The Spine Journal 16 (2016) 876–883

Clinical Study

The effect of body mass index on fluoroscopic time and radiation dose during lumbar transforaminal epidural steroid injections

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Received 30 January 2016; accepted 18 March 2016

Abstract

OBJECTIVE: Transforaminal epidural steroid injections (TFESIs) are a commonly used, effective treatment for radicular pain. Accurate delivery of the injected medication helps to ensure maximum therapeutic efficacy and to decrease possible adverse events, and fluoroscopy is the preferred and most common image-guidance modality used to ensure accurate needle placement during lumbar TFESIs. However, fluoroscopic-guided lumbar TFESIs put patients at risk because of radiation exposure. The purpose of this study was to determine the relationship between body mass index (BMI) and fluoroscopy time and radiation dose during lumbar TFESIs.

DESIGN: A retrospective study design was used.

SETTING: The study was conducted at an academic orthopedic center. All procedures were performed by physicians board-certified in Physical Medicine and Rehabilitation (PM&R) and with subspecialty certification in sports medicine, or by a trainee under close supervision from an attending physician.

PARTICIPANTS: Participants were patients who underwent fluoroscopic-guided lumbar TFESIs between February 2013 and March 2015 with a documented height/weight, fluoroscopy time, and radiation dose.

INTERVENTIONS: All patients received unilateral or bilateral lumbar TFESIs with fluoroscopic guidance. Fluoroscopy time and dose were recorded.

MAIN OUTCOME MEASURES: The main outcome measures were fluoroscopy time and radiation dose. A Bonferroni correction was implemented for multiple comparisons, defining statistical significance at $p<.01$.

RESULTS: A total of 2,443 injections were performed on 1,548 patients. There were 419 normal, 572 overweight, and 557 obese patients, respectively. There were 1,426 first-time injections and 1,017 repeat injections. Sixty-nine percent (1,681) were unilateral injections, and 26.4% (645) were single level injections. A trainee was involved in 1,361 (55.7%) of the injections performed. The mean fluoroscopy time for all injections was 30.0±17.5 seconds, and the mean radiation dose was 2,164±1,484 mGy-cm^2. The mean fluoroscopy time was 27.7±15.2 seconds for normal weight patients, 30.0±21.0 seconds for overweight patients, and 32.2±15.1 seconds for obese patients, showing a significant difference between groups ($p<.001$). The mean radiation doses for each group were 1,376±450, 1,911±653, and 3,029±640 mGy-cm^2, respectively, with a significant increase in radiation dose with increasing BMI ($p<.001$).

FDA device/drug status: Not applicable.

Author disclosures: ***DC:*** Nothing to disclose. ***RM:*** Nothing to disclose. ***BC:*** Nothing to disclose. ***AF:*** Nothing to disclose. ***ZLM:*** Nothing to disclose.

This research was not supported by any industry funds. All authors contributed significantly to and approved the contents of the paper. The paper has not been published previously.

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http://dx.doi.org/10.1016/j.spinee.2016.03.041
1529-9430/

CONCLUSIONS: The findings of this study demonstrate that fluoroscopy radiation dose and fluoroscopy time during lumbar TFESIs are increased in patients with an elevated BMI, and in patients of greater age, but the presence of a trainee had no effect on fluoroscopy time.

Keywords: Back pain; Body mass index; Epidural steroid injection; Fluoroscopy; Lumbar transforaminal; Radiation

Introduction

Transforaminal epidural steroid injections (TFESIs) are a commonly used, effective treatment for radicular pain [1–4]. Transforaminal epidural steroid injections require precise needle placement within the epidural space of a selected vertebral neural foramen to deliver corticosteroid in close proximity to the affected spinal nerve root [3]. Accurate delivery of the injected medication helps to ensure maximum therapeutic efficacy and to decrease possible adverse events [5]. Accordingly, fluoroscopy is the preferred and most common image-guidance modality used to ensure accurate needle placement during lumbar TFESIs [5,6].

The use of fluoroscopic guidance in TFESIs, however, exposes patients and practitioners to radiation; minimizing this exposure is an integral part of reducing associated health risks [7,8]. An important characteristic of a fluoroscopic system is its sensitivity, which refers to the amount of radiation exposure required to obtain acceptable imaging. For example, it is known that patients with an elevated body mass index (BMI) receive higher radiation doses for equivalent studies because greater emission from the fluoroscope is needed to pass through a deeper tissue mass to reach the detector [9–12]. Fortunately, fluoroscopy systems use an automatic exposure control that adjusts to patient attenuation to optimize the dose/image quality ratio to provide the best image resolution with the lowest radiation dose [13,14]. Although BMI has been shown previously to correlate with increased fluoroscopy dose in several other interventional procedures [9,12,13,15], it cannot be assumed this will be the case with every interventional procedure. It stands to reason that variations in local tissue type/depths and variations in procedural techniques could affect radiation dose differently.

Although the radiation exposure needed to produce one fluoroscopic image is relatively low, the large series of images encountered in fluoroscopic procedures results in increased exposure to patients and staff. This means that the total fluoroscopic time is also one of the major determining factors of radiation exposure to patients and staff [16]. Because procedure time is variable, it is necessary to understand the various factors that can influence the procedure and fluoroscopic times during TFESIs to limit radiation exposure. Moreover, as radiation doses are cumulative and patients often undergo more than one TFESI [17], knowledge of the amount of radiation exposure per injection is also important.

The purpose of this study was to determine the relationship between BMI, fluoroscopy time, and radiation dose during lumbar TFESIs. Additionally, this study aimed to identify demographic and procedural characteristics that are associated with increased fluoroscopy time. These fluoroscopy time and radiation dose data are placed within the context of an acceptable radiation exposure threshold.

Methods

This study was approved by the local Institutional Review Board. A retrospective review of consecutive fluoroscopic injections between February 2013 and March 2015 at an academic orthopedic clinic was performed. These data were obtained by querying the institution's prospectively collected clinical database. All lumbar TFESIs were evaluated. Patients with missing fluoroscopic time or BMI data were not included in the analysis. Collected data included age, gender, height, weight, involvement of a trainee (defined as resident or fellow), fluoroscopy time (in seconds), and fluoroscopic dose (either in mGy-cm^2 or mrad-cm^2, which was converted to mGy-cm^2). Fluoroscopy time and radiation dose data were recorded by the fluoroscopy system and transcribed into the clinical database after each procedure. Six attending physicians with board certification in Physical Medicine and Rehabilitation (PM&R) and/or sports medicine performed or supervised all injections. Body mass index was calculated using the recorded height and weight within 3 months of the injection. Using the Center for Disease Control and Prevention (http://www.cdc.gov/obesity/adult/defining.html) definitions, obese BMI was defined as ≥30 kg/m^2, overweight was between 25 kg/m^2 inclusive and 30 kg/m^2, and normal BMI was less than 25 kg/m^2.

Injection procedure

The TFESI procedure was completed in the following manner: With the patient in a prone-lying position, the skin was prepped in a sterile manner with povidone-iodine or chlorhexidine, followed by standard sterile draping. The target level for injection was identified with the use of the fluoroscopic C-arm. Local anesthetic (1% lidocaine) was administered for skin and soft tissue anesthesia followed by insertion of a 22-gauge spinal needle. Under fluoroscopic guidance, the needle was advanced to the subpedicular transforaminal space, lateral and superior to the nerve root. Both oblique and posteroanterior approaches were used depending on attending physician preference. Proper needle tip placement was confirmed by the injection of contrast through microbore tubing under live fluoroscopic observation. After confirmation of an epidural contrast pattern and lack of vascular flow, a steroid and lidocaine combination was injected. The injectate consisted of either betamethasone, methylprednisolone, triamcinolone, dexamethasone, or a