Rammohan Tiwari, M.D., Ph.D.,
Jasper Quak, M.D., Ph.D.,
Saskia Egeler, M.D., Ph.D.,
Ludi Smeele, M.D., D.D.S., Ph.D.,
Isaac v.d. Waal, D.D.S., Ph.D.,
Paul v.d. Valk, M.D., Ph.D., and
René Leemans, M.D., Ph.D.

Tumors of the Infratemporal Fossa

ABSTRACT—Neoplastic processes involving the infratemporal fossa may originate from the tissues in the region, but more often are the result of extension from neighboring structures. Metastatic lesions located in the region are rarely encountered. Because of its concealed localization, tumors may remain unnoticed for some time. Clinical signs and symptoms often arise late, are insidious, and may be mistakenly attributed to other structures. The close proximity of the area to the intracranial structures, the orbit, the paranasal sinuses, the nasopharynx, and the facial area demands careful planning of surgical excision and combined procedures may be called for. Modern imaging techniques have made three-dimensional visualization of the extent of the pathology possible. Treatment depends on the histopathology and staging of the tumor. Several surgical approaches have been developed over the years. Radical tumor excision with preservation of the quality of life remain the ultimate goal for those tumors where surgery is indicated. Experience over a decade with various pathologies is presented.

The infratemporal region, by virtue of its relatively concealed location, is inaccessible for clinical and endoscopic examination. Space-occupying lesions in the area, with the exception of those with an inherent rapid growth pattern, may continue to grow unnoticed for considerable period. When symptoms do appear they are insidious and may not draw attention until there is some impairment of function. Because of the relative infrequency of these lesions, there is paucity of information at the general practitioner and sometimes even at the specialist level.

As a result, the diagnosis is often delayed. Not uncommonly, attention is first drawn by radiological investigation carried out in an effort to seek further information. Although interest in the pathologies and surgical intervention in the area has long been known, the last decade has seen renewed interest. Some of the earliest publications on the surgical approaches to the area appeared in the last century.[1] They were mainly directed to the relief of pain from sphenopalatine neuralgia,[2,3] but the morbidity of some of these approaches was unacceptable and they did not gain popularity. In 1928, Sewal

Sukll Base Surgery, Volume 10, Number 1, 2000. Departments of ORL Head Neck Surgery (RT, JQ, RL), Neurosurgery (SE) Maxillofacial Surgery (LS) Pathology (PvdV), and Oral Pathology (IvdW), Division of Surgical Oncology, Reconstruction, and Skull Base Surgery, Academic Hospital VU, Amsterdam, The Netherlands. Reprint Requests: Dr. Leemans, Department of Otolaryngology Head Neck Surgery, Division of Surgical Oncology, Reconstruction and Skull Base Surgery, Academic Hospital VU, De Boelelaan 1117, 1081 HV Amsterdam The Netherlands. 1052-1453/2000/E1098-9072(2000)10:01:0001–00010:SBS00168X

described a transantral approach for the excision of the sphenopalatine ganglion, which was well received.[4] This approach is still practiced to date, although for other indications. Newer and bolder surgical approaches were introduced in the 1960s by pioneers such as Conley,[5] Barbosa,[6] and Crockett.[7] These approaches and others were perfected in the following years. Tumors in this region often spread to the surrounding spaces and may involve intra- and extracranial structures. This anatomical area has therefore become the focus of attention of several specialities including neurosurgery, maxillofacial surgery, otolaryngology, opthalmology, skull base surgery, and surgical oncologists. The purpose of this article is to present our experience over more than a decade with tumors of this region.

SURGICAL ANATOMY

The infratemporal fossa is the irregular retromaxillary space bounded above by the greater wing of the sphenoid medially and a part of the squama of the temporal bone laterally, bordered by the infratemporal crest. The medial boundary of the fossa is formed by the lateral surface of the lateral pterygoid plate of the sphenoid. This boundary is breached anterosuperiorly by the presence of the pterygomaxillary fissure through which the fossa communicates with the pterygopalatine fossa. Just posterior to the junction of the lateral pterygoid plate with the body of the sphenoid is the foramen ovale and posterolaterally few millimeters away is the foramen spinosum. The cartilagenous eustachean tube is immediately posteromedial. The average distance between the lateral pterygoid plate in adults at this point from the upper border of the zygomatic arch is 38.2 mm and represents the distance to the foramen ovale.[8,9] The posterior margin of the medial pterygoid plate, which represents the lateral wall of the nasopharynx, is on an average 47.8 mm from the zygoma.[8] The posterior wall of the maxilla forms the anterior surface of the space and at its superolateral corner communicates with the orbit via the inferior orbital fissure. Although the zygoma forms the bony lateral boundary of the fossa, the space is virtually closed laterally by the temporalis muscle as it descends to the coronoid process. Laterally, the fossa communicates with the temporal fossa between the zygomatic arch and the lower temple. Inferiorly, the space communicates with the neck, but is partially closed by the medial pterygoid muscle and its fascial covering. This muscle marks the boundary with the parapharyngeal space that communicates with the infratemporal fossa behind its posterior border. The internal carotid artery and the internal jugular vein are on a posterior plane and are not encountered in the space. The temporalis, lateral, and medial pterygoid muscles occupy the space from lateral to medial in that order. The space is traversed by the maxillary artery from lateral to medial and the mandibular nerve and its branches from above downwards. Anatomical variations in the course and branching pattern of these vessles and nerves occur not infrequently.[10]

Table 1. Tumors of Infratemporal Fossa

	Reported Series in the Literature	
	Cases	*(Tumor)*
Conley (1964)	27	7 primary
Shapshay et al. (1976)	7	1 primary
Shaheen (1982)	36	10 primary
Johnson and Maran (1982)	12	4 primary
Hertzanu and Mendelsohn (1984)	16	8 primary
Sekhar (1987)	18	not specified
Lepkowski et al. (1991)	10	3 primary
Vaillant (1994)	10	5 primary
This series (1998)	33	13 primary

Table 2. Primary Tumors of the Infratemporal Fossa (1985–1998)

Fibrosarcoma	1
Hemangioma	1
Hemangiopericytoma	1
Histocytosis x	1
Hodgkin's Lymphoma	1
Meningioma	2
Neurofibroma	1
Osteosarcoma	1
Rhabdomyosarcoma	2
Schwannoma	2

CLASSIFICATION

The infratemporal fossa is usually involved by tumors extending from surrounding areas such as the

Table 3. Benign Tumors of the Infratemporal Fossa (1985–1998)

Hemangioma	1
Lipoma	1
Meningioma	2
Nasopharyngeal fibroma	5
Schwannoma	2

Table 4. Malignant Tumors of the Infratemporal Fossa (1985–1998)

Adenoidcystic carcinoma	7
Adenocarcinoma	4
Fibrosarcoma	1
Hemangiopericytoma	1
Histocytosis x	1
Hodgkin's lymphoma	1
Osteosarcoma	1
Rhabdomyosarcoma	2
Squamous cell carcinoma	4

paranasal sinuses, middle cranial fossa, the nasopharynx, the parotid gland, and the external ear canal. These tumors are termed contiguous. A smaller number of tumors originate from the tissues in the space itself and are called primary tumors. Metastasis to the area from tumors elsewhere is rare. This classification was suggested by Conley,[11] and is practical and universally accepted. Table 1 lists the documented series reported in the literature.[12–18] The number of primary tumors in each series is mentioned and comprise 25 to 30% of all tumors in the area. Of the 33 patients with tumors of the infratemporal fossa seen by us, 13 were primary neoplasms (Table 2).

PATIENTS AND METHODS

Thirty-three patients were treated between January 1985 and December 1998 for tumors involving the infratemporal fossa. Tables 3 and 4 show the benign and malignant tumors seen by us. All patients were White Caucasians. There were 13 males and 20 females. Their ages varied between a minimum of 7 to a maximum of 83 years. Clinical features of 14 illustrative cases, their histological diagnosis, the therapeutic approach and outcome is summarized in Table 5.

DISCUSSION

Pathology

Tumors of the infratemporal fossa present a wide spectrum of pathologies, benign and malignant. Adenoidcystic carcinoma is the most frequently encountered malignant tumor in the region. In addition to the one case reported here we encountered six more cases of adenoidcystic carcinoma where the tumor was contiguous and extended from the maxillary sinus, deep lobe of the parotid gland, or recurred in the area after excision of the primary in the ethmoid or the soft palate, making it the most common pathology. The indolent growth pattern of this tumor often leads to delayed diagnosis and symptoms could be traced upto 2 years before diagnosis in our patients. Shotton et al.[19] reported their experience of 13 cases of adenoidcystic carcinoma treated with type C infratemporal fossa approach. They considered that these tumors originate primarily in the nasopharynx and also put forward a classification of adenoidcystic carcinoma in this region. All the adenoidcystic carcinomas treated by us were stage III or IV and in two of the seven cases the tumor seemed to originate from the deep lobe of the parotid gland and in one case probably from ectopic salivary tissue. Perineural spread so characteristic of this tumor makes radical excision a delusion. In our experience, even after extensive surgical excision when dealing with this tumor in the infratemporal fossa, postoperative radiotherapy is essential. Extension to the lateral wall of the cavernous sinus via the foramen ovale used to be considered inoperable. Although neurosurgical developments in the last decade have made surgical excision of this extension a reality, it should be carefully weighed against the possibility of microscopic irradical excision as well as the ensuing morbidity.[20] Prognosis depends upon the tumor stage and presence of perineural or perivascular extension. Distant metastases are not uncommon and if solitary, surgical excision should be considered.

Two patients in this series were diagnosed rhabdomyosarcoma, both were histologically of alveolar type. Both underwent surgery after failed chemotherapy and were also irradiated postoperatively. The role of surgery in this tumor is in diagnosis and treatment. Radical surgery may be contemplated when total excision is possible.[21] In recent years brachytherapy with after loading technique following surgery and followed by reconstruction a week later has been reported.[22] Close cooperation between the medical oncologist and the surgeon is essential to determine the timing of surgical intervention. Prognosis is dependant on the histologic type and is said to be worse in alveolar variety with 5-year survival of as low as 9% as compared to betryoid, embryonal and spindle cell varieties, where survivals upto 86% at 5 years have been reported.[23]

The clinical course of the patient with histocytosis X was aggressive and dramatic. The presentation with preauricular swelling, trismus was suggestive of a space-occupying lesion in the region of infratemporal fossa, but subcutaneous nodules suggested a disseminated process. While the presence of a mass in the infratemporal fossa was confirmed on magnetic resonance imaging (MRI) scan, histopathology of one of the subcutaneous nodules showed appearance of histocytosis and a hematologist consultation was requested. However, the patient died of intracerebral hemorrhage before treatment could be started. It was considered as a malignant form of Letterer–Siwe syndrome. The exact etiology of this disease entity, which is seen more in children than adults, is unknown. Recent ultrastructural and immunohistochemical studies have identified the histocytic cells in Langerhans histocytosis lesions to be part of the Langerhans dendritic cell system. Although the Langerhans cells in the lesion are clonal, this does not define it as a neoplasm.[24–26] This case exemplifies the importance of establishing a histologic diagnosis before any form of therapy.

The presenting symptoms of the two cases of meningiomas seen in this region were different in each case, namely facial swelling in one and hearing loss in the other. Extradural meningiomas occur as extracranial extension of intracranial tumor. One of our patients, Case 7 is an example of a secondary meningioma extending from the middle cranial fossa to the infratemporal fossa via the foramen ovale and eventually causing

Table 5. Primary Tumors of the Infratemporal Fossa

Sex—Age	*Presenting Symptoms*	*Diagnosis*	*Approach—Therapy*	*Outcome*
F 68	Swelling left cheek 6 months	Meningioma	Refused surgery. External beam radiotherapy 44 Gy, 22 fractions	Stable follow-up 10 years
F 39	Heaviness of head. Difficulty in chewing on right side. Hypoaesthesia right cheek. Tingling right half of tongue 6 months	Adenoid cystic carcinoma	Maxillary swing. Postop radiotherapy 62.5 Gy, 31 fractions	Died 14 months later of liver metastasis
F 13	Swelling left cheek	Lipoma	Transoral via gingivolabial sulcus	Total tumor removal. Full recovery
F 33	Moderate unilateral hearing loss. Right earache 6 years	Schwannoma	Preauricular transzygomatic	Full recovery. Follow-up 5 years
M 21	Slowly progressive trismus 5 months. Headache	Alveolar rhabdomyosarcoma	Preop chemotherapy less than 50% response. Extended maxillotomy. Postop radiotherapy 63 Gy, 30 fractions. Recurrence 3.5 years later. Total maxillectomy. Postop chemotherapy	Survived 5 years
F 83	Paraesthesia left nasal ala, upper lip, zygoma. Swelling left cheek. Hypoaesthesia left infraorbital area	Hodgkins lymphoma grade 1E	Radiotherapy 33 Gy, 11 fractions	Died 8 months later
F 29	Moderate unilateral hearing loss 3 months	Meningioma middle cranial fossa and infratemporal fossa	Staged preauricular, transcranial, transzygomatic. Postop radiotherapy 55 Gy, 27 fractions	Controlled asymptomatic
F 47	Right preauricular pain. Swelling under the right mandible 3 weeks. Right preauricular swelling. Subcutaneous swelling left arm, left infraclavicular area, left occupital area. Hypoaesthesia lower jaw. Mild trismus	Histocytosis X. Leterer Siwe disease. Atheromatous cyst right submandibular area	Haematologist consultation	Died 5 weeks later of intracerebral haemorrhage related to histocytosis
F 79	Slowly progressive trismus 2 years. Swelling right cheek	Adenocarcinoma	Preauricular, transzygomatic, transmandibular	Doing well NED Follow-up 3 years
M 43	Unilateral nasal obstruction 4 months	Schwannoma	Transmandibular + facial degloving	Temporary abducens. Paresis for 3 weeks. Complete recovery. No complaints. Follow-up 2 years
F 28	Sensation of pressure over the right upper jaw. Swelling right gingivolabial sulcus 5 months	Osteosarcoma	Transmandibular + facial degloving + composite free flap iliac crest	Doing well. Follow-up 18 months
M 46	Hemifacial pain. Epiphora. Hypoaesthesia cheek and chin 3 years	Fibrosarcoma. Extension to ethmoid, sphenoid, nasopharynx, orbit, middle cranial fossa	Preauricular, transcranial + transzygomatic + transmandibular + facial degloving. Rectus abdominis free flap. Postop radiotherapy 66 Gy, 33 fractions	Doing well
M 7	Unilateral, frontoparietal headache 1 month. Rhinorrhea	Alveolar rhabdomyosarcoma	Chemotherapy, radiotherapy, surgery, brachytherapy in other institution	Short follow-up
F 20	Pain right molar area. Submucosal buccal swelling	Malignant hemangiopericytoma	Preauricular transzygomatic + transmandibular + facial degloving + rectus abdominis free flap. Postop radiotherapy 66 Gy, 33 fractions	Metastates to thoracal and sacral spine. Radiotherapy 80 Gy once a week for 2 weeks Good palliation

conductive hearing loss as a result of eustachean tube malfunction. Part of the intracranial tumor had grown across the median line to involve the lateral wall of the opposite cavernous sinus. It was decided to radiate this postoperatievely. Case 1 can be regarded as primary extracranial meningioma, an uncommon entity. The origin of truely ectopic variety is thought to arise from arachnoid cells, which are normally present in the arachnoid membrane, subarachnoid space, and in association with dural vein and sinuses.[27] These tumors have been reported in the nose, paranasal sinuses, orbits, temporal bone, scalp, infratemporal fossa, neck, and as far as the parotid gland.[28–31] Four major variants of the tumor have been described, namely the syncytial or meningotheliomatous, transitional, fibrous, and angioblastic. The last variety has an aggressive growth with a tendency to recurrence. Both tumors in this series were meningiotheliomatous. Differential diagnosis of a meningioma histopathologically from paraganglioma may be difficult. Case 1 was thought to be a paraganglioma, but finally the diagnosis of a meningioma was established on the basis of positive reaction to Vimentin and occasionally to S-100 protein. Paragangliomas, though rare, do occur and a case of catecholamine-secreating paraganglioma of the infratemporal fossa has been reported in the literature.[32]

Peripheral nerve tumors are known to occur frequently in the infratemporal fossa and are usually benign,[33,34] but malignant tumors of peripheral nerve sheath have been reported.[35] Their slow growth may produce symptoms pertaining to other organs and delay the diagnosis. They are invariably primary tumors. In one of our patients the presenting symptom of conductive hearing loss due to serous otitis was misleading and patient received treatment elsewhere for several years before a diagnosis of space-occupying lesion was made on computed tomography (CT) scan.

The patient with the large lipoma in Case 3 was of clinical interest because, although a diagnosis of lipoma had been made several years ago, sarcomatous change is known to occur and reports of liposarcomas in this region have appeared in the literature.[36] Lipoma is the most common mesenchymal tumor and some 13% occur in the head and neck, however, its occurrence in the infratemporal region is unusual. The histology of the tumor and the age of the patient were determining factors in the choice of the approach which, though unconventional, proved to be satisfactory with no resultant morbidity.

Hemangiopericytoma is a complex vascular tumor, which is supposed to arise from the pericyte. Histologically, it demonstrates great variability. Its lack of uniformity in appearance and growth, unpredictable clinical course, and biological behavior make therapeutic decision making difficult.[37] Intraoperative appearance in our patient was suggestive of its origin in the medial pterygoid muscle. This is a highly unusual localization. Only one case has so far been reported as originating from the pterygopalatine fossa.[38] A decision to irradiate postoperatively our patient was taken after extensive discussion with the pathologist and radiotherapists. The overweighing argument was the uncertainty of the radicality of the excision margins because of the peculiar localization, the extent of the tumor and its histology. The biological behavior of this tumor, in our patient proved aggressive with metastases appearing in the thoracal and sacral spine within 6 months of treatment of the primary tumor. Symptomatic relief of pain was obtained by palliative radiotherapy to the metastases.

Fibrosarcoma is commonly seen in the extremities, but is a rare tumor in the infratemporal region. Of 29 fibrosarcomas in the head neck area treated in UCLA, only 2 (7%) had their origin in this area.[39] Tumor grade, tumor size, and surgical margin status are considered the most important prognostic factors. The only patient in this series with fibrosarcoma had extension to the sphenoid, ethmoid, nasopharynx, orbital, and middle cranial fossa and although, the tumor was macroscopically removed enbloc, we considered postoperative radiotherapy advisable, in keeping with the experience of larger series reported in the literature.[40]

A large variety of rare tumors of the infratemporal fossa, mostly mesenchymal in origin, have been reported in the literature, including giantcell tumors,[41] hemangiomas,[42,43] histiofibroma,[44] synovial sarcoma,[45] recurrent benign parotid tumors,[46] and solitary fibrous tumors.[47] An early diagnosis requires awareness on the part of the family physician as well as the specialist. Surgery plays a major role in their management. However, some of the benign tumors such as hemangiomas may be extensive and without symptoms. Clinical evaluation and judgement is essential before embarking on the treatment. While prognosis is related to histology and stage at presentation, most tumors can be successfully treated with preservation of function and aesthetics. The crucial problem in tumors with intracranial extension is the involvement of the cavernous sinus and although surgical intervention to this structure is possible, the histology of the disease process, radicality of proposed excision, ensuing morbidity after the procedure and the intraoperative risk of complications are some of the questions that need to be carefully considered.

Diagnosis

Histopathology of the tumor and assessment of tumorextension are the first essential parameters in the management. CT scan is essential for lesions that are bony in origin or where bony changes arise as a result of spread or expansion of the growth.[48] MRI scan with contrast can better evaluate the soft tissues and is helpful in evaluating intracranial extension or intramuscular infiltration.[49] It sometimes may be able to identify the tissue of origin of the tumor, but this is difficult in large

tumors and those with multiple extensions. A histologic diagnosis can be obtained by aspiration cytology in majority of cases, however, CT-guided, fine-needle aspiration may sometimes be needed in deep-seated lesions.[50,51] Biopsy is called for if cytology is not conclusive and is necessary in soft-tissue sarcomas. In one of our patients aspiration cytology had confirmed the presence of malignant cells, but it was the histologic picture of the cutaneous metastasis, which established the diagnosis of histocytosis x. The transantral and transoral route via the gingivolabial sulcus are the routes most frequently used for obtaining a biopsy. Angiography is often required in vascular tumors. The role of surgery in mesenchymal tumors is diagnostic and therapeutic. Surgical excision is also indicated in epithelial tumors.

Surgical Approaches

There are a variety of surgical approaches available and the surgeon has to choose the appropriate technique that will provide maximum exposure with minimal morbidity so as to preserve the quality of life. Table 6 presents the various surgical approaches available. Combined approaches usually offer the best solution in tumors with multiple extensions. Neurosurgical consultation and collaboration is essential in all cases where intracranial extension is suspected. One of the frequently encountered problems is the extension of the malignant process to the lateral wall of the cavernous sinus. If it is possible to excize this tumor extension, the surgical procedure can be extended intracranially. The

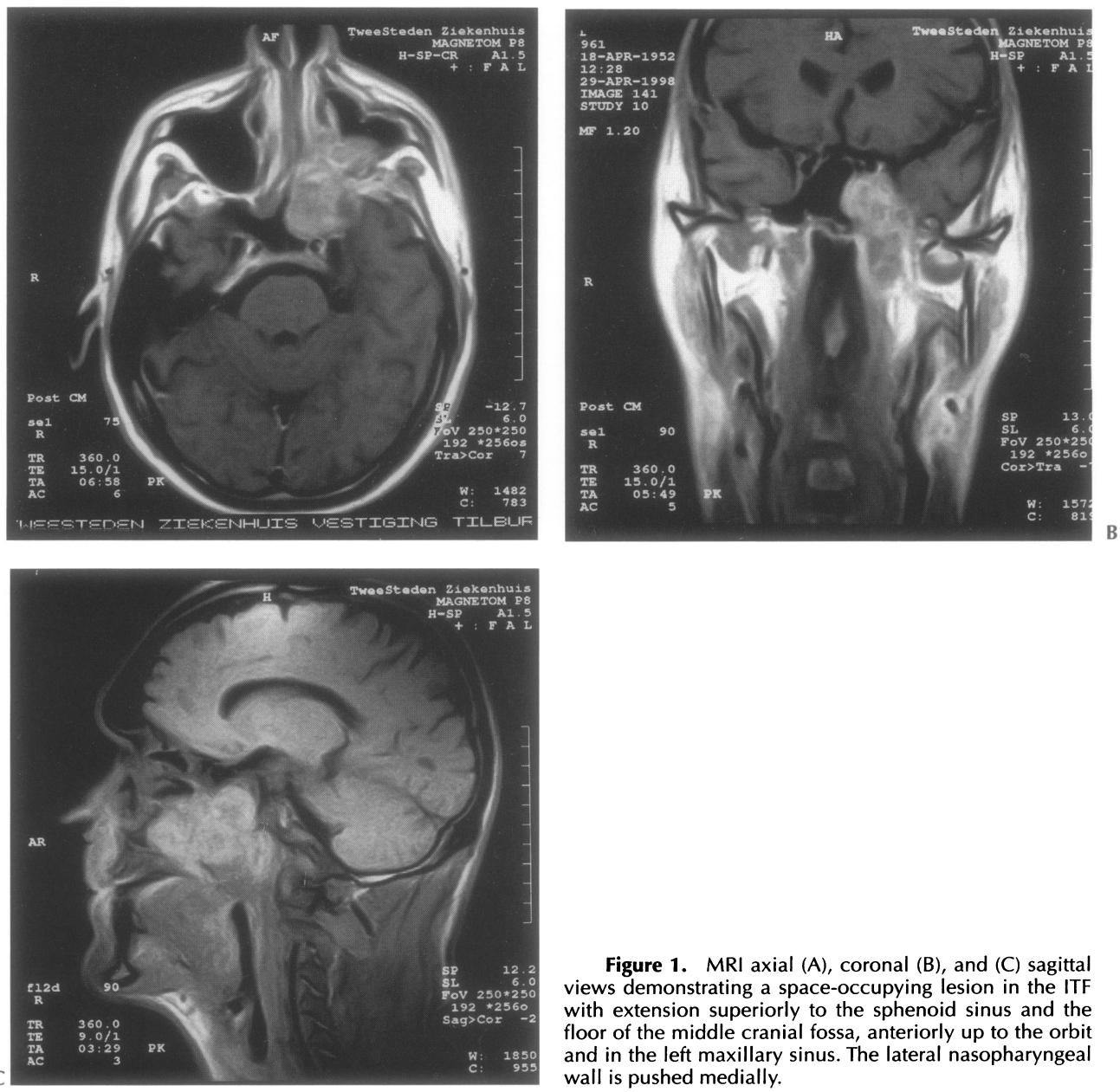
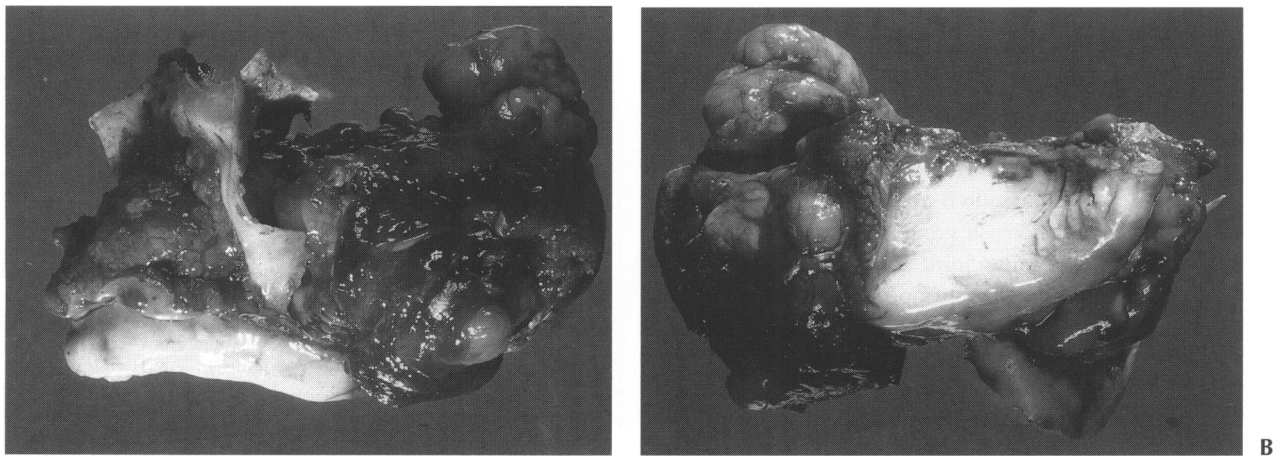


Figure 1. MRI axial (A), coronal (B), and (C) sagittal views demonstrating a space-occupying lesion in the ITF with extension superiorly to the sphenoid sinus and the floor of the middle cranial fossa, anteriorly up to the orbit and in the left maxillary sinus. The lateral nasopharyngeal wall is pushed medially.



A B

Figure 2. (A, B) Lateral and inferior of views of the operative specimen of tumor. The main mass of the tumor is retromaxillar and extends into the maxillary sinus through the posterior wall, which is totally destroyed. The intracranial and sphenoid sinus extensions are removed en bloc.

histopathological nature of the disease is often the determining factor in the selection of the approach. However, if a total excision is not possible, then it is difficult to justify the neurovascular complications that may ensue and may compromise the quality of life of the patient. One of the significant contributions to the field of surgery of this region in this centrury was by Fisch, who combined the skills of otological and head neck surgery.[52] He advocated type C approach for this purpose.[53] However, there are some limitations to this technique. The hearing is permanently sacrificed in the ear on the side affected and in the hands of others there is a reasonable incidence of facial weakness. His procedure has therefore been modified by others.[54] Sekhar et al.[16] described a subtemporal preauricular infratemporal fossa approach for the purpose of excision of lesions in the regions of the sphenoid, clival bone, medial half of petrous temporal bone, infratemporal fossa, nasopharynx, retro- and parapharyngeal area, ethmoid, sphenoid and maxillary sinuses, and the intradural clivus-foramen magnum area.[16] The conductive hearing apparatus, when not involved by pathology, is preserved. In our experience a combined middle fossa craniotomy with preauricular transzygomatic approach provides good access to the region and this can be combined with a transmandibular and facial degloving approach to obtain maximum exposure (Figs. 1a–c, 2a, 2b, and 3). Patients appreciate the absence of a facial scar. However, this should never should compromise adequate tumor excision. This approach is also suitable for surgical

Table 6. Surgical Approaches to the Infratemporal Fossa

Approach	*Author (Year)*
Transoral	via superior gingivolabial sulcus
Transantral	Sewall (1926)
Transpalatinal	Kornfehl (1996)
Extended maxillotomy	Krause & Baker (1982)
Extended osteoplastic Maxillotomy	Catalano and Biller (1993)
Maxillary swing	Wei (1991) Hernandez (1986)
Transmandibular	Conley and Barbosa (1956–1961)
Transzygomatic	Barbosa (1961)
Facial translocation	Janecka (1990)
Transcranial	Sekhar (1987)

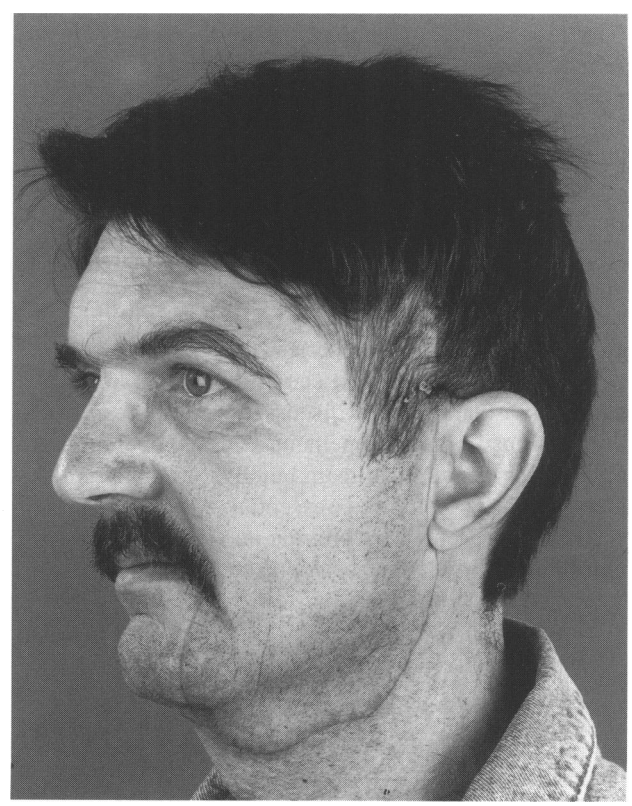


Figure 3. Postoperative appearance of patient.

exposure of the internal carotid artery and cavernous sinus. In dealing with tumors, subdural dissection medially with minimal retraction of the temporal lobe would allow access to the cavernous sinus. The working space provided by a paramedian mandibulotomy can be improved further by an additional mandibulotomy just below the intercondylar notch and above the entrance of the inferior alveolar vessles and nerve.[55] Subluxation of the temporo-mandibular joint can further improve the access. The maxillary swing approach provides access to midline structures, but is unsuitable and inadequate for the purpose of approaching tumors of the infratemporal fossa. In situations where the tumor is fixed to the mandibular periosteum, segmental mandibulectomy is indicated. Control of the internal carotid artery and internal jugular vein from the neck and through the petrous bone provides dual control. Several other approaches to this region have been described and are listed in Table 5.[56–61] Some of these provide limited exposure, others produce temporary morbidity, which is sometimes unacceptable to the patient. Even when the lateral wall of the nasopharynx is excised and a through-and-through defect into the nasopharynx exists, wounds heal well without fistulization after a temporalis muscle flap. The donor area defect is camouflaged easily. When tumor excision is complete, the use of free vascularized composite flaps provide immediate bulk and surfacing.

Postoperative complications in our series were minimal and transient and there was no operative mortality. In three patients with malignant tumors of the deep lobe of parotid, the facial nerve had to be sacrificed and a gold implant in the upper eyelid was inserted. Some patients experienced postoperative trismus, which improved on physiotherapy instituted soon after surgery, but occasionally this persists, especially if postoperative radiotherapy follows. All patients operated upon the infratemporal region undergo a middle-ear drainage and placement of a drainage tube.

There have been several reports of individual cases of neoplasms of the infratemporal fossa, but fewer series of primary tumors have been reported. In this article, we have presented a series of 13 primary tumors, which is so far the largest series in the literature. The pathology is varied and is discussed with reference to its implications in the management. Close cooperation not only within the surgical team but also with the radiologist and the pathologist is essential. A combination of surgical approaches that provide maximum access with minimum morbidity has been presented.

REFERENCES

1. Carnochan JM. Excision of the trunk of the second branch of the fifth nerve. Am J Med Soc 1858;1:134
2. Sluder G. Etiology, diagnosis, prognosis and treatment of sphenopalatine ganglion neuralgia. JAMA 1913;61:1202–1205
3. Segmond PP. De la resection du nerf maxillaire superieur et du ganglion spheno-palatin dans la fente pterygomaxillaire par la voie temporale. Revue de Chirurgie 1890;10:173–197
4. Sewall EC. An operation for the removal of the sphenopalatine ganglion. Ann Otol Rhinol Laryngol 1926;79:967–969
5. Conley JJ. The surgical approach to the pterygoid area. Ann Surg 1956;144:39–43
6. Barbosa FJ. Surgery of extensive cancer of paranasal sinuses. Arch Otolaryngol 1961;73:129–133
7. Crockett DJ. Surgical approach to the back of the maxilla. Brit J Surg 1962;50:819–821
8. Tiwari RM. Surgical landmarks of the infratemporal fossa. J Cranio-Max-Fac Surg 1998;26:84–86
9. Goldenberg RA. Surgeons view of the skull base from the lateral approach. Laryngoscope 1984;96(Suppl 36):1–21
10. Krompotić-Nemanić J, Draf W, Helms J. The paranasal sinuses and the retromaxillary space. In: Krompotie-Nemanic J, Draf W, Helms J. Surgical Anatomy of the Head and Neck. New York: Springer, 1988;136–173
11. Conley JJ. Tumours of the infratemporal fossa. Arch Otolaryngol 1964;79:498–504
12. Shapshay SM, Elber E, Strong MS. Occult tumours of the infratemporal fossa. Arch Otolaryngol 1976;102:535–538
13. Shaheen OH. Swellings of the infratemporal fossa. J Laryngol Otol 1982;96:817–836
14. Johnson AT, Maran AGD. Extracranial tumors of the infratemporal fossa. J Laryngol Otol 1982;96:1017–1026
15. Hertzanu Y, Mendelsohn DB. Computed tomography of the infratemporal fossa in primary jaw pathology. Clin Radiol 1984;35:203–207
16. Sekhar LN, Schramm VL, Jones NF. Subtemporal preauricular infratemporal fossa approach to large lateral and posterior cranial base neoplasms. J Neurosurg 1987;67:488–499
17. Lepkowski A, Dej S, Grabska M, et al. Diagnosis and treatment of tumours of the infratemporal fossa. Polish Journal of Otolaryngology 1991;65:422–425
18. Vaillant JM. Chirurgie de la fossa infratemporal. Rev Stomatol Chir Maxillofac 1994;95:446–450
19. Shotton JC, Schmid Stephan, Fisch U. Infratemporal fossa approach for adenoidcystic carcinoma of skull base and nasopharynx. Otolaryngol Clin North Am 1991;24:1445–1463
20. Al Mefty O, Smith RR. Surgery of tumours invading the cavernous sinus. Surg Neurol 1988;30:370–381
21. McGill T. Rhabdomyosarcoma of head and neck update. Otolaryngol Clin North Am 1989;22:631–636
22. Schouwenberg PF, Kupperman D, Bakker FP, Blank LE, de Boer HB, Voute TA. New combined treatment of surgery, radiotherapy and reconstruction in head and neck rhabdomyosarcoma in children: The AMORE protocol. Head Neck 1998;20: 283–292
23. Wijnaendts LCD, Van der Linden JC, Unnik AJM, Delemare JFM, Voute PA, Meijer CJLM. Histopathological classification of childhood rhabdomyosarcomas: Relationship with clinical parameters and prognosis. Hum Pathol 1994;25: 900–907
24. Favara BE. Langerhans histocytosis. Pathobiology and pathogenesis. Sem Oncol 1991;18:3–7
25. Yu RC, Chu C, Buluwela L, Chu AC. Clonal proliferation of Langerhans cells in Langerhans cell histiocytosis. Lancet 1994;343:767–768
26. Willman CL. Detection of clonal histiocytes in Langerhans cell histiocytosis: Biology and clinical significance. Br J Cancer 1994;70:S29–S33
27. Granich MS, Pilch BZ, Goodman ML. Meningiomas presenting in the paranasal sinuses and temporal bone. Head Neck Surg 1983;5:319–328
28. Inglis AF, Yarington TC, Bolen J, Seattle WA. Extrameningeal meningiomas of the infratemporal fossa. Diagnosis and treatment. Laryngoscope 1987;97:689–692
29. Hoye SJ, Hoar CS, Murray JE. Extracranial meningioma presenting as a tumour of the neck. Am J Surg 1960;100:486
30. Wolff M, Rankow RM. Meningioma of the parotid gland. Hum Pathol 1971;2:453–459
31. Farr HW, Gray GF, Vrana M, Panio M. Extracranial meningioma. J Surg Oncol 1973;5:411–417

32. Cantrell RW, Kaplan MJ, Atuk NO, Winn HR, Jahrsdoerfer RA. Catecholamine secreating infratemporal fossa paraglanglioma. Ann Otol Rhinol Laryngol 1984;93:583–588
33. Arena S, Hilal EY. Neurilemmomas of the infratemporal space. Arch Otolaryngol 1976;102:180–184
34. Beauvillain C, Calais C. Nervous tumours of the infratemporal fossa. Ann Otolaryng (Paris) 1991;108:107–111
35. Colmenero C, Rivers T, Patron M, Sierra I, Gamallo C. Maxillofacial malignant peripheral nerve sheath tumours. J Cranio-Max-Fac Surg 1991;19:40–46
36. Chevalier D, Parent M, Lecomte-Houcke M, Picquet TT. Liposarcoma de la fossa infratemporale. Ann Oto-laryng (Paris) 1991;108:253–255
37. Enzinger FM, Smith BH. Hemangiopericytoma. An analysis of 106 cases. Hum Pathol 1976;7:61–82
38. Abdel Fattah HM, Adams GL. Hemangiopericytoma of the maxillary sinus and skull base. Head Neck 1990;12:77–83
39. Mark RJ, Sercarz JA, Tran Luu, Selch M, Calacterra TC. Fibrosarcoma of the head and neck. Arch Otolgyngol Head Neck Surg 1991;117:396–401
40. Vay JL, O'Sullivan B, Catton C, Cummings B, Fornesier V, Gullane P, Simm J. An assessment of prognostic factors in soft-tissue sarcoma of the head and neck. Arch Otolaryngol Head Neck Surg 1994;120:981–986
41. Cook HF, Miller R, Yamada R. Giant cell tumour of the infratemporal fossa. J Oral Maxillofac Surg 1986;44:651–656
42. Toriumi DM, Shermataro CB, Pecaro BC. Cavernous haemangioma of the infratemporal fossa. Ear Nose Throat J 1989; 68:252–259
43. Knox RD, Pratt MF, Gaven PD, Giles WC. Intramuscular haemangioma of the infratemporal fossa. Otolaryng Head Neck Surg 1990;103:637–641
44. Menard M, Laccourreye O, Chabardes E, Carnot F. Histocytofibrome de la fossa infratemporale. Ann Otolaryng (Paris) 1991;108:103–106
45. Mossbock B, Beham A, Karcher H. Synovialom der fossa infratemporalis. Dtsch Z Mund Kiefer Gesichts Chir 1988;12: 303–306
46. Marsot-Dupuch K, Raveau V, Chourad Ch. Unusual localisation of a recurrent benign parotid tumour in the infratemporal fossa. Annales de Radiologie 1992;35:489–493
47. Rayappa CS, McArthur PD, Gangopadhyay K. Solitary fibrous tumour of the infratemporal fossa. J Laryngol Otol 1996;110: 594–597
48. Doubleday LC, Ting BS, Wallace S. Computed Tomography of the Infratemporal Fossa. Neuroradiology 1981;138:619–624
49. Chong VF. Comparing computed tomographic and magnetic resonance imaging visualization of the pterygopalatine fossa in nasopharyngeal carcinoma. Ann Acad Med Singapore 1995;24:436–441
50. Shapsay SM, McCann CF, Vemakli A, Vaughan CO, Strong MS. Diagnosis of infratemporal fossa tumour using percutaneous core needle biopsy. Head Neck Sug 1979;2:35–41
51. Spearman M, Curtin H, Dusenbury D, Janecka IP, Reyna EL. Computed tomography. Directed fine needle aspiration of skull base parapharyngeal and infratemporal fossa masses. Skull Base Surg 1995;5:199–205
52. Fisch U. Infratemporal fossa approach to tumours of the temporal bone and base of skull. J Laryngol Otol 1978;92:949–967
53. Fisch U, Fagan P, Valvanis A. The infratemporal fossa approach for the lateral skull base. Otolaryng Clin North Am 1984; 17:513–552
54. Holliday MJ, Nachlas N, Kennedy DW. Uses and modifications of the infratemporal fossa approach to skull base tumours. Ear Nose Throat J 1986;65:101–106
55. Attia EL, Bentley KC, Head T, Mulder D. A new external approach to the pterygomaxillary fossa and parapharyngeal space. Head Neck Surg 1984;6:884–891
56. Kornfehl J, Gstottner W, Kontrus M, Seeling R. Transpalatine excision of a cavernous haemangioma of the infratemporal fossa. Eur Arch Otorhinolaryngol 1996;253:172–175
57. Krause CJ, Baker SR. Extended transantral approach to pterygomaxillary tumors. Ann Otol Rhinol Laryngol 1982;91:395–398
58. Catalano PJ, Biller HF. Extended osteoplastic maxillotomy. Arch Otolaryngol Head Neck Surg 1993;119:394–400
59. Altemir FH. Transfacial access to retromaxillary Area. J Maxillofacial Surg 1986;14:165–170
60. Wei WI, Lam KH, Sham JST. New approach to the nasopharynx. The maxillary swing approach. Head Neck 1991;13:200–207
61. Janecka IP, Sen CN, Sekhar LN, Arriaga M. Facial translocation. A new approach to the cranial base. Otolaryngol Head Neck Surg 1990;103:413–419