Intraneural perineurioma of the common peroneal nerve

Case report and review of the literature

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Intraneural perineurioma, or localized hypertrophic mononeuropathy (LHM), is a focal lesion that produces a slowly progressive mononeuropathy in a peripheral nerve. The authors describe the clinical presentation, magnetic resonance imaging characteristics, and pathological characteristics of a perineurioma involving the peroneal nerve. Although there has been much debate surrounding the cause of this lesion, a literature review supports the argument that this is a neoplastic lesion, best referred to as intraneural perineurioma. Surgical management includes excision to prevent progression of palsy and placement of a nerve graft if clinically indicated.

A 28-year-old woman presented with a 2-year history of progressive painless right peroneal nerve palsy. Magnetic resonance neurography revealed a right common peroneal nerve mass. At surgery, the mass was easily excised, leaving significant nerve fascicles intact. Intraoperative biopsy was not performed nor was a nerve graft placed. Pathological investigation demonstrated onion bulb–shaped whorls consistent with the appearance of intraneural perineurioma; immunohistochemical analysis confirmed the diagnosis.

A review of the literature supports the argument that perineurioma, or LHM, is a neoplastic process, making “intraneural perineurioma” the most appropriate name. The authors also demonstrate the utility of MR neurography in the identification isolated nerve tumors and review the surgical management of this lesion.

Key Words • localized hypertrophic mononeuropathy • perineurioma • magnetic resonance neurography

We present a case of a common peroneal nerve perineurioma. In this report we also reiterate the utility of high-resolution MR imaging of peripheral nerve, or MR neurography, in identifying perineuriomas and other isolated intraneural nerve tumors presented by Simmons and colleagues. Finally, issues related to surgical management raised by Gruen, et al., are reviewed in this report.

Case Report

History. This 28-year-old woman initially presented in July 1995 with a mild right foot drop and change of gait, which had developed slowly over the previous year. Examination revealed decreased dorsiflexion, inversion and eversion of the right foot and toes, normal plantar flexion, and decreased sensation to light touch along the anterior aspect of the foot, all of which were consistent with a right common peroneal nerve palsy. The initial clinical findings were confirmed by the result of electromyography and nerve conduction studies, which demonstrated a nerve block at the fibular head. The patient was instructed not to cross her right leg over her left leg and was given an ankle–foot orthosis to use. At no time were other associated disease problems identified. She was reevaluated in 1997.

Abbreviations used in this paper: EMA = epithelial membrane antigen; LHM = localized hypertrophic mononeuropathy; MR = magnetic resonance; STIR = short tau inversion recovery.
and found to have steppage gait with a complete foot drop; a sensory examination performed at the time produced findings consistent with peroneal neuropathy. It was recommended that she try electrical stimulation therapy, which elicited no muscle reaction to direct therapy. At that point, she was referred to our institution for reevaluation.

**Examination.** On examination, the diagnosis of steppage gait was confirmed. The patient hyperflexed her hip due to the lack of dorsiflexion strength in her ankle. During the motor examination she displayed 0/5 strength in her foot dorsiflexors, extensor hallucis longus muscle, and ankle everters. She continued to exhibit normal strength in her plantar flexors. Sensory examination revealed hypesthesia over the lateral aspect of the lower right calf, dorsum of the foot, and web space. Her knee jerks and ankle jerks were intact and symmetrical.

In addition to repeated electromyography and nerve conduction studies, the patient underwent MR neurography to assess the level of the conduction block and to determine whether structural changes such as demyelination, inflammation, or a mass lesion could be identified.

Magnetic resonance neurography involves the use of high-resolution, high signal-to-noise techniques with sufficient image contrast to emphasize peripheral nerve anatomy and morphological characteristics. Such techniques were used to evaluate this patient. Magnetic resonance neurography was performed using a 1.5-tesla clinical imager with high-performance gradients (Signa Nvi/Cvi; General Electric Medical Systems, Milwaukee, WI). Specialized radiofrequency surface-phased-array coils (Median Diameter Array; UltraImage, Seattle, WA) were applied to the skin overlying the expected distribution of the common peroneal nerve. A series of axial T1-weighted spin-echo sequences, T1-weighted fast–spin echo sequences with fat suppression and STIR fast–spin echo, and coronal STIR sequences were performed. Also included was gadolinium-enhanced T1-weighted spin-echo imaging with fat suppression in the axial and coronal planes through the suspected neoplasm.

The main imaging parameters included the following: field of view, 12 cm; matrix, 256 x 256; slice thickness, 4 to 5 mm; and number of excitations, 2. Times to repetition and echo were 650 msec and 9 msec, respectively, for the T1-weighted images and 5300 msec and 108 msec, respectively, for the T1-weighted images. One hundred fifty milliseconds constituted the STIR inversion time. Flow compensation and spatial saturation were used to reduce the pulsation artifact. Magnetic resonance neurograms of the right lower extremity were obtained using T1-weighted, gadolinium-enhanced T1-weighted, and T1-weighted fast–spin echo sequences in both coronal and axial planes.

Magnetic resonance neurography revealed an abnormal enhancing mass approximately 6 cm in length in the common peroneal nerve. The mass involved both the deep and superficial peroneal segments of the common peroneal nerve. At the time, it was suggested that the lesion represented a neurofibroma. Marked fatty atrophy of the anterior compartment muscles and less extensive fatty atrophy of the lateral compartment muscles were also noted (Fig. 1).

**Operation.** An incision was made through the posterolateral aspect of the right lower extremity from approximately the midhigh level, moving posteriorly within the midline of the thigh and extending distally to approximately the popliteal fossa. The incision continued laterally and distally along the lateral calf to approximately the

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**Fig. 1.** Left: High-resolution T1-weighted fast–spin echo MR neurogram obtained with fat suppression at the level of the popliteal fossa immediately superior to the fibular head. For orientation, the left margin of the figure is lateral and the top is rostral. The common peroneal nerve (observed between solid arrows) is abnormally enlarged, is increased in signal, and provides poor delineation of the normal fascicular architecture. The proximal common peroneal nerve displays an increased signal with several swollen and hyperintense fascicles due to increased endoneurial fluid (one prominent fascicle is depicted by the arrowhead). The nerve distal to the tumor (open arrow) exhibits a more normal appearance, which is isointense with surrounding muscle. Note the normal hyperintense deep veins in the center of the fossa. Center: Gadolinium-enhanced fat-suppressed coronal T1-weighted MR neurogram obtained in the same orientation as that shown at left. There is intense enhancement of the tumor (solid arrow) and minimal enhancement of the proximal peroneal nerve (arrowhead), indicating a slight breakdown in the blood–nerve barrier. The normal nerve distal to the tumor is nonenhancing. Bar = 1 cm. Right: Gadolinium-enhanced fat-suppressed axial T1-weighted MR neurogram obtained through the lateral popliteal fossa. The solid arrow indicates the heterogeneously enhancing tumor that invades both the deep and superficial segments of the nerve. This finding can be compared with the normal nonenhancing common tibial nerve (open arrow). C = lateral femoral condyle.
midcalf region. We recognized the right peroneal nerve by palpation and identified an abnormal mass extending approximately 4 cm within the thigh just proximal to the bifurcation of the common peroneal nerve. The proximal and distal boundaries of the abnormal mass were defined visually and with the aid of a nerve stimulator. Stimulation through the normal portion of the nerve demonstrated good contraction of the muscles in the patient’s foot, whereas no movement was noted when the abnormal mass was stimulated. With microsurgical dissection, the mass was easily shelled from surrounding nerve fascicles. Its gross appearance was consistent with that of a neurilemmoma. Because the patient’s paresis had been complete for longer than 2 years and there was conduction of impulses through the preserved fascicles, a graft was not placed.

Pathological Findings. The tissue sections demonstrated peripheral nerve with enlargement caused by extensive “onion bulbing.” This was characterized by proliferation of cells around individual nerve fibers. These proliferations were compacted with no loose intervening stroma. The myelin stain demonstrated no appreciable myelin in the enlarged area of the nerve. Epithelial membrane antigen demonstrated staining of cells surrounding the nerve fibers. Staining for S-100 protein did not highlight the proliferating cells around the nerve fibers, but did enhance normal-appearing nerve axons (Fig. 2). Proliferative changes were not seen in tissue from the tumor margins. This staining pattern is consistent with proliferation of perineural cells, demonstrating conclusively that the onion bulb–shaped whorls are of perineurial rather than Schwann cell origin.2,5 The final diagnosis was separate from that of a reactive hypertrophic neuropathy because the staining pattern and the close compaction of the onion bulb–shaped whorls.

Postoperative Course. The patient exhibited no change immediately postoperatively in her neural deficit. At 2 years postoperatively and at 5 years following onset of the deficit, she was stable with no improvement in her foot drop.

Discussion

To date more than 50 cases of intraneural perineurioma have been documented by histological analysis and in most immunoreactivity has also been demonstrated with EMA positivity and S-100 protein negativity.2,5,9,11,14,16,17 Using tissue culture, cytogenetics, and fluorescent in situ hybridization, Emory and colleagues demonstrated that the intraneural perineurioma represents a neoplasm consistent with loss of a gene on chromosome 22, similar to findings in other peripheral nerve tumors and intracranial meningiomas. Because of this genetic evidence, those authors argued that the most descriptive and accurate term for this lesion is “intraneural perineurioma;” however, in their re-
cent study, Gruen, et al. referred to this lesion as LHM, despite their argument that it is rare to find a history consistent with reactive change. Authors of other recent reports have also referred to this lesion as LHM and perineurioma interchangeably.

In the management of peripheral nerve lesions, MR neurography has provided helpful information about lesion localization and extent of involvement. By demonstrating the incorporation or displacement of normal fascicles, MR neurography assists in the preoperative identification of isolated nerve tumors. Finally, surgical management of intraneural perineurioma includes excision of the mass is helpful in planning graft length if necessary. Additionally, MR neurography can be used to evaluate innervated muscles for pattern, extent, and age of denervation. All these findings provide preoperative information of the lesion to prevent further motor decline. The available literature does not provide enough clinical information to formulate firm guidelines for the subsequent placement of a nerve graft. Rather, the decision to place a nerve graft should be based on surgical judgment and accepted clinical indications.

Conclusions

Our review of the literature supports the argument that nerve lesions composed of perineural cells demonstrating onion-bulb formation,EMA, positivity, and S-100 protein negativity represent a neoplastic process. Because of uncertainty concerning the nature of this lesion, its nomenclature has not been firmly established. We argue that the term “intraneural perineurioma” adequately describes both the location and cellularity of the lesion. We have also demonstrated the utility of MR neurography in the identification of isolated nerve tumors. Finally, surgical management of intraneural perineurioma includes excision of the lesion to prevent further motor decline. The available literature does not provide enough clinical information to formulate firm guidelines for the subsequent placement of a nerve graft. Rather, the decision to place a nerve graft should be based on surgical judgment and accepted clinical indications.

References

8. Inaba H, Hizawa K, Li K, et al: Perineurioma. A distinctive form having LHM, 10 underwent placement of nerve grafts and seven of these demonstrated improvement. Of the four patients who did not receive grafts, the two who had demonstrated some positive intraoperative nerve action potentials also recovered some function. Although Gruen, et al., argued that this shows the significant benefit of routine nerve grafting, a further review is not as definitive. Table 1 shows that in 16 patients treated with resection of a focal mass and nerve graft placed found in a literature review, follow-up information demonstrates clear improvement in eight cases and slight improvement in two more. In an additional three of five cases treated with excision alone, the patient also demonstrated some improvement. This, a literature review of a small number of cases indicates that placement of a nerve graft following lesion excision should be based on accepted clinical indications, including negative intraoperative action potentials.

<table>
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<tr>
<th>Authors &amp; Year</th>
<th>Nerve Location</th>
<th>Symptom Duration</th>
<th>Follow Up</th>
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<td>5 yrs</td>
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<tr>
<td></td>
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<td>2 yrs</td>
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<tr>
<td></td>
<td>median</td>
<td>14 mos</td>
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<td>2 mos</td>
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* NA = not available; + = clear improvement; +/- = slight improvement; – = no improvement.

TABLE 1
Results after nerve graft in patients in whom follow-up information is available*
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Manuscript received July 18, 2000. Accepted in final form January 12, 2000. Address reprint requests to: M. Peter Heilbrun M.D., Department of Neurosurgery, University of Utah School of Medicine, 50 North Medical Drive #3B409, Salt Lake City, Utah 84132. email: peter. heilbrun@hsc.utah.edu.