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TRANSFORAMINAL APPROACH IN SMA PATIENTS: CAUSE OF NERVE INJURY OR TREATMENT OPTION? A CASE REPORT

Ronay Bozyel Aksin, MD[1], Savas Sencan, MD[1], Erhan Biyikli, MD[2], Serdar Kokar, MD[1], and Osman Hakan Gunduz, MD[1]

Background: Administering intrathecal nusinersen to patients with spinal muscular atrophy (SMA) is commonly done under fluoroscopic guidance, and the use of the transforaminal intrathecal route has also been reported to be successful without major complications. However, this case report presents a patient who developed radicular neuritis following a transforaminal administration of nusinersen.

Case Report: A 28-year-old patient with SMA type 2 and severe scoliosis experienced persistent back and leg pain after a transforaminal intrathecal injection. Lumbar magnetic resonance imaging revealed contrast enhancement of the left L4 nerve root, suggesting neuritis. Despite medical treatment, the patient's symptoms did not improve significantly. As an alternative, a transforaminal epidural steroid injection, a method used commonly for radicular pain, was administered. After the procedure, the patient's pain was markedly alleviated.

Conclusion: This case highlights the diagnosis and management of a rare iatrogenic complication associated with transforaminal access and emphasizes transforaminal epidural steroid injection as a potential treatment option in similar clinical scenarios.

Key words: Case report, spinal muscular atrophy, intrathecal, lumbar puncture, epidural steroid injection

BACKGROUND

Spinal muscular atrophy (SMA) is a hereditary disorder characterized by progressive neurodegeneration of the second motor neurons in the spinal cord due to mutations in the survival motor neuron (SMN1) gene (1). Three disease-modifying therapies for SMA have been approved by the United States Food and Drug Administration (FDA). Nusinersen and risdiplam, two of these treatments, enhance the splicing of SMN2 to produce full-length SMN protein. The former medication is administered intrathecally, and the latter is administered orally. Onasemnogene abeparvovec is a one-time intravenous gene transfer therapy approved for children under 2 years of age (2).

Patients with SMA frequently develop scoliosis, with nearly 100% of those who have type 2 or type 3 of the disorder exhibiting the condition (3). In some studies, the lifetime probability that individuals will require spinal fusion and instrumentation is as high as 80% in patients with SMA types 1c and 2 and 40% in patients with SMA type 3 (4). Spinal fusion caused by rotoscoliosis in patients with nonambulatory SMA complicates the traditional methods of intrathecal intervention, since posterior spinal elements or the presence of implants can alter intrathecal access (5). As a result, lumbar puncture (LP) under fluoroscopic guidance is frequently preferred when conventional blind methods are not

From: [1]Department of Physical Medicine and Rehabilitation, Division of Pain Medicine, Faculty of Medicine, Marmara University, Istanbul, Türkiye; [2]Department of Radiology, Faculty of Medicine, Marmara University, Istanbul, Türkiye

Corresponding Author: Ronay Bozyel Aksin, MD, E-mail: ronaybozyel@gmail.com
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feasible. In certain patient groups, such as those with SMA, previous fusion surgery, or ankylosing spondylitis, the posterior interspinous puncture approach can be challenging due to alterations in vertebral anatomy (6). While the interspinous approach is frequently used with fluoroscopy, studies have indicated that the transforaminal approach can be performed safely as an alternative (5,7). Despite this information, the present case report presents a spinal nerve root injury in an SMA patient who received an LP through the transforaminal approach. The aim of this report is to contribute to the literature regarding the management of this serious potential complication.

CASE PRESENTATION

A 28-year-old female patient diagnosed with SMA type 2 was under follow-up in the neurology clinic and received intrathecal nusinersen therapy. On physical examination, the patient's extremities appeared atrophic, with muscle strength graded at 4/5 in the bilateral upper extremities and at 3/5 in the bilateral lower extremities. Deep tendon reflexes were absent, and the patient was nonambulatory, requiring a wheelchair for mobility. On this patient, previous LP procedures had been performed under fluoroscopic guidance with sedoanalgesia.

The patient was prepared for the procedure appropriately, with skin antisepsis performed and sedation administered with the assistance of an anesthesiologist. During the LP performed most recently to this procedure, the interlaminar approach was unsuccessful. Because the literature reported that the transforaminal approach was safe to use, a decision was made to proceed with it. Intrathecal nusinersen was administered via the transforaminal approach, as previously described, under fluoroscopic guidance. After the cerebrospinal fluid (CSF) flow was confirmed, 5 mL of CSF was collected with the assistance of a neurologist, followed by a slow injection of 5 mL of nusinersen. Approximately 2 hours after the effects of the sedoanalgesia wore off, the patient reported severe pain, numbness, and a burning sensation in the lower back and left thigh, which was consistent with neuropathic pain. Upon repeated examination, no loss of muscle strength was observed. The severity of the patient's pain, as measured on the Numeric Rating Scale (NRS), was 10/10. Initial treatment with NSAIDs (Ethodolac 2 x 400 mg) and tramadol (3 x 50 mg) provided the patient with only 30% relief for 2 hours before the pain returned. Given the neuropathic nature of the pain, gabapentin (3 x 300 mg) was added first, followed by pregabalin (2 x 75 mg). However, the patient was unable to tolerate either medication due to dizziness and nausea. Contrast-enhanced lumbar magnetic resonance imaging (MRI) revealed contrast enhancement in the left L4 nerve root, which was interpreted as iatrogenic neuritis (Fig. 1). Approximately 20 days later, the radiculopathy symptoms persisted despite ongoing medical treatment. The patient was subsequently hospitalized for further management.

Since medical therapy had not been effective for the patient, a left L4-L5 level transforaminal epidural steroid injection (TFESI) under fluoroscopy via a subpedicular approach was planned. The patient was placed in the prone position, with a pillow set under her abdomen to reduce lumbar lordosis. The injection site was cleaned and covered with a sterile drape. For clear visualization of the L4 foramen, the fluoroscopy device was positioned at oblique (0-30°) and caudal angles (0-15°). After the patient's skin and subcutaneous tissue were numbed, the tip of a 22-gauge spinal Quincke needle was slowly advanced into the L4 foramen under intermittent fluoroscopic imaging. After the required depth was confirmed through a lateral view, 1-2 mL of contrast dye (300 mg/50 mL iohexol) was injected. Epidural spread without vascular leakage was observed (Fig. 2), and 5 mL of a drug mixture (12 mg of dexamethasone, 1 mL of 0.5% bupivacaine, and 1 mL of saline) were injected. One hour after the procedure, the patient's NRS score was 1/10. No adverse effects were observed, so the patient was discharged after 2 hours, with recommendations. At the third-week and third-month follow-ups, the NRS score was 0/10, and the patient no longer needed analgesic medications.

DISCUSSION

The typical complications of any LP include headache, CSF leakage, bleeding, and nerve root injury. However, in transforaminal lumbar puncture (TFLP), the possibility of puncturing the intra-abdominal and retroperitoneal organs, including the kidneys, intestines, aorta, and other vessels, is an additional concern (5). In a case series that compared TFLP to other techniques, no major complications were reported, and only 3 minor complications occurred (5). In another study that included 77 cases wherein the transforaminal approach was used for intrathecal nusinersen administration, no major complications were reported except for one case of post-dural puncture headache that required an epidural

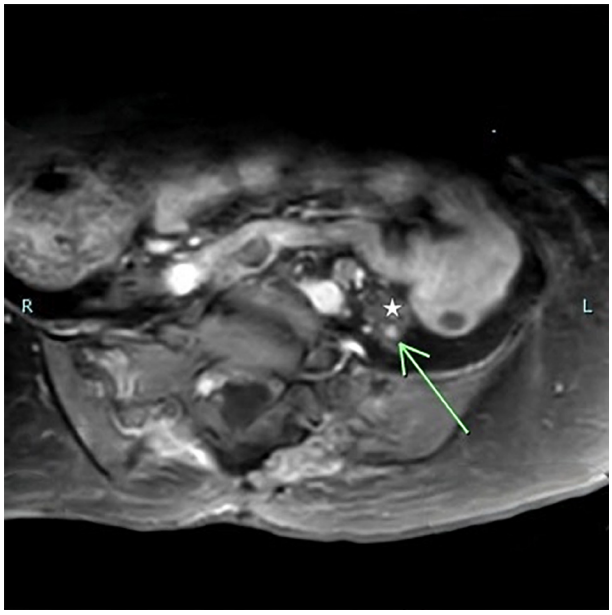

Fig. 1. The enhancing L4 nerve root is seen on the contrast-enhanced T1-weighted MRI sequence (indicated by the tip of the green arrow).
Asterisk: Psoas muscle.

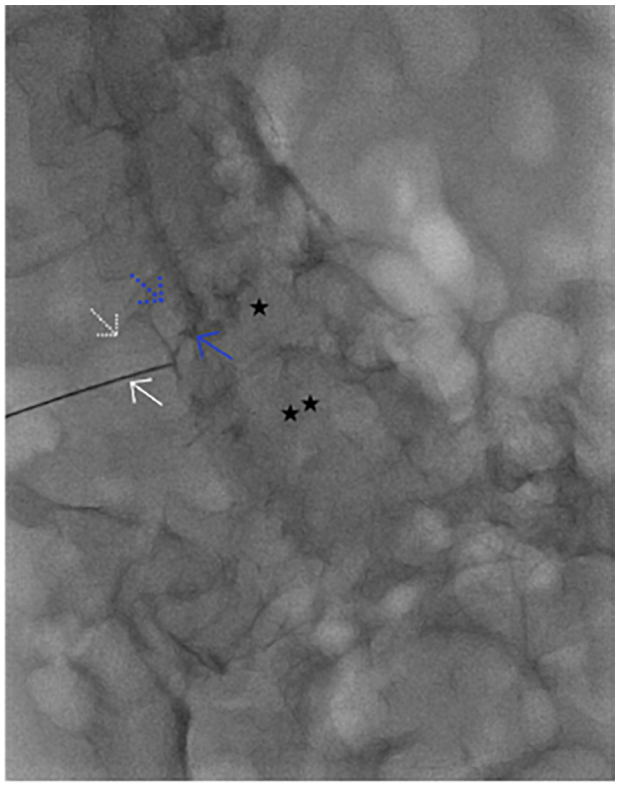

Fig. 2. Under fluoroscopic guidance, after confirming the required depth, 1-2 mL of contrast dye (300 mg/50 mL iohexol) was injected, demonstrating epidural spread along the L4 nerve root without vascular leakage (indicated by the tip of the solid blue arrow).
Solid white arrow: Procedure needle.
Dashed blue arrow: Pedicle of the L4 vertebra.
Dashed white arrow: Transverse process of the L4 vertebra.
Black single asterisk (*): L4 vertebra corpus.
Black double asterisk (**): L5 vertebra corpus.

blood patch (7). Radiculopathy was reported in 3 (18%) of the 17 TFLP procedures performed on 2 patients. That complication, which occurred only when 20-gauge needles were used, was temporary, resolving before discharge. No permanent postprocedural radiculopathy or other complications were observed (5). Another series also reported a case of radiculopathy that resolved with conservative treatment after a transforaminal approach (6). In contrast to the cases reported in previous studies, this present case exhibited prolonged radiculopathy symptoms and a lack of response to conservative treatment. Those issues could be attributed to increased nerve irritation resulting from the abnormal foraminal anatomy associated with advanced scoliosis (5,6). Unlike cases in which nerve root irritation was linked to thick needle diameter, the irritation in this present case was unlikely to be related to needle size, since a thinner spinal needle (22G spinal Quincke needle) was used (5).

The transforaminal approach was selected due to the failure of the interlaminar approach caused by the patient's advanced scoliosis. However, in severe scoliosis, the foraminal anatomy and, consequently, the localization of the nerve root within the foramen may change. Such an alteration might have been another contributing factor to the development of resistant neuritis in this patient, although TFLP has been reported as safe in other studies (5,7). In this case, despite conservative treatment, severe radiculopathy symptoms persisted for nearly 20 days; therefore, advanced therapy was considered. Transforaminal epidural steroid injection (TFESI) was selected primarily because it allowed direct targeting of the L4 nerve root, where neuritis was identified on contrast-enhanced MRI. Although intravenous or oral steroid alternatives were available, the epidural route was preferred to avoid the systemic side effects associated with the administration of high doses of systemic steroids.

Epidural steroid injections can be performed through 3 approaches: the caudal, the lumbar interlaminar,

and the transforaminal. The transforaminal approach provides important advantages, such as its abilities to distribute a higher amount of injectate into the anterior epidural area and deliver the maximum amount of injectate directly into the targeted area (8). TFESI may exert its effect through the anti-inflammatory and neural membrane stabilization effects of the steroid injection, increased blood flow of the ischemic spinal root due to the local anesthetic agent, and removal of cytokines due to the washout effect of the injection material (9). The effectiveness of TFESI in this case, in which neuritis was identified, may be attributed to the technique's aforementioned mechanisms, particularly its anti-inflammatory effects. In addition, TFESI has been shown to reduce not only nociceptive pain but also neuropathic pain in patients with lumbar radiculopathy. These findings are consistent with the prominent neuropathic symptoms observed in this patient and the marked clinical improvement after the TFESI (9).

In this case, no complications were observed after the injection, and mid-term pain relief was achieved. These results align with previous studies' reports that TFESI is a safe and effective treatment for radicular pain (8,9). The limitations of this case include the potential impact of sedoanalgesia on nerve injury and the inability to adequately assess the patient's response to medical therapy.

Intrathecal nusinersen therapy has been administered continuously to the patient in this case for approximately 2 years. To avoid repeated LPs, risdiplam—administered orally—may be a reasonable alternative. However, this decision should be made after formulating an individualized treatment plan that considers the patient's age, SMA type and stage, motor function status, pulmonary and bulbar functions, and reimbursement options. A previous study showed that switching from nusinersen to risdiplam was associated with a favorable safety profile and the preservation of motor function (2).

In this case, an iatrogenic nerve injury that presented with radiculopathy symptoms following a transforaminal intrathecal approach was encountered. Although some studies have reported short-term radicular pain that resolved before discharge or with conservative treatment, no prior reports have described cases resistant to conservative management. To the best of our current knowledge, this is the first reported case of radicular pain resulting from spinal nerve root injury that was managed successfully with TFESI. Accordingly, this case report may provide a valuable contribution to the existing literature.

CONCLUSIONS

The possibility of spinal nerve root injury should not be ignored in applications of intrathecal nusinersen that use the transforaminal approach. This potential complication may be related to the changes in foraminal anatomy caused by advanced scoliosis in patients with SMA. For SMA patients who are unresponsive to conservative treatments, TFESIs should be considered as a safe and effective treatment option for radicular pain due to spinal nerve root injury.

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