

Original Article

Neurological complications of lumbar and cervical dural punctures with a focus on epidural injections

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Abstract

Background: Various types of lumbar dural punctures may contribute to neurological injury. The etiologies of dural injury include; inadvertent dural punctures due to epidurals placed for labor anesthesia, epidural steroid injections (ESI/transforaminal TESI; approximately 9 million ESI performed in the US per year), deliberate placement of intradural pain devices, and spontaneous cerebrospinal fluid (CSF) fistulas. Resulting neurological complications may include; spinal headaches/intracranial hypotension, subdural hematomas, and 6th nerve cranial palsies. Furthermore, uniquely in the cervical spine, inadvertent cervical dural punctures attributed to cervical ESI (CESI) may lead to intramedullary spinal cord injuries (e.g. resulting in monoparesis to quadriplegia) or spinal cord strokes due to intravascular/vertebral artery injections.

Methods/Results: In 8 studies, inadvertent lumbar dural punctures contributed to intracranial hypotension, subdural hematomas, and double vision/6th cranial nerve palsies. In 5 of the 6 studies, inadvertent dural punctures occurring during CESI were responsible for intramedullary spinal cord injuries, or direct intravascular/vertebral injections resulting in monoplegia/quadruplegia.

Conclusions: Inadvertent lumbar dural punctures led to multiple neurological complications including intracranial hypotension, subdural hematomas, and double vision/6th cranial nerve palsies. Uniquely, inadvertent cervical dural punctures solely due to CESI directly resulted in intramedullary spinal cord injuries or cord stroke and monoplegia/quadruplegia attributed to intravascular/vertebral artery injections. The potential neurological risks/complications/adverse events attributed to lumbar and cervical ESI must be taken into account before spine surgeons and others order these procedures.

Key Words: Cervical, complications, epidural steroid injection, lumbar, monoplegia, new deficit, quadriplegia, risks, sixth cranial nerve palsy

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INTRODUCTION

Various types of lumbar and cervical dural punctures result in significant neurological injury. In the lumbar spine, lumbar dural punctures may be attributed to; inadvertent epidural injections for labor/anesthesia, deliberate epidural steroid

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injections (ESI) [(lumbar LESI)/transforaminal TFESI]), direct placement of intradural/intrathecal pain devices, deliberately when placing intradural pain devices, or in rare instances, spontaneously. Neurological complications attributed to these lumbar punctures include; spinal headaches/intracranial hypotension, subdural hematomas, and 6th cranial nerve palsies/double vision. Cervical dural punctures solely attributed to cervical ESI (CESI), uniquely risked monoparesis/quadruplegia due to intramedullary spinal cord injections/injury, or stroke due to intravascular vertebral artery injections. The neurological complications/adverse events (AE)/risks of lumbar and cervical ESI must be carefully considered when spine surgeons and other specialists order these procedures often for minimal spinal complaints.

LUMBAR SPINAL EPIDURAL INJECTIONS IN US

Look at how often non FDA (Food and Drug Administration) approved ESI are being performed in the U.S. Manchikanti *et al.* estimated that approximately 9 million epidural steroid injections are performed in the US per year.^[15] They examined the frequency of LESI performed in the US Medicare population between 2000 and 2014, and found it increase by 99%; 36.2% were lumbar interlaminar or caudal epidural injections. In addition, over this period, there was a 609% increase in lumbar transforaminal ESI. Bhatia *et al.* assessed the data regarding the efficacy of LESI based on 8 randomized

controlled trials; 366 patients received TFESI with steroids, whereas 405 had TFESI with a local anesthetic alone without steroids.^[2] Although the TFESI steroids afforded “moderate” analgesia at 3 months, they had no impact on “physical disability or incidence of surgery”. In short, they had no long-term documented efficacy. Furthermore, there were marked variations in the quality of meta-analysis data, and they recommended better “well designed, large, randomized studies” be performed in the future. An additional notation by Yang *et al.* was that lumbar ESI performed within 3 months of one-level spine surgery correlated with an increased risk of wound infection (e.g. 0.8–1.7% of patients).^[21] They, therefore, recommended that more than 3 months elapse between LESI and single level spine procedures. Another concern is that recent ESI (e.g. within 3 months of surgery) increase the incidence of inadvertently puncturing the dura in patients with severe stenosis/ossification of the yellow ligament.

INADVERTENT LUMBAR INTRADURAL INJECTIONS OCCURRING DURING ATTEMPTED EPIDURAL INJECTIONS FOR ANESTHESIA DURING LABOR AND DELIVERY

Inadvertent lumbar dural punctures resulted in intracranial hypotension, subdural hematomas, and/or 6th cranial nerve palsies in 4 patients undergoing

Table 1: Lumbar epidural spinal injections and inadvertent dural puncture (DP) lead to intracranial hypotension, subdural hematomas, and/or cranial nerve palsies

Author Reference	Number Patients	Procedures	Findings	Morbidity	Treatment
Woodward ^[20] 1994	Inadvertent DP for labor	Epidural for OB-GYN/labor	Treated with EBP	48 hours later persistent headache/neck pain	Success with Repeat EBP
Velarde ^[18] 2000	Deliberate DP 58 yo M	Placement of intradural device for drug Treatment	Persistent CSF leak: day 4 Postural headaches	Left 6th N Palsy MR posterior SDH	Treated successfully with EBP
Davies ^[9] 2001	39 yo F	Epidural for OB-GYN/labor	20 hours later; Postural headache EBP-48 hours	14 days later headache recurred MR- left SDH Dysphasia RUE sensory loss	Craniotomy for SDH
Ferrari ^[10] 2001	Inadvertent DP for labor 26 yo F	Epidural for OB-GYN/labor	Post-procedure day 6-EBP	Increased Postural headaches-vomiting CT Brain day 9	Small SDH No surgery
Arcand ^[11] 2004	Unintentional DP 40 yo F	Bilateral 6th nerve palsies within 24 hours	Typical for lumbar DP	Treatment; EBP within 24 hours	Diplopia resolved 36 days later
Khemka ^[12] 2006	Spontaneous DP 43 yo M	Postural headaches Left 6th Nerve palsy	MR: R dural enhancement Downward displaced brain stem	LP confirmed spontaneous intracranial hypotension	Managed with EBP
Corbon-nois ^[8] 2010	Inadvertent DP	Epidural for OB-GYN/labor	MR showed Intracranial hypotension	Double vision Postural headache	Immediate treatment EBP

SDH: Subdural Hematoma, OB-GYN: Obstetrics/Gynecology, MR: Magnetic Resonance Imaging, LP: Lumbar Puncture, ESI: Epidural steroid injection, M: Male, F: Female, yo: year old, CSF: Cerebrospinal Fluid Leak, EBP: Epidural Blood Patches, DP: Dural Puncture

attempted epidural spinal injections performed to deliver anesthesia during labor/delivery [Table 1].^[8-10,20] The first patient developed intracranial hypotension alone, whereas the second patient exhibited both intracranial hypotension and double vision; both were successfully treated with epidural blood patches (EBP).^[8,20] The third patient was a 39-year-old female who developed postural headaches 20 hours after her epidural injection; she required an EBP (epidural blood patch) 48 hours post-injection.^[9] However, 14 days later, with headaches, expressive dysphasia, lack of coordination, and sensory loss in the right arm, she underwent an MR scan that documented a left SDH; she required a craniotomy, for which she required a craniotomy. The fourth patient, a 26-year-old female developed postural headaches 6 days after an epidural; she was first treated with an EBP.^[10] Nine days later, with vomiting and continued postural headaches, the brain CT showed a small hemispheric SDH that did not require surgery.

THREE CASES OF DOUBLE VISION/6TH CRANIAL NERVE PALSIES DUE TO DELIBERATE, INADVERTENT, OR SPONTANEOUS LUMBAR DURAL PUNCTURES

Three cases of double vision/6th cranial nerve palsies were variously attributed to deliberate, inadvertent, or spontaneous lumbar dural punctures [Table 1].^[1,12,18] In the first case, a 58-year-old male developed intracranial hypotension/postural headaches and a left 6th cranial nerve palsy 4 days after placement of an intrathecal pain device (e.g., intradural/subarachnoid drug-delivering device for chronic back pain).^[18] When the brain MR showed a small posterior SDH, he required an EBP for symptom resolution. In the second case, a 40-year-old female developed bilateral 6th nerve palsies 24 hours after an “unintentional dural puncture;” this was immediately treated with an EBP, and her diplopia resolved 36 days later.^[1] In the third case, a 43-year-old male spontaneously developed a left 6th cranial nerve palsy accompanied by postural headaches/intracranial hypotension that correlated with MR scan findings of dural enhancement/downward displacement of the brain stem; for the intracranial hypotension, the patient was successfully managed with an EBP.^[12]

CERVICAL EPIDURAL SPINAL INJECTIONS

Bureau *et al.* noted the “catastrophic complications” that may be seen with cervical ESI (BUREAU 2014).^[4] To minimize these risks, they designed a 4-week randomized double blind controlled study to compare the safety/efficacy for cervical intrafacet steroid injections (noted to have fewer AE (Adverse Events))

vs. TFESI. Twenty-eight patients had facet injections alone vs. 28 who underwent cervical CT-guided TFESI; facet injections significantly reduced the pain score by 45.3% vs. TFESI that showed a “nonsignificant” pain score reduction of just 9.8%. Furthermore, cervical facet injections effectively managed cervical radiculopathy use; and were a safer option than TFESI. The study by Wald *et al.* discussed/compared the safety/efficacy of CT-guided TFESI in the cervical spine using a posterior approach, but demonstrated no significant differences in pain relief when compared with other approaches.^[19]

FOUR CERVICAL EPIDURAL STEROID INJECTIONS RESPONSIBLE FOR INTRAMEDULLARY SPINAL CORD INJURIES

Four patients in 3 studies developed monoplegia/quadruplegia following intramedullary spinal cord injections occurring during cervical ESI (CESI) [Table 2].^[7,11,13] The first two patients developed irreversible intramedullary cord damage after these injections.^[11] The third patient, a 55-year-old-male, was immediately quadriparetic following a fluoroscopically-guided cervical transforaminal (TFESI) utilizing Iohexol; the MR study documented an intramedullary injection of the dye that directly correlated with his deficit.^[13] The fourth patient, a 29-year-old female, had a CESI performed with Depo-Medrol at the C5-C6 level; she acutely developed a left-hemiparesis/hemisensory deficit that clearly corresponded with the C5-C6 MR-documented location of an intramedullary cord injection.^[7]

TWO CASES OF CERVICAL EPIDURAL STEROID INJECTIONS RESULTING IN INTRAVASCULAR VERTEBRAL ARTERY INJECTIONS AND SPINAL CORD STROKES

In two cases, CESI resulted in inadvertent intravascular vertebral artery injections, responsible for to irreversible quadriparesis/quadruplegia [Table 2].^[3,14] In the first case, a 53-year-old male with multiple cervical disc “protrusions” underwent a left C5-C6 TFESI.^[14] Within 10 to 15 minutes, he developed weakness in his left arm and both legs. Although the first emergent MR showed no changes, at 24 hours, the subsequent MR revealed a patchy increased cord signal extending from the odontoid to the C4-C5 level. This was consistent with diffuse vascular cord infarction, and correlated with the patient’s incomplete quadriplegia. The second case involved a patient undergoing a C6-C7 CESI who immediately developed respiratory arrest/irreversible quadriplegia due to an inadvertent intravascular/vertebral injection resulting in a spinal cord stroke.^[3]

Table 2: Cervical epidural steroid injections (CESI) result in intramedullary cord lesions, intravascular injections, and 6th cranial nerve palsies

Author Year	Number Patients	Procedures	Findings	Morbidity	Treatment
Hodges ^[11] 1998	2 CESI for disc disease yielded Intramedullary cord damage	Increased pain/quadripareisis first day	Post CESI MR scans showed intramedullary cord damage	Fluoroscopy not avoid intrathecal/Intramedullary ESI injections	Advocated cervical ESI under local anesthesia
Simon ^[17] 2002	39 yo F C1-C2 Myelogram Intramedullary Injection	Immediate right face/neck/arm pain	RUE Monoparesis paresthesias hyperreflexia	Myelogram-CT documented Intramedullary contrast and cord swelling	Treated with high dose steroids:
Ludwig ^[14] 2005	53 yo Left C6 TFESI -I discs Intravascular injection	10-15 minutes later; weakness LUE/both LE quadripareisis	1 st MR; normal MR 24 Hours later; Increased T2 cord signal C0-C4/C5 l	Incomplete quadriplegia-Intravascular injection	Diagnosis; Cord Infarction
Bose ^[3] 2005	CESI C6-C7 Intravascular Injection	Done by fellowship trained pain specialist	Outpatient Surgicenter Used C-arm Fluoroscopy	Immediate quadriplegia respiratory arrest Intravascular Injection	6 hours/6 mos MR-confirmed Vascular event
Lee ^[13] 2008	55 yo M Neck LUE pain-radiculopathy C6-7 TFESI Fluoroscopy Intramedullary Injection	MR: Direct intramedullary injection of Iohexol	Immediate quadripareisis with contrast in cord Deficit at 4 hours RUE/LE recovered but LUE plegic	MR confirmed Intramedullary Injection: cervical cord contrast and air	12 months later LUE remained plegic
Cohen-Addad ^[7] 2012	29 yo F Cervical ESI Used Depo-Medrol C5-C6 Intramedullary Injection	Immediate left hemiparesis motor/sensory deficits	Immediate MR Left cord lesion	Intramedullary Injection MR 2.5 years later showed Wallerian Degeneration	MR Abnormal T2 signal at 4 levels
Carr ^[5] 2016	Cervical ESI Review	Complications Cord Infarction Infection	Acute complications 1.9% out of 19,170 ESI	No major complications, deficits, hemorrhage, epidural clots	Total Adverse Events 1.9%
Schneider ^[16] 2016	Rare AE of Cervical ESI Review	Paralysis and stroke	More common AE are rather minor	Most AE are transient	Rate of AE <1%
Childress ^[6] 2016	Cervical radiculopathy Review	Typically resolves spontaneously	Nonoperative treatment may include CESI	CESI may be helpful	Higher CESI risks of major AE

ESI: Epidural Steroid Injections, MR: Magnetic Resonance Imaging, RUE: Right Upper Extremity, CT: Computed Tomographic Scan, TFESI: Transforaminal Epidural Steroid Injection, LUE: Left Upper Extremity, F: Female, M: Male, yo: year old, LE: Lower Extremities, AE: Adverse Events, CESI: Cervical ESI

ONE CASE OF CERVICAL MYELOGRAPHY LEADING TO AN INTRAMEDULLARY SPINAL CORD INJECTION/QUADRIPLEGIA

A 39-year-old female underwent a C1-C2 myelogram and immediately noted “right-side face, neck, and arm pain and paresthesias” accompanied by right arm weakness/hyperreflexia [Table 2].^[17] The myelo-CT documented an intramedullary spinal cord injection; contrast was seen within the upper cord, resulting in marked cord swelling.^[17] She was placed on a high-dose methylprednisolone protocol, but only showed mild symptomatic improvement.

THREE STUDIES MINIMIZE OR LARGELY DENY COMPLICATIONS OF CERVICAL EPIDURAL STEROID INJECTIONS

Three additional studies minimized or largely denied that significant complications resulted from cervical

ESI [Table 2].^[5,6,16] When Childress and Becker (2016) discussed the use of CESI to manage cervical radiculopathy, they barely acknowledged they “may have higher risks of serious complications.”^[6] Although Carr *et al.* (2016) noted that cord infarction and infection may be potential complications attributed to CESI, they documented “no major complications” (e.g., neurologic deficits, significant hemorrhaging, or epidural hematomas) in their very large series.^[5] Schneider *et al.* (2016) stated CESI rarely resulted in paralysis and stroke, and noted “the more common adverse events were rather minor, generally transient, and mostly occurred at incidences of less than 1%.” [Table 2].^[16] Certainly, these latter studies indicate that complications are either not reported or under-reported in the spine literature.

CONCLUSION

Various types of lumbar and cervical dural punctures result in significant neurological injury. In the lumbar spine,

these may occur during attempted epidural anesthesia for labor/delivery, while performing LESI/TLESI, during placement intradural pain devices, or spontaneously. They can result in intracranial hypotension, subdural hematomas, and double vision/6th cranial nerve palsies. In the cervical spine, all dural punctures were attributed to CESI resulting in monoplegia/quadruplegia directly attributed to intramedullary spinal cord injuries or vertebral artery injections/cord strokes. The neurological complications attributed to lumbar and more notably cervical ESI must be carefully considered when choosing to perform any type of epidural injection, particularly for those with too often, minimal complaints.

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Conflicts of interest

There are no conflicts of interest.

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