PM R XXX (2018) 1-6

www.pmrjournal.org

Images

Neural Foraminal Lesions: An Imaging Overview

Raza Mushtaq, MD, Jack Porrino, MD, Sylvestor A. Moses, PhD, Gloria J. Guzmán Pérez-Carrillo, MD, MSc

Introduction and Anatomic Considerations

The neural foramina allow passage of spinal nerves, arteries, veins, and lymphatics from the spinal canal to the periphery [1,2] and are formed by various surrounding osseous and nonosseous structures. The anterior border is made up of the posterior aspect of adjacent vertebral bodies, the intervertebral disk, and the posterior longitudinal ligament. The superior and inferior borders of the foramen are formed by the vertebral notches of the superior and inferior vertebral pedicles. The facet, or zygapophyseal, joints form the posterior border [1,2]. Laterally, the foramen is covered by overlying psoas muscle and fascia [2].

Clinical Background

Many lesions have been associated with nerves exiting at the level of the neural foramen. The purpose of this review is to describe the various pathologies at this site, which typically present with compression through the neural foramina in a longitudinal fusiform manner [3]. Peripheral nerve sheath tumors (PNSTs) constitute the majority of these lesions; however, there are a large number of foraminal/extraforaminal and neoplastic/non-neoplastic differential considerations for such lesions [3,4].

Neoplastic Lesions

Benign PNSTs

Neurofibromas and schwannomas (neurilemomas) are the 2 major benign PNSTs [2,5,6]. Peripheral nerves can be involved at any level but typically afflict major nerve trunks [5].

Neurofibromas

Neurofibromas constitute 5% of all benign soft-tissue neoplasms. These tumors typically affect young patients in their second or third decades of life, without a sex predilection [6,7]. These are usually solitary lesions involving superficial small cutaneous nerves that present as small, painless masses. Neurofibromas can also affect deeper, larger major nerve trunks, which often produce neurologic symptoms [5]. On histology, these lesions are composed of abundant collagen with interlacing fascicles of elongated cells [6].

Nearly 10% of neurofibromas are associated with neurofibromatosis. These patients have a greater incidence of malignant transformation [5]. In neurofibromatosis type 1 (NF1), neurofibromas have been divided as localized, plexiform, and diffuse types on a pathologic basis. The localized neurofibromas in NF1 tend to be larger and multiple, involving the deeper nerves. Plexiform neurofibromas involve longer segments of major nerves, resulting in large multilobulated masses that are considered pathognomonic for NF1. Diffuse neurofibromas occur most commonly in children and are often localized within the subcutaneous tissues [5].

Cross-sectional evaluation of neurofibromas on computed tomography (CT) reveals a well-defined low attenuating mass, often intradural extramedullary, that demonstrates homogeneous enhancement with associated pressure related dysplastic osseous abnormalities [3,8] (Figure 1). On magnetic resonance imaging (MRI), these lesions demonstrate hypointense signal on T1-weighted sequences and hyperintense signal on T2-weighted sequences with avid enhancement on postcontrast images [3,5,6]. A characteristic target sign has been described on T2-weighted sequences with a central hypointense region surrounded by homogeneously hyperintense signal (Figure 1) [3]. The central hypointense signal is due to high content of dense fibrous and collagenous material, whereas the peripheral hyperintense signal is constituted predominately by abundant myxoid material with high fluid content. A similar target sign can be appreciated on sonographic examination, with a well-defined hypoechoic lesion containing a central hyperechoic region [5].

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https://doi.org/10.1016/j.pmrj.2018.02.014

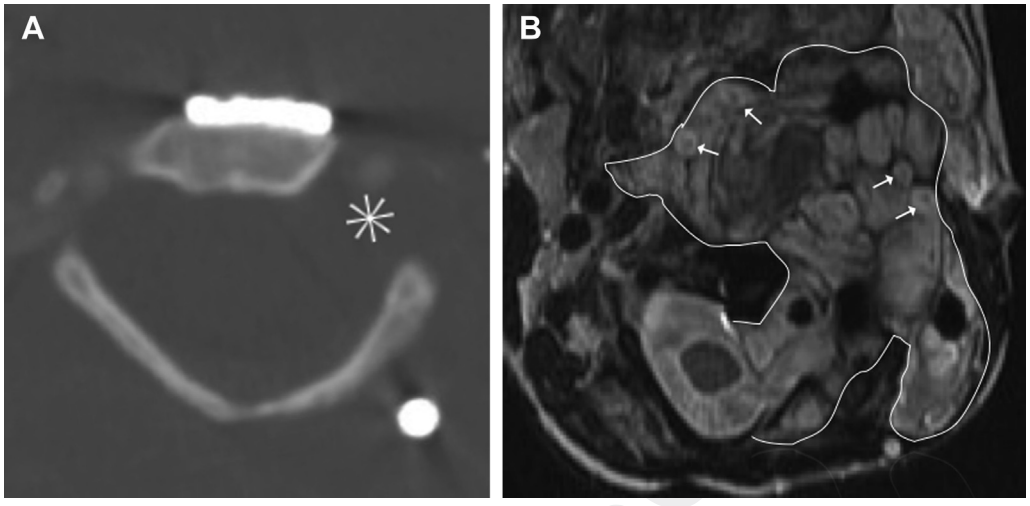

Figure 1. Plexiform neurofibroma in a patient with neurofibromatosis type 1. There is an enlarged left neural foramen (asterisk) on the axial computed tomographic (CT) image (A) related to an expansile mass (outlined) seen best on the corresponding axial T2-weighted magnetic resonance image (MRI) (B). Several target signs (arrows)—a central hypointense region surrounded by homogeneously hyperintense T2 signal—are denoted on MRI. Hardware about the cervical spine is incidentally noted on the CT image.

Schwannomas

Small schwannomas are generally asymptomatic, with larger masses causing symptoms from compression of adjacent nerves [5]. Histologically, schwannomas are composed of varying degrees of Antoni A (organized areas of cellular spindle cells) and Antoni B (loosely arranged areas of hypocellular myxoid tissue) regions that are often S-100 protein—positive on immunohistochemical analysis [6,9].

Imaging characteristics of schwannomas are similar to those of neurofibromas, which typically present as solitary, lobulated, and grossly encapsulated intradural extramedullary masses. However, schwannomas tend to demonstrate cystic degeneration, hemorrhage, and xanthomatous changes (Figure 2) [3,5]. In addition, an eccentric location of the mass compared with the associated nerve suggests a histologic diagnosis of schwannoma, whereas a central location favors neurofibroma [3]. Schwannomas often allow for nerve-sparing surgeries due to their encapsulated nature; conversely, neurofibromas require sacrificing the involved nerve due to their intimate relationship with the nerve [5].

Malignant Peripheral Nerve Sheath Tumors

Malignant peripheral nerve sheath tumors (MPNSTs) are also known as malignant schwannomas, neurogenic sarcomas, and neurofibrosarcomas. MPNSTs affect a slightly older population, those 20-50 years of age, as compared with benign PNSTs. Nearly 50% of MPNSTs are found in patients with NF1, but only 5% of patients with NF1 develop MPNSTs [5].

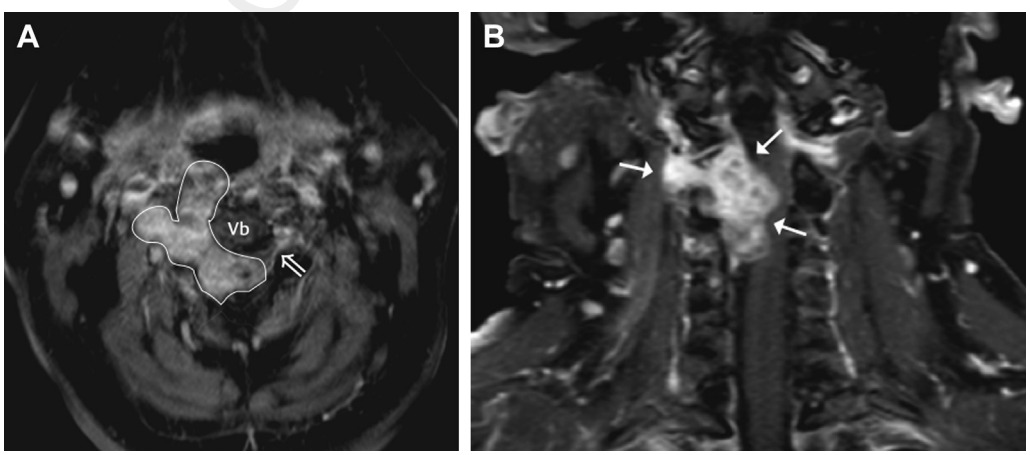

Figure 2. Cervical schwannoma. Axial (A) and coronal (B) fat-suppressed postcontrast T1-weighted magnetic resonance images demonstrate an avidly enhancing mass expanding the right C2-C3 neural foramen and causing lateral displacement and severe compression of the spinal cord from the C2 through C4 level (the mass is outlined in [A] and denoted by closed arrows in [B]). Vb, vertebral body; the open arrow in (A) points to the normal left neural foramen.