Parapharyngeal Space Tumors: The Infratemporal Fossa Approach

Abstract—Tumors of the parapharyngeal space, although mostly benign in their histopathology, present a challenge to the surgeon due to the limited access. Multiple approaches have been described in the literature for the extirpation of these tumors. The usual anatomic division of the parapharyngeal space into prestyloid and poststyloid spaces does not help the clinician determine which approach to use for a specific tumor. We have reviewed our 10-year experience at the University of Zurich. The usual presentation of the patients and the histopathologic characteristics of their tumors are compared. The radiological evaluation of these patients, their perioperative course, and complications are analyzed. The different surgical techniques used to treat the 72 patients in our series are described, with a special emphasis on the infratemporal fossa approach. Furthermore, a clinical division of the parapharyngeal space in the superior-inferior axis is established. The usefulness of this classification in helping the surgeon to decide which surgical approach is the most suitable for a particular lesion is discussed. (*Skull Base Surgery*, 5(2):73–81, 1995)

The parapharyngeal space is a potential space that presents a formidable challenge to the surgeon. Tumors involving this area pose difficulties in both their preoperative diagnosis and their surgical extirpation. Although there is general consensus on the surgical techniques to use for the removal of smaller tumors, there remains among different authors with different backgrounds considerable controversy as to the approach to use for larger tumors that extend to the skull base. We have reviewed and analyzed our experience with these tumors at the University of Zurich over the past 10 years. Our purpose was to introduce a classification according to tumor location and establish a therapeutic decision-making algorithm. The usefulness of the infratemporal fossa approach^{1–3} in resecting these tumors safely and radically in one stage through an aseptic field is also emphasized.

their age and sex, their symptoms, and their physical signs on presentation. The radiological findings and the possibility of familial trends were also analyzed.

The second group of variables characterized the tumors themselves: size, location, extent, histopathology, bilaterality/multifocality, and incidence of preoperative biopsy.

A third set of variables that had to do with the surgical and presurgical management consisted of preoperative embolization, type of approach, blood transfusions, radicality of tumor removal, duration of surgery, use of microscope, and facial nerve monitor.

A fourth and last group of variables that evaluated the postoperative course of these patients consisted of complications, duration of hospitalization, duration of follow-up, and postoperative medications.

MATERIALS AND METHODS

The charts of 72 patients with parapharyngeal space tumors that were operated on at the University of Zurich over a 10-year period were reviewed. Four sets of variables were analyzed. The patients were analyzed as to

RESULTS

This retrospective analysis of 72 patients over the past 10 years showed that 55 patients had tumors of the parapharyngeal space proper, while 17 patients had tumors originating elsewhere and extending into the para-

pharyngeal space. The average age was 43 years, with males making up 54% of the group. Upon presentation the patients complained most commonly of impaired swallowing and sore throat, followed by decreased hearing. Less common symptoms included facial neuralgias and trismus (cranial nerve V), facial paresis (cranial nerve VII), and, in one instance each, decreased vision due to ptosis (cranial nerve III) and diplopia (cranial nerve VI). Other vague complaints included headaches, generalized weakness, and anorexia.

After these patients underwent a complete physical examination, displacement of the soft palate and tonsillar fossa and neck swelling were noted to be the most common and equally prevalent physical signs. The other findings were ear effusions and retractions of the tympanic membranes. Less common findings included cervical lymphadenopathy, facial paralysis, ptosis, and diplopia.

Parapharyngeal space tumors represent only 0.5% of all head and neck tumors. In our series 90% of these tumors were benign in nature. The histopathology showed that pleomorphic adenomas and neurinomas were the most common diagnoses. They constituted 85% of all the cases, of which 60% were pleomorphic adenomas and 40% neurinomas of all kind. The only other significant pathologic subgroups consisted of adenoid cystic carcinomas and mucoepidermoid carcinomas in 5% of cases, and locoregional extensions of squamous cell carcinomas in another 5% of cases. One case each of hemangiopericytoma, fibrosarcoma, lymphoma, spinal cell undifferentiated carcinoma, and juvenile angiofibroma were also seen (Fig. 1).

Forty-three percent of our patients were referrals, having undergone a surgical procedure elsewhere in the past, while 57% were primary cases. Tumor location determined the type of surgical approach they were offered at the University of Zurich. Patients with tumors in the inferior parapharyngeal space (15%) were offered a cervical approach. Patients with tumors in the middle parapharyngeal space (35%) were offered a parotid-cervical

approach. Patients with tumors in the superior parapharyngeal space (50%) were offered an infratemporal fossa approach. The last subgroup could be further divided according to the type of infratemporal fossa approach used: type C (80%), type D (15%), or a combination of type A or B with type C (5%).

The operative microscope and the facial nerve monitor were used during every case whenever microdissection was needed and/or the facial nerve was at risk. Patients undergoing an infratemporal fossa approach on average received 1.1 L of blood during surgery. This is most commonly due to the rich pterygoid venous plexus. The patients are informed preoperatively of the likelihood of blood transfusions and autotransfusions are encouraged. The average tumor size was determined from the pathology specimen after it was placed in formalin. This process may produce an underestimation of the actual tumor size. Tumor embolization was performed in 91% of patients who underwent an infratemporal fossa approach and in only one patient each who underwent a cervical or parotid-cervical approach. Internal carotid artery balloon occlusions were performed in 7 patients undergoing the infratemporal fossa approach for massive tumors encasing or invading the internal carotid artery. The extent of removal was complete in the cervical subgroup (100%). One patient in the parotid-cervical group who had undergone previous attempts at removal of a pleomorphic adenoma had a subtotal resection due to multiple satellite lesions, a radical removal rate of 96%. In the infratemporal fossa subgroup removal was complete in all except 3 patients (85%), 1 patient with mucoepidermoid carcinoma, 1 patient with an adenoid cystic carcinoma, and 1 patient with a squamous cell carcinoma. In each case the tumors had massively invaded the cavernous sinus, extending through the skull base with encasement of the internal carotid artery. Surgical resection was offered for palliation, to improve the quality of life, alleviate pain, and improve peroral nutrition (Table 1). There were no perioperative deaths, major strokes, or permanent facial paralysis in our series. Three patients had major pulmonary insufficiency, 1 due to asthma and 2 due to fluid overload. Transient facial paralysis was common; 20% of patients undergoing the parotid-cervical approach had postoperative paresis of the marginal mandibular branch, most likely due to stretching from anterior and inferior displacement of the mandible. Twenty percent of patients undergoing the infratemporal fossa approach had postoperative paresis of the frontal branch due to excessive dissection and elevation of that branch by the infratemporal fossa retractor. Significant facial neuralgia occurred in 34% of patients who underwent the infratemporal fossa type C approach with mandatory sacrifice of V3. Long-term follow-up reveals that these complaints subside over a period of 2 years. These findings are confirmed by other reports. The other two complications that are specific to the infratemporal fossa type C approach are a mandatory conductive hearing loss and a 2% incidence of temporo

Figure 1. Histopathologic distribution.

Table 1. Perioperative Features

	<i>Location Approach</i>		
	<i>Inferior Cervical (15%) (n = 11)</i>	<i>Middle Parotid-Cervical (35%) (n = 25)</i>	<i>Superior Infratemporal (50%) (n = 36)</i>
Size (cm ³)	6	4	4
Transfusion (L)	0	0	1.1
Embolization	+/-	+/-	++
Surgery (h)	2 ± 0.5	3 ± 1.5	6 ± 1.5
Hospitalization (d)	7	7	14
Radical removal (%)	100	96	85
ICA balloon	—	—	+

ICA = internal carotid artery.

mandibular joint complaints with mild malocclusions necessitating orthognathic retraining (Table 2).

DISCUSSION

The parapharyngeal space is in the shape of an inverted pyramid on a pedestal.⁴ The base is formed by the greater wing of the sphenoid at the skull base. The apex is at the level of the greater cornu of the hyoid bone. The medial wall is composed of the superior constrictor muscle. The prevertebral fascia forms the posterior wall. The lateral wall from an anteroposterior direction is formed by the medial pterygoid muscle, vertical ramus of the mandible, the deep lobe of the parotid, and the posterior belly of the digastric muscle, respectively. The parapharyngeal space is divided into prestyloid and poststyloid spaces. The prestyloid space contains the medial and lateral pterygoid muscles, the ramus and condyle of the mandible, the deep lobe of the parotid gland, the maxillary artery, and branches of V3. The retrostyloid space contains the carotid sheath; the cervical sympathetic trunk; cranial nerves IX, X, XI, and XII; and multiple lymph nodes. Because the base, lateral, and posterior walls of the parapharyngeal space are bony, tumors tend to grow medially. Hence, the most common physical sign is a medial and inferior displacement of the soft palate and tonsillar fossa.

The histopathology of tumors of the parapharyngeal space is diverse. The most common lesions are pleomorphic adenomas. They may arise from the deep lobe of the parotid and are in this situation superficial to the superior constrictor muscle, or they may originate from minor salivary glands and occur deeper than the superior constrictor muscle. Because these salivary lesions are prestyloid in location, they tend to displace the contents of the carotid sheath posteriorly. The next most common group of tumors are the neurogenous tumors. These include schwannomas, ganglioneuromas, neurofibromas, and neuroblastomas. Being retrostyloid lesions, they displace the carotid sheath contents anteriorly. Other tumors of interest include meningiomas that may extend into the parapharyngeal space through the foramen ovale, spinosum, or jugulare. Lymphomas may arise in any of the multiple parapharyngeal lymph nodes. Fibrosarcomas are the most common sarcomas involving this space. Rare entities include mesenchymal tumors, lipomas, cysts, hemangiomas, teratomas, rhabdomyosarcomas, locoregional extensions, and metastatic lesions. Tumors of neural crest origin like paragangliomas of the carotid or vagal bodies are of particular interest, and these patients should undergo testing for possible catecholamine secretion because failure to do so may result in a fatal outcome. These patients should be questioned as to the occurrence for palpitations, headaches, and paroxysmal hypertension.

Table 2. Complications

	<i>Location Approach</i>		
	<i>Inferior Cervical (15%) (n = 11)</i>	<i>Middle Parotid-Cervical (35%) (n = 25)</i>	<i>Superior Infratemporal (50%) (n = 36)</i>
Death	0	0	0
Central nervous system	0	0	0
Pulmonary	0	2%	3%
Facial nerve			
Permanent	0	0	0
Temporary			
Frontal	0	0	20%
Marginal	0	20%	0
Trigeminal nerve	0	0	34%
Temporomandibular joint	0	0	2%
Hearing loss	0	0	80%

Twenty-four-hour urine collections for vanillylmandelic acid and metanephrines should be performed. Metaiodobenzylguanidine scans may be helpful in localization and confirmation of secretors. With secreting tumors, total preoperative β and α blockade with propranolol and phenoxybenzamine is mandatory prior to any tumor manipulation.

The standard radiological investigations used at the University of Zurich include computed tomography (CT), magnetic resonance imaging (MRI), angiography, embolization, and balloon occlusion of the internal carotid artery.

Computed Tomography

The CT of the skull base is high-resolution, thin sections produced by fourth generation scanners in the axial and coronal views. It is ideal for assessing tumor size, location, and relationship to adjacent bony structures. Computed tomography sialograms, as described by Biller et al,⁴ may be useful in further delineating parapharyngeal space tumors of parotid gland origin.

Magnetic Resonance Imaging

The advent of multiplanar, high-field MRI with gadolinium has further advanced the neuroradiological examination of these tumors. Magnetic resonance imaging gives the most useful preoperative information about the size and extent of the tumor and its relationship to contiguous structures—specifically, the internal carotid artery. The ability to visualize the tumor in three planes can be useful in assessing carotid encasement. Along with MRI characteristics of vascular lesions, it helps select which patients will be referred for angiography. The most common tumors of the parapharyngeal space are salivary in origin. Tumors originating from the minor salivary glands occur deeper than the superior constrictor muscle. These may be differentiated from deep lobe parotid gland tumors by the presence of a distinct fat plane on the MRI scan.

Angiography

Angiography is indicated in extensive vascular tumors or in tumors that show carotid artery encasement on MRI. The findings in turn will select which patients will need preoperative embolization and which patients will need internal carotid artery balloon occlusion.

Surgical Approaches

A multitude of surgical approaches have been described in the literature for the resection of parapharyngeal space tumors. The approaches used at the University of Zurich are shown in Figure 2.

CERVICAL APPROACH

This approach consists of making an external submandibular incision.⁵ The submandibular gland may be excised, and the marginal mandibular branch of the facial nerve is identified, preserved, and elevated. The mass may be palpated at this point. The tissues over it, consisting mainly of the styloglossus muscle and the stylohyoid ligament, are incised, and the parapharyngeal space is entered. The tumor is shelled out by blunt finger dissection. This technique provides limited exposure and is thus ideal for small tumors. If additional space is needed the mandible may be dislocated anteriorly or an angle mandibulotomy may be performed. Because blunt finger dissection is necessary for tumor extraction, this technique provides poor control of vascular structures and may result in incomplete tumor removal. We have reserved this technique for tumors in the lower parapharyngeal space extending to the neck.

CERVICAL-PAROTID APPROACH

Larger tumors and tumors of the deep lobe of the parotid can be approached by first making a preauricular

Figure 2. Therapeutic algorithm.

skin incision that extends beneath the mandible.⁶ A parotid flap and inferior neck subplatysmal flaps are elevated. The facial nerve and its main branches are identified. The inferior branches of the facial nerve are displaced superiorly, the deep lobe of the parotid gland is reached, and all tumors in this location along with their parapharyngeal extensions are removed en bloc.^{7,8} This approach provides identification and control of the carotid artery, jugular vein, and the lower cranial nerves in the neck. If additional space and exposure is needed, this approach can also be combined with osteotomy of the mandible; however, the use of the operating microscope and the infratemporal fossa retractor has obviated this in the majority of cases. This approach is inadequate for extensive tumors that extend to or through the skull base, although some authors have advocated a separate suboccipital craniotomy at the same setting. We have reserved this technique for tumors in the midparapharyngeal space without extensions superiorly into the skull base or posteriorly around the petrous internal carotid artery.

Type C

This approach provides access to the sphenoid and maxillary sinuses, the nasopharynx, pterygomaxillary fossa, parapharyngeal space, eustachian tube, intrapetrous carotid artery, and parasellar region. It is an anterior extension of the type A and B approaches. It starts by either a preauricular or a retroauricular skin incision, followed by wide undermining of the edges and double-layer blind sac closure of the external auditory canal. The main trunk of the facial nerve is identified along a line that bisects the distance between the tip of the mastoid and the lower aspect of the external auditory canal. The frontal branch is identified and dissected as peripherally as possible. The zygomatic arch is identified and freed of its overlying soft tissues to the level of the lateral orbital rim. Two holes are drilled anteriorly in the arch, which is divided between them. Posteriorly the arch is divided close to the temporomandibular joint. The attachments of the temporalis muscle are released and the arch pedicled on the masseter muscle is displaced inferiorly. The temporalis muscle is freed from its origin and displaced inferoanteriorly covering and protecting the frontal branch of the facial nerve. At this point a subtotal petrosectomy is performed, which consists of the following steps:

1. Removal of the remaining skin of the bony external auditory canal, the tympanic membrane, and the ossicular chain.
2. Detachment of the sternocleidomastoid muscle from the mastoid tip and removal of the mastoid tip.
3. Skeletonization of the middle fossa dura, sigmoid sinus, and posterior fossa dura.
4. Skeletonization of the fallopian canal from the geniculate ganglion to the stylomastoid foramen leaving an intact layer of bone around the facial nerve.
5. Complete exenteration of petrous air cells.
6. Identification of the vertical and horizontal segments of the internal carotid artery medial to the eustachian tube.

The glenoid fossa is then drilled away, and only if necessary, a condylectomy is done. Otherwise the temporomandibular articular disc is removed. The infratemporal fossa retractor is inserted. The bony base of the middle cranial fossa is gradually removed in a posteroanterior direction without manipulation of the brain itself. The cartilaginous eustachian tube is removed and the horizontal portion of the internal carotid artery is exposed to the level of the foramen lacerum and cavernous sinus anteriorly. The mandibular branch of the trigeminal nerve and the middle meningeal artery are electrocoagulated and divided. Proceeding further anteriorly, the pterygoid muscles are excised and the lateral and medial pterygoid

INFRATEMPORAL FOSSA APPROACH

The infratemporal fossa approach provides a direct surgical access to the entire length of the lateral skull base, from the nasopharynx and parapharyngeal space anteriorly to the foramen jugulare posteriorly. Depending on the location of the lesion any of four approaches may be used; each provides optimal access to differing but somewhat overlapping regions of the skull base.

Type A

This approach provides access to the infralabyrinthine portion of the temporal bone; it is well suited for tumors of the jugular foramen including vagus neuromas, carotid aneurysms, and glomus vagale or jugulare tumors. A permanent anterior transposition of the facial nerve is required.

Type B

Provides access to the vertical and horizontal parts of the internal carotid artery, petrous apex, and mid to lower clivus. Applications include epidermoid cysts, chordomas, and chondrosarcomas of the clivus.⁹ The facial nerve is identified and left in situ without any manipulation. Due to the anterior location of parapharyngeal tumors the type A and B approaches are rarely, if ever, used for these tumors. Access to the parapharyngeal space is provided by the infratemporal fossa type C or D approaches. These are described in more detail below.

plates are drilled away. This approach gives wide access to the infratemporal and pterygopalatine fossae, the parasellar region, nasopharynx, and the entire parapharyngeal space. This microsurgical dissection technique provides perfect control of the vertical and horizontal intrapetrous segments of the internal carotid artery. It is well suited for extensive tumors invading the skull base and tumors involving the intrapetrous eustachian tube or internal carotid artery. This procedure also provides perfect identification, visualization, and protection of the facial nerve. There are no visible facial scars. Disadvantages include a conductive hearing loss, motor and sensory deficit following sectioning of V3, and occasionally, if the condyle of the mandible is resected, a mild malocclusion. The last two complications are well tolerated by patients and give rise to no long-term complaints.

Wound closure consists of meticulous hemostasis, rewiring of the zygomatic arch, use of the vascularized temporalis muscle flap to fill the defect, a two-layer closure of the soft tissues, and negative suction drains.

Type D

This approach is an even more anterior modification of the type C approach. It consists of a preauricular incision with a plane of dissection anterior to the middle ear, petrous horizontal internal carotid artery, and the eustachian tube. In a fashion similar to the type C approach, the main trunk and frontal branch of the facial nerve are identified and dissected. The zygomatic arch is transected, pedicled on the masseter muscle, and temporarily displaced inferiorly. The temporomandibular joint is left

intact. The bony base of the middle cranial fossa is removed by a similar microsurgical dissection. The temporalis muscle is detached from the squama of the temporal bone and retracted inferiorly. In contrast to the type C approach no subtotal petrosectomy is done, and hence the middle ear and the eustachian tube are left intact. The horizontal internal carotid artery cannot be directly identified or dissected in this approach. The type D approach gives access to the nasopharynx, pterygopalatine fossa, orbit, and the parapharyngeal space. Advantages include sparing of the middle ear and eustachian tube functions. Disadvantages include a more limited exposure. This approach is therefore inadequate for larger lesions that extend to or obtain part of their blood supply from the horizontal intrapetrous internal carotid artery. The decision of whether to use the wider type C or the more limited type D approach for parapharyngeal space tumors should be made preoperatively and based on the location, size, and extent of the tumor and the involvement of the adjacent intrapetrous structures like the horizontal internal carotid artery or the eustachian tube.

Figures 3 to 8 illustrate two representative cases. The first patient was a 33-year-old female who had undergone elsewhere seven "parotid" procedures for a giant left parapharyngeal pleomorphic adenoma (Figs. 3 and 4). The second patient was a 75-year-old female who had 10 previous operations, 2 transpalatal and 8 "parotid," for a large right parapharyngeal pleomorphic adenoma (Figs. 5 and 6). Both patients underwent a combined parotid-cervical/infratemporal fossa type C approach through a preauricular skin incision (Fig. 7). Figure 8 shows the exposure in this combined approach with the possibility of working on both sides of the facial nerve trunk. In

Figure 3. Axial magnetic resonance imaging view, giant left parapharyngeal pleomorphic adenoma.

Figure 4. Coronal magnetic resonance imaging view, giant left parapharyngeal pleomorphic adenoma.

tumors extending more posteriorly into the infratemporal fossa proper or even the jugular foramen the infratemporal type C approach may be combined with an infratemporal type A or B approach. This intrinsic flexibility of the infratemporal fossa approach allows us to tailor the operation to the particular tumor in question.

CONCLUSIONS

The surgical decision-making algorithm followed at the University of Zurich consisted of a cervical submandibular approach for tumors in the inferior parapharyngeal space (hypopharynx) extending inferiorly into the cervi-

cal area. For tumors in the midparapharyngeal space (mesopharynx) a parotid-cervical approach was used with anterior and inferior retraction of the mandible. For smaller tumors of the superior parapharyngeal space (epipharynx) extending to the skull base an infratemporal fossa type D approach was used sparing the middle ear, temporomandibular joint, and cranial nerve V3. For massive tumors of the entire parapharyngeal space that extended to or through the skull base superiorly or encased the petrous portion of the internal carotid artery an infratemporal fossa type C approach was used with a mandatory conductive hearing loss, removal of the temporomandibular articular disc, and sacrifice of cranial nerve V3 (Fig. 3).

Figure 5. Axial magnetic resonance imaging view, large right parapharyngeal pleomorphic adenoma.

Figure 6. Coronal magnetic resonance imaging view, large right parapharyngeal pleomorphic adenoma.

Thirty-two of the above-mentioned patients (22 with a benign and 10 with a malignant tumor) have been followed for more than 5 years postoperatively. Of the 22 patients with benign tumors 19 (86%) presented with no evidence of disease and 3 (14%) with recurrent disease. Five of the 10 patients with a malignant tumor were still alive 5 years following surgery. Only one of these patients

presented evidence of residual disease. The figures demonstrate that the presented approaches are particularly successful in eliminating benign disease of the parapharyngeal space. Extensive malignant tumors still present on a long-term basis a challenge when they infiltrate the dura creating multiple deficits of cranial nerves.

In our series there were no perioperative deaths,

Figure 7. Preauricular skin incision for combined parotid-cervical/infratemporal approach.

Figure 8. Exposure and access to both sides of facial nerve trunk in combined approach.

strokes, myocardial infarctions, or airway problems requiring tracheotomy. We have avoided intraoral procedures and procedures requiring mandibular osteotomies.¹⁰ The advent of the operating microscope, facial nerve monitoring, and microdissection techniques have had a major impact on the introduction of the infratemporal fossa approach for parapharyngeal space tumors. This approach provides the shortest working distance, and thus a direct surgical access to the entire lateral skull base. It also provides an aseptic route for the radical and safe removal of these tumors without disfiguring facial scars.

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