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Original Research

The Effect of Body Mass Index on Fluoroscopic Time and Radiation Dose During Sacroiliac Joint Injections

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Abstract

Background: Sacroiliac joint (SIJ) injections are commonly performed under fluoroscopic guidance. Radiation exposure to patients and providers has not been comprehensively studied, particularly the effect of body mass index (BMI).
Objective: To identify whether patients with a larger BMI require longer fluoroscopy time or a larger radiation dose during performance of an SIJ injection.
Design: Retrospective study of an academic institution database.
Setting: Academic outpatient musculoskeletal clinic.
Patients: All patients who underwent SIJ injections during a 10-year period.
Main Outcome Measurements: Machine-reported fluoroscopic time and machine-reported radiation dose. A Bonferroni correction was implemented with $P \leq .01$ as statistically significant.
Results: A total of 453 SIJ injections were performed in 359 patients. No statistically significant differences in fluoroscopy time were found between patients with BMI scores identified as normal, overweight, and obese ($P = .054$). However, the radiation doses were significantly greater for patients with higher BMI scores (χ^2 [2, n = 441] = 62.4, $P < .001$); the median (interquartile range) doses were 1210 (839), 1671 (1240), and 2090 (2170) mGy-cm^2 for normal weight, overweight, and obese patients, respectively. Although longer needles were used more often in obese patients (χ^2 [2, n = 452] = 31.5, $P < .001$), fluoroscopy time was not associated with needle length ($P = .162$). No relationships were identified between fluoroscopy time and first-time (as opposed to repeat) injection ($P = .123$), trainee involvement (χ^2 [1, n = 698] = 3.9, $P = .049$), or age ($P = .337$).
Conclusions: Patients with an elevated BMI score who are undergoing SIJ injection receive an increased radiation dose despite equivalent fluoroscopic time. This finding suggests that the increased dose is likely due to x-ray output from the fluoroscope traversing a greater tissue mass, as opposed to the physician requiring more fluoroscopic images for proper needle placement. Fortunately, the increased radiation dose delivered to patients with a larger BMI score likely has negligible effects.

Introduction

The sacroiliac joint (SIJ) has been reported to cause up to 30% of cases of low back/buttock pain [1] and may be injected with an anesthetic and a corticosteroid under fluoroscopic guidance for both diagnostic and therapeutic purposes. The difficulty associated with these procedures could conceivably increase the patient's radiation exposure if more fluoroscopic time is required.

In addition to its well-documented deleterious health effects [2-6], elevated body mass index (BMI) has been shown to increase radiation exposure in fluoroscopic procedures because of increased needle manipulation time, increased positioning time, and increased emission from the C-arm to pass through increased tissue mass to the detector [7-13]. Smuck et al [8] demonstrated increased procedure and fluoroscopy times for overweight patients during fluoroscopic-guided spine procedures. To our knowledge, no reports have been published on the effects of BMI with regard to fluoroscopy time or radiation dose with SIJ injections. The purpose of this study was to determine the relationship between BMI, fluoroscopy time, and radiation dose during SIJ injections.

A brief discussion on radiation units is required before discussing radiation dose calculations. We will only comment on international system units for the sake of simplicity. Biologic absorption of radiation, or the effective radiation dose, varies based on tissue and

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radiation type and is reported as sieverts (Sv). For x-rays, 1 Sv corresponds to approximately 1 gray (Gy) [10], which is a physical quantity of radiation unrelated to biologic tissue. The dose-area product (DAP) takes into account the area of tissue under examination and is reported as Gy-cm^2 or mGy-cm^2.

Methods

After Institutional Review Board approval was obtained at our institution, a retrospective review of consecutive fluoroscopic injections between 2003 and 2014 was performed by querying the institution's prospectively collected clinical database. All patients who received an SIJ injection were screened. Patients lacking data regarding fluoroscopic times, age, gender, or BMI were not included in the analysis. Demographic data were collected, including age, gender, height, and weight. The presence of a trainee (defined as a resident or fellow) was recorded. Based on the fluoroscope report, fluoroscopy time was reported in seconds, and the radiation dose (technically a DAP) was reported in either mGy-cm^2 or mrad-cm^2 (and subsequently converted to mGy-cm^2). The total procedure time could not be accurately assessed and was not included. Seven attending physicians with board certifications in Physical Medicine and Rehabilitation or Sports Medicine performed the injections or supervised trainees. Trainees were either Physical Medicine and Rehabilitation residents or Sports Medicine fellows (both in programs accreduted by the Accreditation Council for Graduate Medical Education). If bilateral injections were performed, the total radiation dose and fluoroscopy time were halved to create a calculated dose and time for each injection. BMI was calculated from recorded heights and weights at the time of the procedure. If height and weight were not available, values within 3 months of the procedure date were included. Obese was defined as a BMI score $\geq$30; overweight, a BMI score $\geq$25 and $<$30; and normal, a BMI score $<$25. Six patients were technically underweight (BMI $<$18.5) but were recorded as having a normal BMI using the aforementioned definition.

Injection Procedure

For SIJ injections, a posterior approach was used on patients in a prone position. Povidone-iodine or chlorhexidine skin preparation was performed, followed by application of a standard sterile drape. After anatomic localization with the fluoroscopic C-arm, a local anesthetic (1% lidocaine) was administered, followed by introduction of a 1.5- to 6.0-inch, 22- or 25-gauge needle into the posteroinferior SIJ recess. Proper needle placement was ensured with anteroposterior and lateral fluoroscopic views coupled with injection of contrast material into the joint space (see Figure 1). For the purposes of this study, individual images were not reviewed for confirmation of arthrogram. A steroid (1 mL of dexamethasone [10 mg], triamcinolone [40 mg], methylprednisolone [40 or 80 mg], or betamethasone [6 mg]) was mixed with 2-4 mL of 2% lidocaine and injected into the joint.

Statistical Analysis

With the use of statistical analysis similar to that reported in the study by Smuck et al [8], we analyzed the normality of the frequency distributions of fluoroscopy time and radiation dose with a Kolmogorov-Smirnov goodness-of-fit test. Because neither the radiation dose nor the time was normally distributed, log-transformations were attempted to normalize their

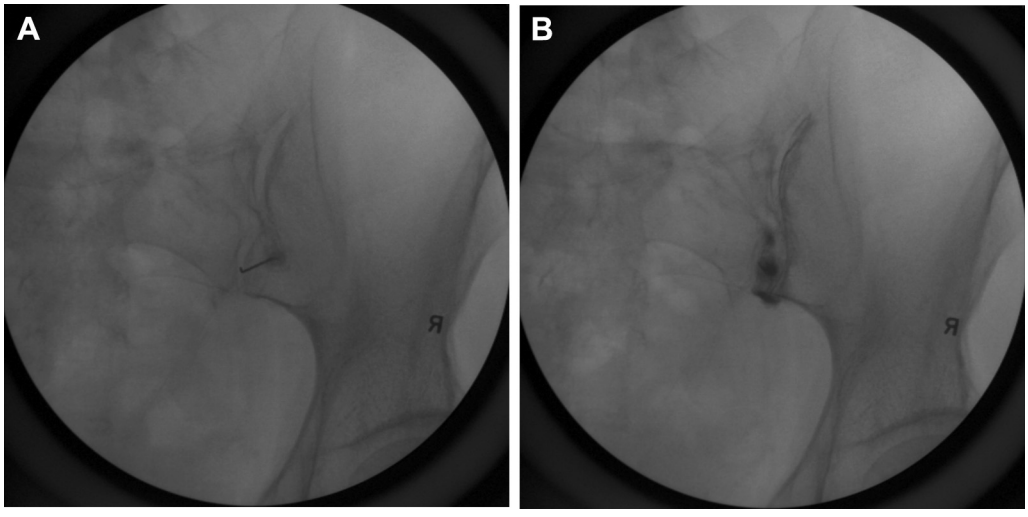

Figure 1. Fluoroscopic image of a sacroiliac joint injection with typical needle position in an oblique view, both prior to (A) and after (B) injection of contrast material, with a contrast pattern seen in the final image.