Review Article

Major risks and complications of cervical epidural steroid injections: An updated review

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Abstract

Background: Too many patients, with or without significant cervical disease, unnecessarily undergo cervical epidural steroid injections (CESIs). These include interlaminar (ICESI) and transforaminal ESI (TF-CESI) injections that are not Food and Drug Administration (FDA) approved, have no documented long-term efficacy, and carry severe risks and complications.

Methods: Here we reviewed recent reports of morbidity and mortality attributed to the various types of CESIS. Major complications included; epidural hematomas, infection (abscess/meningitis), increased neurological deficits due to intramedullary (quadriparesis/quadriplegia), and intravascular injections (e.g., vertebral artery injections leading to cord, brain stem, and cerebellar strokes). The latter injections leading to strokes were typically attributed to the particulate steroid matter (e.g., within the methylprednisolone injection solution) that embolized into the distal arterial branches.

Results: Complications of cervical CESI/TF-CESI injections producing epidural hematoma, new neurological deficits (intramedullary injections), or intravascular injections resulting in strokes to the cord, brain stem, and cerebellum are often underreported. Interestingly, several other cases involving adverse events of CESI/TF-CESI may now be found in the medicolegal literature.

Conclusions: Cervical epidural injections (e.g., CESI, ICESI, and TF-CESI) which are not FDA approved, provide no long-term benefit, and are being performed for minimal to no indications. They contribute to significant morbidity and mortality, including; epidural hematomas, infection, inadvertent intramedullary cord injections or cord, brain stem, and cerebellar strokes. Furthermore, these injections are increasingly required by insurance carriers prior to granting permission for definitive surgery, thus significantly delaying in some cases necessary operative intervention, while also subjecting patients at the hands of the insurance companies, to the additional hazards of these procedures.
INTRODUCTION

Many patients with even minor cervical complaints without significant magnetic resonance/computed tomography (MR/CT) documentation of significant cervical pathology are increasingly being subjected to high-risk cervical epidural steroid injections (CESIs) [e.g., interlaminar (ICESI) and transforaminal (TF-CESI)]. Major complications of these injections include; epidural hematoma, infection (abscess, meningitis), new neurological deficits (e.g., monoparesis to quadriplegia) due to intramedullary injections, and strokes to the spinal cord, brain stem, and/or cerebellum attributed to intravascular injections among others. Further, these cervical injections are still not approved by the Food and Drug Administration (FDA), and have not been proven to be either safe or effective in the cervical or lumbar spine.

LACK OF FDA APPROVAL OF CERVICAL EPIDURAL INJECTIONS WITHOUT DOCUMENTATION OF SAFETY/EFICACY

Here we reviewed the literature between 2004–2013 and 2017–2018 regarding the severe risks/complications/mortality of CESIs, interlaminar (ICESI), and TF-CESI along with selective lumbar ESI (LESI) and TF-LESI. Further, cervical and lumbar epidural injections are still not approved by FDA as their safety/efficacy have never been established. In 2007, Abbasi et al. recommended performing prospective blinded randomized controlled trials (RCTs) to document such safety/efficacy; to date, none have yet been adequately completed [Table 1]. Further, the severe additionally, the severe complications of these procedures are typically under- or unreported in the spinal literature, and are more likely to be found in medicolegal suits [Table 2].

SUMMARY OF RISKS/COMPLICATIONS OF CERVICAL AND LUMBAR EPIDURAL INJECTIONS 2004-2013

Multiple risk and complications of CESI (ICESI, TF-CESI) were reported between 2004 and 2013. In 2004, Tiso et al. quoted the major morbidity/mortality of TF-CESI that included; paresthesias, hematoma, epidural abscess, meningitis, arachnoiditis, subdural/subarachnoid injections, and intraarterial injections resulting in stroke [Table 1]. Abbasi et al. (2007) documented an overall 0–16.5% frequency of complications from ICESI [Table 1]. In 2013, Epstein further summarized the morbidity/mortality of cervical injections performed by various pain management specialists (e.g. radiologists, physiatrists, or anesthesiologists [Table 1]). Noteworthy, was the lack of training for all three specialists in how to perform a neurological examination, and for the latter two, how to interpret neuroradiological studies (e.g. MR/CT).

SUMMARY OF RISKS/COMPLICATIONS OF CERVICAL AND LUMBAR EPIDURAL INJECTIONS 2017-2018

In 2017, Epstein (2017) again focused on the continued risks/complications of both cervical (CESI, ICESI, TF-CESI) and lumbar (LESI, ILESI, TF-LESI) ESI [Table 2]. It was noted that about 9 million epidural injections are performed per year in the US, and they are still not FDA approved. In five of the six cervical ESI studies that Epstein identified, inadvertent dural punctures (CESI) resulted in intramedullary spinal cord injuries and paralysis, or intravascular vertebral artery injections resulted in strokes (e.g., to the spinal cord/brain stem/cerebellum). Schneider et al. (2018) additionally discussed how CESI contributed not only to intramedullary and intravascular injections, leading to embolic infarcts (e.g., from particulate steroids), but also to hematomas, abscesses, vertebral artery dissections, pain, side effects of steroids, and vasovagal reactions [Table 2].

RISKS OF INTRAMEDULLARY EPIDURAL SPINAL INJECTIONS

Cervical ESIs and rarely high LESIs (e.g., CESI, ICESI, TF-CESI, TF-LESI) may result in inadvertent intramedullary cervical and thoracic/conus cord injuries [Tables 1 and 2]. Landers (2017) presented a patient who, immediately following an ICESI, became quadriplegic due to an intramedullary injection [Table 2]. The authors presented other cases of CESI resulting in intramedullary injections, and recommended that practice guidelines be revised to avoid such injuries in the future.

Key words: Cervical, coma, death, epidural steroid injections, infection, intramedullary, intravascular, paralysis, quadriplegia
Table 1: Summary of articles on CESIs 2004-2013

| Author [ref] Year | Procedures performed | Complications | Complications | Complications |
|-----------------|----------------------|---------------|---------------|---------------|
| Huntoon(1)     | Lumbar TF-ESI attempted Failing | Left L1 TF-ESI 1 mL iopamidol with 5 mL 0.125% bupivacaine and 40 mg triamcinolone | Within 3 minutes irreversible paraplegia | MR high-cord signal |
| Ludwig(1)      | Cervical cord stroke 2005 | 53 yo M Left C6 TF-ESI/Fluoro | 1st MR: Negative | 2nd MR: 24 hours. High T2 cord signal C0-C4/C5/Stroke |
| Epstein(1)     | AE all cervical and lumbar CESI, TF-ESI, LESI, TF-LESI 2013 | Pain management: Radiologists, physiatrists, anesthesiologists | Risks: 6% CSF leak | Risks: 16% Arachnoiditis |
| Abbasi(1)      | Complication Interlaminar CESI (ICESI) 2007 | Review Major AE | 4 Major cerebellar and brain stem strokes | Risks: 11.6% Stroke |
| Scanlon(1)     | TF-ESI 8 Brain and spinal cord Strokes 2007 | Survey American Pain Society | Significant risks AE and neurological injury with TF-ESI | Fatalities: 5 Brain stroke |

ESI: Epidural spinal injections, CESI: Cervical epidural steroid injections, MI: Myocardial infarction, CTPESI: Cervical transforaminal epidural steroid injections, CILES: Cervical interlaminar epidural steroid injection, CEA: Cervical epidural abscess, LUE: Left upper extremity, LE: Lower extremities, FDA: Food and Drug Administration, RCT: Randomized controlled trials, AE: Adverse events

CERVICAL INTRAVASCULAR EPIDURAL INJECTIONS

Several articles identified intravascular CESI resulting in major morbidity/mortality [Table 1]. In 2004, Tiso et al. presented a patient with a C5-C6 disc herniation on MR; following a C5-C6 TF-CESI, he developed a massive cord/brain stem/cerebellar infarct attributed to an intraarterial injection with resultant embolization of particulate steroids [Table 1]. This occurred even after confirming accurate needle placement with biplanar fluoroscopy, after performing several heme-negative aspirations, and utilizing trial injections of contrast. Despite emergent cerebellar decompression, the patient never recovered. In 2005, Ludwig and Burns observed a 53-year-old male who developed left upper and bilateral lower extremity quadripareis 15 min following a left C6 TF-CESI performed under fluoroscopy [Table 1]. Although the first MR showed no intramedullary cord signal changes, the second MR 24 h later revealed a C0-C4/5 intramedullary cord stroke (e.g., patchy high signal intensity in the cord) attributed to an intravascular injection (e.g., embolization of particulate steroids; this resulting in permanent paraplegia). Abbasi et al. (2007) added additional four cases of major cerebellar/brain stem strokes [Table 1]. Scanlon et al. (2007) further questioned, after looking at the incidence of stroke following TF-CESI, whether these procedures were “more dangerous than we think” [Table 1]? They again confirmed the lack of adequate RCTs to establish the safety/efficacy of TF-CESI. Additionally, the reviewed eight cases of brain/spinal cord infarction appearing in the literature, and added four cases of major cerebellum/brainstem infarction. Interestingly, when they surveyed US physician members of the American Pain Society [e.g., 21.4% response rate (287 of 1340)], they identified 78 complications of TF-CESI. These included; 16 vertebrobasilar brain infarcts, 12 cervical spinal cord infarcts, and 2 combined brain/
spinal cord infarcts: 13 of these patients sustained fatal injuries [Table 1]. They observed that TF-CESIs correlated with an unacceptably high incidence of complications that included; intraarterial injections/strokes/embolism (e.g., to the basilar artery, midbrain, pons, cerebellum, thalamus, temporal, and occipital lobes), along with the occasional vertebral artery perforation, dissection, thrombosis, or vasospasm.

### UTILIZING ULTRASOUND TO IDENTIFY VESSELS SURROUNDING C5-C7 CERVICAL NERVE ROOTS PRIOR TO SELECTIVE CERVICAL C5-C7 NERVE ROOT BLOCKS

Lee et al. (2017) utilized ultrasound (US) to document the size/location/number of vulnerable and susceptible perineural blood vessels prior to performing selective nerve root blocks from C5 to C7 (2012–2014) [Table 2].

| Author [ref] Year | #Cervical ESI | Procedures performed | Complications | Complications | Complications |
|-------------------|--------------|----------------------|---------------|---------------|---------------|
| Landers[2] 2017   | Spinal cord injury | Attempted cervical interlaminar ESI | Practice guidelines to avoid these complications | 2 Weeks after IV therapy: MR improved <WBC and<CRP and <neck/back pain | Rapid diagnosis and treatment emphasized |
| Zhang[3] 2017     | Cervical ESI | MR confirmed C6-T8 case Review Treatment: IV vancomycin >4 weeks and imipenem and cilastatin | Rare complication Large lesions require surgery | 7 Hemorrhages | 3 Dural penetrations |
| Smith[4] 2017     | 14,247 Admission over 8 years 1182 CESI 4617 LESI | Lumbar Interlaminar injections 13 required neurosurgery | 0.51% CESI 0.15% LERI 0.09% all neurosurgical admissions | 3 Infections (LESI related) | CESI Intramedullary cord injury, stroke to vertebral |
| Epstein[5] 2017   | AE LESI | AE LESI SDH 6 cranial palsies Hematomas | AE CESI IM injections Strokes, clots, cord/brain stem/vertebral | CESI | 5 of 6 studies; dural punctures with CESI |
| Lee[6] 2017       | Cervical roots sensitive to injury: selective root blocks | 74 patients Cervical radiculopathy Prior to injection | US-guided nerve block 2012-2014 Evaluated vessels around C5, C6, C7 | US identify vessels: surround roots prior to injection | Multiple susceptible vessels: At C5, C6, C7 levels C5 (4), C6 (9), C7 (10) |
| Schneider[7] 2018 | Complication of CESI | Aberrant needle placement Stroke Hematoma Abscess Intramedullary injection | CTFESI Embolic Vertebral injection particulate steroids | CTFESI or CILESI Pain Vasovagal Events |
| Sanders[8] 2018    | Epidural hematoma 79 yo M | ICESI Did not stop 81 mg ASA Prophylaxis for MI | American Society Regional Anesthesia and Pain Medicine Guidelines | Recommend; Hold ASA medications | 5 days before ICESI |

ESI: Epidural spinal injections, CESI: Cervical epidural steroid injections, MI: Myocardial infarction, CTFESI: Cervical transformaminal epidural steroid injections, CILESI: Cervical interlaminar epidural steroid injection, CEA: Cervical epidural abscess, SDH: Subdural hematoma, AE: Adverse events, US: Ultrasound

## HIGH LUMBAR L1 TRANSFORMAMINAL ESI INJECTION/CORD STROKE

In 2004, Huntoon and Matin (2004) identified a 64-year-old male with a history of multiple prior lumbar operations, who underwent a left L1 TF-LESI; it contained 1 mL of iopamidol (Isovue), 5 mL of 0.125% bupivacaine, and 40 mg of triamcinolone [Table 1]. Within 3 min, he was irreversibly paraplegic. The MRI showed a cord infarct (e.g., hyperintense intramedullary cord signal on T2-weighted images) at the T11/L2 level (e.g., conus medullaris). Despite the utilization of high-dose steroids, the patient’s deficit remained fixed.

## INCIDENCE OF HEMORRHAGES DUE TO VARIOUS CERVICAL/LUMBAR EPIDURAL STEROID INJECTIONS

Two studies cited the risks of peri-procedural hematomas in patients undergoing CESI and LERI [Table 2]. Smith et al. (2017), over an 8-year period, identified complications following 1182 ICESI and 4617 ILESI [Table 2]. Thirteen patients required emergency neurosurgery to address; 7
hemorrhages, 3 infections (all after lumbar injections), and 3 inadvertent dural punctures. Notably, six of seven patients developed epidural hematomas despite being managed with current guidelines [e.g., requiring prolonged cessation of anticoagulation \((n = 3)\), or taking only aspirin \((n = 3)\)]. Surgical decompression in all cases fortunately resulted in neurological improvement. In the case study from Sanders et al. (2018), a 79-year-old male continued prophylactic baby aspirin therapy (81 mg) prior to a LESI due to a recent myocardial infarction [Table 2].[8] The patient and his physicians failed to follow the antiplatelet and anticoagulation guidelines of the American Society of Regional Anesthesia and Pain Medicine that required the 81 mg of ASA be held for 5 days before such a procedure. The result was an immediate postinjection epidural hematoma and permanent paraparesis.

**CERVICAL EPIDURAL ABSCESS DUE TO CESI**

Zhang et al. (2017) noted that CESI rarely result in cervical epidural abscess (CEA).[13] In some cases they may be effectively treated with antibiotic therapy alone, but in others, they may warrant operative debridement [Table 2].[13] Their patient had a CESI, and later developed a C6-T8 CEA on MR. The patient was effectively treated with 4 weeks of intravenous vancomycin, imipenem, and cilastatin. Following just 2 weeks of therapy, the patient’s symptoms and laboratory studies improved [e.g., for the latter, the white blood cell count decreased along with the neutrophil count, and C-reactive protein (CRP)]. Three months later, the patient fully recovered, and the follow-up MR documented complete resolution of the abscess. Notably, in the US, infectious disease consultants would typically require a minimum of 6 weeks of intravenous antibiotic therapy, followed in some cases by long-term suppressive oral antibiotics.

**CONCLUSION**

Cervical ESI (CESI, ICESI, TF-CESI) and lumbar ESI (LESI, ILESI, TF-LESI) are not FDA-approved and have no RCT-documented long-term safety or efficacy. Further, CESI and occasionally high LESI (e.g., TF-LESI at the L1 level) risks include severe morbidity and mortality. Intramedullary or intravascular injections result in irreversible paralysis and/or strokes (e.g., cord, brain stem, and cerebellar strokes).

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**Conflicts of interest**

There are no conflicts of interest.

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