# Benefits of maxillectomy with internal dissection of masticator space by transmandibular approach in the surgical management of malignant tumor of the upper gingiva and hard palate: a clinical review of 10 cases

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Short title: Maxillectomy by transmandibular approach

**Abstract**. The purpose of our study was to review patients with tumors that extended to the posterior portion of the upper gingiva and hard palate, and to evaluate the postoperative outcomes. Ten consecutive patients with tumors in the upper gingiva and hard palate, who underwent maxillectomy with internal dissection of the masticator space by the transmandibular approach were retrospectively reviewed. Among the 10 patients, the pathological diagnoses were 7 squamous cell carcinomas, adenoid cystic carcinoma, malignant melanoma, and osteosarcoma, respectively. Loco-regional control was achieved in 8 of 9 patients (88.9%). Two patients had residual moderate trismus. Cosmetic issues were not noted in any patients. En bloc resection of the maxilla with the internal portion of the masticator space and neck through the parapharyngeal space by the transmandibular approach is useful and satisfactory for the excision of a tumor with involvement of the posterior portion of the upper gingiva and hard palate.

## Introduction

Oral cancer represents about 1-3% of all human cancers, and is the 6th most frequent cancer in the world.[1,2] Oral cancer continues to show a poor prognosis and remains a lethal disease for more than 50% of cases diagnosed annually.[3] The upper gingiva and hard palate, subsites of the oral cavity, represents 10% of all oral cancers.[4] Oral cancers of the upper gingiva and hard palate often have similar clinical presentations and management because of their adjacent anatomies; however, the relative rarity of these cancers compared to other primary sites has resulted in only small case series lacking survival or other outcome analyses.[5-11] Several reports have revealed that patients with a tumor that extended to the retromaxillary region, oropharyngeal soft palate or infratemporal fossa had poor survival outcomes.[8,12,13] One of the reasons for the poor prognosis of these cases is thought to be recurrence in the parapharyngeal space or the masticator space.[8,12-14] Some lymph vessels of the maxilla are known to pass through the parapharyngeal space and flow out into the upper jugular lymph nodes. Therefore, we previously suggested the necessity of en bloc resection of the maxilla and neck through the parapharyngeal space by the transmandibular approach in patients with a tumor that extended to the retromaxillary region.[12,13] Moreover, the masticator compartment of the infratemporal fossa is an obvious source of local recurrence in maxillary malignant tumors with posterior extension to the infratemporal fossa.[8,14,15] Anatomically, the masticator space is delineated by the superficial layer of the deep cervical fascia. At the base of the mandible, the superficial layer of the deep cervical fascia splits into two layers.[16,17] The outer layer encloses the masseter muscle, extends over the zygomatic arch and attaches to the temporalis muscle and the lateral orbital wall. The inner layer extends deep into the medial pterygoid muscle and attaches to the skull base medial to the foramen ovale (Fig. 1A). These two layers fuse along the

anterior and posterior borders of the mandibular ramus, enveloping the space. This space includes the mandibular nerve and its branches, internal maxillary artery and its branches, adipose tissue and masticatory muscles (Fig. 1B). Oral cancer adjacent to the masticator space can deeply invade the masticator space components simply because of anatomic vicinity, and is staged as T4b.[18] At this site, surgical resection by a conventional approach is often difficult, resulting in unsatisfactory survival.[18] In particular, a tumor with involvement of the posterior portion of the upper gingiva and hard palate sometimes relapses at the infratemporal fossa in the internal portion of the masticator space.[8,12,13,15] In such cases, some authors have proposed that the transmandibular approach was an effective technique for maxillectomy with internal dissection of the masticator space.[12,13,14,19]

The purpose of our study was to review our patients who underwent a maxillectomy with internal dissection of the masticator space by the transmandibular approach and to evaluate the postoperative outcomes.

## Patients and methods

### Patients

From 2004 to 2012, 10 consecutive patients with involvement of the posterior portion of the upper gingiva and hard palate (Fig. 2), who underwent maxillectomy with internal dissection of the masticator space by the transmandibular approach were retrospectively reviewed (Table 1). Staging was performed using clinical data recorded at the time of initial assessment of each patient according to the TNM classification system of the American Joint Committee on Cancer (AJCC), sixth edition.

**Surgical procedure of en bloc resection of the maxilla with the internal portion of the masticator space and neck through the parapharyngeal**

## space by the transmandibular approach

The technique of en bloc resection of the maxilla and neck through the parapharyngeal space has been previously described.[12,13,14] The surgical technique for en bloc resection starts with an incision in the lower lip and mandibular split after dissection of the neck (Fig. 3A and B), followed by resection of the medial pterygoid and temporalis muscles from the mandible (Fig. 3C). The inferior alveolar neurovascular bundle is cut off after ligating at the mandibular foramen (Fig. 3D), followed by resection of the lateral pterygoid muscle from the condyle, and the mandibular ramus is pulled upwards and backwards (Fig. 3E). The styloid process is cut off at the base, and the stylohyoid, styloglossus, and stylopharyngeal muscles are resected. The external carotid artery is ligated and cut off beyond the lingual artery branch, and the dissection is extended along the internal carotid artery into the posterior part of the parapharyngeal space while palpating the pharyngeal constrictor muscle. Maxillectomy is then performed in the usual manner. The upper cheek flap is raised over the maxilla through the upper gingivobuccal incision. This allows exposure to the orbital rim. After a standard osteotomy for maxillectomy, the soft tissue of the infratemporal fossa along with the pterygoid muscles is left attached to the pterygoid plates (Fig. 3F). This is followed by osteotomy in the upper part of the pterygoid process, and the maxilla and the internal portion of the masticator space and neck are resected en bloc through the pterygoid muscle and parapharyngeal space (Fig. 4). Finally, a large flap, usually a free radial forearm or rectus abdominis flap, is transplanted to the parapharyngeal and buccal space to minimize cosmetic issues and difficulties with swallowing.

## Assessment of complications

Complications were assessed related to the surgical procedure of en bloc resection of

the maxilla and neck through the parapharyngeal space, including trismus, osteotomy site infection, cosmetic issues, difficulty with swallowing, or paresis of the inferior alveolar and lingual nerves. Trismus is defined using a gradual classification: mouth opening >30 mm indicates normal or light trismus, mouth opening between 15 and 30 mm indicates moderate trismus and mouth opening <15 mm indicates severe trismus.[20] These complications were evaluated 6 months postoperatively.

# Results

## Patient characteristics

There were 7 men and 3 women, with a median age 61.5 (range, 37 to 82). Among the 10 patients with tumors, the pathological diagnoses were squamous cell carcinoma (SCC; n = 7), adenoid cystic carcinoma (ACC; n = 1), malignant melanoma (n = 1), and osteosarcoma (n = 1), respectively. All patients underwent neck dissection at the same time as resection of the primary tumor. Patients presenting with a clinically positive metastatic cervical lymph node underwent modified radical neck dissection (mRND type II, n = 7), whereas patients with a clinically negative metastatic cervical lymph node underwent supraomohyoid neck dissection (SOHND, n = 1) or selective neck dissection (SND, n = 2). Eight patients were reconstructed with free vascularized flaps (radial forearm flap, n = 6; rectus abdominis flap, n = 1) or pectoralis major myocutaneous flap, and all flaps survived without complications at the donor site.

## Treatment outcome and complications

All tumors were removed en bloc with sufficient safety margins except for one adenoid cystic carcinoma in the maxilla with positive histologic margins. Pathologic examination of the surgical specimens revealed metastatic lymph nodes in 7 cases.

Postoperative adjuvant radiotherapy of 60 Gy was given in 2 patients.

Mean and median overall survival were 56.5 and 42 months, respectively. Seven patients (70%) are alive without evidence of disease. Local control was achieved in 8 of 9 patients (88.9%). One patient developed local recurrence 10 months postoperatively. However, this patient underwent salvage resection and is alive without evidence of disease. One patient who developed regional recurrence died of disease after 10 months, but this regional recurrence was contralateral neck recurrence.

Complications related to the procedure are presented in Table 2. Trismus was a common complaint, which improved with time and physiotherapy in all but 2 patients who had residual mouth opening between 15 and 30 mm (moderate trismus, +). Osteotomy-related complications such as metal miniplate exposure, infection, or nonunion were not noted in any patients. Cosmetic issues because of the incision in the lower lip were not noted in any patients (Fig. 5). Two patients had a slight difficulty with swallowing. The inferior alveolar and lingual nerves were assessed. The inferior alveolar nerve was sacrificed in 8 patients, and other patients had temporary paresis of the nerve. Hypoanesthesia of the lingual nerve was not noted in any patients with preservation of the lingual nerve.

## Discussion

The overall or absolute 5-year survival for the upper gingiva and hard palate ranges from 24% to 80% and is difficult to interpret, as they are often grouped to include other sites and other pathological entities, such as salivary gland tumors.[5,8] In general, there is a trend toward a worse survival outcome in advanced disease stages, as observed in other series. Some authors have reported that patients with advanced primary tumors of the upper gingiva and hard palate exhibited high rates of regional failure.[6-11] In most

cases, successful salvage was not achieved. These retrospective studies recommended that elective neck dissection be considered for patients with SCC of the upper gingiva and hard palate.[7,9-11] In the current cases, elective neck dissection was performed in 3 patients who were clinically as node-negative and were found to be pathologically N0. In this study, the necessity of elective neck dissection was not noted because of the small number of cases. Some authors reported that a few patients with involvement of the posterior portion of the upper gingiva and hard palate died of metastases to the lateral retropharyngeal node, despite successful control of local and regional tumors.[12,13,21,22] There are two main routes for lymphatic vessels from the maxilla to the neck. The first runs from the maxillary gingiva to the submandibular nodes through the buccal lymphatic vessels or buccal nodes. The second runs from the soft palate to the upper jugular nodes through the parapharyngeal or retropharyngeal space. The lateral retropharyngeal nodes are located in the lateral area of the retropharyngeal space. Previously, the authors reported that carcinoma with involvement of the posterior portion of the upper gingiva and hard palate sometimes metastasized to the lateral retropharyngeal lymph node through the parapharyngeal or retropharyngeal space.[12,13,22] Therefore, we proposed that en bloc resections of the maxilla and cervical lymph nodes through the parapharyngeal space should be performed in patients with posteriorly invasive maxillary cancer accompanied by lymph node metastases in the upper jugular region.[12,13] In our current cases, only one of 10 cases showed neck failure; however, this patient died of distant metastasis to the lung because of contralateral neck recurrence. We considered that the improvement of regional control in patients with posteriorly invasive maxillary cancer benefited from en bloc resection of the maxilla and cervical lymph nodes through the parapharyngeal space.

Some investigators reported that there seemed to be a worse prognosis when the

infratemporal fossa was involved compared with when there was no infratemporal fossa involvement.[8,12,13,15] McMahon et al.[15] reported that the masticator compartment of the infratemporal fossa was an obvious source of recurrence. The contents of this space are mainly the mandibular nerve and its branches, internal maxillary artery and its branches, adipose tissue, and masticatory muscles such as the medial and lateral pterygoids, masseter, and temporalis. The masticator pace is infiltrated by the direct spread of cancer from the maxillary alveolus and palate posteriorly.[8,15] The trismus that commonly accompanies masticator space involvement often makes physical examination difficult, so CT and MR imaging are important for characterizing and mapping of the pathology.[17,23,~~24~~] In our current cases, tumor involvement of the masticator space was assessed by both CT and MRI. In general, the pattern of local recurrence is largely predictable and explained by anatomical considerations. Specifically, the posterior and superior portions of the upper gingiva and hard palate, which are more difficult to access, are the most common portions of relapse.[15] Maxillectomy is usually performed through a Weber-Fergusson incision. With this approach, however, it is difficult to access the pterygoid process, masticator space including pterygoid muscles, or infratemporal fossa extensively.[14-15] ~~Tiwari[25]~~Tiwari[24] reported the use of a transmandibular approach for total maxillectomy for en bloc resection of the pterygoid process with infratemporal muscles in addition to the maxillectomy specimen. We have adopted this surgical approach for patients with involvement of the posterior portion of the upper gingiva and hard palate.[12,13] In this series, local recurrence was not observed in any of the 10 cases.

Hence, we considered that en bloc resection of the maxilla and neck using the mandibular swing approach in tumors extending from the posterior portion of the upper gingiva and hard palate to the masticator space could be useful and satisfactory for

loco-regional control. On the other hand, trismus is the most common complication of the procedure. We previously reported that trismus became minimal by resection of the pterygoid muscles at the same time as parapharyngeal dissection using the mandibular swing approach. Chatni et al.[14] reported that postoperative trismus was due to periarticular fibrosis at the temporomandibular joint, and this complication could be minimized to a certain extent by performing a coronoidectomy. In our series, however, 3 patients had residual moderate trismus, one patient was reconstructed with a pectoralis major myocutaneous flap, and other 2 patients did not undergo reconstruction. Therefore, we concluded that reconstruction using free vascularized flaps such as a radial forearm flap and rectus abdominis flap should be performed whenever possible. Nair et al.[19] reported that postoperative trismus was associated with the postoperative radiotherapy. However, our 3 patients with residual moderate trismus did not received postoperative radiotherapy. In our series, we could not clarify the effect of postoperative radiotherapy on trismus. Naturally, the complication of trismus should be managed by aggressive postoperative physiotherapy.

~~Although the Weber-Fergusson incision has been the classic approach for surgical management of maxillary tumors, this incision leads to poor cosmesis due to ectropion and upper lip scarring.~~ For en bloc resection of the maxilla with the internal portion of the masticator space and neck through the parapharyngeal space, the mandibulotomy is crucial procedure. The lower lip incision used for a mandibulotomy formed the upper part of the Macfee incision without additional incisions.[16] ~~In the lip split and mandibulotomy, moreover, effective methods that improve functional and aesthetic outcomes have been reported.[16,26]~~[19,25] In our series, cosmetic issues because of the incision in the lower lip were not noted in any patients. We therefore concluded that lip split mandibulotomy for access to the maxilla without additional upper lip incision

could result in good cosmesis.

In conclusion, en bloc resection of the maxilla with the internal portion of the masticator space and neck through the parapharyngeal space by the transmandibular approach is useful and satisfactory for excision of a tumor with involvement of the posterior portion of the upper gingiva and hard palate. This approach allowed good surgical access to the masticator space or parapharyngeal space, and resulted in the improvement of loco-regional control.

## Competing interests

None declared.


## Funding

None.


## Ethics approval

This study was approved by the ethics committees of the Nagasaki University Hospital.

## Patient consent

Consent obtained.

## Statement to confirm

All authors have viewed and agreed to the submission

## Figure legends

*Fig. 1.* Anatomy of the masticator space. (A) Coronal line diagram shows the superficial layer of the deep cervical fascia splitting into two layers at the base of the mandible. The outer layer encloses the masseter muscle, extends over the zygomatic arch and attaches to the temporalis muscle and the lateral orbital wall (1). The inner layer extends deep to the medial pterygoid muscle and attaches to the skull base medial to the foramen ovale (2). (B) Axial line diagram shows the outer and inner layers fusing along the anterior and posterior borders of the mandibular ramus and enveloping the space. The masticator space includes the mandibular nerve and its branches, internal maxillary artery and its branches, adipose tissue and masticatory muscles. Note the close relation of the masticator space with the prestyloid parapharyngeal space (black dots) medially. MP, medial pterygoid muscle; M, masseter muscle; LP, lateral pterygoid muscle; T, temporalis muscle; FO, foramen ovale, P, parotid gland; ECAR, external carotid artery; ICAR, internal carotid artery; JUG, jugular vein; STY, styloid process.

*Fig. 2.* Computed tomography shows a tumor extending to the posterior portion of the upper gingiva and hard palate, pterygoid plates, and masticator space.

*Fig. 3.* Intraoperative photographs. (A) Lower lip split and mandibulotomy after dissection of the neck. Site of mandibulotomy anterior to the mental foramen. (B) Subperiosteal dissection of the lingual aspect of the mandible. (C) The mandible was swung laterally, offering wide exposure of palatal, labial, and infratemporal surfaces of the maxilla. The medial pteryngoid muscle was detached from the mandible. (D) The mandible was swung further, cutting the inferior alveolar neurovascular bundle at the

mandibular foramen (hemostatic forceps pointing). (E) After resection of the lateral pterygoid muscle from the condyle, the mandibular ramus was pulled upwards and backwards. (F) Further mandible swing gave good exposure of the internal portion of the masticator space, and was followed by osteotomy of the upper part of the pterygoid process (white arrow).

*Fig. 4.* Final surgical specimen shows en bloc resection of the maxilla with the internal portion of the masticator space and neck through the parapharyngeal space.

*Fig. 5.* Postoperative appearance of a patient showing good cosmesis.

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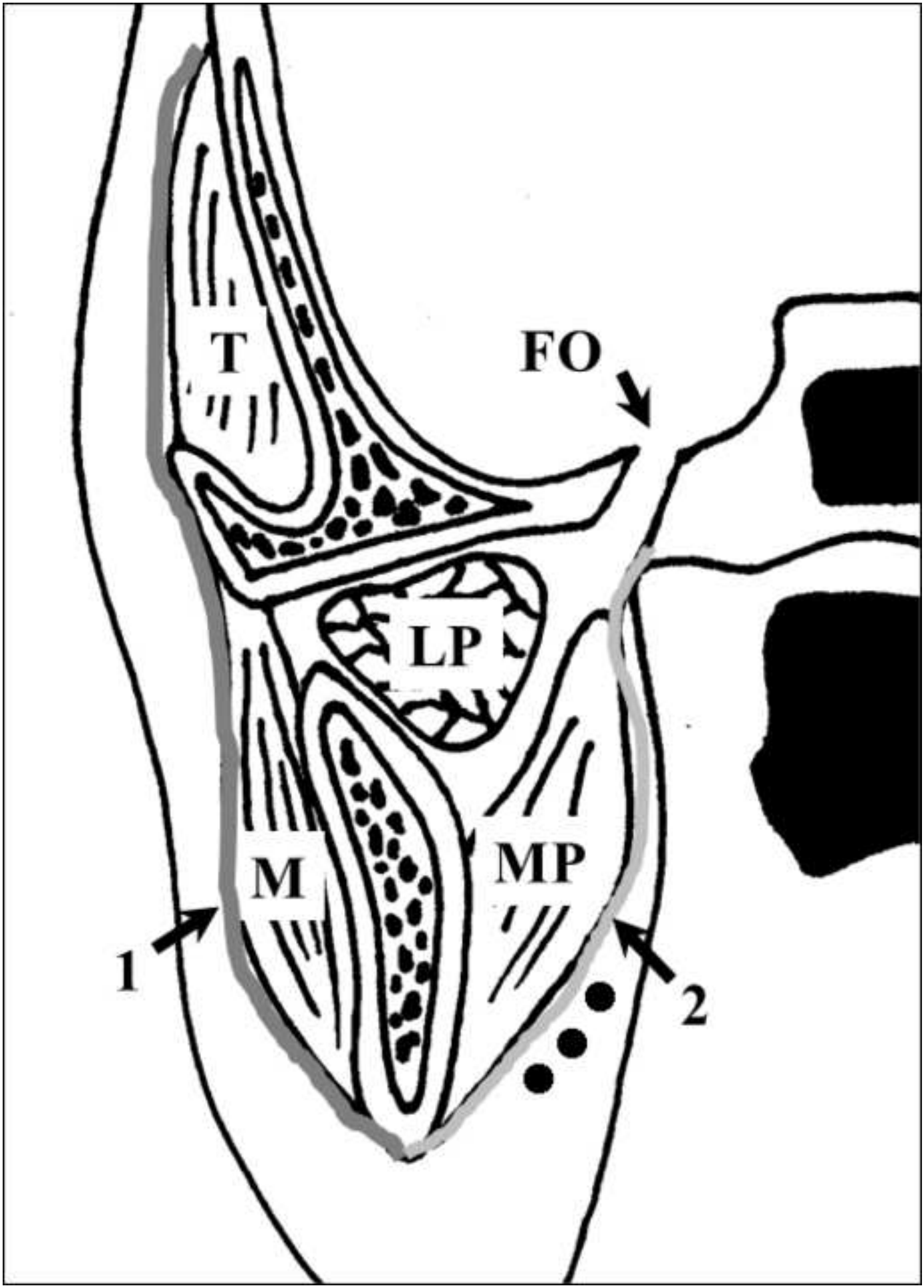
Figure 1A



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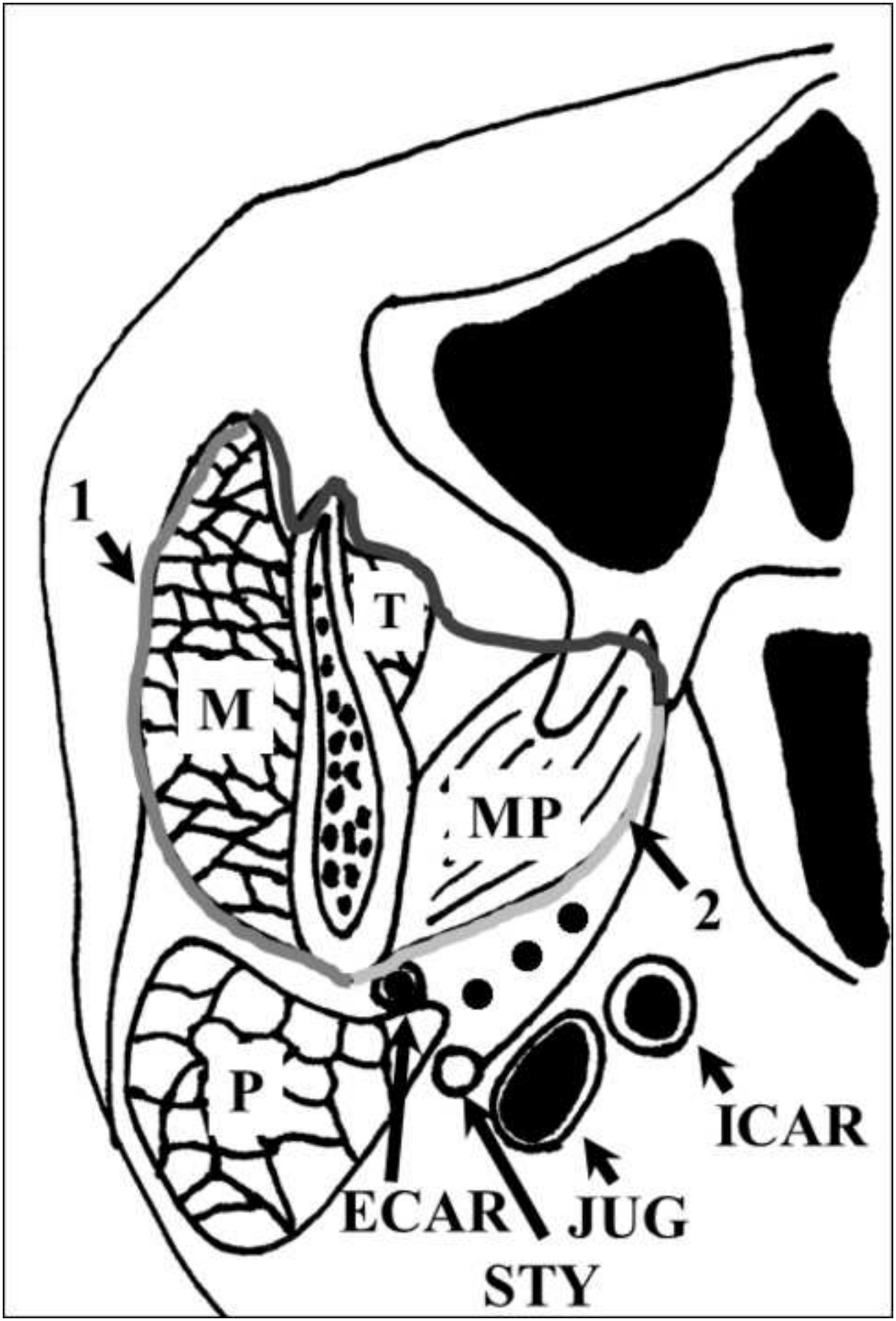

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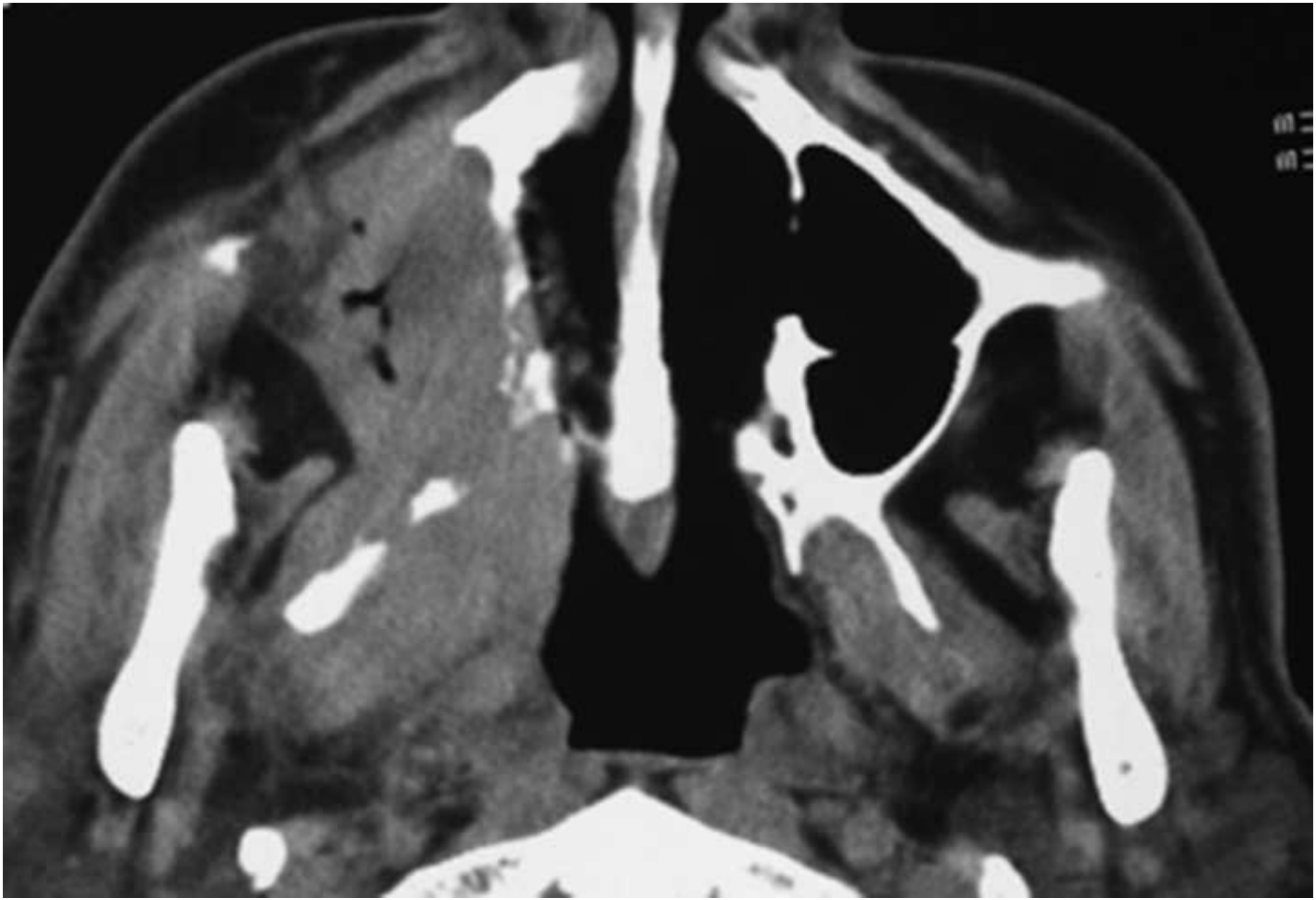

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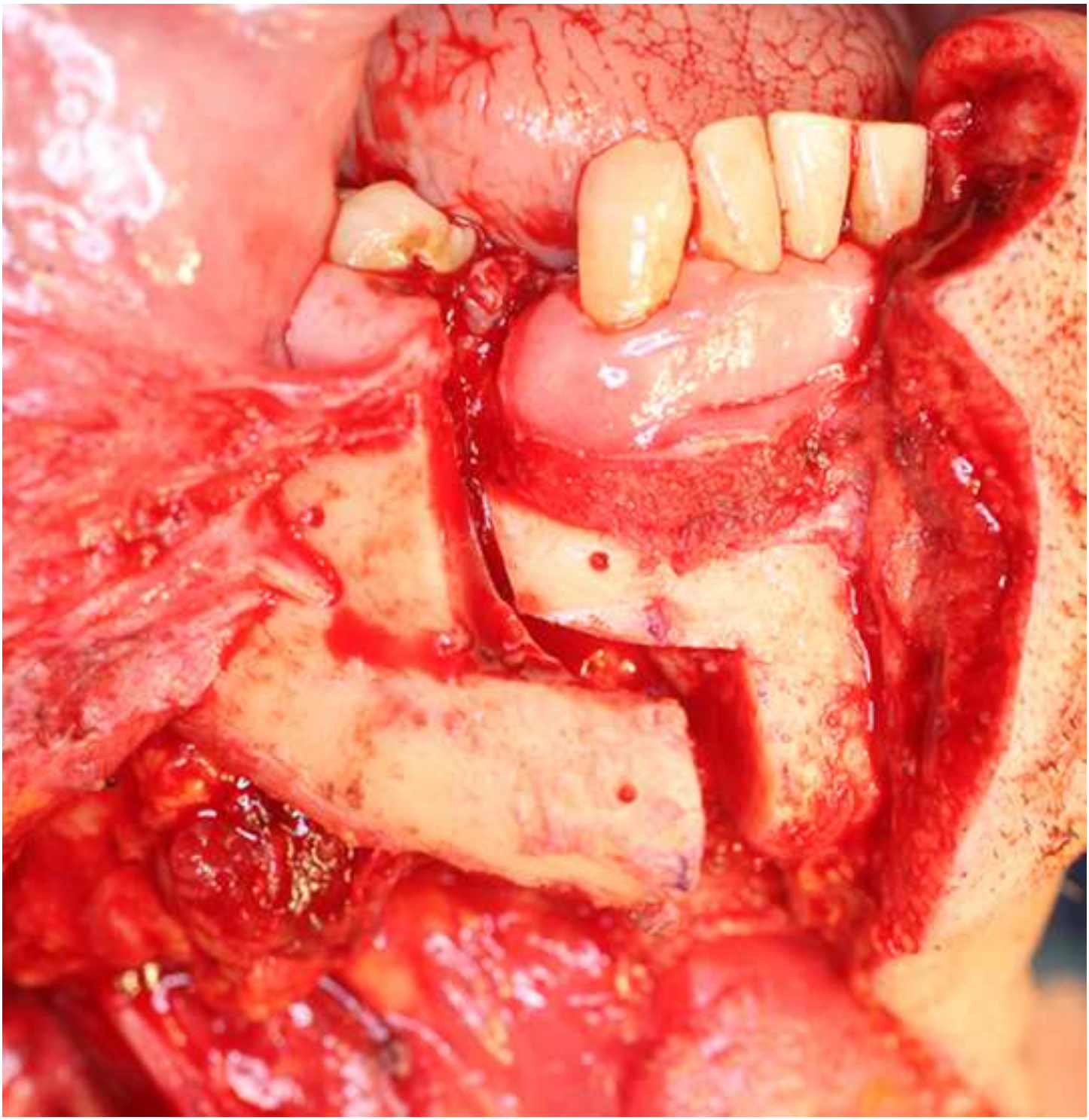

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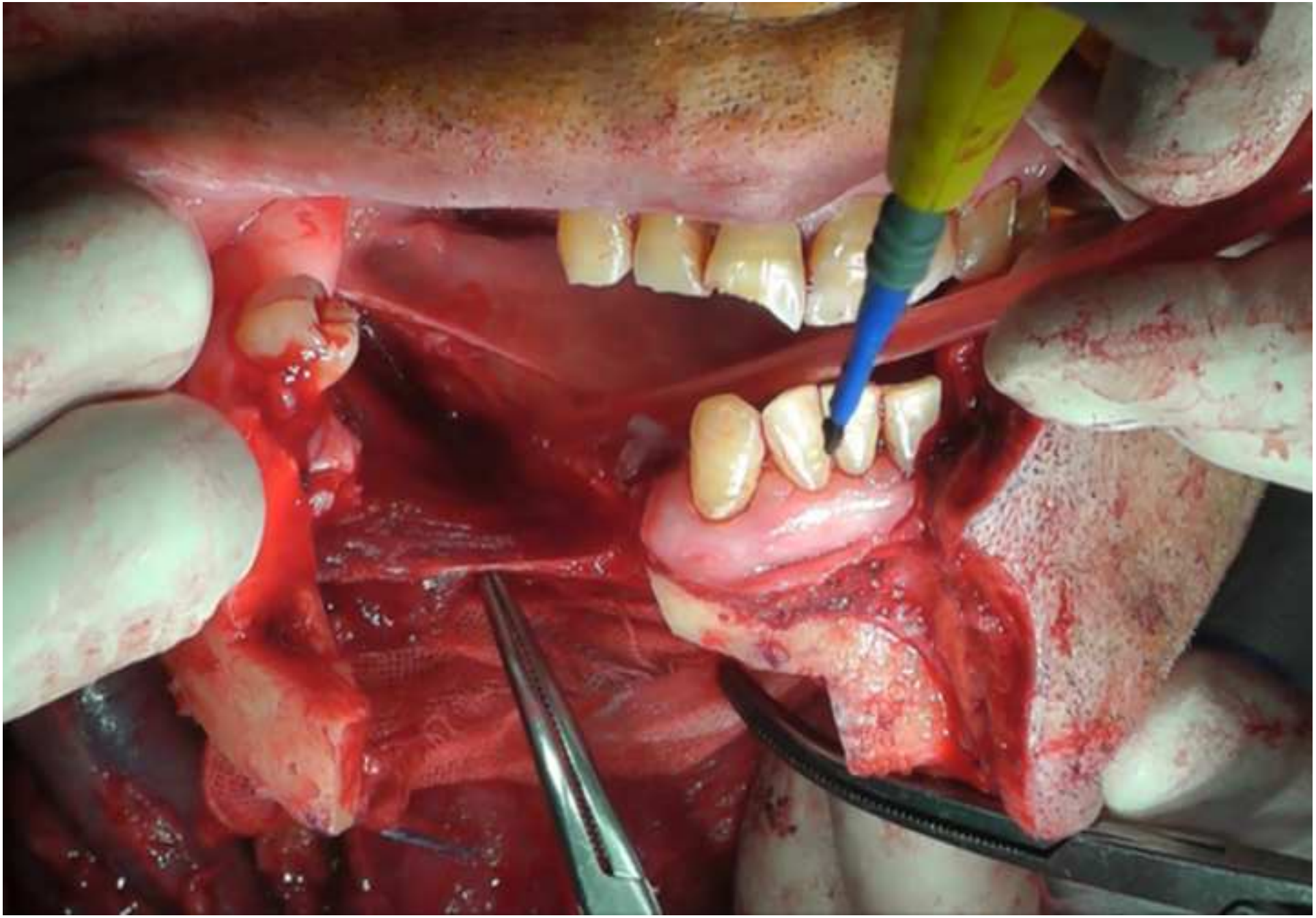

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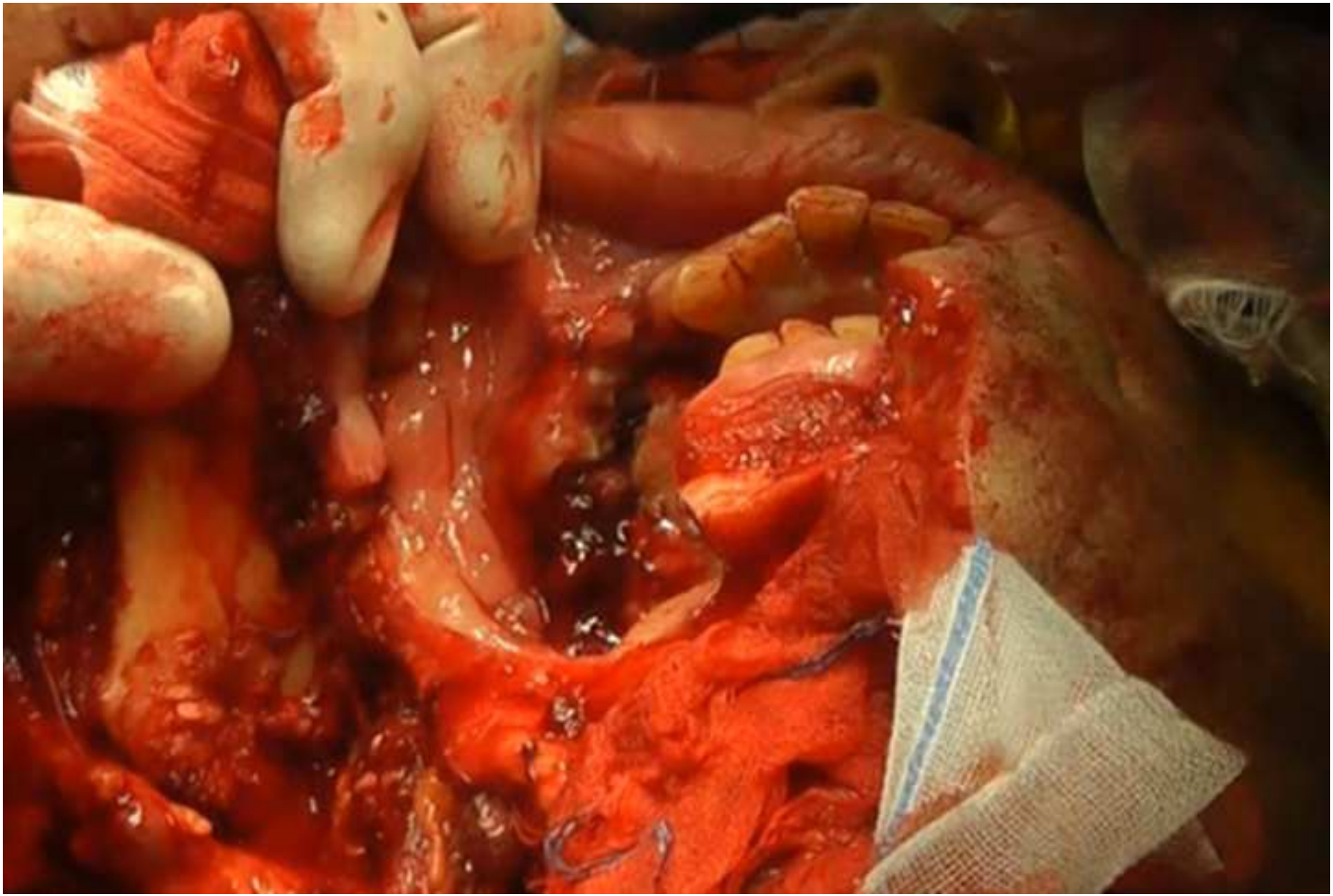

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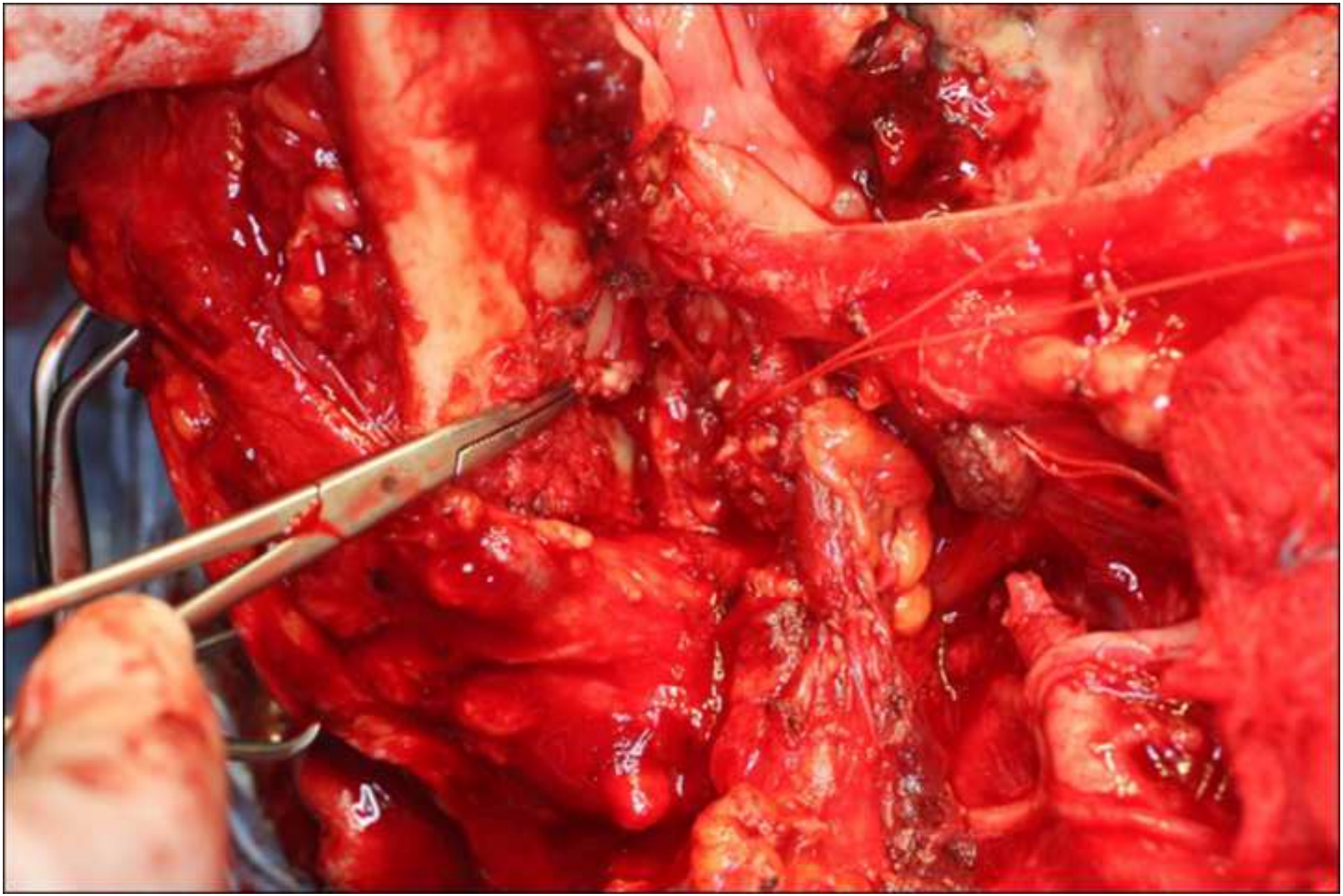

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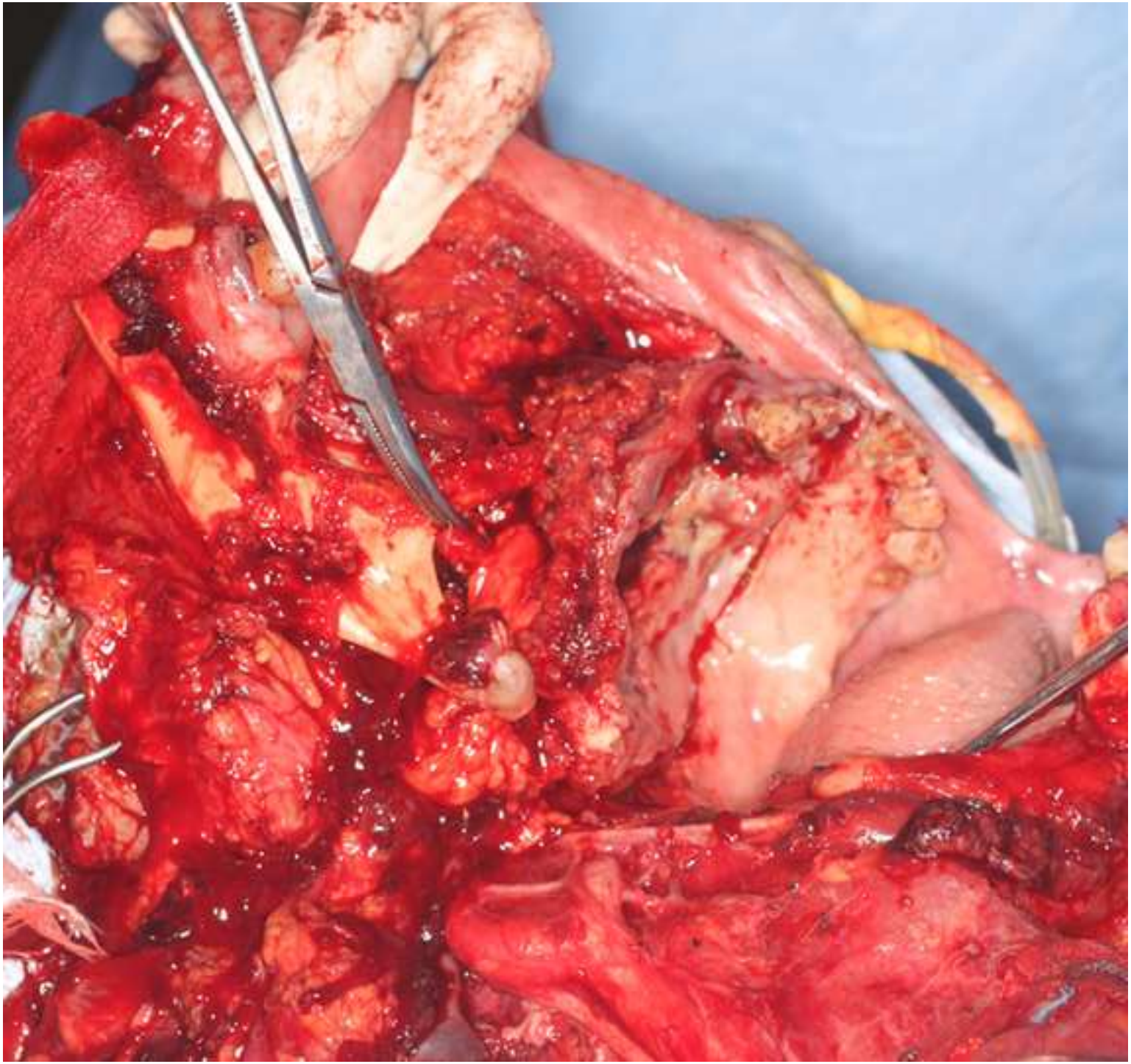

**Figure 3F**

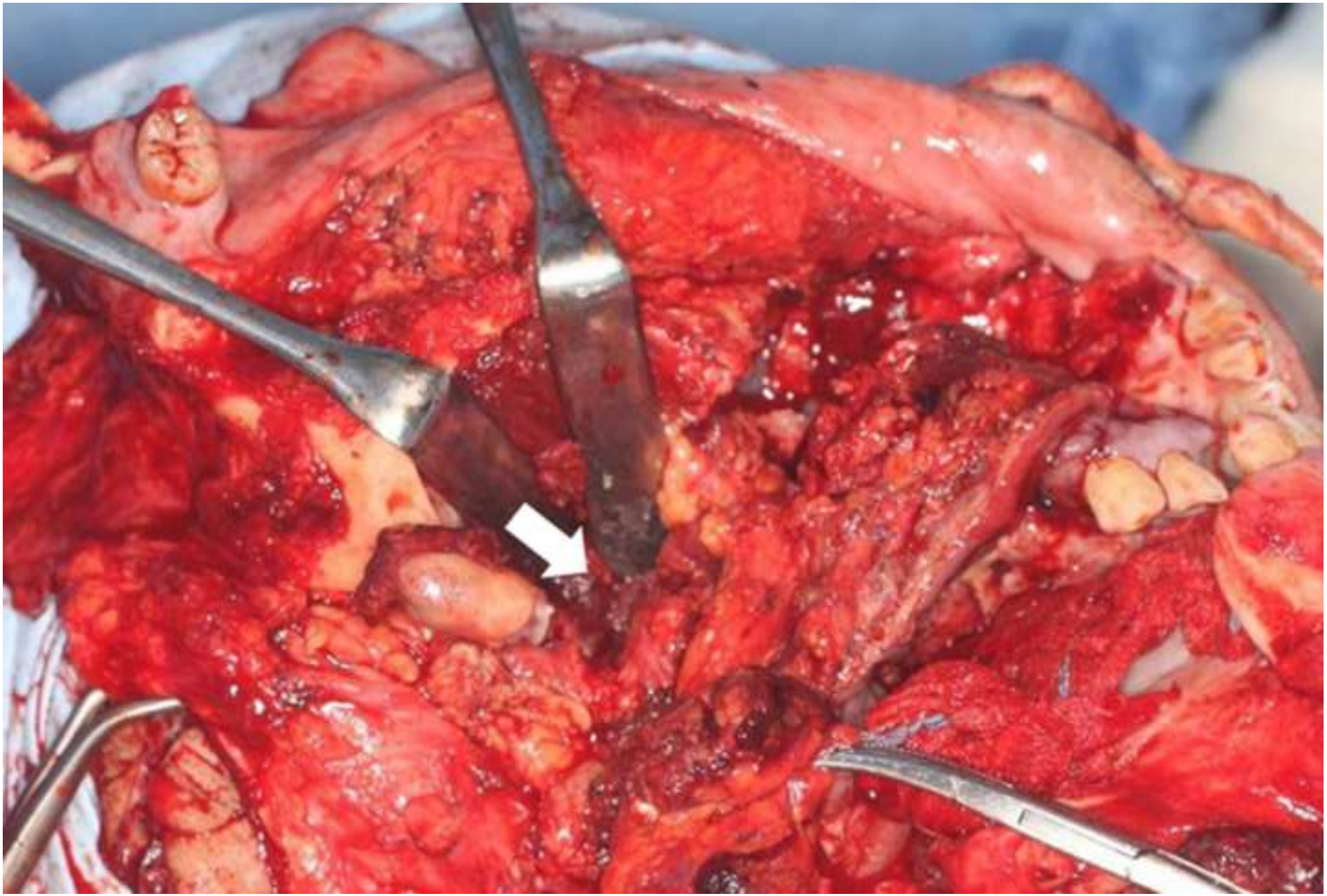

**Figure 4**

**Figure 5**

*Table 1*. Demographics and treatment summaries of 10 patients undergoing en bloc resection of the maxilla with the internal portion of masticator space and neck through the pararharyngeal space by transmandibular approach

| Patient | Age /Gender | Site | Pathological diagnosis (TN stage) | Procedure [a] | Reconstruction | Survival |
|---|---|---|---|---|---|---|
| 1 | 37/F | Hard palate | Adenoid cystic carcinoma (T4bN0) | Maxillectomy + SND | Radial forearm free flap | Alive 10 years with lung metastasis |
| 2 | 52/M | Maxillary gingiva | Squamous cell carcinoma (T4bN1) | Maxillectomy + mRND | No reconstruction | Alive without evidence of disease after 9.5 years |
| 3 | 52/M | Maxillary gingiva | Squamous cell carcinoma (T4bN1) | Maxillectomy + mRND | Radial forearm free flap | Alive without evidence of disease after 8.5 years |
| 4 | 72/M | Maxillary gingiva | Squamous cell carcinoma (T4bN2c) | Maxillectomy + bilateral mRND | Radial forearm free flap | Died of pneumonia after 3 months |
| 5 | 76/F | Maxillary gingiva | Squamous cell carcinoma (T4bN2b) | Maxillectomy + mRND→PORT | Radial forearm free flap | Alive without evidence of disease after 6.5 years |
| 6 | 82/M | Maxillary gingiva | Squamous cell carcinoma (T4bN2b) | Maxillectomy + mRND→PORT | Radial forearm free flap | Alive without evidence of disease after 4.5 years |
| 7 | 63/M | Hard palate | Malignant melanoma (T4bN1) | Maxillectomy + mRND | Rectus abdominis flap | Died of neck recurrence after 10 months |
| 8 | 77/M | Hard palate | Osteosarcoma (T4bN0) | Maxillectomy + SND | No reconstruction | Alive without evidence of disease after 2.5 years |
| 9 | 78/M | Maxillary gingiva | Squamous cell carcinoma (T4bN1) | Maxillectomy + mRND | Pectoralis major myocutaneous flap | Alive without evidence of disease after 2.5 years |
| 10 | 78/F | Maxillary gingiva | Squamous cell carcinoma (T4bN0) | Maxillectomy + SOHND | Radial forearm free flap | Alive without evidence of disease after 2 years |

a mRND, modified radical neck dissection; SOHND, supraomohyoid neck dissection; SND, selective neck dissection; PORT, postoperative radiotherapy.

*Table 2.* Complications related to the procedure in 10 patients undergoing en bloc resection of the maxilla with the internal portion of masticator space and neck through the parapharyngeal space by transmandibular approach

| Patient | Trismus[a] | Osteotomy-related complication | Cosmetic issues | Difficulty with swallowing | Inferior alveolar nerve | Lingual nerve |
|---|---|---|---|---|---|---|
| 1 | − | No | No | No | Sacrificed | Normal |
| 2 | + | No | No | No | Temporary paresis | Normal |
| 3 | − | No | No | No | Sacrificed | Normal |
| 4 | Unknown | Unknown | No | Unknown | Sacrificed | Normal |
| 5 | − | No | No | No | Sacrificed | Normal |
| 6 | − | No | No | No | Sacrificed | Normal |
| 7 | − | No | No | No | Sacrificed | Sacrificed |
| 8 | + | No | No | Slight | Sacrificed | Normal |
| 9 | + | No | No | Slight | Sacrificed | Normal |
| 10 | − | No | No | No | Temporary paresis | Normal |

a −, mouth opening >30 mm indicates normal or light trismus; +, mouth opening between 15 and 30 mm indicates moderate trismus; ++, mouth opening <15 mm indicates severe trismus.