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An update on technical and safety practice patterns in transforaminal epidural steroid injections

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ABSTRACT

Introduction: Previous studies have suggested variability in practice patterns for transforaminal epidural steroid injections (TFESIs) despite published safety guidance. The purpose of this study was to understand recent trends in periprocedural safety practices in TFESIs and how some aspects of interventional pain practice may have been influenced by the coronavirus disease 2019 (COVID-19) pandemic and related supply chain shortages.
Methods: A 91-item survey was distributed to 111 program directors of Accreditation Council for Graduate Medical Education accredited Pain Management fellowships, 42 North American Spine Society and Interventional Spine and Musculoskeletal Medicine recognized fellowship directors, and 100 private practice interventional pain physicians to capture current practices in epidural steroid injections from March 2021 to March 2022. Additional responses were obtained through advertising on social media platforms consisting of interventional pain physicians. Cross sectional data from survey responses specific to TFESI-related practices were gathered and analyzed.
Results: Of 103 complete survey responses, 102 physicians perform TFESIs (cervical, 33.3%; thoracic, 40.2%; lumbar, 100%; sacral, 89.2%). There was variability in preprocedural imaging review, sedation practices, contrast and fluoroscopy techniques, and type and dose of steroid preferred. Many physicians saw a decrease in number of procedures performed weekly as a result of the COVID-19 pandemic.
Conclusions: There remains practice variability in various periprocedural aspects of TFESIs despite existing safety recommendations. Further research is needed to identify ongoing barriers to adherence to established guidelines. Recent practice trends may have been affected by unique challenges posed by the COVID-19 pandemic, and these trends should be considered in the event of future supply chain limitations and/or need for disaster response.

1. Introduction

Epidural steroid injections (ESIs) via the interlaminar or transforaminal approach are a valuable tool in both the diagnostic workup and therapeutic management of neck and back pain. Compared to the interlaminar ESI (ILESI) approach, a transforaminal ESI (TFESI) theoretically allows for more targeted delivery of corticosteroid into the anterior epidural space to selectively reduce inflammation and modulate pain signals [1,2]. From an anatomical standpoint, direct cord compression due to a post-procedural complication such as epidural hematoma may theoretically be less likely following TFESI than ILESI [3]. However, TFESIs pose unique technical challenges due to the proximity of the needle target to the arterial supply of the exiting nerve roots, spinal cord, and posterior cerebral circulation [3,4]. For lumbar TFESIs, inadvertent intravascular injection of particulate steroid into lumbar radicular arteries or directly into the artery of Adamkiewicz has been implicated in distal cord or conus ischemia [4,5]. In the cervical spine, injury or injection to the cervical radicular arteries or the ascending vertebral arteries in the ventral aspect of the neural foramen poses risk to cervical cord, brainstem, or posterior cerebral ischemia [3]. Thus, when compared to ILESIs, TFESIs are more often implicated in severe, permanent complications, and even death [4].

In response to these safety concerns, the Food and Drug Administration commissioned a multidisciplinary working group to develop a set of technical considerations to enhance the safety of these procedures. This statement includes specific guidance for TFESI practices regarding type of steroid, imaging guidance, use of contrast media, and sedation practices [6]. Despite this, a recent survey of interventional pain

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physician practices obtained prior to the coronavirus disease 2019 (COVID-19) pandemic suggests that variability still exists in actual periprocedural safety practices for TFESIs [7]. To complicate matters more recently, there have been a number of shortages of medications used in interventional pain procedures, such as local anesthetic, iodinated contrast media (ICM), and preservative-free dexamethasone [8–10]. These shortages were exacerbated by supply-chain related issues secondary to COVID-19.

The purpose of the present survey study is to understand recent patterns in periprocedural technical and safety practices for TFESIs. We will also discuss aspects of practice that may have been influenced by the COVID-19 pandemic and supply chain shortages in key materials and medications used in TFESIs.

2. Methods

This cross-sectional study was approved by the Institutional Review Board (IRB) of our institution; written informed consent was waived by the IRB and electronic informed consent to participate was collected at the beginning of the survey. A 91-item survey was created using research electronic data capture (REDCap) [11] tools hosted at our institution to gauge demographics and practice patterns among interventional pain physicians in the United States. Survey questions were formulated based on literature review of prior practice trends and in light of newer guidelines and consensus recommendations [7,12,13]. We additionally collected data related to preprocedural imaging review [14], as well as specific aspects of interventional pain medicine that were known to be affected by the COVID-19 pandemic at the time of the survey's creation, including procedural volume and steroid dose [10].

The survey was directly distributed to all 111 program directors of Accreditation Council for Graduate Medical Education accredited Pain Management fellowships, and all 42 North American Spine Society and Interventional Spine and Musculoskeletal Medicine recognized fellowship directors. To mitigate sample bias and ensure roughly equal distribution to both private and academic practitioners, the survey was also distributed to two private practice interventional pain physicians per state for a total of 100 private practice physicians. Private practitioners were chosen randomly from a list generated via the American Society of Interventional Pain Physicians 'Doctor Finder' feature and internet Yelp search. We solicited additional survey responses through posts on private forums and members-only social media platforms comprised of interventional pain management physicians.

Emails with a link to the REDCap survey were distributed to this generated list of physicians a total of 3 times over a 12-month period (03/2021-03/2022). Only the principal investigator and actively involved investigators had access to the data.

Physicians who did not perform ESIs and physicians who were in training at the time of the survey were prevented from completing the survey via an automated survey stop action. Survey responses were analyzed using IBM SPSS Statistics [15] software. This manuscript was prepared in accordance with the STROBE guidelines [16].

3. Results

3.1. Demographics

Of 120 physicians who responded to the survey, 103 had completed survey data and were included in further analysis. All but one performed TFESIs, for a total of 102 interventional pain physicians included in this report. Most respondents (93.1%) performed both ILESIs and TFESIs, while seven (6.9%) performed TFESI only. One-third (33.3%) of respondents performed TFESI at the cervical level, 40.2% thoracic, 100% lumbar, and 89.2% sacral. Complete demographic data can be found in Table 1.

Table 1
Demographics.

Primary Specialty	Anesthesiology	50 (49%)
	PM&R	51 (50%)
	Radiology	1 (1%)
Fellowship Training	Anesthesiology Pain Management	54 (52.9%)
	PM&R Pain Management	13 (12.7%)
	Interventional spine (non-surgical)	12 (11.8%)
	PM&R Sports Medicine	8 (7.8%)
	Other	2 (2%)
	No fellowship	13 (12.7%)
Years in Practice	<1 year	12 (11.8%)
	1–5 years	15 (14.7%)
	6–10 years	19 (18.6%)
	11–15 years	19 (18.6%)
	16–20 years	19 (18.6%)
	>20 years	18 (17.6%)
Weekly Procedure Volume	0–10	29 (28.4%)
	11–20	32 (31.4%)
	21–30	17 (16.7%)
	31–40	8 (7.8%)
	41–50	3 (2.9%)
	>50	13 (12.7%)

Numerical data are listed as: number of respondents (%).
Abbreviations: PM&R, Physical Medicine & Rehabilitation.

3.2. COVID-19 related practices

As a result of the COVID-19 pandemic, 51.5% of physicians reported a temporary decrease in total number of weekly ESIs performed, while 33% reported a persistent decrease in weekly ESIs at the time this survey was collected one year after the onset of the pandemic. 84.3% of physicians used the same dose of steroid as they did prior to the pandemic, while 15.7% used a lesser dose of steroid.

3.3. Periprocedural practices

Twelve (11.8%) respondents did not require advanced imaging (CT, MRI) prior to performing ESI. If imaging were available prior to performing ESI, most respondents (82.4%) would review the CT or MR images in addition to the radiology report, 12.7% would review radiology report only, 3.9% would review images only, and 1% (one respondent) would review none of the above.

Over half of respondents (52.9%) did not provide sedation during ESIs. Sedation practices are detailed in Table 2.

3.4. Cervical TFESI practices

Thirty-four of 102 (33.3%) respondents performed cervical TFESI (C-TFESI). Four of these respondents did not complete a fellowship incorporating interventional spine procedures. Prior to needle insertion, 73.5% reported maximizing anteroposterior (AP) foraminal dimension with fluoroscopic oblique angle adjustment, and 61.8% reported maximizing foraminal height with craniocaudal adjustment. The bent needle

Table 2
Sedation practices.

% of cases in which sedation is used	Never	54 (52.9%)
	0–5%	13 (12.7%)
	6–25%	11 (10.8%)
	26–50%	10 (9.8%)
	51–75%	8 (7.8%)
	76–100%	6 (5.9%)
Routine use of sedation in C-TFESI	No	28 (82.4%)
	Yes	6 (17.6%)
Type of sedation typically used	Intravenous only	30 (62.5%)
	Oral only	5 (10.4%)
	Oral or intravenous	13 (27.1%)

Numerical data are listed as: number of respondents (%).
Abbreviations: C-TFESI, cervical transforaminal epidural steroid injection.

tip technique was used by 41.2% of respondents. 32.4% of respondents selected that they primed the needle hub with contrast. Extension tubing was used by 79.4%. To rule out intravascular uptake, live fluoroscopy was used by 91.2% and digital subtraction angiography (DSA) was used by 52.9%. Two physicians who performed C-TFESI did not respond to use of either live capture or DSA. A lidocaine test dose, prior to injection of steroid, was used by 32.4%.

Corticosteroid preferences for C-TFESI are summarized in Fig. 1 with dexamethasone preferred by 91.2%. The most common dose of dexamethasone for those who use it was 10 mg (64.5%), followed by 4 mg (12.9%), 8 mg (12.9%), and less frequently, 6 mg (3.2%), 15 mg (3.2%), and 16 mg (3.2%). Both physicians who used betamethasone reported their typical dose as 6 mg. The physician who used methylprednisolone did not specify their typical dose. Total injectate volume, including steroid, saline, and local anesthetic components was less than 2 mL for 35.3% of respondents, 2 mL for 47.1% of respondents, and 3 mL for 17.6% of respondents.

3.5. Lumbar TFESI practices

The Quincke needle was the most commonly used (91.2%) spinal needle during lumbar TFESI (L-TFESI). Few physicians used a blunt tip (4.9%), Chiba (2%), Whitacre (1%), or other unspecified type (1%). The 22-gauge 3.5-inch spinal needle was most widely used (73.5%), followed by 25-gauge (16.7%), 20-gauge (4.9%), other unspecified gauge (3.9%), and 18-gauge (1%).

To gain entry to the epidural space, 93.1% of respondents used the subpedicular (i.e., “safe triangle”) approach, 19.6% used the retrodiscal, infraneural (i.e., “Kambin’s triangle”) approach, 9.8% used a two-needle technique (i.e., spinal needle through an introducer needle), and 1% used another unspecified approach. Physicians were able to select multiple approaches, and primary approach was not specified in this survey. When assessing needle tip depth under fluoroscopy during L-TFESI, 61.8% of respondents used a lateral view followed by final adjustment with anteroposterior (AP) view, 18.6% used ipsilateral oblique view (i.e., “Scotty dog” view) followed by final adjustment with AP view, and 19.6% used a lateral view only. Seventy-eight percent of respondents utilized extension tubing to minimize movement of the needle tip once it has reached its target prior to changing syringes and injecting steroid mixture, while the remaining 21.6% did not routinely use extension tubing.

Ninety-two physicians answered questions about fluoroscopy practices in L-TFESI. Typical contrast volume used per procedure can be found in Fig. 2. When evaluating contrast pattern, 95.7% used an AP view, 44.6% used a lateral view, and 17.4% used an oblique view. Live image capture was preferred by 66.3%, while DSA was preferred by 16.3%, and 17.4% preferred spot capture only. If a patient was allergic to ICM, 41.2% of 102 respondents selected they would administer

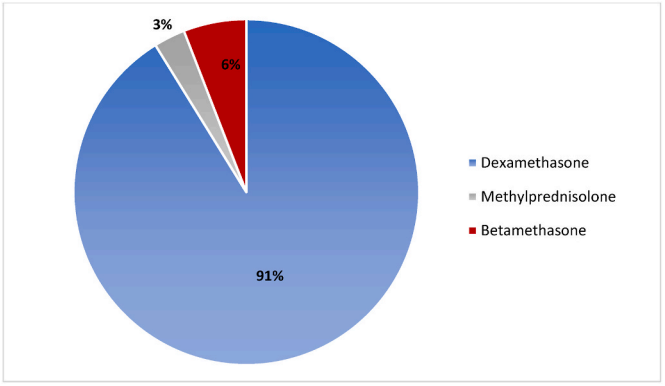

Fig. 1. Dexamethasone was the preferred injectate for 91.1% of respondents, while 5.9% preferred betamethasone, and 2.9% preferred methylprednisolone.

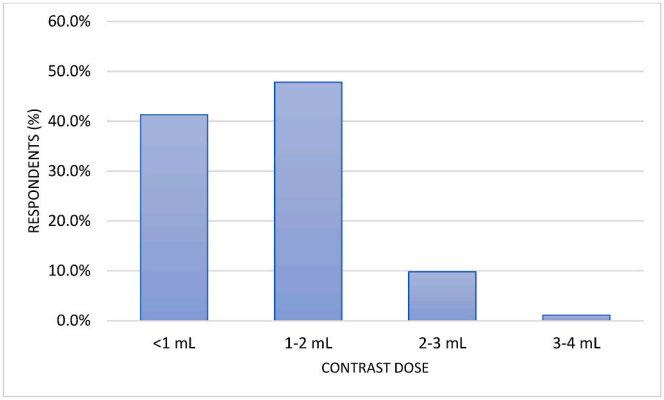

Fig. 2. 41.3% of respondents used <1 mL contrast, and 47.8% used 1–2 mL. Few respondents used >2 mL of contrast.

gadolinium-based contrast medium (GBCM) instead, while 38.2% preferred premedication with steroid and antihistamine prior to using ICM, and 20.6% selected to proceed with injection without using contrast. The typical dose for GBCM per procedure for those who used it was <1 mL for 53.5%, 1–2 mL for 44.2%, and >2 mL for 2.3%.

Most (61.5%) physicians routinely added a local anesthetic to the steroid mixture for TFESIs, while 13.5% added a local anesthetic for diagnostic TFESIs only. The remaining respondents did not use local anesthetic for TFESIs.

Corticosteroid preferences for L-TFESI are detailed in Fig. 3, with dexamethasone preferred by 74.5% of respondents. Among those who used dexamethasone, the most common dose was 10 mg (60%), followed by 4 mg (17.3%), then 8 mg (8%), 20 mg (6.6%), 12 mg (2.6%), 16 mg (2.6%), 5 mg (1.3%), and 15 mg (1.3%). 40 mg was the most common methylprednisolone dose (58.3%), followed by 80 mg (41.7%). For those who used triamcinolone, 37.5% used 40 mg, 37.5% used 80 mg, while 25% used less than 40 mg (specific dose unspecified). Of those who used betamethasone, 50% used 6 mg and 50% used 12 mg. Total injectate volume used, including steroid, saline, and local anesthetic components was less than 2 mL for 11.8%, 2 mL for 43%, 3 mL for 32.4%, 4 mL for 11.8%, and 5 mL or more for 2%.

4. Discussion

The purpose of this report is to provide a detailed update on practice trends in technical and safety aspects of TFESI. While the majority of serious complications have been associated with C-TFESI, there remains risk of neurovascular injury in L-TFESI especially if precautions are not

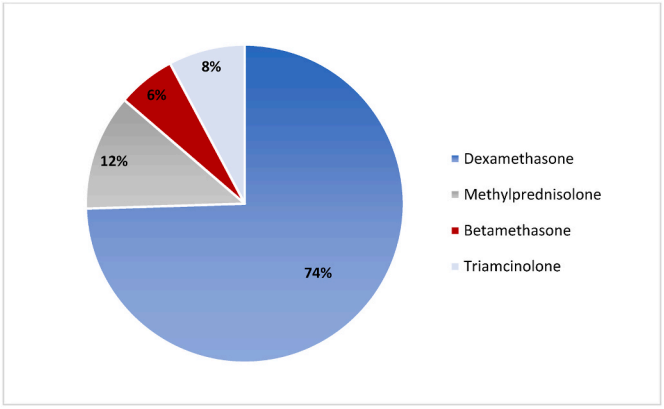

Fig. 3. Dexamethasone was the preferred injectate for 74.5% of respondents, followed by methylprednisolone (11.8%), triamcinolone (7.8%), and betamethasone (5.9%).

taken [3]. In line with previous literature, our data suggests variability in key safety protocols including use of extension tubing, contrast and fluoroscopy practices, and injectate preferences despite published guidance [7,12,13]. Our results suggest that further educational efforts and clarification of existing guidelines are needed.

Given that survey responses were collected during the COVID-19 pandemic, this study may shed light on how pain physicians adapted to material shortages needed for TFESIs. Most respondents saw at least a temporary decrease in procedural volume secondary to the elective nature of pain interventions plus changes to practice flow to mitigate disease spread, and 84.3% used a smaller steroid dose than prior to the pandemic. Understanding the impact of the pandemic on pain practice will enable interventional pain societies to provide practical guidance in the event of future supply chain limitations and/or disaster response.

While the overall trend toward use of live fluoroscopy has improved since prior to the release of the 2015 multisociety recommendation [6,12], a handful of physicians still utilized spot capture alone. DSA was used inconsistently in conjunction with live fluoroscopy despite increased sensitivity in the detection of intravascular injection compared to live capture [17]. The ideal contrast volume needed to identify vascular uptake is unclear and should be further studied. In theory, smaller ICM volumes could increase the likelihood of false negative vascular uptake due to impaired visualization at lower volumes and potential for rapid washout. Most physicians used between 1 and 2 mL ICM, followed closely by <1 mL. During the ICM shortage, guidelines allowed for TFESIs below L2 without ICM provided that a non-particulate steroid was used, but recommended delaying TFESIs above L2 [9]. The ICM shortage may have played a role in the decrease in procedure volume reported during the pandemic and may have prompted respondents to use a lower volume of ICM than prior to the shortage. In the case of ICM hypersensitivity reaction, 41.2% respondents used GBCM, which carries risks of nephrogenic systemic fibrosis, intracranial gadolinium deposition, and encephalopathy [18], and therefore should not be used in place of ICM in the event of an ICM shortage [9].

Dexamethasone was the preferred injectate for both C- and L-TFESI for most physicians. Few respondents preferred particulate injectate despite no clear evidence supporting a superior therapeutic effect and increased risk of vascular complications [19]. In light of the dexamethasone shortage, guidance suggested that particulate steroid could be considered for L-TFESI provided that all precautions are taken leading up to the injection [10]. The proportion of respondents in our survey who reported using dexamethasone is higher than that of pre-pandemic surveys, despite the dexamethasone shortage [7,12], though the overall dose of steroid was decreased for most physicians. While the 10 mg dose of dexamethasone was most commonly used in both C- and L-TFESI, the majority physicians reported a decrease in their preferred dose since the pandemic, which may reflect an adaptation to the dexamethasone shortage. While the ideal total dose of corticosteroid in TFESI is unknown, data suggests meaningful clinical improvements at as low as 4 mg of dexamethasone [20]. Therefore, performing TFESI with lower doses of dexamethasone may provide an avenue for pain physicians who wish to continue TFESIs, especially at the cervical level, should they face dexamethasone shortages in the future.

Though our survey did not capture type or dose of local anesthetic, we observed a decreased proportion of physicians who utilized local anesthetic in TFESIs compared to prior to the pandemic (61.5% compared to 88.4% for L-TFESI) [12], which could be a manifestation of local anesthetic shortage. Guidance released during the shortage recommended using a 25-gauge or thinner needle for comfort [8], though 73.5% of our respondents still preferred a 22-gauge needle. Future work might seek to identify how decreased use of local anesthetic translates to patient outcomes.

Guidelines support preprocedural sedation on a case-by-case basis as long as the patient can communicate adverse sensations during the procedure [6]. Similar to findings reported by Hynes et al. [21], a subset of respondents in our study reported routine use of sedation, and intravenous sedation delivery was preferred by most of those respondents. More judicious sedation practices may be warranted, while understanding that patient- and physician-specific considerations in sedation practices were not fully captured in our survey.

Finally, while not outlined in periprocedural safety guidelines, in our clinical experience, independent review of advanced imaging is a key step to procedural planning prior to any interventional procedure. Understanding degree of foraminal narrowing and presence and location of intraforaminal disc or osteophytes could aid in assessing optimal needle trajectory. Imaging review could also aid in detection of anomalous or aneurysmal vertebral artery, synovial or perineural cysts [14]. A subset of physicians (11.8%) did not require advanced imaging prior to proceeding with injection, and where imaging was available, some reported reviewing the radiology report only. More research is needed to elucidate how independent advanced imaging review prior to TFESI may affect clinical outcomes.

As with any survey study, our results may have been influenced by nonresponse and recall biases. Given our recruitment methods which included advertising the survey via private social media platforms, it was difficult to assess the response rate we observed. While our results do contain a relatively equal distribution of interventional pain physicians with Anesthesiology and Physical Medicine & Rehabilitation backgrounds, our sample contained few physicians from alternative specialty backgrounds. Although our methods were designed to reach an equal number of private and academic practitioners, we did not obtain data to specify each physician's practice setting, geography, sex, race, or ethnicity, and differences may have influenced results. We also recognize certain aspects of data collected specific to L-TFESI were not collected specific to C-TFESI, such as alternative steroid doses, needle type, and contrast volumes used.

5. Conclusions

In summary, there remains variability in various technical and safety aspects of TFESI. Practice patterns may have been influenced by unique challenges posed by the COVID-19 pandemic. Further research is warranted to identify ongoing barriers to adherence to previously established safety guidelines.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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