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The patient was advised regular follow-up. However, the patient had recurrence of symptoms 6 months post-surgery and a repeat MRI done showed recurrence of the lesion. The patient was re-operated. This time, a right far-lateral approach was taken to facilitate access to the cyst located ventral to the upper cervical nerves. The cyst was decompressed and the cyst wall was completely excised [Figure 2]. Postoperative period was uneventful. The HPE showed a cyst lined by columnar mucinous epithelium [Figure 3].

Case 2

A 36-year-old lady presented with complaints of intermittent right-sided headache of 2 years duration with a 20-day history of diplopia, mild deviation of angle of the mouth to the left, and decreased hearing in the right ear. Neurological examination revealed right 6th, 7th, and 8th nerve paresis with cerebellar ataxia. Audiological investigation revealed a right sensorineural hearing loss. An MRI of the brain showed an extra-axial lesion in the right cerebellomedullary cistern, measuring 4 × 3 × 2.5 cm, extending from lower clivus up to the rim of foramen magnum [Figure 4]. The various possibilities considered were NC, epidermoid or dermoid cyst.

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magnum and extending into the jugular foramen. The cyst was decompressed by puncturing the cyst wall and aspirating its thick yellow contents. The cyst wall was gently separated and excised under Nerve Integrity Monitoring (NIM) [Figure 5]. The surgical cavity was irrigated with steroid impregnated saline. The postoperative period was uneventful.

The HPE was suggestive of NC with cyst wall lined with pseudostratified ciliated columnar epithelium [Figure 6].

**Discussion**

The NC is an unusual congenital cyst of endodermal origin, particularly rare at the CVJ[5]

**Embryology**

NCs are thought to result from the disorder in the separation of the ectodermally derived spinal cord and the endodermally derived foregut during the closure of the neurenteric canal. Although this theory explains the appearance of spinal NCs caudal to the clivus (which is the cranial margin of the endoderm in embryos) as in Case 1, it does not explain the
Shetty, et al.: Neurenteric cysts at the CVJ

There are several theories as to the origins of intracranial NCs. Cheng et al.\cite{8} suggested that they result from the rostral closure of the notochord by the mesenchyme forming the clivus. Graziani et al.\cite{9} suggested that intracranial NCs are remnants of Seessel’s pouch, a transient out-pouching of the oro-pharyngeal membrane at the cranial end of the foregut. This latter theory is supported by the fact that NCs share several immunohistochemical staining characteristics with Rathke’s and colloid cyst. All three are positive for cytokeratin, epithelial membrane antigen (EMA), and carcinoembryonic antigen (CEA), and negative for glial fibrillary acidic protein (GFAP). NCs, in addition, are positive for CA19-9. However, these theories do not explain laterally positioned intracranial NCs. Kulkarni et al.\cite{10} put forth the theory of variable regression of endodermal–ectodermal adhesions at the cephalic end of the notochord which could explain the laterally positioned NCs rostral to the clivus.

### Clinical features

Most CVJ NCs are located ventrally in the midline, anterior to the brainstem.\cite{7} In our patients, the NCs were atypically located – laterally at the CVJ. Clinically, CVJ NCs can either mimic spinal NCs (relapsing and progressive myelopathy) or they can mimic intracranial NCs and present with symptoms from mass effect (headaches, cranial nerve involvement, gait disturbances, and long tract signs) or inflammation (recurrent aseptic meningitis). Both our patients presented with symptoms secondary to progressive direct mass effect.

### Imaging

NCs can exhibit variable signal intensity characteristics depending upon the protein content of the cyst fluid. They can be either hypo, hyper, or isodense on the computed tomography (CT) scan. Most NCs are proteinaceous. On an MRI, they are iso to slightly hyperintense to cerebrospinal fluid (CSF) on T1W images and typically very hyperintense on T2W and FLAIR images. They may show a mild restriction on diffusion-weighted images with occasional cyst wall enhancement on contrast.\cite{2} The imaging characteristics in our patients were typical of NCs except for the unusual location.

Unlike spinal NCs, intracranial and CVJ NCs are rarely associated with bony abnormalities.\cite{3} Only two cases of CVJ NCs have been reported to have associated bony anomalies.\cite{5} No associated bony anomalies were seen in our patients.

The differential diagnosis for CVJ NCs includes arachnoid cyst, epidermoid cyst, dermoid cyst, Rathke’s cleft cyst, and schwannoma. Although a CT can exclude arachnoid and ependymal cysts (isodense to CSF), an MRI may be helpful in ruling out epidermoids (restricted diffusion), dermoid cysts (with fat suppression), and schwannomas (which enhance strongly). Only a pathologic examination using immunohistochemical staining can make a definitive diagnosis of NC.

### Surgical approach

NCs are mostly located in front of the neural axis. The ideal approaches to NCs at the CVJ would be the transcondylar or a far-lateral approach.\cite{6} Other approaches that have been employed are transoral, transclival endoscopic endonasal approach (EEA), suboccipital, retrosigmoid, and subtemporal approaches.\cite{1} If an appropriate surgical approach is not employed, there is a high probability of subtotal resection and subsequent recurrence as seen in our patient (Case 1). By employing the far-lateral approach, we were able to achieve total excision in both our patients. For ventrally located NCs, the transcondylar approach might be ideal.

The best outcomes are associated with total removal of the cyst wall. The residual cyst wall is said to have proliferative potential and can also rarely undergo malignant transformation.\cite{11,12} If the remnant walls are large enough to overlap, resealing of
the remnant cyst wall can occur with subsequent expansion of the cyst either by cyst epithelial secretion or by osmotic CSF accumulation. This was probably the cause of recurrence in our patient (Case 1). Hence, total excision should be the goal. However, if the cyst wall is densely adherent to the surrounding neurovascular structures, sub-total excision may be a reasonable option. During the operation, if small pieces of the remaining cyst wall can be distinguished from the arachnoid membrane and electrocoagulated to shrink them, overlapping can be avoided, thereby decreasing the chances of recurrence. Neither radiation nor chemotherapy has been recommended.\[3\]

Despite the apparent total cyst wall removal, a delayed recurrence is possible. Signs of aseptic meningitis or increasing levels of CA19-9 in the CSF are possible indicators of recurrence.\[3,4\] This necessitates extended serial follow-up imaging\[4\] for at least 10 years following surgery\[3\] and re-operation should be considered in cases of recurrence.

In conclusion, CVJ NCs are rare lesions often mimicking other cystic lesions on neuroimaging. The incidence of intracranial and CVJ NCs is gradually increasing. It is therefore important to be familiar with the clinical characteristics, imaging features, and management options of NCs.

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