Resection of benign sciatic notch dumbbell-shaped tumors

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Objective. The operative management of combined intrapelvic and extrapelvic sciatic notch dumbbell-shaped tumors is challenging. The relatively rare occurrence of these tumors and the varied extent of disease have made it difficult for surgeons to establish definitive surgical indications or predict favorable neurological outcomes based on preoperative imaging data.

Methods. In the past 3 years, the authors treated five patients presenting with radiating leg pain as a result of benign sciatic notch dumbbell-shaped tumors. These tumors in three patients with unilateral leg symptoms were considered unresectable by other neurosurgeons because of presumed direct intrinsic neural involvement. After high-resolution magnetic resonance (MR) imaging demonstrated that the extensive tumors were separate from the sciatic nerve and the lumbosacral plexus, however, these patients underwent a combined one-stage transabdominal and posterior transgluteal complete resection. Normal neurological status was maintained postoperatively in these three patients, and after more than 1 year of postoperative follow up, there were no tumor recurrences.

In two patients with bilateral symptoms and extensive tumor burden, serial MR images showed that innumerable tumors directly involved the entire cross-sectional area of the sciatic nerves and extended longitudinally to the lumbosacral plexuses. Tumor debulking or resection in these patients would have resulted in neurological deficits and would not have addressed their neuropathic pain, and therefore no surgery was performed. These two patients were treated pharmacologically and advised to monitor their tumor status over the course of their lifetimes in case of malignant transformation of the tumor.

Conclusions. A combined one-stage transabdominal and transgluteal approach allows safe resection of selected benign but extensive sciatic notch tumors. High-resolution MR imaging is a useful tool in the management of these tumors because it allows the surgeon to visualize the anatomical relationships of the tumor to the sciatic nerve. The authors believe that as this imaging technology advances, it will provide surgeons with a method to predict definitively which sciatic notch tumors displace rather than directly involve the sciatic nerve, and therefore indicate which tumors can be resected safely and completely.

KEY WORDS • dumbbell-shaped tumor • sciatic notch • neurofibromatosis • plexiform neurofibroma

The operative management of dumbbell-shaped tumors, regardless of location, remains challenging. Intrapelvic and extrapelvic sciatic notch dumbbell-shaped tumors are especially difficult to treat. The relatively rare occurrence of these tumors has made it difficult to establish clear management guidelines and surgical indications, perfect challenging surgical approaches, or measure outcomes. Sciatic notch dumbbell-shaped tumors should be considered separately from other large lesions affecting the sciatic nerve along its course, including those confined to the pelvis or buttck. In this study, we describe our operative technique of resecting benign sciatic notch dumbbell-shaped tumors in selected patients. Proceeding with these resections was based on favorable MR imaging characteristics, which suggested displacement of the sciatic nerve and lumbosacral plexus, rather than intrinsic involvement of these neural structures.

Clinical Material and Methods

The lead author (R.J.S.) evaluated symptomatic sciatic notch dumbbell-shaped tumors in five patients over the last 3 years. Medical geneticists diagnosed NF1 in four of these patients. Previous neurosurgeons at other hospitals, after reviewing initial MR images, considered all of the sciatic notch tumors in these patients to be unresectable (Fig. 1), because the tumors were presumed to directly involve the sciatic nerves due to tumor location, size, and tracking pattern along the course of the nerve; therefore, tumor resection was not considered due to concerns that it would damage the integrity and function of the sciatic nerve.

Three female patients (17, 37, and 64 years of age) had unilateral symptoms and tumors, and NF1 was diagnosed in the two younger patients. These three patients presented with a 6- to 12-month history of progressive pain radiating...
from the buttock down the leg, accompanied by an enlarging mass in the buttock area in one patient. In one patient, the pain prevented ambulation. Sensorimotor testing results were normal in these patients. Percussion tenderness was present over the sciatic nerve at the buttock in all three patients.

Two male patients (17 and 24 years of age) had bilateral symptoms and tumors, and NF1 was also diagnosed in these patients. These two patients had extensive tumor burden in their limbs, and in the spinal canal in one patient. Both patients had moderate neurological deficits (which remained stable over several years), but maintained a high functionality despite their neuropathic pain. Percussion tenderness was present diffusely along the course of the sciatic nerve complex from the sciatic notch regions to the legs bilaterally.

**Imaging Protocol**

Additional MR images of the pelvis were obtained at our institution in all five patients, specifically to visualize the anatomical relationship of the tumors to the lumbosacral plexus and sciatic nerve within the pelvis and buttock. Fat-saturated \( T_1 \)- and \( T_2 \)-weighted MR images were obtained in each case in the axial, sagittal, and coronal planes. The MR field of view was individually optimized for each patient, with a minimum acquisition matrix of \( 256 \times 256 \) and with thin sections in each plane to maximize spatial resolution. The most recent imaging was performed on a 3-tesla Signa Excite system (3T94; General Electric Healthcare, Waukesha, WI) to optimize the signal-to-noise ratio and to achieve a high in-plane resolution. Contrast MR imaging was performed in two patients in the study.

A single radiologist interpreted the new MR images, noting whether the tumor appeared to be separate from the sciatic nerve within the notch (a potentially resectable tumor) or directly involved the sciatic nerve (an unresectable tumor). In all five patients, the tumors appeared to be benign, both from a clinical and imaging perspective. Those patients who appeared to have resectable tumors underwent PET scanning and/or additional imaging studies. A PET scan was also obtained for patients with unresectable lesions. A CT-guided needle biopsy procedure was performed in each patient to establish the tissue diagnosis preoperatively. If a PET scan showed increased uptake in the lesion, PET–CT fusion images were obtained to determine specifically the area of abnormality, in an effort to reveal any site of malignant degeneration. Otherwise, routine biopsy sampling procedures were performed.

**Operative Technique**

Patients who were thought to have potentially resectable lesions underwent a one-stage combined transabdominal (intrapelvic) and translumbar (extrapelvic) surgical exposure in collaboration with a colorectal surgeon. Ureteral stents were inserted by a urologist at the onset of the operation. The intrapelvic exposure was performed using a low midline incision, with the patient supine. The abdomen was explored, first to rule out metastasis and then to confirm that the tumor had a benign appearance. The sigmoid colon and upper rectum were mobilized to gain access to the presacral and laterosacral spaces. The ureters and iliac and gonadal vessels were identified and retracted to provide exposure of the intrapelvic portion of the tumor and the neural elements comprising the sciatic nerve. The tumor was mobilized, and neural elements were identified proximally and protected in vasoloops. The nerves were then dissected from the sacrum to the sciatic notch.

Once the tumor was sufficiently mobilized within the pelvis, the patient was then placed in a lateral decubitus position. The sciatic nerve was exposed in the buttock via a transgluteal muscle-splitting approach in two cases and an infragluteal approach in one case when more extensive exposure was deemed necessary. The sciatic nerve (and its peroneal and tibial components) was identified at the distal extent of the exposure. The dissection was then continued proximally. The piriformis muscle was divided and the neurolysis was continued to the level of the sciatic notch, where care was also taken to identify and preserve major gluteal nerve branches.

Further mobilization of the sciatic nerve and the lumbosacral plexus could be done through both the buttock and pelvic exposures sequentially or simultaneously. Once the nerves, vessels, and other tissues were protected, the tumor could then be resected safely, and any large mass was delivered through the buttock exposure. Intramuscular needle electrodes were used to monitor sciatic-innervated muscles for neurotonic discharges in two cases.

**Results**

**Surgical Group**

Three patients with unilateral, sciatic notch, dumbbell-shaped tumors were believed to have resectable lesions. Magnetic resonance images of the pelvis in each case helped identify a large intra- and extra pelvic multilobulated mass centered near the sciatic notch; the sciatic nerves were clearly identifiable in multiple MR image planes, and were displaced and not encased by the primary mass. The two patients with NF1 had masses with imaging
characteristics typical of plexiform neurofibromas, without features suggesting malignant degeneration such as necrosis or irregular contours. No comparison images were available to assess any change in mass size or shape over time.

One patient (Case 1) had three major masses, whereas the other (Case 2) had innumerable smaller masses (Figs. 2 and 3). The third patient’s (Case 3) mass had MR imaging features that were indeterminate. Results from T1-weighted imaging showed that the mass was markedly hypointense compared with muscle, an atypical feature for a neurogenic tumor (Fig. 4). The PET scans did not reveal an area of increased uptake in one of the two patients with NF1; in the other, there were scattered foci of increased intensity throughout the mass that were of indeterminate significance but of concern for malignant degeneration (Case 1). A CT scan of the chest and a PET scan in the third patient were normal. Preoperative biopsy specimens revealed plexiform neurofibromas in both patients with NF1 and a myxoma in the third patient.

Gross-total resection of all tumors was achieved in the three operated cases (Figs. 5 and 6). In these cases, the sciatic nerve and lumbosacral plexus were visualized as distinct from the tumor(s) intraoperatively. The well-encapsulated intrapelvic portion of the tumor was delivered through
the sciatic notch. A widening of the notch was not necessary, as the long-term growth of the lesions had already enlarged the notches. In Case 1, in addition to a relatively large mass, multiple masses were removed in a piecemeal fashion from the pelvis. In all cases, at the conclusion of the tumor resections, the sciatic nerve and lumbosacral plexus were well decompressed longitudinally from the buttock to deep within the pelvis. Rare neurotonic discharges were noted during nerve manipulation. Intraoperative and final histological investigators confirmed the preoperative biopsy specimen findings in these cases.

The postoperative courses were uneventful in all patients. All patients had normal neurological function immediately after the surgery and after more than 1 year of postoperative follow up (Fig. 7). Two of the three patients also had complete pain relief and the third noted significant improvement in pain. Postoperative MR imaging showed complete resection of the tumors (Figs. 2 and 3) and no recurrence. In all cases the displaced sciatic nerves had returned to their normal locations after surgery. All of the sciatic nerves on the operated sides of the patients had increased signal intensity on $T_2$-weighted MR images compared with preoperative
images, presumably due to edema from surgical mobilization and protection during tumor resection.

**Nonsurgical Group**

The two patients with bilateral lesions had innumerable individual tumors arising within the sciatic nerves and the lumbosacral plexuses, and the authors believed that the lesions were unresectable (Fig. 8). No increased uptake in these lesions was revealed by PET scans. Biopsy specimens of these tumors obtained elsewhere were reviewed again at our institution and were found to be consistent with a diagnosis of plexiform neurofibromas. These lesions had the classic imaging features of plexiform neurofibromas, with multiple tumors affecting the individual fascicles along the length of these major nerves. There were no overt clinical or imaging features that would indicate a concern for malignant transformation of the tumors. Additional biopsy specimens and surgery were not recommended, because tumor debulking or resection would have resulted in neurological deficit. Surgery was also not thought to have a favorable chance of improving neuropathic pain because the patients’ lower limb pain syndromes could not be localized to a focal area. These two patients were treated pharmacologically at a pain clinic, and were advised to continue with serial clinical and imaging examinations throughout their lives under the direction of a neurofibromatosis clinic. Neurological function in these two patients did not change over 2 years,
Fig. 5. Case 1. Intraoperative photographs. A: Through the anterior approach to the pelvis, the neural components of the lumbosacral plexus (protected in vasoloops) have been dissected off the tumor capsule (asterisk). B: Through the posterior approach to the buttock, a segment of tumor (asterisk) can be seen penetrating the gluteus maximus superficially. The sciatic nerve is encircled in vasoloops. C: Deeper dissection in the posterior exposure allows safe resection of the tumors that are separate from the sciatic nerve (large tumor with asterisk). D: The large dumbbell-shaped tumor (asterisk) is being delivered through the sciatic notch as seen from the posterior exposure.

Fig. 6. Case 2. Intraoperative photographs. A: Right-sided sciatic notch dumbbell-shaped tumor resection performed simultaneously through transabdominal and transgluteal exposures. The combined collaborative intrapelvic and extrapelvic approaches allow safe exposure of the sciatic notch. B: After the tumor has been resected from the pelvis, additional tumor mass is dissected from the posterior buttock exposure; the sciatic nerve is free from tumor. C: The sciatic nerve at the level of the sciatic notch (arrow) is seen from the posterior approach. D: Resected specimens.
and their pain was controlled reasonably successfully without surgical intervention.

Discussion

Lesions within the sciatic notch have the capability and the capacity to grow extremely large and form extensive dumbbell-shaped masses, often before producing clinical symptoms or neurological findings. Surgery has proven formidable for these tumors, and demanded the need for combined operative exposures because of the tumor’s size and the difficult anatomical relationships between the tumors and the sciatic nerves.

Although we recognize the current controversies in surgical indications as well as the limitations in distinguishing benign from malignant lesions both clinically and using imaging, we readily appreciate the utility of high-resolution MR imaging in the overall management of sciatic notch tumors in patients. This case series demonstrates that with high-resolution MR imaging, one can identify tumor and sciatic nerve relationships even in complex sciatic notch dumbbell-shaped tumors, with careful inspection of the imaging features as described. These anatomical relationships as seen on multiple neuroimages may allow surgeons to predict preoperatively if they can maintain sciatic nerve integrity and postoperative function if complete resection is performed, potentially avoiding unnecessary, invasive, and/or injurious surgery. This method of preoperative imaging also has implications for resection of the more common neurogenic or nonneurogenic tumors involving the sciatic notch that do not extend into the pelvis (Fig. 9). In these cases, in which the masses are localized to the sciatic notch, definitive identification of the relationships of the sciatic nerve to the mass will similarly assist in planning operative interventions and in predicting outcomes.

Conclusions

We believe that the integration of advanced imaging is an important component of a multidisciplinary surgical team approach to the comprehensive evaluation and treatment of patients with sciatic notch dumbbell-shaped tumors. This imaging technique allows a distinction between tumor and nerve and can help predict a tumor’s resectability. Even when these tumors are of a neural origin, they seem to arise from small branches or fascicles (more frequently than previously thought) rather than the main sciatic nerve along

Fig. 7. Case 1. Immediate postoperative photographs of the patient standing on her heels (A) and toes (B).

Fig. 8. Case 4. Fat-saturated T2-weighted coronal (A) and axial (B) MR images. A: In contrast to the MR images of the first three patients (see Figs. 1–4), this patient has innumerable neurogenic tumors directly involving the vast majority of fascicles of the sciatic nerve complexes along their courses, from the lumbosacral plexuses through the sciatic nerves down the legs. B: Image showing the multifascicular involvement of both sciatic nerves at the level of the ischial tuberosity. Note that the tumors involve both femoral nerves as well.
which they track. It appears that in patients with extensive unilateral sciatic notch dumbbell-shaped tumors, safe and complete resection may be predictable and achievable in selected cases.

References


