Tumors and Surgery of the Parapharyngeal Space

Kerry D. Olsen, MD

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Tumors and Surgery of the Parapharyngeal Space

Kerry D. Olsen, MD

The parapharyngeal space, an area of complex anatomic relations, is involved in a wide variety of benign and malignant neoplasms. Because primary parapharyngeal space tumors are rare, it is difficult to obtain surgical experience in this region. This paper reviews the anatomy, presentation, evaluation, surgical approaches, and pathologic features of complications reported in managing patients with parapharyngeal space neoplasms. Two surgical procedures have been used by the author to treat 44 tumors in the parapharyngeal space. The cervical-parotid approach was used in 38 patients, and the cervical-parotid approach with midline mandibulectomy was used in 9 patients. Of the 44 tumors, 32 were benign lesions and 12 were malignant neoplasms. Forty tumors were primary parapharyngeal space tumors, and 4 cases represented isolated metastases to parapharyngeal nodes. Recurrent tumors accounted for 12 of the 44 cases. Discussion of the indications, surgical technique, and select points pertinent to using these two operative procedures is based on the operative experience gained from these 44 patients. The use of these two operations resulted in low morbidity and provided a safe, efficacious approach to the management of all parapharyngeal space neoplasms encountered.

INTRODUCTION

Tumors of the parapharyngeal space are rare, accounting for only 0.5% of head and neck neoplasms.1 The wide spectrum of benign and malignant neoplasms encountered in this complex, deep anatomic region contributes to the challenge of surgical treatment of parapharyngeal space tumors. A systematic logical approach to the diagnostic evaluation of patients with parapharyngeal space tumors is necessary to ensure management decisions that minimize morbidity.

The parapharyngeal space is actually a potential space located lateral to the upper pharynx. This

bilateral fat-containing region extends from the skull base to the hyoid bone. Various synonyms for parapharyngeal space have been reported in the literature: lateral parapharyngeal space, parapharyngeal space, pharyngomasticatory space, pharyngomaxillary space, pterygopharyngeal space, and pterygomandibular space. The term “parapharyngeal space” is most commonly used in the recent literature.2

This paper presents an overview of the anatomy, presentation, evaluation, treatment, and treatment options for parapharyngeal space neoplasms. The author’s experience with many tumors in this area led to the use of two surgical approaches for treating tumors in this region: the cervical-parotid approach and the cervical-parotid approach with midline mandibulectomy. The indications, surgical technique, and complications of these procedures will be discussed in detail.

ANATOMY

Surgical must be knowledgeable about the complex anatomy of the parapharyngeal region to remove tumors from this area safely. Failure to appreciate the regional anatomic relationships can result in the selection of an incorrect surgical approach. The result may be inadequate access with difficulty in tumor removal, damage to vital structures, tumor spillage, and recurrent neoplasms.

The parapharyngeal space is often described as an inverted pyramid with its base at the skull and apex at the greater cornu of the hyoid bone (Fig. 1). The parapharyngeal region is further compartmentalized by thick fascial layers that direct tumor growth. Prior descriptions of these fascial layers varied.3

The superior border of the parapharyngeal space is a small portion of the temporal bone. The superior medial wall is enclosed by a fascial connection from the medial pterygoid plate to the spine of the sphenoid. This fascia passes medial to the foramen ovale and the foramen spinosum. These foramina are not included in the superior bone limits of the parapharyngeal space but, rather, are in the infratemporal fossa or masticator space (Fig. 2).

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Send Reprint Requests to Mayo Clinic, 200 First St. SW, Rochester, MN 55905.

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The inferior boundary of the parapharyngeal space ends at the junction of the posterior belly of the digastric muscle and the greater cornu of the hyoid bone. The firm fascial attachments in this area limit parapharyngeal space extension inferior to the hyoid bone. This fascia, however, can be weak and serve as an ineffective barrier to the spread of infection.

The posterior border of the parapharyngeal space is formed by the fascia over the vertebral column and paravertebral muscles. The anterior limit is composed of the pterygomandibular raphe and medial pterygoid fascia.

The lateral wall of the parapharyngeal space is made up of the fascia overlying the medial pterygoid muscle and the ramus of the mandible. The fascia of the medial pterygoid muscle superiorly incorporates the sphenomandibular ligament that extends from the spine of the sphenoid to the lingula of the mandible. This dense fascia then continues as a firm layer to the skull base. This fascial layer separates the parapharyngeal space from the inferior alveolar nerve, the lateral pterygoid muscle, and the condyle of the mandible. The retromandibular portion of the deep lobe of the parotid gland also forms a small portion of the lateral border, as does a portion of the posterior belly of the digastric muscle.

The parapharynx, the oral cavity, and a portion of the thyroid gland. These nodes are connected superiority to the node of Rouviere, situated in the retropharyngeal space, which drains the nasopharynx, upper oropharynx, and sinuses. Inferiorly, the lymphatic drainage continues to the jugular digastic nodes, which are outside and inferior to the parapharyngeal space. A direct connection from the lymphatics of the thyroid gland to the parapharyngeal nodes was reported. Lymph channels extend along the posterior wall of the pharynx and terminate in the lateral retropharyngeal node. This pathway exists as a result of the embryologic development of the thyroid gland from the tongue base. Similarly, hypopharyngeal and laryngeal tumors that involve the posterior pharyngeal wall may also metastasize to the lateral retropharyngeal nodes.

In summary, the only nonrigid borders of the parapharyngeal space are the medial and inferior areas. In addition, laterally, a small opening occurs in the stylopharyngeal tunnel. It is in this last area that the more medial fascia of the tensor veli pala
tini muscle separates from the more lateral fascia of the medial pterygoid muscle, causing a space for parotid tumors to enter the parapharyngeal space. Additional descriptions of the anatomy of the parapharyngeal space can be found in several excellent reviews.

Reports of parapharyngeal space neoplasms that contain a large number of deep lobe parotid tumors, jugular foramen neoplasms, infratemporal fossa tumors, or carotid body tumors should be reviewed critically because they probably refer to tumors that are not neoplasms of the parapharyngeal space. Discrepancies in tumor incidence from various reports can often be explained by these differences in defining the limits of parapharyngeal space tumors.

TUMOR PRESENTATION

Parapharyngeal space tumors generally pre-
sent as asymptomatic masses. They often are discovered during a routine physical examination. Their presence should be suspected when a subtle fullness is noted in the soft palate or tonsillar region or when there is mild fullness near the angle of the jaw (Fig. 5). Clinical detection of early parapharyngeal space lesions is difficult. Small tumors cause few symptoms. The tumors must grow to at least 2.5 to 3.0 cm before a mass can be detected clinically.  

As tumors enlarge and extend superiorly, they may cause symptoms related to the eustachian tube and, rarely, middle ear effusions. As tumors expand medially, voice change, nasal obstruction, aspiration, and dysphagia can occur. Rarely, tumors have been found that require immediate tracheotomy for relief of upper airway obstruction. As tumors enlarge, they may compress the 9th, 10th, 11th, or 12th cranial nerve, causing hoarseness, dysphagia, or dysarthria. Horner's syndrome may also be produced by tumor pressure on the superior cervical ganglion.  

For a benign tumor to cause nerve deficit, it must generally enlarge to a considerable degree. Pain, trismus, or cranial nerve paralysis often suggests malignancy. Several reports described obstructive sleep apnea symptoms secondary to parapharyngeal space lesions. The symptoms include loud snoring, restless sleep, and daytime hypersomnolence from the airway encroachment secondary to palatal and tonsillar displacement from pleomorphic adenomas and cystic hygromas.  

Malignant tumors of the parapharyngeal space can cause carotid sinus hypersensitivity and glossopharyngeal neuralgia. Asystole, bradycardia, and hypertension were reported in inflammatory or malignant conditions in the parapharyngeal space. These symptoms may be due to neural irritation of the glossopharyngeal afferent fibers.  

Tumors of the parapharyngeal space are often misdiagnosed as infections or tonsillitis. Three of 23 patients reported by Allison, et al. underwent tonsillectomy because of unilateral tonsillar swelling. The actual problem was a parapharyngeal space lesion. Another case of a neurofibroma in the parapharyngeal space was initially misdiagnosed as quinsy. Patients often complain of a mild sore throat, a lumplike feeling in the throat, or dysphagia. The swelling in the tonsillar and soft palatal region may be misdiagnosed as a peritonsillar abscess. Delays in diagnosis have also occurred because patients were being treated for presumed nasal obstruction, eustachian tube dysfunction, or serous otitis media. Patients have also been misdiagnosed with temporomandibular joint dysfunction or temporomandibular condition when in actuality they had a parapharyngeal space lesion.  

The performance of a complete head and neck examination is one of the most important aspects of the evaluation of parapharyngeal space tumors. However, the anatomic location of the parapharyngeal space makes it difficult to detect early tumor presence and size. For a mass to be noted on clinical examination, it generally must be at least 3.0 cm in diameter. Only a mass of considerable size will cause a visible bulge or palpable abnormality of the lateral pharyngeal wall or external neck. Swelling of the medial wall of the oropharynx is generally the first sign of a parapharyngeal space lesion. Parotid tumors displace the tonsil and neurogenic tumors often more characteristically displace the posterior portion of the pharynx and posterior tonsillar pillar. As tumors enlarge superiorly, they fill the space between the head of the tensor veli palatini muscle, causing soft palate and nasopharyngeal swallowing. As a tumor extends inferiorly, it presents as a palpable mass near the angle of the jaw. Cranial nerve function should be noted.  

Bimanual palpation with one of the physician's fingers in the patient's mouth and the physician's other hand on the patient's neck assesses mobility, pulsation, and tumor extent and may help determine the tumor's origin. The finding of a pulsatile mass is generally not a helpful differentiating characteristic because of the frequency of transmitted pulsations. Clinical examination, however, remains difficult because the parapharyngeal space lies deep to the muscles of mastication, the mandible, and the parotid glands. Usually, the overlying pharynx is diagnosed with temporomandibular joint dysfunction; however, when mass is noted at physical examination in addition to a lateral pharyngeal mass, this indicates a parotid tumor extending through the stylomandibular tunnel.

**PARAPHARYNGEAL SPACE TUMORS**

Tumors of the parapharyngeal space include primary neoplasms, direct extension from adjacent regions, and metastatic disease (Table I). Malignant tumors can invade the parapharyngeal space from the nasopharynx, oropharynx, mandible, maxilla, oral cavity, or parotid gland. The node of Rouviere is often the first site of metastasis of nasopharyngeal or antral carcinoma. This review will focus on primary neoplasms of the parapharyngeal space and not on tumors that involve the parapharynx by direct extension from adjacent areas. Primary parapharyngeal tumors, however, can extend intracranially through the jugular foramen or into the retropalatine space.  

Reports in the literature indicate that 80% of parapharyngeal space tumors are benign and 20% are malignant. The most common primary tumors are salivary gland neoplasms that originate from the deep lobe of the parotid gland or from minor salivary gland tissue. Two percent of parotid lesions are said to present as parapharyngeal space tumors. Neurogenic tumors, primarily neurilemomas and paragangliomas, are the second most frequent group of neoplasms.  

Overall, however, parapharyngeal space tumors are rare. Work and Hybel noted only 48 parapharyngeal space neoplasms in a 10-year period. McLarath and co-workers reported 112 patients with parapharyngeal space tumors in a 30-year period at the Mayo Clinic. In a 10-year period, 5 cases of parapharyngeal space neoplasms were identified at two Southern Illinois University teaching hospitals. Considering the complexity of the contents of the parapharyngeal space, it is not surprising that there is a wide variety of neoplastic tumors. A compilation of 318 cases of parapharyngeal space neoplasms reported in the literature showed 45.6% salivary gland origin, 23.3% neurogenic, 15.1% involvement of lymph nodes, and 16.1% miscellaneous. Another report of eight studies in the literature reviewed by John, et al. found the following tumor distribution: 44.6% salivary gland tumors, 29.4% neurogenic tumors, 8.3% lymphomas, 4.6% infective cause, 2.3% metastatic, and 10.8% miscellaneous. A report from the University of Pittsburgh showed 35% mixed tumors, 28% salivary body tumors, and 4% other tumors. Cervical masses are most frequently reported, and 36% were miscellaneous. Two other reports found that 90% of salivary gland tumors and 20% of neurogenic tumors were accounted for by neurogenic tumors, 27% to 40%, and miscellaneous, 10% to 33%. Overall, approximately 50% of tumors of the parapharyngeal space are salivary gland tumors in origin and 20% are neurogenic.  

**SALIVARY GLAND NEOPLASMS**

In the majority of reports, pleomorphic adenoma is the most common parapharyngeal space tumor. This tumor generally originates from the deep...
TABLE I
Tumors of the Parapharyngeal Space.

Primary tumor
Direct extension from adjacent structures
Mandible
Maxilla
Nasopharynx
Nasoethmoidal
Nasal cavity
Oral cavity
Oropharynx
Temporomandible joint
Metastatic tumors
Follicular thyroid carcinoma
Medullary thyroid carcinoma
Osteogenic sarcoma
Paget's disease of bone
Squamous cell carcinoma

Removal of parapharyngeal pleomorphic adenomas, in most cases, involves, by necessity, a capsulectomy. Recurrence is possible, especially if the capsule is broken and tumor spillage occurs. Previous biopsy or attempts at transoral surgery also increase the risk of recurrence. However, the loose areolar tissue in the parapharyngeal space may permit capillary dissection with minimal trauma. This may account for a lower recurrence of parapharyngeal pleomorphic adenomas than would occur in a comparable series of extracapsular lobe parotid tumors removed via enucleation. 

Other benign salivary tumors have occurred in the parapharyngeal space. These include 2 cases of Warthin's tumors and 2 oncocytomas of 17 benign salivary lesions in one study. A benign lymphoepithelial lesion has also been reported in the parapharyngeal space.

The frequency of malignant parapharyngeal salivary tumors compared to benign salivary tumors varied from a low of 24% to a high of 75%. The reported malignant tumors include mucoepidermoid carcinoma, adenoid cystic carcinoma, acinic cell carcinoma, malignant mixed carcinoma, squamous cell carcinoma, adenocarcinoma, and a case of malignant Warthin's tumor.

Neurogenic Tumors
The most common neurogenic neoplasm found in the parapharyngeal space is the neurilemmoma or schwannoma. This tumor is generally of the vagus nerve or sympathetic chain. Overall, approximately 30% of all neurilemmomas occur in the head and neck area, with the majority originating from the vagus nerve. The vagus nerve has been reported to be the nerve of origin in 50% of parapharyngeal neurilemmomas. In other workers, however, the most frequent neoplasm of the vagus nerve was a paraganglioma in 50%. A neurilemmoma noted in 31%, neurofibromas in 14%, and neurofibrosarcoma in 6%. Cranial nerves IX through XII and the cervical sympathetic chain are all endangered by schwann cells and can also give rise to neurilemmomas.

In general, parapharyngeal neurilemmomas are uncommon. The first case of a neurilemmoma in the parapharyngeal space was reported by Figi in 1933. Guggenheim reviewed the world literature in 1953 and reported 34 cases of neurilemmoma in the parapharyngeal space. In 1981, 114 cases of parapharyngeal schwannomas had been reported. By 1984, Chang and Mitchell could find only 61 neurilemmomas specifically involving the vagus nerve in the parapharyngeal space.

Neurilemmomas are generally benign slow-growing tumors and present as masses. They usually do not affect their nerve of origin. With time they can cause obstructive symptoms and loss of nerve function. Pain is uncommon. There have been many reports of large neurilemmomas with associated nerve dysfunction. In a report of 16 patients with neurilemmomas of the parapharyngeal space whose ages ranged from 24 to 72 years, half the patients were asymptomatic. Only 1 patient had Horner's syndrome and 1 had a fixed cord. The carotid artery is usually displaced anteromedially by most parapharyngeal neurilemmomas. The most common enhancing extraparotid lesion on computed tomodensitometric (CT) scan is the schwannoma.
associated pharyngeal mass that displaces the tonsil medially. Extension into the parapharynx above the level of the posterior belly of geniculate muscle justifies inclusion as parapharyngeal space tumors. The usual presentation is a painless mass located posterior to the jaw and the tumors are not considered parapharyngeal in origin. Overall, parapharyngeal tumors are multicentric in 10% to 20% of cases and have been reported to be more common in females.6,7 In addition, there can be a strong familial tendency with an autosomal dominant inheritance.8,9

Vagal paragangliomas often cause bulging of the lateral pharyngeal wall. Symptoms due to vagal nerve involvement, like hoarseness or dysphonia, may be present.10 Up to 30% of vagal paragang- liomas present with cranial nerve deficits manifesting as vagal paralysis or jugular foramen syn- drome.11 The malignant rate was reported to be 10%, with cervical nodes positive in two thirds of these cases.12

Three documented cases of vagal paragangliomas producing catecholamines were reported.10 Therefore, all potential paragangliomas must be screened for possible secretion of bioactive amines. Glomus vagale tumors can extend intracranially and produce a fatal outcome. Special consid- eration in the evaluation has to be directed to their vascularity, which can encompass and surround the internal carotid artery. In up to 10% of cases, major vessels have been reported to be recesed with the tumor, and associated nerve injury is possible.10

Carotid body tumors that interfere with swallowing or speaking, compress the palate or pharynx, or experience an aggressive growth pattern should be considered unusual for a patient who presented to die of an untreated carotid body tumor, and me- tastasis is rare.12 Surgical removal is generally done in individuals who are less than age 70 years and in good health.

Additional neurogenic tumors include neurofibromas and ganglion cell tumors and their mimetic counterparts: paragangliomas and schwannomas.12 Neurofibromas are the third most common mass occurring in the parapharyngeal space. Neurofibromas generally occur as multiple lesions. They intimately involve the nerves of origin and preservation of the nerve is generally not possible. Cranial nerve deficits occur more often with neurofibromas than with schwannomas.12 Neurofibromas in the para- pharyngeal space have been reported13 to involve the vagus nerve, the glossopharyngeal nerve, and the pharyngeal nerve. A ganglionoma of the parapharyngeal space was described in two se- ries.14

Several malignant nerve tumors have also been described in the parapharyngeal space. Malignant neuroblastoma or sympathicoblastoma was reported by Brandenburg.15 Malignant schwannomas have also been described in several papers.16-21

Miscellaneous Tumors

Nine cases of temporal bone meningiomas extending into the parapharynx were reported by Nager, et al.22 These tumors may repre- sent extracranial extension of a primary intracra- nial meningioma, a neoplasm arising from the jugular foramen, or a tumor originating from arachnoid cell clusters within the trunk of a cranial nerve or from its perineural sheath. Malignant transformation also can occur from a primary intracranial meningioma.23 Additional cases of meningiomas of the parapharyngeal space were reported by Rose, et al.24 and Lai, et al.25 An additional case report25 of an extracranial meningioma that filled the parapharyngeal space was thought to be an ectopic meningioma.

Nervous vascular lesions were reported as primary neoplasms of the parapharyngeal space. These include hemangiomas and lymphangiomas.25-27,32,42,44 Arteriovenous malformation of the parapharyngeal space was described in one report.26 Internal carotid aneurysms were also described, with the aneurysm type presenting as a mass le- sion.28,29 Hemangiopericytoma and hemangioendothelioma were also found.29 Isolated myeloma was described in the parapharyngeal space.29

Several additional lesions were described in multiple reports: lipomas,32,35,42,44,45 hemangiomas,12,42,44 extracardiac rhabdomyomas,30-32 parapharyngeal and branchial cleft cysts,13,16,42,44 paraesophageal, esophageal, and dermoid tumors.42 Isolated lesions reported in single reports include amyloid tumor,2 Kimura's disease,3 fibromatoses,2 leiomyomas,23 lymphomas,23 rhabdomyomas,30 lymphangiomas,23 and melanomas.12,30

Miscellaneous tumors are also found in the parapharyngeal space. The most commonly reported lesion is isolated lymphoma. The largest series reported in the literature was from the Mayo Clinic in 1963.23 This series excluded lymphomas involving Waldeyer's ring and excluded any lympho- mas in the parapharyngeal space that also had involvement of the neck or systemic involvement of the reticuloendothelial system. The Mayo Clinic series reported in 20 patients ranging in age from 3 to 82 years. The patients often complained of a sore throat at the time the mass was first discovered. Physical examination typically revealed an irregular mass that had rapidly increased in size.30 Eight additional cases of lymphoma of the parapharyngeal space were reported and isolated case reports of lymphoma confined to the parapharyngeal space were also described by Ogawa,15 Shios,29 and Basse.15

Ectomesenchymoma is a rare malignant para- pharyngeal tumor that consists of mixed malignant fibrous histiocytoma and primitive neuroecto- dermal tumor. The neural crest may be the site of origin, and recurrence and metastasis are common. Two series of cases totaling 4 cases of this unusual neoplasm. Chordoma remains an unusual neoplasm when isolated to the parapharyngeal space. It can occur even without evidence of cervical bone involvement.31,32 Malignant fibrous histiocytoma confined to the parapharyngeal space was also described in reports.15,25

Additional descriptions of unusual malignant tumors originating in the parapharyngeal space include malignant teratoma,23 chondrosarcoma,23 rhabdomyosarcoma,25 malignant hemangiopericytoma,23 meningioma,23 fibrosarcoma,25,26 liposar- coma,23 malignant meningioma,23 and an unusual case of undifferentiated neoplasm that originated in the parapharyngeal space with a plasmacytoma.25 A rare malignant cartilaginous body tumor was also reported to be involved by the parapharyngeal space, and eight additional cases of parapharyngeal space tumors are listed in Table II.

Squamous cell carcinoma can metastasize to lymph nodes in the parapharyngeal space. This is not uncommon with tumors of the parotid gland, parotid cavity tumors, oropharyngeal tumors, and hypo- pharyngeal tumors. However, it is rare to have parapharyngeal metastasis present as the initial manifestation of a tumor. In contrast, several re- ports6,42,45 in the literature described a parapharyngeal mass that was found to be metastatic thyroid carcinoma as the first manifestation of a thyroid tu- mor. This included papillary thyroid cancer, med- ullary carcinoma, and metastatic follicular carcinoma of the thyroid.

EVALUATION OF PARAPHARYNGEAL SPACE TUMORS

Radiographic study of all parapharyngeal space tumors is essential. A computed tomography (CT) scan with and without contrast medium or a mag- netic resonance imaging (MRI) study with gadolinium injection should be performed. Angiographic procedures may be necessary and fine-needle aspira- tion can also be done in selected cases. The results of these studies provide necessary information for treatment planning.3

Computed tomography imaging is capable of displaying the soft tissues of the parapharyngeal space extremely well. CT scans may be helpful in separating prestyloid deep-lobe parotid tumors from extraparotid salivary neoplasms. The best way to distinguish between these two lesions is the finding of a fat plane between the deep lobe of the parotid gland and the posteroleseral aspect of a mass. The fat represents compressed and dermal supporting tissue in the parapharyngeal space and, when seen, the tumor is extraparotid.4 Unfortunately, for les- ions larger than 4 cm, this is not always possible and it is difficult to determine whether a tumor origi- nates in a minor salivary gland or in the parotid gland.

Benign prestyloid salivary tumors can cause erosion of the pterygoid plate, and this finding is not pathognomonic for malignant lesions. Radiographi- cally, low-grade malignancies are difficult to distin- guish from benign parapharyngeal space tumors. In general, prestyloid tumors are usually sali-vary gland neoplasms that displace the carotid sheath contents posteriorly. It is also important to look for evidence of skull base or cervical vertebral erosion and extension through the jugular foramen into the cranial cavity.

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Retrostyeiid tumors generally displace the internal carotid artery in an anteromedial direction. This displacement occurred in two thirds of the parapharyngeal neurilemmomas evaluated by CT. However, schwannomas can displace the carotid artery in many different directions because of the unpredictable tumor position between the great vessels and the site of origin of the tumor. Vessel displacement depends on the nerve of origin and whether the tumor arises near the base of the skull or in the inferior portion of the parapharyngeal space.

Large pleomorphic adenomas have a less homogeneous appearance on CT and contain irregular areas of minimal enhancement which can give an appearance similar to that of many neurilemmomas. Neurilemmomas also often have areas of hemorrhage, cystic necrosis, and fatty deposition. Lesions that show enhancement on CT with contrast medium include paragangliomas, hemangiomas, hemangio- pericytomas, aneurysms, and neurilemmomas (Fig. 6).

Indications of malignancy in the parapharyngeal space include irregular tumor margins, spread into surrounding tissues and fat planes on CT, and evidence of enlarged necrotic nodes in the cervical area or in the retropharyngeal space. CT scan has been shown to be helpful in assessing the parapharyngeal space and extension of neoplasms into adjacent regions. The parapharynx is often invaded directly by parapharyngeal tumors, and CT aids in the assessment of this region in patients who have nasopharyngeal carcinoma. Excellent examples of parapharyngeal pathologic features in CT axial studies were presented.

Currently, MRI provides the most useful preoperative information about the extent of the tumor and its relationship to surrounding structures. The capability of imaging the coronal and sagittal planes directly with MR scan is a significant advantage over CT. MRI also has the advantage of outlining the position of the internal carotid artery relative to the tumor. In the future, MR angiography may replace formal angiography for many lesions. As with CT scans, MR images also help to distinguish between intraparotid and extraparotid neoplasms by noting the retention or absence of a fat plane separating the lesion from the carotid gland. In general, the distinction between intraparotid and extra- parotid masses is so clear in MR images that a clearly defined MR scan rather than CT scans because of better definition of the soft tissue interface available with MR imaging.

The most common parapharyngeal neoplasms can be accurately differentiated from each other by their appearance on MR scans or by the direction in which the parapharyngeal fat or the internal carotid artery (or both) are displaced. Although it is difficult to distinguish between neurilemmomas and minor salivary gland tumors on the basis of their MR scans, neurilemmomas generally displace vessels anteriorly. MRI can identify paragangliomas greater than 2 cm by the presence of signal flow void characteristics. The presence of vascular flow voids distinguishes paragangliomas from the less vascular neurilemmomas. Metastatic renal cell cancers and thyroid carcinomas must be ruled out by history. It is still extremely difficult to distinguish malignant parotid tumors from benign tumors unless there are marked irregular margins seen on MR scan (Fig. 7). There was little specific information provided by adding CT to MR study.

If on the basis of history, examination, and imaging studies, a paraganglioma is suspected, patients should undergo testing for possible catecholamine secretion. Glomus jugulare tumors, carotid body tumors, and vagal paragangliomas all secrete catecholamines. Historical points that may dictate the presence of catecholamine production include labile hypertension, tremulousness, headache, pallor, palpitations, and sweating. Urine should be tested for the presence of vanillylmandelic acid, metanephrines, dopamine, epinephrine, and norepinephrine. Serum catecholamine levels can also be analyzed. Failure to discover a secreting tumor operatively may have dire consequences during surgical removal of the lesion. If the secreting tumor is found, preoperative blockade with propran- oloid and phenoxybenzamine may help control intraoperative arrhythmias and hypertension.

From CT or MR scans, it is difficult to determine if the carotid artery is invaded by tumor. Enlargement of the patient also undergoes electromyographic and is observed for clinical evidence of neurologic dysfunction. A carotid occlusion study must identify patients who are at greater risk of cerebral infarction developing after permanent embolization. Tumor embolization is used for paragangliomas with intracranial extension. Embolization is performed 1 day prior to surgery when the carotid artery is removed in a single operation. Embolization is not used by the author for carotid body tumors or for vagal paragangliomas that do not extend through the jugular foramen.

Transoral biopsy prior to surgery is contraindicated for most parapharyngeal space tumors. This technique causes the pharyngeal mucosa to adhere to the tumor capsule, and subsequent removal is more difficult. In addition, there is a risk of hemorrhage and tumor rupture in greater than 5% of subsequent recurrent lesions. Fine-needle aspiration prior to surgery is an easy procedure that can be performed transorally without difficulty. It is generally accurate in confirming the presence of pleomorphic adenoma. A report by Allison et al. of 12 patients who underwent fine-needle aspiration of nonvascular tumors found no complications, but their results were diagnostic for pleomorphic adenomas only. In addition, metastatic signs are not seen in patients with high-grade tumors. Fine-needle aspiration biopsies guided by ultrasonographic or CT scan can be helpful in cases of nonpalpable lesions.

**SURGICAL APPROACHES**

Many surgical procedures have been described for the treatment of parapharyngeal space lesions. This may be indicative of the problems in managing various tumors in an anatomic area that is difficult to access. The goal of parapharyngeal surgery should be to provide adequate tumor visualization that ensures complete removal. Intraoperative visualization of surrounding nerves and vessels and control of any hemorrhage. The operation must be planned so that it can extend to adjacent regions if necessary. Morbidity and mortality should be nearly zero.

Most authors recognize that the best surgical approach used for tumors of the parapharyngeal space is an external one. An external operation can be performed without mandibulectomy. Division of the mandible was first reported by Ariel et al. (1954). They discussed resection of the posterior aspect of the ascending ramus or actually dividing the ramus with a saw. Retraction of the mandibular condyle allowed improved access to the parapharyngeal space. However, the authors reported that they did not have to utilize mandibulectomy in any of the parapharyngeal tumors, even with lesions up to 11 x 9 x 9 cm. They did not believe that the morbidity from mandibulectomy i.e., inferior alveolar nerve
The cervical approach has been recommended by many authors as the best access route for removal of parathyroid space tumors. The cervical approach uses a transverse incision at the level of the hyoid bone. The submandibular gland is often removed to gain access to the parathyroid. This approach does not involve visualization of the facial nerve. Base described the removal of the submandibular gland with identification of the nerve in the course of the facial nerve. An incision through the fascia deep to the submandibular space allows for blunt dissection of the tumor. The approach is then extended to include division of the digastric, stylohyoid, and styloglossus muscles from the bone and further improved access to the parathyroid space. Dissection using the fingers is then necessary. Warren et al. described the cervical approach by retracting the sternocleidomastoid muscle and carotid sheath backward while elevating the mandible forward. The styloid process and stylohyoid mandibular ligament were divided. Lai et al. also stated that, in the transcervical approach, the digastric and stylohyoid muscles were retracted or divided to allow access to the parathyroid space tumor. The submandibular gland was generally retracted, and the inferior pole of the parotid gland was retracted upward.

Cervical-Parotid Approach

A cervical approach was also described in which an incision is made in front of the ear in a standard parotidectomy fashion. The main trunk of the facial nerve is identified, with exposure of the parotid deep to the skin. The posterior belly of the digastric muscle is then divided, exposing the internal and external carotid arteries, jugular vein, and one half of the sternocleidomastoid and mandibular ligament, stylohyoid muscle, and styloglossus muscle are followed to the styloid process where they are divided close to the styloid process. The styloid is then removed with the bone-cutting forceps. According to Stell, this approach was used successfully in 47 surgical procedures. Four individuals required either mandibulotomy or mandibulectomy. Cook and Ranger described a mandibular osteotomy via a standard parotid incision extending into the submandibular region. They divided the mandible at the second premolar area and repaired it with plates. This did cause inferior dental nerve damage, and some patients have required a slight increase in salivary pharyngeal wall. Problems with the transcervical approach have included bladder surgical removal, with increased incidence of fistula formation. There is also risk to the ascending of tumor cells, damage to vascular structures, hemorrhage, increased risk of infection, and increased risk of the patient's death.

Transoral Approach

The transoral approach is usually planned for deep lobe parotid tumors. This is a difficult area approach described by a number of authors. Proctor described a transoral-transcervical approach which was used in 5 patients. It is described as a difficult area approach. The transoral-transcervical approach was described by Yoshida et al. as a technique which was used in 5 patients. It is described as a difficult area approach. The transoral-transcervical approach was described by Yoshida et al. as a technique which was used in 5 patients. It is described as a difficult area approach.

Transoral-Transcervical Approach

A series of these cases was reported by the Mayo Clinic. The transoral-transcervical space tumors removed prior to 1988 reported that the transoral-transcervical approach was used in 5 patients. The transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors. The parathyroid transoral-transcervical approach has been used in the removal of malignant tumors.
cision extended along the floor of the mouth and al-veolar lingual sulcus onto the anterior tonsillar pil-lar. The tonsil and upper constrictor muscles were moved medially, giving access to parapharyngeal space lesions that extend to the skull base and to highly vascular tumors.

Similar procedures for removing parapharyngeal space tumors have been described by other authors.11,12 Keski13 also described the midline transmandibular approach for skull base lesions. He reported the removal of 6 parapharyngeal space tu-mors via this approach: 3 glomus vagales, 1 vascular schwannoma, 1 internal carotid aneurysm, and 1 chordoma paragangial tumor. This approach was chosen primarily for vascular parapharyngeal space tumors. The cervical-transparotid approach via a midline mandibulotomy incision was also used for lat-eral skull base surgery for the removal of cancers that involve the parapharyngeal space.13-15

The importance of the removal of retropharyngeal nodes for tonsil, oropharyngeal, and hypo-pharyngeal lesions was described.15,16 Lynch noted located between the superior constrictor and prevertebral muscles consisted of two main groups: the superior lateral nodal group (Rouviere) at the skull base and a group located in the jugular foramen and the inferior nodal group located at the level of the oropharynx deep to the superior constrictor muscle.17,18 Manktelow19 thought that removal of these lymph nodes from the skull base should be done for all tumors of the tonsillar fossa with superior extension and for lateral and posterior pharyngeal wall tumors and for noso-pharyngeal tumors. Using the mandibular swing ap-proach, Keski11 and Omura, et al.,20 followed the internal carotid artery to the skull base and re-structured the structures medial to this vessel. Refine-ment in preoperative carotid angiography with the mandibular swing osteotomy were reported by Cohen, et al.11

Infratemporal Fossa Approach

The lateral infratemporal fossa approach gives exposure of the skull base as well as the paraphar-yngeal space. This procedure has also been used by Fisch11 for parapharyngeal space lesions that involve the temporal bone and was used in several series.21,11

Smith and Sharkey11 reported their experience with removal of parapharyngeal space cancer via an infratemporal fossa approach and a modification of the technique used by Ugo Fisch. It combined a posterior auricular parotid flap with a parasympa-thetic osteotomy for removal of the mandible or maxilla (or both). Another variation of the infratemporal fossa approach was described by Sok-keh, et al.,22 who used a subtemporal preauricular incision for the treatment of seven patients with le-sions of the parapharyngeal space. Unfortunately, no specific indication or description of the tumor types for these seven cases was given. The operation used a preauricular incision with neck and coronal extension and a temporal craniotomy of the petrous internal carotid artery. They stated that this approach was generally used for tumors that involve the lateral and posterior cranial base; sphenoidal skull base, and medial part of the petrous temporal bone, infratemporal fossa, nasophar-ynx, and retropharynx, and angiofibroma. This did allow for direct access to the ipsilateral pet-rous and upper cervical internal carotid artery. There was minimal brain retraction and facial nerve function was maintained.10,11 Surgical ap-proaches described in the literature are shown in Table III.

COMPICATIONS

Complications of surgery in the parapharyngeal space result from damage to critical structures: the carotid artery, improper preoperative assessment, poor selec-tion of patients, or the use of an inappropriate sur-gical approach. Few reports of parapharyngeal surgical cases in the literature describe complica-tions. One series26 of 54 parapharyngeal space tu-mors found a 4% rate of facial nerve deficits. Major deficits occurred in only 11% of patients. Paraganglioma removal was associated with the greatest frequency of complications. Another report28 of 52 cases described 1 temporary facial palsy, a perma-nent Horner's syndrome, loss of vagus nerve func-tion, major blood vessel injury requiring repair, and 1 case of severe postoperative hemorrhage. In a re-port by Lai, et al.,6 of 15 patients had complica-tions after parapharyngeal surgery surgery, including a Frey's syndrome in 2, Horner's syndrome in 1, and loss of the vagus nerve with resulting hoarseness, and aspiration, and mortality is unavoidable. When the parangangi-Amyloidosis syndrome, and neurogenic tumors.

Surgery for malignant lesions that extend into the parapharyngeal space also has caused signifi-cant morbidity. Described by Smith and Sharkey,11 described results after surgical removal of malignan-ant lesions that involved the parapharyngeal space. Facial nerve dysfunction occurred in all survi-vors, and 4 of the 6 surviving patients required permanent gastrostomy due to dysphagia and in-bility to tolerate food. This long-term morbidity is a reflection of the efficacy of surgical tumor ablation and relief of symptoms from cancer that involves the parapharyn-gal space. Fortunately, many parapharyngeal space tumors are benign lesions and expected morbidity and mortality should be nearly zero. Unfortunately, other complications can occur. A list of complications associated with tumors of the parapharyngeal space is shown in Table IV.

Recurrent

Tumor recurrence is most likely initiated dur-ing the removal of parapharyngeal pleomorphic ad-enomas. Rupture of the tumor capsule with tumor spillage can result in recurrent neoplasms that may not be noted until 10 to 20 years after the initial surgery. Most tumors of the parapharyngeal space, pleomorphic adenoma has an increased risk to the facial nerve and should always be done by an experienced surgeon aided by facial nerve monitoring. In addition, highly vascular tumors or tumors that extend into the jugular foramen area may recur due to the surgeon's inability to totally remove the le-sion secondary to problems with bleeding or expos-ure.

Nerve Injury

During the cervical-parotid or transparotid ap-proach, the facial nerve is isolated and a mild pa-thway to maintain. Permanent facial nerve injury should be extremely rare and steps should be taken to isolate and preserve the nerve and its branches at greatest risk for injury. When the facial nerve must be transected because of intracranial tumor exten-sion, meticulous technique and preservation of a large area of the facial nerve tissue around the nerve in the region of the stylohyoid foramen help minimize postoperative facial weakness. Permanent injury to the facial nerve following parapharyngeal space sur-gery is extremely rare, with the exception of malig-nant neoplasms that involve the parotid gland.

Additional cranial nerves at risk for injury dur-ing surgery of parapharyngeal space surgery are nerves X, XI, and XII, and the cervical sympathetic plexus. Often during the course of removal of a neurogenic tumor, damage to the vagus nerve is unavoidable. When possible, nerve grafting can be performed. If the va-gus nerve is injured during tumor resection, micro-scopy reinnervation or nerve grafting should be done if possible. If the 12th cranial nerve alone is divided, postoperative problems generally are minimal.

However, if cranial nerves X and XII are both disrupted and had normal preoperative function, significant problems with swallowing and speech can occur. Transection of the vagus nerve above the
nervous or ganglion. Likewise, the great auricular nerve is generally divided during the cervical-pa-
rotid flap. After this, the head and neck patients should be told preoperatively about the numbness that will
occur.

Vessel Injury
Carotid artery injury is the greatest potential risk of the paraganglionic space. Un-
controlled bleeding can cause death from hemor-
rhage or stroke. Paraganglionic space tumors can directly compress the jugular vein, internal or external
carotid arteries, and vertebral artery. Vessel injury is most likely to occur during the removal of para-
ganglions, recurrent tumors, and malignant le-
sions or after removal of tumor when the patient
had received radiation therapy. Preoperative as-
essment of the tumor, the use of angiography when appropriate, embolization for vascular lesions that
extend intracranially, and placement of permanent
balloons to occlude vessels if flow has all been
found to decrease the incidence of complications from vessel injury. Surgical procedures that put
the patient at high risk for vessel injury should also be
done by a team of physicians capable of handling all
possible sequelae.

Osteotomies
Osteotomy complications include loss of lower teeth, malocclusion, and neuromas. If there is any con-
cern about adjacent periauricular dental disease, a pre-
operative Panorex radiograph should be taken.111
Direct wiring of the osteotomy site can be done in combination with the insertion of a preformed ling-
ual splint for the edentulous patient. Reconstruction
plastic procedures, such as bone grafting, before man-
dibular fixation is performed, a drill should be used to remove uneven bone from the osteotomy site so
that a minimum of joint stability is achieved.110 Inter-
maxillary fixation is not necessary. Patients who undergo a midline mandibulotomy are generally fed by
a nasogastric tube for 2 weeks.

Other Complications
Large paraganglionic space tumors can im-
pinge on the airway by displacing the pharyngeal
wall medially or by obstructing the bronchi. Trache-
ootmy may be necessary and should always be done with the airway decompressed. Preoperative he-
matoma can also compromise the airway because of
bleeding into the neck. Meticulous hemostasis and suction of blood are necessary. Portable suction
equipment should be used to maintain con-
stant negative pressure, even when the patient is
ambulatory.

Leakage of cerebrospinal fluid and meningitis
are possible complications after removal of paraga-
nglionic space tumors that extend into the jugular
foramen, extend intracranially, or cause destruction
of cervical vertebra. Leakage of cerebrospinal fluid
is most likely after removal of tumors that extend
intracranially.109 In one report,109 leakage from the
jugular foramen area, there was a 45% in-
cidence of postoperative leakage of cerebrospinal
fluid. After tumor excision, the area should be
closed so that it is watertight. If a dural defect re-
mains, a dural graft that uses the temporalis fascia
is preferred over normal skin grafts. The temporalis
muscle or fat is also packed into the area. A local
muscle flap or free flap is used to reconstruct the
defect and augment the skull base closure.110 Spiral
drainage is used for approximately 1 week if there
is concern about the repair. It is not used routinely
in the author's practice.

Because of the large dead space that occurs af-
fter removal of a paraganglionic space tumor, a ser-
onoma can form, and infection is possible. The patient
is maintained on a broad-spectrum cephalosporin
for several days postoperatively. When the oral cav-
ity is entered, metronidazole is also used for pro-
phylaxis.112

If the superficial portion of the parotid gland has to be removed, complications reported for pa-
rotidectomy would also apply for paraganglionic
surgery.

When Not to Operate
It is unlikely that patients will die of an un-
treated benign paraganglionic space tumor. One ex-
ception may be paragangliomas. The true extent of
the disease should be removed to prevent future
morbidity. The aim is to avoid subsequent neuro-
genic damage, dysphagia, airway obstruction, hear-
ing loss, or cosmetic problems that occur from tumor
enlargement. In all cases, the risks of the operation
must be weighted against the disease. This is especially true for malignant tumors, neurogenic
neurons, and vascular tumors in the elderly.

Neurogenic tumors can be present for years without causing neurological, broad-

taxial paralysis is less debilitating than sudden
cessation caused by a nerve transection. In young patients, neurogenic tumors are removed to prevent future
loss of function of adjacent nerves and to try to pre-
serve nerve function. In some cases of isolated symp-
tomatic paraganglionic neurectomies, 25% of pa-
tients with no nerve deficits should probably be
watched. Paragangliomas that have spread widely
can cause progressive nerve paralysis and extend
intracranially with significant morbidity. Again,
el-
derly patients should not undergo surgical removal
of these lesions if they have been present for many
years and have not caused cranial nerve deficits,ecausethe risk of operations outweigh inactivity. Most
premalignant salivary tumors can be removed with lit-
tle morbidity and, therefore, there is little restric-
tion on the age group treated. 109 Because of the risk of
tumors enlargement and pos-
sible malignant degeneration of pleomorphic ade-
nomas.

PERSONAL SERIES
During the past 10 years, the author surgically removed 43 tumors that involved the paraga-
nglionic space. Tumors that extended into the para-
ganglionic space from adjacent structures were ex-
cluded from this report.110 If the paraganglion spaces were treated with skull base resection, biopsy alone, observation, or radiation therapy were not included. Paraganglionic space tumors re-
moved by colleagues at the author's institution are
also excluded. Of these 44 patients, 40 underwent
surgery in the past 5 years. The lesions removed include 40 primary paraganglionic space tumors and
4 cases of isolated metastasis to paraganglionic
nodes.

The mean age of these 44 patients was 46 years, ranging from 29 to 76 years. The male-to-female ratio was 17:27. Twenty-four of the pa-

tients presented with an asymptomatic mass disco-
covered on physical examination or noted by the
patient.

Six patients described pain present in the deep parotid area or diffusely in the mandibular region.
All 6 patients removed to have paraganglionic can-
cers. Three had adenos cystic cancers, 1 squamous cell carcinoma, 1 neurofibrosarcoma, and 1 chor-
doma.

Mild aching in the throat and discomfort in the ear were noted in 4 patients. These individuals all had a 1-vessel paraganglioma. 1 vaginal paraganglioma, and 2 pleomorphic adenomas. One
individual described parasthesias of the third division of the fifth cranial nerve. This individual had an
adenoid cystic carcinoma. She also complained of pain. Trismus, generally of a mild nature, was
described by 5 patients. Two had long lesions that
involved the mandible (malignant and cystic fibroma) and 2 had carcinomas (squamous cell cancer and adenoid cystic carci-

Dysphonia and chronic cough were complaints of the 6 individuals who preoperatively had 10th
nerve paralysis. Decreased hearing was noted in 2 individuals. Both of these individuals removed to treat dysphonia. 1 patient had a persistent hoarse

Two patients had prior treatments for tumors in the neck. 1 patient was treated with radiation therapy for a recurrent nasopharyngeal carcinoma, 1 with a
lymphoma, and 1 with Hodgkin's disease.

The other 2 patients had significant tumors. 1 had a palpable mass, and 1 had an asymptomatic tumor.

Two patients had prior treatments for tumors in the neck. 1 patient was treated with radiation therapy for a recurrent nasopharyngeal carcinoma, 1 with a
lymphoma, and 1 with Hodgkin's disease.

Two additional patients had a tumor that was either a pleomorphic adenoma or a lymphoma that originated from a probable branch of the

Pathologic Findings
Of the 44 patients who underwent surgery, 12 were treated for recurrent tumors of the paraga-
nglionic space. All of these individuals had surgery at
another institution.

Overall, there were 32 benign lesions and 12 malignant tumors. Of the malignant tumors, 4 re-
presented isolated metastasis to the paraganglionic
space without direct extension. If these cases are
excluded from the primary tumors, the benign-to-
malignant ratio would be 27:4. Two had long lesions that
involved the mandible (malignant and cystic fibroma) and 2 had carcinomas (squamous cell cancer and adenoid cystic carci-

Two patients had prior treatments for tumors in the neck. 1 patient was treated with radiation therapy for a recurrent nasopharyngeal carcinoma, 1 with a
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cranial nerve. There were 7 vagal paragangliomas removed; 6 were benign and 1 was malignant. The patient with the malignant vagal paraganglioma had undergone a prior attempt at surgical removal of the tumor and radiation therapy elsewhere. Six carotid body tumors were included that clearly extended into the parapharyngeal space. Although these tumors may not be considered to be primary parapharyngeal space in origin, most series do include carotid body tumors. The author included only those carotid body lesions that definitely extended into the parapharynx and were operated on clinically to displace the tonsil and soft palate, were retroman- dibular on imaging studies or, at the time of sur- gery, clearly extended above the level of the poste- rior belly of the digastric muscle. One of these six individuals had two prior attempts at surgical re- moval of the lesion at another institution that were abandoned because of excessive bleeding. Two of the patients with carotid body tumors had multiple paragangliomas noted on angiographic studies. The final neurogenic tumor was a neurofibrosarcoma of the vagus nerve.

Five benign miscellaneous lesions were re- moved from the parapharyngeal space. These in- cluded a recurrent venous angioma, a hemangioma, a lymphangioma, a carotid artery aneurysm, and an unusual case of reactive lymphoid tissue in the ret- rostyloid area causing 10th and 12th nerve paralysis. Histopathologic findings from specimens of tu- mors removed showed no evidence of lymphoma on pathologic review, and symptoms gradually resolved over time.

The malignant miscellaneous lesions encoun- tered in the parapharyngeal space consisted of 1 pri- mary chordoma and 4 cases of isolated metastases to parapharyngeal space nodes. Two were from squamous cell carcinomas of the tonsil that had noncontiguous tumor, and 1 individual had nasopharyngeal carci- noma involving the superior parotid gland after radia- tion therapy. There was also no evidence of di- rect tumor extension in this patient. The last patient had metastatic osteogenic sarcoma to the parapharyngeal space.

Treatment

The diagnosis and surgical procedures used for each patient are shown in Table V. Thirty-five pa- tients underwent a cervical-parotid approach and nine underwent the cervical-parotid approach with midline mandibulectomy. One patient with a vagal paraganglioma extending intracranially had preop- erative tumor embolization. This individual and one other patient with a neurilemoma extending intra- cranially also had a suboccipital craniectomy per- formed at the time of the cervical-parotid approach to remove the intracranial tumor extension at the same surgery. One patient with recurrent osteo- genic sarcoma confined to the retrosigmoid portion of the parapharyngeal space preoperatively under- went balloon occlusion of the carotid artery.

The cervical-parotid approach with midline mandibulectomy was used for malignant lesions or for extensive benign tumors. The pathologic findings for the malignant lesions included the three cases of isolated metastases. These all occurred in the su- perior parapharyngeal area. Three individuals un- dergoing this operation had extensive vagal paragangliomas that circumferentially involved the carotid artery at the level of the skull base. One was a malignant tumor that had previously undergone two attempts at removal and radiation therapy. A chordoma was excised by this approach also in an individual whose tumor invaded the cervical vertebral bodies and involved the vertebral artery. The only pleomorphic adenoma removed via mandibular osteotomy was a recurrent tumor that had under- gone transoral removal elsewhere several years ear- lier. The tumor recurrence was quite extensive at the level of the nasopharynx and skull base, again surrounding the internal carotid artery on scan.

Follow-up

Of the patients with primary tumors, two had recurrences. One patient with an adenoid cystic carci- noma of the superior parapharyngeal space has lo- cal and distant metastasis. She currently is alive with persistent disease and is asymptomatic. A sec- ond individual with extensive adenoid cystic carci- noma of the parapharyngeal space underwent a full course of radiation therapy after his surgery. He had no evidence of local or regional disease but has extensive pulmonary metastases. He currently is alive and doing well with stable pulmonary lesions. The remaining individuals with malignant tumors have, at this time, no evidence of recurrent disease and, however, the follow-up is less than 2 years in the majority of these cases. There was no known recur- rence of any of the benign tumors, and no patient was lost to follow-up.

Complications

The most frequent complication in these pa- tients was transient facial nerve paresis, which oc- curred in 10 individuals. All 10 recovered com- pletely and the paresis primarily involved the marginal mandibular branch of the facial nerve. Seven patients had permanent loss of the vagus nerve, which occurred in cases of 10th nerve neu- rilemoma or paraganglioma tumor surgery. Of the 7 individuals who lost their vagus nerve, 2 were treated with vocal cord augmentation with Teflon, and 2 patients underwent thyroplasty. Three indi- viduals required no further treatment. Three pa- tients, in addition to losing the 10th cranial nerve, also lost the 12th cranial nerve at the time of sur- gery, which was for extensive paragangliomas. Those patients all had prolonged difficulty with

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (yr)</th>
<th>Sex</th>
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swallowing and eventually were able to eat without supplementation, but one patient was not able to eat normally until 5 months after operation. Sym pathetic nerve injury with Horner's syndrome was noted in two patients. One individual also had a temporary accessory nerve weakness, and one had a permanent loss of the third division of the fifth cranial nerve.

Other complications noted in this series included 3 cases of postoperative infection, 4 hematomas (2 requiring simple drainage procedures), and first bite pain related to mobilization of the tail of the parotid gland.

AUTHOR'S RECOMMENDED SURGICAL APPROACHES

The author has used two surgical approaches during the past 10 years to manage successfully and safely a wide variety of benign and malignant parapharyngeal space tumors. These procedures have the additional flexibility to manage neoplasms that extend into adjacent structures or into the intracranial cavity. The indications and operative technique of the cervical-parotid approach and the cervical-parotid approach with midline mandibulotomy are reviewed in detail.

Cervical-Parotid Approach: Surgical Technique

The cervical-parotid approach used by the author is similar to the surgical technique described by Stell, et al. An incision is made in front of the ear and extended beneath the mandible. A parotid skin flap and inferior neck flap are raised. The inferior and posterior areas of the parotid gland are separated from the sternocleidomastoid muscle, from the carotid sheath, jugular canal, and from the posterior belly of the digastric muscle. The main trunk of the facial nerve is identified (Fig. 8). If it is obvious that the parapharyngeal space tumor is a dumbbell variety of deep-lobe parotid tumor, a superficial parotidectomy is performed. In other cases, the inferior division of the facial nerve is isolated and followed out to the level of the submandibular gland.

The sternocleidomastoid muscle is retracted laterally and the upper jugular nodes are removed to allow identification of deeper structures. The spinal accessory nerve, internal jugular vein, internal and external carotid artery, and cranial nerves XII, XI, and XII are isolated. Vessel loops are placed around the internal and external carotid arteries for security (Fig. 9).

The posterior belly of the digastric muscle is isolated completely down to its insertion on the hyoid bone. The dense stylomandibular fascia between the inferior parotid gland and the submandibular gland is divided so the submandibular gland can be easily retracted medially if necessary. The posterior belly of the digastric muscle and the stylohyoid muscle are separated from their attachments at the mastoid tip and from the styloid process, and are reflected medially. This gives further superior exposure of the internal carotid artery, jugular vein, and adjacent nerves. The external carotid artery is now easily seen passing into the parotid tissue in front of the styloglossus muscle. This artery and its corresponding vein are divided. The angle of the mandible is retracted anteriorly. This stretches the stylomandibular ligament so that it can easily be palpated and visualized (Fig. 10). This ligament is divided, creating a wide opening into the parapharyngeal space. The parapharyngeal space tumor is now easily visualized and can generally be removed under direct vision (Fig. 11). After tumor removal, a Hemovac drain is inserted and the incision is closed in layers (Fig. 12).

Indications

The cervical-parotid approach has been used to remove the majority of lesions encountered in the parapharyngeal space. All deep-lobe parotid neo-

plasms and extraparotid salivary tumors are excised via this approach. In addition, many retro-

styloid tumors, including most neurogenic tumors and small paragangliomas, can be removed in the same manner. Low-grade malignant tumors of the deep lobe of the parotid gland that extend into the parapharyngeal area can also be excised by this op-

eration. For tumors that are known prior to surgery to extend intracranially, the cervical-parotid ap-

proach is combined with a suboccipital craniotomy by a postauricular incision. The cervical-parotid ap-

proach was used in 80% of the author's cases.

Important Points

1. The cervical-parotid approach can be combined with a mandibulectomy or transoral incision to

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improve exposure of the parapharyngeal space. However, this was not necessary in any of the cases in the author’s series.

2. For certain tumors of the retrostyloid space and for prestyloid tumors that extend around the styloid process, division of the styloid muscles and removal of the styloid process are often helpful.

3. The cervical-parotid approach can be extended easily via a postauricular incision to enable the surgeon to perform a subcricoid craniotomy. This should be planned whenever there is radiographic evidence of tumor that extends intracranially or if tumor cannot be removed completely from the jugular foramen region.

4. It is not necessary to perform a superficial or total parotidectomy for most cases of deep-lobe parotid parapharyngeal tumors.

5. Several authors stated that the preoperative differentiation of an extraparotid neoplasm from a deep-lobe parotid neoplasm is important, because extraparotid tumors can be approached through a cervical operation without the need to identify the facial nerve. The author does not agree with this. Extraparotid parapharyngeal space neoplasms often approach the main trunk of the facial nerve at the level of the stylomastoid foramen. By identifying the facial nerve in all cases, there is less chance of its injury.

6. For deep-lobe tumors that extend through the stylomandibular tunnel into the parapharyngeal space, an initial superficial parotidectomy can be performed.

7. In the author’s experience, most deep-lobe parotid tumors are not the dumbbell type, but are more often round and originate from the retroman-
dibular portion of the deep lobe of the parotid gland. There often is a narrow attachment of parotid tissue to the tumor that can be separated easily under direct vision without necessitating removal of the superficial portion of the gland. Even with greater extension into the deep lobe, by identification and retraction of the main trunk of the facial nerve, a wide cuff of deep-lobe parotid tissue can be removed with the tumor. This should always be done because the site of origin is most at risk for rupture of the tumor capsule and tumor spillage.

8. When the superficial and deep lobes of the parotid gland are removed with a large parapharyngeal space tumor, consideration should be given to using a gracilis free flap to repair the significant depression that occurs from loss of the entire parotid gland and surrounding structures.

9. The carotid artery can be followed easily to its foramen by reflecting the muscles off the styloid process and removing the styloid process.

10. It is not necessary to remove the subman-
dibular gland to excise parapharyngeal space tu-

11. Division of all of the stylomandibular liga-
ment is essential to opening the parapharyngeal

12. For recurrent tumors of the parapharyngeal space, especially if a superficial parotidectomy was previously performed, these operations should be done with cranial nerve monitoring, especially facial nerve monitoring.

13. After the operation, it is essential to obtain complete hemostasis. A large Hemovac drain should be left in the defect for at least 2 to 3 days postoperatively to maintain the patient on constant suction drainage. This is done to decrease dead space and subsequent seroma formation and possible in-

14. When parangangliomas extend intracranially, preoperative embolization should be performed the day prior to surgery.

15. The cervical-parotid approach provides excel-

16. The stylomandibular ligament is often a thick fи-
brous band or calcified band that should be divided.

17. For individuals who have had previous transoral excisions, biopsies, or tonsillectomies, it is best to let the tonsillar fossa heal for several weeks prior to surgical therapy. A cuff of pharyngeal mucosa should be included if a transoral biopsy has been done. The transoral wound can be closed easily at surgery.

18. If there is not a loose areolar plane sur-

19. Rupture of a prestyloid pleomorphic ade-

20. Removal of the mastoid tip may be done for pleomorphic adenomas that are tightly compressed into the stylomastoid foramens area.

21. During the removal of prestyloid tumor, care must be taken because a tortuous internal car-
tid artery often has contact with the tumor at a level superior to the styloid process.

22. For suspected malignant lesions, the initial node removed as part of the exposure should always be sent for pathologic study. If a malignant tumor is encountered, an appropriate select or modified neck dissection can be performed, if indicated.

23. During closure, the styloid muscles and pos-
terior belly of the digastric muscle can be reat-
tached.

Cervical-Parotid Approach With Midline Mandibulotomy: Surgical Technique

All individuals undergoing a cervical-parotid approach with midline mandibulotomy have an initial tracheostomy. Then the steps of the cervical-parotid approach are performed. After this is com-
pleted, the incision is extended around the chin and used to split the lower lip in the midline. The an-
terior mandible is exposed. The digastric tendon is separated from the hyoid bone, and the mandible is divided in the midline in a stair-step manner, pre-
serving the incisor teeth if good dentition is present (Fig. 13).

An incision is made intraorally in the floor of the mouth by using cautery and including the sub-
mandibular duct orifice with the mandible. The incision extends back onto the anterior tonsillar pillar and up to the level of the hard palate. Further ex-
tension onto the hard palate is occasionally neces-
sary for nasopharyngeal lesions.

The hypoglossal nerve is identified and followed into the tongue base. The mylohyoid muscle is di-
vided over the hypoglossal nerve. The tongue mus-
culature is reflected medially and the lingual nerve is identified and preserved as it stretches across the
Important Points

1. A tracheotomy and a feeding tube are always necessary with a midline mandibulotomy.

2. It is not necessary, in all cases, to split the lower lip and, if cosmesis is an issue, the incision can be extended across to the opposite side of the neck beneath the mandible, and the tissues can be raised off the mandible as a visor flap. A lower lip split incision, closed carefully and extended around the natural border of the chin, results in a cosmetically acceptable scar in most cases.

3. For individuals who have lower teeth, the mandibular osteotomy can be performed by using an osteotome between the incisor teeth, dividing this portion of bone as the last cut. The remaining bone cuts are made with a Stryker saw.

4. If the teeth are crowded, it is simpler to remove one tooth and make the osteotomy through that site.

5. For individuals with teeth, preoperative impressions are made and a pre-made lingual splint is fabricated, which is wired into position at surgery and removed, generally, in 6 weeks. This further helps to ensure complete healing of the incisionary site and preservation of the lower incisor teeth.

6. The osteotomy is done in a stair-step fashion and can be reapproximated at the end of the operation by using wires or miniplates.

7. The divided mylohyoid, styloglossus, and stylop- hygianous muscles are reattached as part of the closure.

8. In most cases, the lingual nerve can be preserved.

9. It is helpful to enter the parapharyngeal and retropharyngeal space inferiorly just above the 12th cranial nerve. The surgical approach extends the incision and dissection in a superior direction.

10. If, as a result of tumor removal, the 10th and 12th cranial nerves were resected, the retropharyngeal space, the cervical-palatod approach should be given to provide for a cricopharyngeal myotomy and Teflon augmentation prior to closure.

11. Neck dissection can be performed in conjunction with the cervical-palatod approach for tumors that are known to be malignant or when approaching malignancies that extend into the parapharyngeal space.

12. For tumors that involve the nasopharynx, the superior incision can be extended onto the hard palate to allow removal of the eustachian tube area and adjacent muscles.

13. The decision to attempt removal of a malign- ant tumor that has invaded the retropharyngeal space by direct extension or metastatic involvement is always difficult. A complete evaluation must be done first to rule out any evidence of distant metastasis. The patient’s overall health must be assessed and the surgeon should have a frank discussion with the patient about expected goals and risks of surgery. If the decision is made to proceed with surgery, a balloon occlusion study of the carotid artery must be performed first. If this study shows the carotid ar- ter y can be excluded safely, then 2 days prior to surgery, permanent detachable balloons are placed in the internal carotid artery. The patient is placed on anticoagulant therapy for 48 hours prior to sur- gery, and the operation is performed.

14. Hospitalization generally averages 10 to 14 days with the cervical-palatod approach, in which hospitalization is 2 to 3 days. Edema can be significant after the midline mandibulotomy, and a short period of steroid therapy initially is helpful in decreasing oral swelling.

15. Swallowing is often difficult after a midline mandibulotomy because of interruption of the branches of the pharyngeal plexus. Care should be taken in initiating an oral diet.

INTRAOPERATIVE MONITORING

Intraoperative monitoring of regional cranial nerves is now done routinely for tumors that require mandibulotomy or craniotomy. Intraoperative mon- itoring of cranial nerves VII, X, XI, and XII is simple and may decrease the incidence of nerve injury. Monitoring has been most helpful for surgery in which tumors extend intracranially through the jug- ular foramen or for tumors requiring reoperation for a recurrent tumor. Monitoring has been used most often in surgery on recurrent parapharyngeal parotid tumors when a prior partial resection has been done. In this case, intraoperative monitoring of the seventh nerve is done alone.

For tumors with intracranial extension, obvious erosion of the skull base or cervical spine, or exten- sive vascular features, the author performs these operations in conjunction with a neurosurgical col- league. Use of the combined talents of two surgical disciplines ensures maximum ease of tumor re- moval with the least possible morbidity for the pa- tient. If intracranial exposure is necessary or grafting of the carotid artery is necessary, appropriate help is readily available.

SUMMARY

The wide variety of tumors encountered in the parapharyngeal space contributes to unique manage- ment problems. The surgeon must be well versed in the complex anatomy of this area to plan for safe removal of tumor. Imaging studies and the capability to predict preoperatively the results of carotid balloon-occlusion studies render many of the tumors operable. Surgery in the parapharyngeal space should not be considered as an operation performed in an inaccessible area with high morbidity. The use of two surgical procedures, the cervical-parotid ap- proach and the cervical-palatod approach with midline mandibulotomy, has met the goals of surgery in the parapharyngeal space. These goals are excellent tumor visualization, preservation of surrounding nerves and vessels, control of bleeding, and com- plete tumor removal with low morbidity.

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