_3 and T_4 tumour size group. A total of 45 (58.44%) patients underwent primary surgery, while 22 (28.57%) patients underwent salvage surgery post-radiotherapy of 45 Gy.

Table 1 Patient characteristics

Clinical features of the patients		
Age		
<OR = 50	48	62.33%
> 50	29	37.66%
Sex		
Male	56	72.72%
Female	21	27.27%
Location		
Anterior two-third	13	16.88%
Anterior two-third + posterior third	21	27.27%
Anterior two-third + FOM	11	14.28%
Posterior third + extending to BOT	15	19.48%
Whole tongue + FOM extending to BOT	17	22.07%
Treatment given		
Primary surgery	45	58.44%
Salvage surgery	22	28.57%
Histology		
SCC	69	89.61%
Adenoid cystic	8	10.38%

Fig. 2 TNM staging of tongue cancer



Treatment Parameters

All the patients underwent mandibular pull-through surgery, with 45 (58.44%) patients underwent total glossectomy, while 32 (41.55%) patients subtotal/near-total glossectomy with 61 (79.22%) cases had operative time ≤ 30 min, 69 (89.61%) patients had margins of > 5 mm, none of the margins were involved, and pathologies were 69 (89.61%) SCC and 8 (10.38%) adenoid cystic carcinoma. Flaps were reconstructed with 42 (54.54%) PMMC, 24 (31.16%) FRAFF, and 11 (14.28%) ALT. None of the patients underwent laryngectomy (Table 2).

Postoperative Complications and Functions

Of the 77 patients who were operated on, 5 (6.49%) patients had surgical site infections, 6 patients had to undergo re-explorations and partial flap loss, 7 patients had oro-cutaneous fistulas, while 53 (68.83%) patients had no complications/osteoradionecrosis. A total of 94% of patients underwent decannulation, 92% of patients got discharged, and 89% got NG tube removed within 21 POD.

All the patients were satisfied with the cosmetic outcome as there was only a single visor incision and occasionally vertical limb extension was made in difficult neck dissections. A total of 42 patients and 29 patients were able to tolerate soft and liquid diet respectively (Fig. 3). Six patients are on tube feed and are dependent on NG tube. Forty patients had a reasonably good speech, 31 patients were average, and 6 patients had a poor articulation of speech. On the long-term follow up, 9% of the patients developed local recurrence and 11% of patients had regional/lymph node recurrence (Table 3). On 5-year follow-up of these patients,

20% of patients developed recurrence—7 (9%) had a local recurrence and 9 (11%) had a regional recurrence, despite good margins. Most of these patients belonged to the salvage surgery group. Overall survival was 90% and 40% in the primary and the salvage surgery group respectively (Fig. 4).

Discussion

Carcinoma tongue usually involves many sub-sites. Together with SMF, deep infiltrating, and malignancies involving the posterior third and BOT, it becomes a humongous task to

Table 2 Surgery and reconstruction

Surgery and reconstruction		
Time for resection of primary		
≤ 30 min	61	79.22%
> 30 min	16	20.77%
Glossectomy		
Subtotal/near total	32	41.55%
Total	45	58.44%
Margins		
< 5 mm	8	10.38%
> 5 mm	69	89.61%
Involved	NIL	NIL
Reconstruction		
PMMC	42	54.54%
FRAFF	24	31.16%
ALT	11	14.28%

Fig. 3 Follow-up gastrograffin swallow study in post glossectomy patient demonstrating **A** oral phase, **B** pharyngeal phase, and **C** oesophageal phase

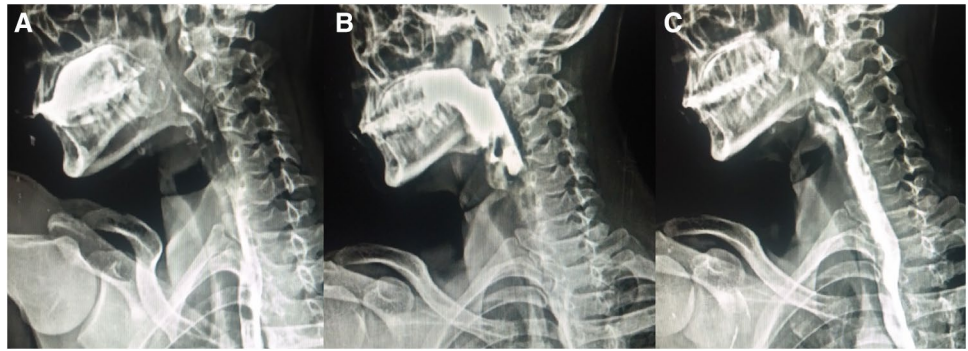


Table 3 Post-op complications and functional outcomes

Post-op complications and functional outcomes		
Complications		
SSI	5	6.49%
OCF	7	9.09%
Re-exploration	6	7.79%
Flap necrosis	6	7.79%
None	53	68.83%
Length of stay		
days	69	89.61%
> 21 days	8	10.38%
Decannulation		
Yes	73	94.80%
No	4	5.19%
Duration of tracheostomy		
≤ 21 days	71	92.20%
> 21 days	6	7.79%
Speech intelligibility		
Good	40	51.94%
Acceptable	31	40.25%
Poor	6	7.79%
Swallowing capacity		
Soft diet	38	49.35%
Liquid diet	22	28.57%
Tube feed	11	14.28%
Duration of NG tube		
≤ 21 days	60	77.92%
> 21 days	11	14.28%
Locoregional recurrence		
Local	7	9.09%
Regional	9	11.68%
None	61	79.22%

resect and reconstruct it. Johanan Fagan [8] had described a few approaches for malignancies involving the posterior third and BOT—firstly, the transoral resection for early tumours with minimal mouth opening and infiltrating tumours in which excision becomes difficult; secondly,

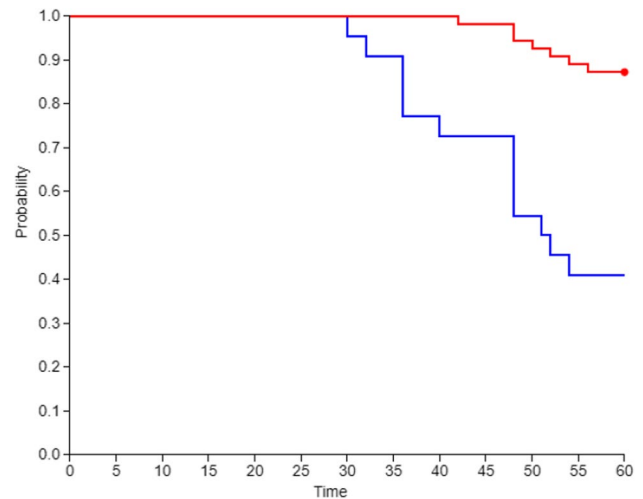


Fig. 4 Overall survival in primary (red) and salvage surgery (blue) in months

the suprahyoid approach, which is one of the external approaches with suprahyoid dissection step during total laryngectomy for BOT with limited access to the cancers that extend far anteriorly into the tongue; the third approach would be the lateral pharyngotomy combined with the suprahyoid approach where an additional exposure can be obtained by extending the incision along the greater cornu of the hyoid bone and the posterior margin of the thyroid cartilage; fourth is the lip-spilt mandibulotomy with mandibular swing approach where median or paramedian mandibulotomy could be done based on the growth and sub-site involved. This approach leads to lip asymmetry and facial scarring [9]. Fifth is the pull-through approach. Studies have also described a visor-flap approach where the flap is raised sacrificing mental nerve causing labial anaesthesia [10].

Although the classical lip-spilt mandibulotomy with mandibular swing approach (with median or paramedian mandibulotomy) allows good access for the resection, various contrasting studies mention complications like mal-union or non-union of the osteotomy, plate failure, wound sepsis, and poor aesthetics and morbidity of up to 35% [2, 11, 12].

There is also uncertainty whether a mandibulotomy should be carried out in a previously irradiated jaw [13]. Functionally, quantitative assessment of the TMJ using the 3D reconstructed models of MRI-CBCT registered image study done by Al-Saleh et al. [14] showed changes occurring at the condylar position with variable degrees of articular disc displacement associated with mandibulotomy with mandibular swing approaches for oral cavity lesions and limits jaw functions and vertical mouth opening in the post-operative follow-up. There were also studies in support of the mandibular pull-through approach where 12 out of 15 patients post-resection were able to maintain an oral diet [15]. For oncological, functional, and cosmetic outcome, we considered mandibular pull-through surgery for the advanced carcinoma tongue lesions in primary and salvage setting. In this technique, combined en bloc resection of tongue lesion and cervical lymphatics was possible with preservation of mandible and lip structures in agreement to findings of Cheng et al. [16]. Also, the lesion was directly visible and we were able to palpate and excise it with adequate margins. This probably could explain 89% of ≥ 5 mm margins with no involved margins and a lower local recurrence rate of 7%, which is in agreement with the studies by Song et al. and Cheng et al. [16, 17]. Thirty-two of our patients had lesions extending into BOT, and we were able to resect with adequate margins. Intra-operatively, once the tongue drops down, early access and ligation at an early course of lingual artery from external carotid artery were possible, minimizing the blood loss and reduced intra-op time of tumour resection (79% cases, ≤ 30 min), while all these and access to BOT could be a cumbersome task in lip-split mandibulotomy technique. No mortality was recorded in this study. The prognosis of resectable cases is considered better than that of unresectable cases, patients undergoing total or subtotal glossectomy for T₃ and T₄ tongue lesions can now be resected to improve the prognosis of cancer that were previously deemed as unresectable [18, 19]. In our study, we had 45 (58.44%) patients who underwent total glossectomy while 32 (41.55%) patients underwent subtotal/near-total glossectomy. Flaps were reconstructed with 42 (54.54%) PMMC, 24 (31.16%) FRAFF, and 11 (14.28%) ALT. To ensure waterproof closure, the flap insert was done posteriorly first and gradually anteriorly to create a dome-shaped protrusion towards the palatal surface. We encountered minimal complications: 5 (6.49%) patients had surgical site infections, 6 patients each had to undergo re-explorations and partial flap loss, 7 patients had oro-cutaneous, while 53 (68.83%) patients had no complications owing to better exposure with this technique and careful flap insertion. No complete flap necrosis was noted. Six patients had to undergo re-explorations due to venous thrombosis immediately on POD₁, and we were able to salvage with minimal necrosis. Cheng et al. in their series used the mandibular lip-split method for patients with

a maximum interincisal opening (MIO) < 15 mm and the pull-through technique for those with larger mouth openings. In this study for SMF, excision of fibrotic bands was done with a scalpel and the defect was grafted, and if required, adjunct procedures like masticatory muscle myotomies were done either prior or later after reconstruction [2]. This provided adequate exposure and helped in flap insertion. No long-term complications like osteoradionecrosis/miniplate exposure, like that seen in lip-split mandibular swing technique, were noticed in this study [20]. Unlike the lip-split mandibular swing technique, where patients usually have pain due to mandibulotomy/TMJ complications [14], here, combined with SMF treatment and the maintained integrity of the mandible, we could start oral liquids early and thereby could achieve decannulation, less dependency of NG tube, and short hospital stay. Anterior–superior hyolaryngeal elevation by hyoid hitch could also have played an adjunct role in early resumption of swallowing function in glossectomy patients [21]. A total of 10% of patients had prolonged stay owing to wound and flap complications; however, no major morbidity or mortality was observed. We followed up with patients, and after 3 months of completion of adjuvant therapy, we got an oral gastrograffin study done and they could swallow the dye with no complication (Fig. 3). Also, with exercises prescribed by the speech therapist, 40 patients had good speech.

In the 5-year follow-up of these patients, 20% of patients developed recurrence—7 (9%) had a local recurrence and 9 (11%) had a regional recurrence, despite good margins. Most of these patients belonged to the salvage surgery group, and they probably would have had a recurrence and succumbed due to aggressive disease pathology. Five-year overall survival (OS) was 90% and 40% in the primary and salvage surgery group respectively (Fig. 4). Minimal post-op morbidity, flap complications, and subjecting them to timely adjuvant radiotherapy could be the reasons for better OS in the primary surgery group.

Limitations of this study were that no recurrent carcinoma tongue lesions were included in the study for a second surgery. None of the cases required laryngectomy, so combined glossectomy with laryngectomy functional outcomes could not be assessed with this technique. None of our patients had mandibular involvement; therefore, segmental/hemi-mandibulectomy with this approach would be challenging as the bone segment can block the orocervical tunnel which would deter the pull-down of oral tissues and en bloc specimen excision due to pre-existing trismus/SMF.

Conclusion

The mandibular pull-through approach had the advantages of good accessibility to the tumour with the least mutilating techniques with shorter operation time, lower rates of postoperative complications, better aesthetics, and based on available data, and is superior to mandibular lip-split surgery for advanced tongue involving BOT and FOM cancers when coupled with SMF surgeries for the Indian scenario. Use of the mandibular pull-through approach for total or subtotal glossectomy provides convenient access for surgery and ensures resection with adequate margins, but cannot bring about any essential change to the survival of patients with advanced oral cancer and requires adjuvant treatment based on the disease pathology involved. Effective surgical treatment can contribute to the survival of these patients combined with new treatment strategies or approach.

Abbreviations SMF: Submucosal fibrosis; POD: Postoperative day; FOM: Floor of mouth; MRI: Magnetic resonance imaging; BOT: Base of tongue; SAN: Spinal accessory nerve; IJV: Internal jugular vein; ALT: Anterolateral thigh flap; FRAFF: Free radial forearm flap; PMMC: Pectoralis major myocutaneous flap; SSI: Surgical site infection; OCF: Oro-cutaneous fistula; NG: Nasogastric; NCCN: National Comprehensive Cancer Network; TNM: Tumour node metastasis; SCC: Squamous cell carcinoma; TMJ: Temporomandibular joint; 3D: Three dimensional; CBCT: Cone beam computer tomography; OS: Overall survival

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