**Introduction**

The parapharyngeal space (PPS) is defined as the deep space that forms an inverted triangular pyramid in the neck where the posterior belly of the digastric muscle and hyoid bone forms the apex of the pyramid, and the temporal bone, its base. The fascia stretching from the styloid pro-
cess to the tensor veli palatini muscle divides the PPS into prestyloid and poststyloid compartments. The prestyloid compartment contains the deep lobe of the parotid gland, fibroadipose tissues, medial and lateral pterygoid muscles and several lymph nodes. Additionally, the internal maxillary artery and vein, lingual, inferior alveolar and auriculo-temporal nerves course through the prestyloid compartment.

In contrast, the poststyloid compartment contains more vital structures such as the internal carotid artery, internal jugular vein and cranial nerves (CN) IX, X and XI. The sympathetic nerve chain and numerous lymph nodes are also located in the poststyloid compartment.

Primary tumours of the PPS are very rare, comprising approximately 0.5% of all head and neck tumours. They often present asymptomatic growth and can stay undetected for long periods of time or may be detected as an incidental mass during screening for another reason. These tumours frequently manifest via medial displacement of the lateral wall of the oropharynx or via a growth on the upper neck, and nearly 50% of patients present with a neck mass.

Symptoms are generally related to the position of the tumour and may include foreign body sensation in the pharynx, difficulty in deglutition and hoarseness. Cranial nerve deficits and otologic manifestations such as hearing loss are rarely observed. A wide variety of primary tumours may be seen in this anatomical region; fortunately most are benign (70-80%). The most frequent benign tumour is pleomorphic adenoma followed by paraganglioma; the most common malignancies are also of salivary gland origin.

There are several approaches for surgery of PPS. The most preferred approaches involve a transcervical route for tumours in the prestyloid compartment and a combined transparotid-transcervical route for tumours in the poststyloid compartment or for those originating from the deep lobe of parotid gland. Transcervical approaches can also be combined with mandibulotomy for removal of malignant tumours, tumours with vascular origin and recurrent tumours. In surgical approaches combined with mandibulotomy, damage to the inferior alveolar nerve, malocclusion and non-union-malunion defects and loss of dentition may occur. Additionally, in some types of osteotomies, lip-splitting may be required. Due to damage to the floor of the mouth during the surgery, tracheostomy and nasogastric tube feeding may be required. Fisch described an infratemporal fossa approach for extremely large PPS tumours invading the temporal bone and middle cranial fossa. An alternative to this approach is the transcervical-transmastoid technique, which obtains proximal and distal control of the jugular bulb and the internal carotid artery by approaching the skull base from the neck and mastoid. In the classic transoral approach to PPS described by Ehrlich in 1950, a curved incision is made along the palatopharyngeal arch and the tumour is enucleated with blunt dissection. Due to its major drawbacks, Ducic et al. described a new superior parapharyngeal space approach involving transsection of the soft palate. Transoral robotic surgical excision of PPS tumours is an evolving technique. Although robotic surgery is performed in the same way as the traditional transoral approach, there is less damage to the surrounding major neurovascular structures than with the transoral approach; furthermore, in cases of pleomorphic adenoma, the likelihood of capsular violation is relatively high and there is insufficient long-term data on recurrence rates. Other disadvantages of this technique are high cost and unavailability of the robotic device.

As seen above, due to the complex anatomy of PPS, many surgical approach techniques have been utilised, and all are associated with adverse effects. Herein, we discuss the efficacy, results and complications of transcervical approaches for accessing the PPS in the presence of benign primary tumours.

Materials and methods

In this study, the records of 67 patients who underwent surgery for PPS tumours between January 2001 and December 2010 in a tertiary referral centre were retrospectively reviewed. All patients had the same surgical team. Only tumours originating from the PPS were included and metastatic lesions or tumours extending to the PPS from other parts of the head and neck were excluded. The preoperative clinical signs, symptoms, neurological evaluation of cranial nerves, operative technique, radiologic and histopathologic findings and operative complications were collected from clinical records.

In 19 cases (28.4%), mandibulotomy was performed due to high suspicion of malignancy according to radiologic findings or revision surgery; therefore, all of these patients were excluded from the study. The remaining 48 patients were called for a follow-up examination to check for locoregional recurrence and cranial nerve deficits. Four patients could not be contacted and were excluded. Diagnosis was made with the help of clinical and radiologic findings. Magnetic resonance imaging (MRI) was the preferred technique, except for patients who were unsuitable for MRI and were consequently examined by contrasted computerised tomography (CT). In cases with a high suspicion of a vascular tumour, MRI angiography was additionally performed. The proximity of tumours to major blood vessels and the parotid gland were determined and their position was classified as prestyloid or poststyloid via imaging techniques. Preoperative evaluation did not involve FNAB or angiography and embolisation in any case.

During follow-up, at months 1, 2 and 6 after surgery, clinical examination was considered sufficient because all tumours had benign histopathologic diagnoses. At month 12 and yearly thereafter, a head and neck MRI was performed to detect possible recurrence of disease.
Results

Of the 44 cases, there were 15 males and 29 females with an age from 27 to 79 years (mean 44.6 years, SD ± 10.77). The most common clinical findings were neck mass (n = 24, 54.5%) and oropharyngeal mass pushing the pharyngeal structures medially (n = 16, 36.4%) (Table I). Other presenting symptoms were tinnitus, hoarseness, cough and dysphagia. In two patients (4.5%), the parapharyngeal mass was discovered incidentally during radiologic studies for other irrelevant pathologies of the head and neck.

In 3 cases a contrast CT scan was preferred due to contraindications for MRI. In the remaining 41 cases, a gadolinium contrasted MRI study was done. In the evaluation of tumours with MRI findings compatible with paraganglioma, routine use of MRI angiography was considered unnecessary, but in 5 cases with a suspicion of vascular origin, an MRI angiography was also performed following the primary radiological study. Radiologic findings compatible with benign tumour histology, which were used to assess the eligibility of the transcervical surgical approach, were defined as the following: well-circumscribed, encapsulated tumour without invasion of surrounding tissues.

The final histopathologic examination revealed vagal paraganglioma in 16 cases (36.4%), pleomorphic adenoma in 13 cases (29.5%) and schwannoma in 10 cases (22.7%) (Table II). Only one schwannoma originated from a cranial nerve, which was expectedly identified as a hypoglossal schwannoma; the remaining schwannomas were from unidentified origins. The comparatively rare tumours observed were giant cell inflammatory granulation tissue (n = 2), neurofibroma (n = 1), lipoma (n = 1) and haemangiopericytoma (n = 1). MRI findings were consistent with histopathologic findings in all cases, and tumours defined radiologically as benign were likewise histopathologically benign.

When tumours were classified radiologically according to location, 27 (61.4%) were discovered to originate from the poststyloid PPS and the remaining 17 (38.6%) originated from the prestyloid PPS. The mean tumour diameter was 5.51 cm (SD ± 1.13). The largest tumour was a pleomorphic adenoma with the longest axis of 11 cm and the smallest was a vagal paraganglioma with a diameter of 3 cm.

In all 44 patients included in the study, transcervical approaches were preferred. In 5 of these patients, a transcervical extension was also done due to the location of the tumour. Of these 5 cases, 4 were pleomorphic adenomas originating from the deep lobe of the parotid and the remaining case was a haemangiopericytoma originating from the poststyloid PPS (Fig. 1).

Cranial nerve paralysis was observed in three patients during preoperative evaluation (Table III). The first patient underwent surgery for a PPS pleomorphic adenoma with the longest axis of 11 cm, where the preoperative cranial nerve (CN) IX, X and XII paralysis did not recover during post-operative follow-up of 18 months (Fig. 2). This was attributed to long-standing presence of the tumour in the PPS and consequent atrophy of the nerves under pressure. One patient underwent surgery for a vagal paraganglioma, with preoperative CN X paralysis, and another had surgery for a schwannoma originating from the hypoglossal nerve (Fig. 3), with preoperative CN XII paralysis. CN paralysis did not recover in any of these patients in the postoperative period because the cranial nerves had to be sacrificed for adequate tumour removal. In the remaining 41 patients (93.2%), no preoperative CN deficit was detected.

In the 41 patients without preoperative CN paralysis, no CN paralysis was observed postoperatively in 22 (50%). In addition to the three patients who showed no improvement in preoperative CN paralysis, permanent CN paralysis developed in 19 cases, the details of which are listed in Table III. No patient with vagal paralysis had obstructive respiratory problems postoperatively owing to the one-sided sacrifice of the nerve. However, all patients had problems with feeding due to aspiration, which was resolved by an Ishihiki type I thyroplasty procedure performed under local anaesthesia within the first postoperative week. Patients with preoperative CN X paralysis did not require any medicalisation procedure because the long-lasting paralysis was compensated spontaneously in the preoperative period. The patient with CN IX paralysis had a moderate velopharyngeal insufficiency postoperatively, which was compensated within the second postoperative week.

One patient who underwent surgery for a vagal paraganglioma experienced a right-sided diffuse cerebral infarction caused by an arterial embolism at the second post-

| Table I. Clinical presentation of parapharyngeal space tumours. |
|---------------------------------------------------------------|
| **Symptom** | **Number of patients** | **%** |
| Neck mass | 24 | 54.5 |
| Oropharyngeal mass | 16 | 36.4 |
| Palatine tinnitus | 3 | 6.8 |
| Incidental | 2 | 4.5 |
| Hoarseness | 2 | 4.5 |
| Dysphagia | 2 | 4.5 |
| Cough | 1 | 2.2 |

| Table II. Final histopathologic diagnosis. |
|-------------------------------------------|
| **Histology** | **Number of patients** | **%** |
| Paraganglioma | 16 | 36.4 |
| Pleomorphic adenoma | 13 | 29.5 |
| Schwannoma | 10 | 22.7 |
| Giant cell inflammatory granulation tissue | 2 | 4.5 |
| Neurofibroma | 1 | 2.3 |
| Lipoma | 1 | 2.3 |
| Haemangiopericytoma | 1 | 2.3 |
operative day, and a left-sided hemiplegia developed. In another patient with a hypoglossal schwannoma, the internal carotid artery was injured during surgery and was repaired primarily. However, during the postoperative 24 hours, an arterial embolism to the middle cerebral artery developed, which resolved in the second postoperative month without a permanent neurological deficit.

Tracheotomy was performed in two patients (4.5%). The first patient was the one who had a 11 cm pleomorphic adenoma. Due to the risk of difficult intubation, preoperative elective tracheotomy was performed. The second patient was monitored in the intensive care unit for a long period after having diffuse cerebral infarct caused by an arterial embolism.

The longest follow-up period was 150 months and the shortest was 30 months. The median follow-up duration was 61 months (SD ± 33.10), which was considered long enough to evaluate local recurrence and possible late complications. There was no local recurrence in any patient during follow-up; however, 4 patients died due to reasons other than the primary disease (9.1%).

**Discussion**

The transcervical route, first described in 1955 by Morfit, is most preferred surgical approach for resection of PPS tumours. A transcervical incision is performed at the level of the hyoid bone following orotracheal intubation. The incision can be extended to the submental area to perform lip splitting if a mandibulotomy is necessitated during the operation. For larger tumours originating from the deep lobe of the parotid and for tumours with a retrostyloid location, partial parotidectomy is required. In the parotidectomy extension, following the identification of the main trunk of the facial nerve, its marginal branch is retracted superiorly and its posterior belly is transected and the mandible is dislocated anteriorly. The internal and external carotid arteries, internal jugular vein, sympathetic chain and CN IX, X and XI are identified. The submandibular gland is pulled anteriorly or may be resected for exposure, and the mylohyoid muscle may be transected to reach the parapharyngeal space. Thereafter, the tumour is dissected bluntly from the surrounding tissues. The limited exposure of the parapharyngeal space is accepted as the major disadvantage of the transcervical route by some authors. However, this issue remains controversial and conflicts with the results of our study.

Reviewing the literature on parapharyngeal tumours approached transcervically, two case series were found. Chang et al. reported on 51 cases with the largest tumour size of 6.8 cm, while Presutti et al. described 18 cases with the largest tumour size of 8 cm. Our case series in-

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**Table III. Complications.**

| Complications          | Tumour histology                                    | Details                                                   |
|------------------------|-----------------------------------------------------|-----------------------------------------------------------|
| CN Paralysis           | Patients with preoperative paralysis (n = 3, 6.8%)    | Affected CN                                               |
|                        | Pleomorphic adenoma (n = 1)                          | IX, X, XII (permanent)                                    |
|                        | Vagal paranglioma (n = 1)                            | X (permanent)                                             |
|                        | Hypoglossal schwannoma (n = 1)                       | XII (permanent)                                           |
|                        | Patients with postoperatively developed paralysis (n = 19, 43.2%) |                                                           |
|                        | Vagal paranglioma (n = 15)                           | X                                                         |
|                        | Schwannoma (n = 2)                                   | X                                                         |
|                        | Hemangiopericytoma (n = 1)                           | IX                                                        |
|                        | Giant cell inflammatory granulation tissue (n = 1)    | X, XII                                                    |
| Vascular Injury (n = 2)| Schwannoma                                           | Laceration of the internal carotid artery                 |
|                        | Vagal paranglioma                                    | Right-sided diffuse cerebral infarction caused by arterial embolism |
| Tracheotomy (n = 2)    | Pleomorphic adenoma                                  | Elective tracheotomy for difficult intubation             |
|                        | Vagal paranglioma                                    | Right-sided diffuse cerebral infarction, prolonged intubation |

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**Fig. 1.** Haemangiopericytoma of the parapharyngeal space. Note the submandibulary gland is excised, the digastic muscle is transected and its posterior belly is resected (white arrow). A parotidectomy extension is done (white star) and following identification of the facial nerve, its marginal branch is retracted superiorly (black arrow).
volved 44 cases and the largest tumour was a pleomorphic adenoma with a horizontal diameter of 11 cm. It should be emphasised that the vertical diameter should be evaluated rather than the horizontal diameter to determine whether the tumour is suitable for excision through a transcervical route. If the vertical extension of the tumour is suspicious for intracranial extension, a transcervical approach is dispensable. Furthermore, it should be taken into consideration, particularly in neurogenic tumours, that it might be very difficult to dissect the tumour from the surrounding tissues, especially in the vicinity of the cranial base. The schwannoma that originated from the hypoglossal nerve is a good example for this situation among our patients. In this case, the tumour extended to the level of the hypoglossal canal and the internal carotid artery was gradually thinned due to pressure applied by the mass. Consequently, the internal carotid artery was lacerated during blunt dissection of the mass. For this reason, we do not recommend a transcervical approach for tumours with a long vertical dimension and radiologically suspected to invade the cranial foramen.

The indications for mandibulotomy in PPS are malignant neoplasms, recurrent neoplasms, large benign neoplasms and highly vascular neoplasms with the need for improved vascular control. In our opinion, the indications for mandibulotomy should be limited only to malignant or recurrent tumours; however, size and hypervascularity of the tumour are not definite indications for mandibulotomy. As mentioned in our series, some hypervascular tumours such as haemangioperistoma and vagal paragangliomas can be safely excised via a transcervical approach. Additionally, the giant pleomorphic adenoma with a diameter of 11 cm was a good example for large PPS tumours underlining that mandibulotomy is unnecessary just owing to the size of the tumour.

In addition to transcervical and transmandibular techniques, transoral routes should be considered for well-selected cases. Nevertheless, we do not employ this technique regardless of tumour size in any parapharyngeal masses. Surgical exposure is extremely poor in this technique; the risk of tumour rupture is very high, and in the event of rupture, it is extremely difficult to clean the spilled tumour cells from the operative field successfully, so recurrence in such a vital body part is unavoidable. Furthermore, control of neurovascular structures is mostly inadequate, resulting in massive intraoperative blood loss and cranial nerve deficits. MRI seems to be superior to CT in diagnosis and assessment of PPS tumours because it demonstrates the size of the tumour and the neighbouring tissues more clearly. The presence of dystrophic calcifications seen on CT and the well-defined, smoothly lobulated tumour contour detected on MRI are the best predictors for pleomorphic adenoma, which is the most common PPS tumour in the literature.

The second most common PPS tumour in the literature and the most common one in our series is vagal paraganglioma, the diagnosis of which is usually made correctly depending on MRI characteristics. On MRI, the most characteristic finding of a paraganglioma is the presence of serpentine or punctate low-signal intensity regions, termed as the “salt and pepper” appearance, which results from its hypervascularity. Other radiological findings of a PPS paraganglioma are the easily discernible delineation of tumour borders and the anterior displacement of the internal carotid artery. The second most common tumour type in our case series was the nerve sheet tumour, which also have characteristic radiological signs includ-
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FFNAB will not change preoperative treatment planning. Consequently, FNAB of PPS tumours is technically difficult and foramen is made mostly with the help of radiology, so we believe that preoperative radiological evaluation is sufficient to distinguish malignant from benign tumours.

Nonsurgical treatments such as radiotherapy and stereotactic radiosurgery can be used in symptomatic cases. The most serious complication of PPS surgery is CN paralysis involving CN VII, IX, X, XI and XII. Among our patients, excluding three cases that had preoperative paralysis, permanent CN paralysis occurred in 19 cases (43.2%) in the postoperative period. However, regarding the fact that 15 of these cases were vagal paragangliomas and two were schwannomas, the high rate of paralysis is considered reasonable since CN X has to be sacrificed in the surgery of vagal paraganglioma. Neurogenic tumours like paragangliomas, particularly vagal paragangliomas are accepted to have the greatest risk of neurological sequelae in comparison with other PPS tumours. Informing the patient about the possible neurological complications prior to the operation will improve the patients’ compliance with the rehabilitation program because speech and swallowing therapy may be necessary during postoperative rehabilitation of patients with paralysis of CN IX, X or XI. Because most of these tumours are benign and grow slowly, the morbidity that would be caused by CN sacrifice should be taken into consideration while making the decision of surgical treatment, especially in older patients. The principle of ‘primum non nocere’ should be kept in mind.
There were no recurrences during the follow-up period of 61 months. This result demonstrates the efficacy of the transcervical technique, but might also be related to the fact that the majority of cases were well-capsulated neurogenic tumours.

Conclusions

The ideal surgical approach for the PPS should be one that does not damage important surrounding structures. To prevent possible perioperative vascular and postoperative neurological morbidities, all of the lower cranial nerves, internal carotid artery and internal jugular vein must be identified. The transcervical approach should be the first choice for excision of PPS tumours owing to its advantages of providing direct access to the PPS and control of neurovascular structures from the neck. With improvements in combination with video-assisted and image-guided minimally-invasive surgical techniques, the transcervical approach will be much more useful in the future. Because the majority of these tumours are benign and their en-bloc excision with safe margins is sufficient for treatment, it is unnecessary to increase the postoperative morbidity by performing mandibulotomy or other highly invasive procedures.

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