Case Report
Penetration of a Cervical Radicular Artery During a Transforaminal Epidural Injection

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Abstract
Background. Inadvertent cannulation or penetration of the cervical radicular arteries during cervical transformaminal epidural injections (TFESIs) is a serious clinical risk, and purportedly, the cause of possible spinal cord injury sustained during this procedure.

Case. Here, we present a case of inadvertent intravascular penetration of a cervical radicular artery during a C5–6 TFESI and demonstrate the best image capture to date of direct ramification of a cervical radicular artery into the anterior spinal artery.

Conclusion. This observation reinforces the need for contrast injection and real-time digital subtraction fluoroscopy during cervical TFESIs for the prevention of spinal cord injury and fatalities.

Key Words. Cervical Radicular Arteries; Cervical Transformaminal Epidural Steroid Injections; Spinal Cord Injury; Cervical Spine

Introduction
Cervical transformaminal epidural steroid injections (C-TFESIs) are an adjunct to the nonsurgical management of radicular pain, providing effective pain relief for patients with documented cervical radicular pain [1,2]. Relief from radicular pain purportedly results from the injection of steroids near the exiting nerve root in the immediate vicinity of inflammation, subsequently suppressing the inflammatory response [3]. Although a C-TFESI is a technically challenging technique, the reported incidence of complication is small and can include trauma to the spinal nerve, dural puncture, and possible infections [4]. Multiple recent studies have raised safety concerns regarding the more devastating complication of spinal cord vascular injury, which can result in infarction, anterior spinal artery syndrome, and possible death [5,6]. The prevalence of intravascular penetration at this cervical level is postulated to arise from the wide variation in the anatomic location of the cervical arteries and considered to occur through unintentional cannulation during C-TFESIs [7,8].

Brouwers et al. [5] first described the cervical anterior spinal artery syndrome after infarction of the spinal cord during a diagnostic blockade of the right C6 nerve, presumably due to penetration of a cervical radicular artery and impaired perfusion. In a later study, Baker et al. [6] showed that the cervical radicular arteries did in fact give rise to smaller branches that passed medially from the intervertebral foramen and terminated in the field of the spinal cord. Potential cannulation of a cervical radicular artery is demonstrated to be a real clinical phenomenon. Here, we present the best documentation and image capture to date in the literature of a cervical radicular artery ramifying into the anterior spinal artery of a live patient, receiving a left C6-level C-TFESI.

Case Study
A 49-year-old man presented with a two-month history of intermittent severe neck and shoulder pain radiating down the left arm and tingling in the left hand, diagnosed to be radicular in nature. A magnetic resonance imaging (MRI) described widespread bone and disc degenerative change, including reduction in space height and endplate osteophyte at C5/6 and C6/7, slightly to the left of midline producing some cord and left C6 nerve root compression. Since referral to the clinic, the patient had undergone a successful TFESI 8 months prior, providing the patient with 6 months of significant pain relief, and a subsequent trial interlaminar C7–T1 block, which proved unsuccessful.

On the day of question, under live C-arm fluoroscopic visualization, using posterior anterior and oblique views, the 25-g, 2.5-inch spinal needle with a bent tip was correctly placed into the upper and posterior aspect of the left C5–6 foramen. Using a direct posterior view and
anterior spinal artery by the cervical radicular artery. Cervical radicular artery with contrast, under digital subtraction fluoroscopy; and (d and e) ramification of the cervical radicular artery at the C6 level directly feeding into the anterior spinal artery, tracking the vessel on to the spinal cord and then reinforcing both cephalically and caudally. In view of the fact that the artery had been penetrated, no steroid was injected on this occasion and the patient suffered no ill effects. Since this occasion, the patient has undergone a successful C-TFESI, in which intravascular penetration did not occur and significant pain relief was obtained.

Discussion

This case reinforces the observation that despite the correct technique being used and the fact that the patient had successfully received this treatment previously, accidental intra-arterial injection can still occur during C-TFESIs. In this case, intra-arterial injection was evident angiographically, and the direct feeding of a cervical radicular artery into the anterior spinal artery was recorded by digital subtraction. Furthermore, even though the blood aspirations proved negative, cannulation of the artery still occurred, supporting the view by Furman and colleagues, that while a positive blood aspiration has a 97.9% specificity, it has a sensitivity of only 44.7% [9]. The varying incidence of intravascular penetration is proposed to arise from multiple factors, including the size, sharpness, and positioning of the needle within the foramen, rate of injection, and vascular engorgement [10]. In contrast to digital subtraction, commonly employed intermittent fluoroscopic guidance techniques often fail to recognize intravascular uptake due to rapid washout, thus, increasing the possibility of venous and arterial injection of steroids [10].

The injection of steroidal particulate into the anterior spinal artery can lead to catastrophic infarction of the spinal cord and anterior spinal artery syndrome, with the latter diagnosed by complete motor paralysis with the loss of pain and temperature sense but sparing of position, vibration, and motion sense in the posterior columns [5,11,12]. Previously reported cases have resulted in complications ranging from paraplegia to death [3–5,13]. Given that, great emphasis has been put on understanding the physical properties of corticosteroids, such as water solubility and particle size due to injected particulate steroids acting as an embolus, as recently exemplified in a porcine study whereby injected particulate steroids caused severe neurological deficits [14]. In a study by Dreyfuss and colleagues [15], a comparison between particulate triamcinolone and nonparticulate dexamethasone resulted in no statistical or clinical difference in pain relief effectiveness. Therefore, spinal cord infarction could theoretically be prevented through the use of nonparticulate agents instead.

Opponents of C-TFESIs advocate abandoning this technique in preference for injections via the interlaminar route [16]. However, reports have suggested that the interlaminar approach also has associated risks including possible epidural hematoma, injection into the Batson’s plexus, and spinal cord trauma [17]. Moreover, a direct comparison between 4,389 interlaminar and 1,579 transforminal injection found no significant variation between groups with regard to minor or serious complications [18]. Therefore, with continued use, several recommendations to reduce the risks associated with C-TFESIs include the standardization of injecting techniques with advanced training of surgeons and the use of digital subtraction angiography, along with real-time fluoroscopy, for the detection of intravascular penetration [10,19]. While digital subtraction techniques are not universally available to all spinal injectionists and have associated disadvantages such as increased radiation exposure to the patients, it would seem prudent that this adjunct be used were available due to the added resolution of vascular structures and improved prevention of fatal complications during C-TFESIs.

Conclusion

This case report brings to light the very serious complications of C-TFESI without the addition of digital subtraction fluoroscopy along with the anatomical occurrence of a cervical radicular artery at the C6 level directly feeding into
the anterior spinal artery. The capturing of these images demonstrate that live fluoroscopy and digital subtraction should be considered mandatory for C-TFESIs as intermittent fluoroscopy may frequently miss intravascular uptake due to rapid washout, resulting in the inadvertent injection of steroidal particulate matter into the spinal arteries, leading to catastrophic outcomes.

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References


