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Glomus jugulare tumours: Are they really so benign?
By Wendy Blackburn, Grace Leung and Catherine Morash

Abstract
Glomus jugulare tumours are rare, hypervascular and usually benign tumours involving the skull base. Diagnosis can be significantly delayed due to the slow and insidious clinical presentation. The primary manifestations involve auditory and lower cranial nerve deficits. Treatment options may include surgery, radiation and embolization. Surgery is the optimal treatment modality, but is not without serious potential complications. These complications are linked to the location and vascular nature of the tumour. Glomus jugulare tumours present a significant diagnostic and management challenge to all members of the health care team.

Overview
Glomus jugulare tumours are rare, hypervascular, slow-growing, and usually benign tumours that arise from the jugular foramen on the skull base. These tumours originate from the jugular bulb and extend to involve the middle ear. The glomera jugulare, or glomus bodies are small collections of paragangliar tissue derived from embryonic neuroepithelium and typically found in the region of the jugular bulb (Coles, 2004; Pluta & Juliano, 2006).

These tumours, also referred to as paragangliomas tumours, arise from various locations in the body and are named according to the location from which they arise (Coles, 2004; Pluta & Juliano, 2006). Those located in the middle ear are referred to as glomus tympanicum, the carotid body as carotid body tumours, and the vagus nerve as glomus vagale tumours. Other less common sites include the periaortic area, trachea, larnyx, mandible, nose, ciliary ganglion, and fallopian tubes (Boedeker, Ridder, & Schipper, 2005; Coles, 2004; Pluta & Juliano, 2006).

Historical perspective
In 1945, the first patient was diagnosed with a glomus jugulare tumour by Rosenwasser. Although vascular tumours of the middle ear had been previously reported, he was the first to recognize the origin of the tumour as being from the glomus jugulare. Rosenwasser was the first to document the surgical removal of a glomus jugulare tumour (Pluta & Juliano, 2006).

Prevalence
Glomus jugulare tumours usually occur in the fifth and sixth decades of life, but have been reported in patients as young as six months and as old as 88 years (Moffat, 1989; Pluta & Juliano, 2006). These tumours occur predominantly in women with a female to male ratio of 3 to 6:1. These tumours are rare with an estimated annual American incidence of one case per 1.3 million people (Moffat, 1989; Pluta & Juliano, 2006).

Glomus jugulare tumours are the most common tumour of the middle ear and are second to vestibular schwannoma for tumours affecting the temporal bone (Moffat, 1989; Pluta & Juliano, 2006).

Etiology
Glomus jugulare tumours develop from the chief cells of the paraganglia, also known as glomus bodies, which are located within the adventitia layer of the wall of the jugular bulb. Paraganglia are small masses of tissue less than 1.5 mm in size, comprising clusters of epithelioid (chief) cells within a network of capillary and precapillary vessels. Paraganglia tumours develop from the neural crest and are thought to function as chemoreceptors (Pluta & Juliano, 2006).

Although most paragangliomas are sporadic, they can also be familial with an autosomal dominant inheritance pattern. The occurrence of tumours in familial cases is dependent on the age and gender of the patient. Tumours rarely occur in patients younger than 18 years of age and only in children of males possessing the disease gene (Pluta & Juliano, 2006).

Pathophysiology
Glomus tumours are slow growing, highly vascular, encapsulated, and locally invasive tumours. They tend to grow within the temporal bone via pathways of least resistance such as air cells, vessels, skull base foramina, and the Eustachian tube. Pluta & Juliano, 2006, affirmed that the invasion and erosion of bone in a lobular fashion, often sparing the ossicular chain is characteristic of this tumour.

Initially, the skull base erosion occurs in the region of the jugular fossa and postero-inferior petrous bone with subsequent extension of the erosion to the mastoid and adjacent occipital bone. Significant extension into intracranial and extracranial contents as well as into the sigmoid and inferior petrosal sinuses may occur (Pluta & Juliano, 2006).

Pluta & Juliano, 2006, indicate that neural infiltration is also fairly common. The same authors also stated that metastases from glomus tumours occur in approximately four percent of cases and metastases have been found in lung, lymph nodes, liver, vertebrae, ribs, and spleen.

Approximately four per cent of glomus tumours are functional and produce clinically significant levels of catecholamines, norepinephrine, or dopamine with symptoms mimicking that of a pheochromocytoma (Pluta & Juliano, 2006).

The Glasscock-Jackson and Fisch classification of glomus tumours is widely recognized and is based on the extension of tumour to surrounding structures and is closely linked to morbidity and mortality (Pluta & Juliano, 2006).
Case study

The following case study will present a woman who presented with a glomus jugulare tumour to the neurosurgery service. Clinical presentation, diagnostic work up and treatment options will be discussed. The case study will also demonstrate the effect on the patient and family indicating the extensive emotional and physical support required in these cases.

Mrs. V is a 50-year-old woman seen in September 2005 by neurosurgery for 8-week history of frontal headache. She was otherwise healthy and active with no significant past medical history. She was not taking any medications and had no known allergies. She was a non-smoker.

Clinical presentation

Because of the invasiveness and location of tumour growth, glomus jugulare tumours present a significant diagnostic and management challenge. The onset of symptoms in patients with glomus jugulare tumours is slow and insidious and, as a consequence, diagnosis is often significantly delayed (Pluta & Juliano, 2006).

The most common symptoms include conductive hearing loss and pulsatile tinnitus. Other auditory signs and symptoms are ear fullness, hemorrhage, bruit, otorrhea, and the presence of a middle ear mass noted upon examination. Significant ear pain is unusual. Vertigo and sensorineural hearing loss tends to be more significant with larger tumours (Coles, 2004; Pluta & Juliano, 2006). Otoscopic examination reveals a characteristic, pulsatile, reddish-blue tumour behind the tympanic membrane. Cranial nerve involvement is common with glomus jugulare tumours with hoarseness and dysphagia being the most common symptoms. Paresis of cranial nerves IX and X, also referred to as jugulare foramen syndrome, is pathognomonic for this tumour, but usually occurs one year after the initial symptoms of hearing loss and pulsatile tinnitus (Coles, 2004; Pluta & Juliano, 2006).

Both Coles, 2004, and Pluta and Juliano, 2006, documented that less commonly, the clinical presentation may include facial nerve palsy, hypoglossal nerve palsy, or Horner Syndrome. With intracranial extension of the tumour, clinical symptoms such as headache, hydrocephalus, and elevated intracranial pressure may occur. Ataxia and other brainstem symptoms may also develop. Involvement of the dural venous sinuses may clinically mimic sinus thrombosis (Pluta & Juliano, 2006).

In approximately two to four per cent of patients, the initial or predominant symptoms are pheochromocytoma-like symptoms, namely hypertension and tachycardia. These symptoms are the result of the production of catecholamines, norepinephrine, or dopamine excreted by the tumour. As well, somatostatin, vasoactive intestinal polypeptide (VIP), calcitonin, and neuron-specific enolase may be produced by the tumour (Pluta & Juliano, 2006).

Case study

Mrs. V's presenting signs and symptoms included hearing loss in the right ear, tinnitus, unsteady gait and headaches. She described occasional swallowing difficulties, especially when she ate quickly, as well as an abnormal sensation on the right side inside of her mouth. There was weakness to her right shoulder and she described changes to her voice.

On examination, Mrs. V. had an asymmetrical horizontal gaze, sporadic nystagmus that was more prominent on right gaze. She did not have vertical nystagmus. There was sensory loss on the right side of her face. Her right nasolabial fold was less prominent than on the left with widening of the right palpebral fissure. There was mild atrophy of the right side of her tongue with fasciculations. She also presented with an asymmetrical elevation of her soft palate and a decreased gag reflex on the right side.

She had normal extraocular muscle movements. There was asymmetric elevation of her right shoulder due to weakness. Except for the right shoulder weakness, the rest of her muscle strength and sensation was normal. She was able to walk independently but had obvious gait ataxia. There was no limb or trunk ataxia. In summary, she had impairment of cranial nerves V, VII, VIII, IX, X, XI, and XII pre-operatively.

Diagnosis

An array of diagnostic imaging is utilized to diagnose and plan treatment for glomus jugulare tumours. Plain skull x-rays demonstrate enlargement of the lateral jugulare foramen and fossa. The extent of bone destruction can be visualized on computerized tomography (CT) with thin sections. Magnetic Resonance Imaging (MRI) with gadolinium is best at delineating tumour boundaries. A combination of CT scanning and contrast MRI is the gold standard for diagnostic imaging for glomus jugulare tumours. For large tumours involving the internal carotid artery, a CT angiogram (CTA) and/or magnetic resonance angiogram (MRA) is recommended. The venous drainage systems need to be carefully examined prior to sinus occlusion during surgical resection (Pluta & Juliano, 2006). Pluta and Juliano also recommended vertebral angiogram to exclude arterial feeders from the posterior circulation.

<table>
<thead>
<tr>
<th>Glasscock-Jackson and Fisch Classification</th>
<th>Description</th>
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<tr>
<td>Type A Tumour</td>
<td>Tumour limited to the middle ear cleft (glomus tympanicum)</td>
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<tr>
<td>Type B Tumour</td>
<td>Tumour limited to the tympanomastoid area with no infralabyrinthine compartment involvement</td>
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<tr>
<td>Type C Tumour</td>
<td>Tumour involving the infralabyrinthine compartment of the temporal bone and extending into the petrous apex</td>
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<td>Type C 1 Tumour</td>
<td>Tumour with limited involvement of the vertical portion of the carotid canal</td>
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<td>Type C 2 Tumour</td>
<td>Tumour invading the vertical portion of the carotid canal</td>
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<tr>
<td>Type C 3 Tumour</td>
<td>Tumour invasion of the horizontal portion of the carotid canal</td>
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<tr>
<td>Type D 1 Tumour</td>
<td>Tumour with an intracranial extension less than 2 cm in diameter</td>
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<tr>
<td>Type D 2 Tumour</td>
<td>Tumour with an intracranial extension greater than 2 cm in diameter</td>
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Case study
Mrs. V. underwent a CT/CTA and MRI of her head. Her MRI showed a very large vascular tumour in the right side of the posterior fossa. The tumour enhanced markedly with gadolinium and was honeycomb in nature. The point of tumour origin appeared to be in the region of the jugular foramen with extra and intradural extension down to the level of C2 between the internal jugular vein and the internal carotid artery. Intra-cranially compression and distortion of the pons, medulla and the fourth ventricle also occurred with tumour extension up to the petrous apex. The lateral ventricles were minimally large in size for her age and the temporal horns were not prominent (see Figure 1).

The diagnosis of glomus jugulare tumour and glomus tympanicum was established and due to the size of the tumour, brainstem involvement, and clinical presentation, surgery was considered to be the best treatment option. A referral to both the Ear Nose and Throat (ENT) service and to a physician specializing in head and neck surgery was initiated.

The CT/CTA indicated that the intracranial portion of the tumour at the greatest diameter was approximately 4.5 cm. The right internal jugular vein was not well-delineated in the region of the tumour, but could be seen again at the level of the hypoglossal canal and in the neck. The internal carotid artery was displaced significantly anteriorly and the mass was up against the internal carotid artery. A large ascending pharyngeal artery appeared to supply the tumour (see Figure 2).

Differential diagnosis
According to Pluta and Juliano, 2006, differential diagnosis include the following: chordoma, otitis media, eosinophilic granuloma, meningioma, schwannoma, neurofibroma, chondrosarcoma, carcinoma, osteoma, otosclerosis, chronic mastoiditis, cholesterol granuloma, aneurysm, idiopathic hemotympanum, arterial malformation, persistent stepedial artery, and lymphoma.

Medical treatment
According to Gottfried, Liu, and Couldwell, 2004, and Krych, Foote, Brown, Garces, and Link, 2006, the optimal management of glomus jugulare tumours remains controversial. Observation, surgical excision, radiotherapy and stereotactic radiosurgery, alone or in combination, may all be considered appropriate treatment modalities. Factors to consider in treatment decisions include size, extent and location of the tumour, previous treatment, patient’s age and wishes, general health and neurological status (Krych et al., 2006). The vascularity, inaccessibility, and potential extensive local spread, all contribute to the difficult management of these patients (Whitfield, Grey, & Moffat, 1996). The development of skull base techniques and improvement in Gamma knife and stereotactic technology has improved treatment of these complex tumours. Those patients being managed conservatively would be followed through serial imaging (Jordan, Roland, Mcmanus, Weiner, & Giller, 2000). Studies support that complete tumour resection provides the best quality of life for the patient. However, not every patient is amenable to the risks of tumour removal, and not all tumours can be surgically accessible, i.e., situations where there is poor collateral circulation or risk of cranial nerve damage is significant (Whitfield et al., 1996).

Pre-operative preparation
Pre-operative workup may include CTA, MRA and/or magnetic resonance venography (MRV) to assess contralateral and ipsilateral arterial and venous distribution. Embolization performed in the pre-operative period aims at reducing blood
loss, minimizing the risk of operative complications, and preventing recurrence by contributing to complete resection (Tasar & Yetiser, 2004). The advent of embolization has increased the positive outcome for patients with these tumours as it decreases tumour vascularity and facilitates surgical removal with low morbidity (Marangos, 1999; Murphy & Brackmann, 1998; Young et al., 1988). Embolization may also be the only treatment option for tumours that are inoperable. A potential risk of embolization includes stroke (Coles, 2004).

Radiation of the tumour may also be performed three to four months pre-operatively to diminish the vascular nature of the tumour (Coles, 2004). Results indicate that this treatment option offers another method for decreasing the risk of hemorrhage, but is not curative (Tasar, 2004).

Patients are routinely screened for catecholamines through 24-hour urine collection for vanillylmandelic acid, metanephrines and total catecholamines. If the results of these tests are abnormal, then pre-operative treatment would include a prescription of alpha and beta-blockers (Pluta & Juliano, 2006). Pluta and Juliano recommended two to three weeks of treatment for elective cases, but for emergency cases, a two- to three-day course of treatment is adequate.

Evaluation of the cranial nerves and a baseline auditory testing may demonstrate how much function has deteriorated due to tumour growth. A Speech Language Pathologist (SLP) should also evaluate the patient’s speech and swallowing as part of the pre-operative workup. These assessments establish a baseline from which post-operative status can be compared (Coles, 2004).

Providing education to the patient and family pre-operatively regarding the medical management, treatment options, potential complications, as well as potential recovery and rehabilitation needs post-operatively will help to alleviate fears and concerns which may arise (Barker, 1994; Hickey, 2003).

Emotional counselling and support for both the patient and family is paramount. Assisting patients to cope with and understand not only their pre-operative status, but also the potential worsening of deficits or the development of new deficits post-operatively is crucial.

Loss of hearing or a decrease in the ability to hear may cause social isolation. Informing patients and family of this potential complication pre-operatively may assist with coping and planning. Even the mildest facial paresis can cause patients significant body image dilemmas.

Social work and nursing can play an important role in assisting patients and families through this very stressful event. Both Barker (1994) and Hickey (2003) recommend that clergy may also be appropriate and should be offered to patients and families as an adjunct choice for supportive counselling.

Case study

A 24-hour urine for catecholamines was completed with no treatment required. Mrs. V. was referred for a neuro-oncologist to assess for possible radiotherapy and to a neuro-radiologist to assess need for embolization.

Many discussions took place between the neurosurgeon, ENT surgeons, neuro-oncologist, neuro-radiologist and the patient and family to discuss treatment options. Risks and benefits of the various treatment options were provided, as well as the potential complications explained to the patient and family. A registered nurse in the pre-operative assessment clinic saw Mrs. V. Pre-operative teaching and supportive counselling was given. Mrs. V. is a very spiritual lady who finds great comfort in her faith and preferred to turn to her clergy for additional support.

Oncology concluded that due to the large size of her tumour and the subsequent considerable mass effect, Mrs. V. had a significantly increased risk for symptomatic radiation-induced edema. If this occurred, her symptoms may be refractory to steroids and urgent surgery would be required. Mrs. V. was also made aware there was a very small risk, less than 1%, of radiation-induced malignancy, which could be fatal. After discussion with her husband, Mrs. V. opted not to undergo radiotherapy.

Mrs. V. opted for pre-operative embolization before surgical removal of the tumour. Informed consent was obtained from the patient.

Mrs. V. underwent pre-operative embolization by the interventional neuro-radiology team. In addition, she had a blue inclusion test, which demonstrated both clinical and radiological success with occlusion of the right internal carotid artery (see Figure 3).

Due to the very large size of the tumour and the extensive amount of time required to perform the necessary surgical procedures, it was decided to schedule the surgery over two days, February 28 and March 1.

Surgical approach

Although the management of glomus jugulare tumours remains controversial, the only curative treatment is radical surgery (Gjuric, 1996; Whitfield et al., 1996). Cure rates of 86% to 100% after complete surgical resection have been reported by Gjuric (1996). Giant tumours with invasion of the internal carotid artery, the clivus, and the pontine-medullary region have a higher surgical and morbidity risk (Gjuric, 1996). Modern microneurosurgical and skull base techniques have enabled safe total resection of these complex and complicated tumours (Liu,

![Figure 3.* Right common carotid artery digital subtraction angiogram during embolization.](image)

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Surgical candidates are considered those patients who are under the age of 55 years, have a unilateral tumour with invasion of the posterior fossa and have oto-neurological deficits. Before surgery can be considered, tumour classification is determined. Tumours are classified into four types. Pluta and Juliano stated in 2006 that A-type tumours can be excised by the transmeatal or perimeatal approach, whereas B-type tumours require complete posterior tympanotomy. Type-C tumours require further resection, which could include internal carotid artery (ICA) trapping, carotid artery embolization and possible intratumoural injection of cyanoacrylate glue to control bleeding. Large D-type tumours require an otologic and a neurosurgical approach, more specifically a skull base resection and posterior fossa resection.

Most patients with glomus jugulare tumours can be managed with a single operation using the translabyrinthine approach. For younger patients with lower cranial nerve deficits, surgery is the only treatment to prevent further damage to the lower cranial nerves (Coles, 2004). For patients with more complex and involved tumours, staged surgical procedures may be required (Coles, 2004).

Case study
Mrs. V’s first surgery was aimed at removing all the bony covering overlying the tumour, as well as rerouting the facial nerve anteriorly to gain more access.

Her first surgery was scheduled for late February and the following procedures were performed:
- tracheostomy
- right temporal bone resection
- right facial nerve decompression
- superiorly based periosteal flap
- sub-occipital craniotomy
- closure of the external auditory canal
- obliteration of the Eustachian tube
- removal of the middle ear contents and tympanic membrane

Mrs. V. was scheduled for the second stage of her operative procedures the following day. The goal of the second surgery was to remove the tumour with possible jaw split for access to the skull base portion, and either a fat or fascia reconstruction for closure.

The following procedures were performed:
- right modified radical neck dissection
- mobilization of the parotid gland
- excision of the right intracranial glomus jugulare tumour
- excision of tumour from right skull base and upper neck
- duraplasty
- placement of titanium mesh

Intra-operative facial nerve monitoring was performed throughout both surgical stages.

Post-operative complications
Hemorrhage, hematoma formation, extensive tumour-brain stem compression, cranial nerve damage, meningitis and CSF leak are all possible post-operative complications. The incidence of lower cranial nerve damage may be as high as 21% to 39%. The facial nerve is the most susceptible to injury and intra-operative monitoring often occurs. Tumour resection using microsurgical techniques could lead to damage of the facial nerve. The use of the gamma knife seems to have improved patient outcomes while decreasing the risk of new cranial nerve damage (Pollock, 2004).

According to Gottfried, 2004, post-operative cerebral spinal fluid (CSF) leak remains a concern with a rate of 8.3% initially and a recurrence rate of 3.1%. Cranial base reconstruction with vascularized myofascial flaps reduces the incidence of post-op CSF leak and the risk of meningitis (Ramina, Maniglia, Fernandes, Paschoal, Pfeilsticker, & Coelho Neo, 2005). As a prophylactic provision, a lumbar drain may be placed for the duration of the surgery with antibiotics prescribed post-operatively (Coles, 2004).

Case study
Mrs. V. had a lumbar drain inserted peri-operatively for CSF decompression as well as fat reconstruction to prevent CSF leakage. Her estimated blood loss was considerable over the two surgical procedures, and she subsequently received two units of packed red blood cells. Her hemoglobin remained stable. She suffered no other immediate post-operative complications.

Nursing care
Patients undergoing this type of surgery offer a multitude of challenges to the neurosurgical nurse. Surgical candidates are often older, undergo a long surgical procedure that may result in considerable blood loss, may have hemodynamic instability related to catecholamine release, may develop or have worsening cranial nerve deficits, may develop a CSF leak or meningitis and may experience cerebral edema with subsequent increased intracranial pressure as a result of disruption of cerebral venous return (Coles, 2004).

To decrease the risk of increased intracranial pressure, the nurse should integrate a number of preventative interventions. It is important to elevate the head of bed 30 degrees and monitor the patient’s neurological status frequently. Examination of the placement of endotraheal or tracheostomy ties should be made regularly to prevent compromise of the cerebral venous return and prevent further increases in intracranial pressure (Coles, 2004). Ensuring the neutral alignment of the patient’s neck will also help to maintain adequate cerebral venous return. Patients may also require the insertion of an intracranial pressure monitoring system for a period of time post-operatively. Aseptic technique is crucial during all manipulations of this system in order to reduce the risk of infection and meningitis related to contamination.
Observation for CSF leaks post-operatively should be a component of every nursing neurological assessment (Coles, 2004; Hickey, 2003; Barker, 1994). Analgesia given regularly will alleviate or minimize the pain associated with this extensive and invasive operative procedure (Coles, 2004). In addition, improved pain control will minimize adverse changes to intracranial pressure (Hickey, 2003; Barker, 1994).

Hemodynamic monitoring is essential peri-operatively and post-operatively due to the potential for catecholamine over-secretion and hypertensive crisis (Al-Mefty & Teixeira, 2002; Coles, 2004; Hall et al., 2003). Excessive release of catecholamines can cause tachycardia, hypertension, palpitations, lightheadedness, and profuse sweating and may result in hypertensive crisis (Hall et al., 2003; Coles, 2004). Management would include the administration of alpha and/or beta-blockers (Coles, 2004). Hemodynamic monitoring is required until stabilization of the blood pressure and heart rate is established (Coles, 2004).

Post-operative cranial nerve deficits should be assessed and compared to the patient’s pre-operative condition. Predominantly cranial nerves V (trigeminal), VII (facial), VIII (acoustic), IX (glossopharyngeal), X (vagus), XI (spinal accessory) and XII (hypoglossal) may be affected interfering with swallowing, hearing, speech and facial movement (Coles, 2004; Hickey, 2003). Due to the involvement of these cranial nerves, particular attention should be given to nutritional status, swallowing ability, oral hygiene, quality of hearing and speech, as well as the integrity of the corneal-blink reflex. The emotional and psychological response of the patient and family to these actual or potential deficits cannot be overlooked by the health care team (Barker, 1994; Hickey, 2003).

Vocal cord paralysis with associated aspiration pneumonia risk is common. A tracheostomy and feeding tube may be required post-operatively for a period of time. A swallowing assessment will determine the patient’s ability to swallow safely and identify appropriate texture consistency. Until an oral diet can be tolerated, a feeding tube may be required temporarily to administer nutrition and medications. During periods of transition from enteral feeds to oral diet, regular assessment for aspiration pneumonia should be done. Good oral hygiene is essential until an effective safe swallow has returned. Prolonged hoarseness may occur (Coles, 2004; Barker, 1994; Hickey, 2003). A referral to a Speech and Language Pathologist for all patients with impairment of speech and/or swallow functions is recommended. Auditory evaluation should be done prior to surgery to establish baseline function, as well as in regular follow-up visits to determine if improvement has been appreciated or if hearing loss has developed or has worsened. Regular follow-up by an audiologist and ENT surgeon may be indicated (Coles, 2004).

Impairment of the facial nerve (VII) results in a decrease or loss of motor strength and parasympathetic function to the face. Loss of these functions results in impairment of facial expression with consequences of body image alterations, interference with communication, and difficulty with pooling of tears and saliva. Taste is affected with subsequent potential alteration in oral intake and appetite. With incomplete closure of the eyelid, the patient is at high risk for corneal abrasions. Therefore, good eye care such as the use of drops and lubricant may be recommended. A tarsorrhaphy may be required in severe cases for temporary protection of the eye. A referral to ophthalmology is required when significant impairment of the facial nerve is present (Barker, 1994; Hickey, 2003).

Patients may be ataxic and require assistance to ambulate safely. Physiotherapy and occupational therapy may be required for gait retraining and ADL retraining (Coles, 2004). Facial retraining programs are available in some physiotherapy departments and may assist in recovery of the facial paresis. Rehabilitation may be beneficial to optimize the patient’s functional abilities (Hickey, 2003; Barker, 1994).

Case study
Post-operatively Mrs. V. had a tracheostomy and was ventilated. Her lumbar drain was in place and subsequently removed on March 7. She never experienced a CSF leak or meningitis. She remained hemodynamically stable throughout her initial post-operative period. Pain was well-managed throughout her hospital stay with the use of morphine initially and then with percocet when enteral feeds began.

On examination she had an absent right corneal reflex, absent gag, a right VII cranial nerve weakness involving a facial droop and incomplete eye closure, and a right-sided motor weakness of her arm and leg.

Mrs. V. never experienced increased intracranial pressure and was alert, obeying commands with all four limbs post-operatively. Tracheostomy mask trials began on March 5 and she was successfully able to breath independently on March 7. She continued to show success with her respiratory wean, but progress was slow due to increased secretions. On March 15 coughing trials began. Unfortunately, on March 16, Mrs. V. suffered respiratory failure for unknown reasons with approximately five minutes of apnea. She was once again ventilated and had copious amounts of secretions. She was treated with antibiotics and eventually weaned off the ventilator. Unfortunately, Mrs. V. suffered a cardiac arrest on March 23. Post-arrest, she was extending both arms bilaterally and flexing both legs. Her MRI showed a brainstem infarct secondary to a hypoxic-ischemic injury.

Mrs. V. continued to have significant cranial nerve weakness of VII, VIII, IX, X, IX, and XII. She was unable to swallow by mouth and subsequently had a PEG tube inserted on March 25 for enteral feeding.

Her neurological recovery was slow, but steady. By April 8 she was awake, able to obey commands, and moving with all four limbs. On April 24 she was talking and was oriented to her name, the year, and the place. Her respiratory secretions were decreasing and on May 8 coughing trials were initiated again. On May 27 her tracheostomy was successfully cored 24 hours per day and she was decannulated on June 18. Unfortunately, on June 21 she experienced stridor and was intubated and ventilated. She had a tracheostomy inserted on June 22. Her secretions continued to be significant for several weeks and on July 13 was deemed appropriate for transfer to the neurosurgical floor. She continued to have significant impairment of cranial nerves V and VII with subsequent incomplete eye closure and underwent a tarsorrhaphy on August 28.

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Radiotherapy
Radiotherapy may be recommended for primary treatment of all glomus tumours that present with evidence of bone invasion or nerve involvement (Cole & Beiler, 1994). Candidates for radiation may include patients, who are a poor surgical risk, have tumour recurrence, complex tumour location or who have had only partial resection. Long-term outcomes following radiosurgery are still unknown (Pluta & Juliano, 2006). Complications following radiation, according to Pluta and Juliano, include secondary tumour development, pituitary and hypothalamus insufficiency, internal carotid artery thrombosis, CSF leak and radiation necrosis.

Long-term outcomes
CT follow-up and endocrine monitoring for tumour recurrence is recommended every six months decreasing to annually when appropriate (Coles, 2004). Following surgical intervention, mortality rate is 6.2% for complete tumour removal followed by radiation. The overall surgical mortality rate is 8.7%. The 20-year survival rate is as high as 94% with 77% patients remaining symptom free (Gjuric Wigand, Wolf, & Weidenbecher, 1996; Pluta & Juliano, 2006).

Patients who have incomplete tumour removal and postoperative radiation had an increased risk for tumour regrowth compared with those patients who had complete tumour removal (Gjuric et al., 1996). Improvement in pulsatile tinnitus may also be considered a positive outcome following surgery (Jordan, et al., 2000).

In the study by Gjuric et al. (1996), resolution of lower cranial nerve deficits occurred more markedly in the group with complete resection of tumour than the partial or the radiation only group. A small group of patients had improvement in their hearing although some patients were deaf prior to surgery. Mortality rate for this patient group was 6.2% with causes such as cerebral edema and apoplexy. Malignant tumours had a poorer outcome.

Case study
Physiotherapy, occupational therapy, social work, speech-language pathology, clinical dietitian, nursing and medicine worked diligently with Mrs. V. and her family to eventually see their hard work pay off with her transfer to a brain injury rehabilitation centre on Oct. 2. At the time of her transfer, she was moving all extremities with generalized weakness, conversing her basic needs and thoughts to her care-givers and family, but continued to have a hoarse voice. She was transferred with a tracheostomy with some thoughts that it might become a permanent tracheostomy as secretions continued to be an issue for Mrs. V. She continued to require a PEG tube for enteral feedings. Her physical care needs were great, but her and her families’ psychological and emotional care needs were greater.

Conclusions
Glomus jugulare tumours continue to present a significant diagnostic and management challenge to all members of the health care team.

Development of surgical and embolization techniques in the last 20 years has led to improvement in outcomes and decreased concerns about the risk of surgical intervention. Gamma knife techniques are useful for recurrent tumours or for tumours that do not have major cervical expansion (Pollock, 2004).

Incomplete tumour resection and full-dose radiation are associated with poorer outcomes and tumour regrowth remains a concern. Multidirectional surgical approaches appear to result in complete tumour removal while preserving function (Gjuric et al., 1996).

Although most glomus jugular tumours are benign, the surgical approach to the tumour is complex and challenging. Radical removal of the tumour can only occur through well-planned surgical procedures that may involve several surgical specialists (Ramina, Maniglia, Fernandes, Paschoal, Pfeilsticker, Neto, & Borges, 2004).

Nurses are in a unique position to provide education, support and counselling to these patients and their families, who often arrive at the hospital setting with feelings of fear, anxiety, loss and powerlessness. Assessment of the family structure, relationships, and methods of coping with stress and crisis are important for the nurse to determine.

Caring for patients with glomus jugular tumours presents unique challenges to the health care team. Nurses caring for these patients must be astute in recognizing lower cranial nerve deficits and their associated potential complications. Nursing can play a key role in maximizing the patients’ ability to function in activities of daily living and consequently optimize the patients’ quality of life.

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