Features and management of strabismus from skull base chordoma

Chordomas are rare neoplasms derived from primitive notochordal remnants that almost always develop from bone and that can occur anywhere along the spinal axis from the clivus to the sacrum.1,2 Fifty percent of these tumours occur in the sacrococcygeal area, 35% arise from the clivus, and 15% arise elsewhere in the vertebral column.3 Skull base chordomas account for 0.3%–1.0% of intracranial tumours.4 Chordomas can develop at any age, but they typically affect patients in the third, fourth, and fifth decades of life.2 These soft, pale-grey tumours produce variable symptoms depending on their location and direction of growth.5 Because of the proximity of clival chordomas to the brainstem, the slow growth of these tumours, and their potential for local invasion, these tumours frequently cause cranial nerve palsies6. Clival chordomas, which account for just over a third of chordomas, cause three groups of symptoms characteristically accompanied by headache: symptoms owing to involvement of the cerebellopontine angle, homonymous hemianopia or other parasellar-associated symptoms, and symptoms suggestive of brainstem compression.7 Neuro-ophthalmic symptoms are common, particularly paralysis of extraocular muscles, but also may include visual field disorders, and less commonly, patients can present with orbital symptoms such as exophthalmos.6 The treatment of these tumours, in particular clival tumours, is challenging and involves a combination of surgery and adjuvant radiation therapy.2 The variability in presentations and the timing of the associated strabismus present a challenge in their surgical management from an ophthalmologic perspective. Here we present a case series of 3 patients presenting with cranial neuropathies secondary to skull base chordomas as well as the management of the associated strabismus.

Case 1: A 48-year-old man presented with a history of sinusitis and horizontal diplopia. Two years prior to presentation, he had a significant resection of a chordoma of the upper clivus. Eighty percent of the tumour was excised. The patient subsequently underwent proton beam radiotherapy in the year following surgery. He developed right cranial nerve VI palsy after neurosurgery and was patched over the right eye to treat his symptomatic diplopia. On examination, his vision was 20/50 OD and 20/20 OS. There was no relative afferent pupillary defect. He also had sensory right cranial nerve V1 and V2 loss. On orthoptic examination, he demonstrated a 90-prism diopter esotropia at distance with an approximately 70 prism diopter esotropia at near. The right eye had an abduction deficit of −8 with poor saccades (Fig. 1). The dilated fundus examination was normal. On presentation, the patient’s examination revealed a complete right cranial nerve VI palsy with a right medial rectus secondary contracture. He underwent multiple strabismus operations. The first was a complete temporal transposition of the right superior rectus and right inferior rectus combined with a botulinum toxin (Botox; Allergan Aesthetics, Madison, NJ) injection to the right medial rectus. In the immediate postoperative period, there was a right esotropia of 8 prism diopeters in the distance and 6 prism diopeters at near. A residual right esotropia of 25 prism diopeters was present 2 months postoperatively. A second operation was performed consisting of a right medial rectus recession of 6 mm and a left medial rectus recession of 5 mm. Subsequently, the patient required re-recessions of

Fig. 1—Case 1 on presentation prior to surgical management of his strabismus. Examination was consistent with a 90 prism diopter right esotropia and a −8 abduction deficit evident on right gaze.
the medial recti. The right medial rectus was re-recessed from 12 to 15 mm from the limbus, and the left medial rectus was re-recessed from 10.5 to 13 mm from the limbus (Fig. 2).

Case 2: A 22-year-old woman presented with horizontal diplopia. Her past medical history was significant for a clival chordoma (Fig. 3) after multiple neurosurgical resections and proton beam radiotherapy. She presented with a 5-year history of diplopia. The orthoptic examination demonstrated a left esotropia of 30 prism diopters in primary gaze and an 80 prism diopter esotropia in left gaze. Abduction was \(-5\), and abduction saccades were poor. The patient was diagnosed with left cranial nerve VI palsy with a left medial rectus contracture. Six months after presentation, the patient underwent a complete left temporal transposition of the vertical rectus muscles combined with a left medial rectus Botox injection. At that time, magnetic resonance imaging (MRI) demonstrated stability and no tumour recurrence. Several months later, a new motility deficit appeared that was consistent with left cranial nerve III palsy. Further consultation with the neurosurgeon and a repeat MRI at this time did not show any evidence of tumour recurrence. The cranial nerve III palsy was deemed to be the result of compression from the original tumour and/or prior radiation treatment. The patient was later referred back by her neurosurgeon and on examination demonstrated complete bilateral ophthalmoplegia including palsies of cranial nerves III, IV, and VI and palsies of left cranial nerves VII and left VI (Fig. 4). Given the patient’s lack of mechanisms to protect the cornea owing to corneal anaesthesia OS, left orbicularis paresis, and an absent Bell’s phenomenon, the decision was made to surgically repair the ptosis OD only with a frontalis suspension (Fig. 5).

Case 3: This 45-year-old woman had a previous history of chordoma (Fig. 6) 8 years prior to presentation. The chordoma was treated in a similar fashion as the first 2 cases. The patient presented with intermittent horizontal and vertical diplopia. She was initially orthotropic in primary gaze but developed a right esotropia after looking to the left with a \(-3\) abduction deficit. In addition, after looking down, she developed an upgaze limitation with a \(-3\) elevation deficit (Fig. 7). Given the patient’s history of radiation therapy, the episodic nature of the diplopia, and the ocular misalignment induced by eccentric gaze, the patient was diagnosed with ocular neuromyotonia (ONM). Management of this patient’s strabismus was nonsurgical, and consideration was given to starting carbamazepine.

Each patient in this series had a history of a treated chordoma and subsequent onset of strabismus. Chordomas are rare, locally aggressive tumours arising from notochord remnants with a predilection for the axial skeleton. They commonly present with headache and diplopia as the initial symptoms. Skull base chordomas most often present with strabismus owing to paralysis of cranial nerve VI. Rarely, chordomas of the clivus can present with rhinorrhea owing to cerebrospinal fluid leak. Survival ranges from 50%–68% at 5 years to 28%–40% at 10 years. Histologically, these tumours are recognized by 3 distinct
patterns: classic, chondroid, and dedifferentiated. The most common pattern encountered is the classic, which consists of islands of vacuolated cells separated by fibrous septa. Imaging is critical for diagnosis. X-ray can be useful in diagnosis when the tumour is advanced and demonstrates bony destruction with a soft tissue mass, but computed tomography (CT) and MRI are more useful imaging modalities. CT typically demonstrates a locally destructive soft tissue mass and lytic lesions and can outline the extension of the tumour as well as identify abnormalities in the ventricular system from compression by the tumour. On MRI, the lesions appear hypodense on T1 flair images with enhancement with gadolinium, whereas they appear hyperdense on T2-weighted images. Treatment that confers the best chance of survival is en bloc resection of the tumour with margins, but this is not always possible because of the location of these tumours and the resulting reconstruction that would be necessary following tumour excision. Surgery is commonly followed by external beam radiation therapy because of high recurrence rates. Because chordomas are relatively resistant to radiation therapy, high doses are necessary, thus increasing the likelihood of associated morbidity. Multiple modalities of radiation therapy can be used in the management of chordomas, including photon radiotherapy, carbon-ion radiotherapy, and stereotactic radiosurgery. The treatment of clival chordomas presents unique challenges, with an
emphasis on management in the preservation of neurologic function, thus limiting the amount of tissue excised.9

Among our patients, the first patient developed cranial nerve VI palsy requiring a complete temporal transposition of the vertical recti and bimedial recession. Although several surgical options exist to manage cranial nerve VI palsies, complete temporal transposition of the vertical recti muscles is the treatment of choice to improve alignment and binocularity and reduce the abduction deficit.11 It has been demonstrated to be a functionally more effective surgery than alternatives such as the Hummelsheim and Jensen procedure. It appears to provide a larger diplopia-free field.14,15 The decision to inject Botox in the medial rectus was made to minimize the risk of anterior segment ischemia incurred by operating on multiple rectus muscles at the same time.16 The rate of anterior segment ischemia is estimated to be 1 in 13 000 to 1 in 30 000, with a higher risk associated with surgery on 3 or 4 rectus muscles.17,18 The Botox acts to cause partial paralysis of the medial rectus muscle as a strategy to release the contracture of this muscle.14,15 It permits surgical weakening of a third muscle at the time of the temporal transposition of the vertical recti.

The second patient presented similarly and did well with the same surgery but subsequently developed bilateral ophthalmoplegia and ptosis. She required ptosis surgery OD to facilitate her visual function. Although cranial nerve VI is usually the first affected when the chordoma extends into surrounding structures, further spread can involve cranial nerves III, IV, and V.19 In the case of patient 2, there was also involvement of cranial nerve VII owing to invasion of the cerebellopontine angle by the tumour. Frontalis suspension was the procedure of choice because of poor levator function. It was completed exclusively in the right eye because of the corneal anaesthesia, absent Bell’s phenomenon, and thus lack of mechanisms to protect the cornea.

The third patient had a chordoma that was treated and likely developed ONM secondary to the radiation therapy years following treatment. ONM is a rare entity characterized by transient diplopia induced by sustained eccentric gaze and one in which most patients have a history of radiation therapy to the parasellar and sellar regions.5,20 Although the mechanism of ONM is not well understood, it is thought to be owing to inappropriate discharges from neurons with unstable cell membranes; thus symptoms can improve with carbamazepine, a membrane-stabilizing agent.6 Given the episodic nature of the strabismus, as well as its being triggered by eccentric gaze, this patient was not a surgical candidate, and consideration was given to administering carbamazepine.

These cases demonstrate the diversity in approaches employed from an ophthalmologic standpoint in the management of strabismus in patients affected by chordomas. In addition, it is evident that cranial nerve palsies can develop years following treatment of the chordoma, either from tumour recurrence or progression or from the adverse effects of high-dose radiotherapy. Thus, lifelong surveillance of these patients is recommended with MRI to monitor for recurrence and the development of further complications.1

Chordomas are rare, locally aggressive neoplasms that can lead to several ophthalmic sequelae. Even with appropriate treatment, ophthalmic complications can occur either from the treatment or from tumour recurrence. Careful follow-up and management are necessary in these patients.

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The authors have no proprietary or commercial interest in any materials discussed in this article.