Trends in Fluoroscopy Time in Fluoroscopy-Guided Lumbar Punctures Performed by Trainees Over an Academic Year

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Abbreviations and Acronyms

BMI
body mass index

FGLP
fluoroscopy-guided lumbar puncture

FT
fluoroscopic time

LP
lumbar puncture

Rationale and Objectives: Fluoroscopy-guided lumbar puncture (FGLP) is an operator-dependent procedure that can contribute to lifetime cumulative radiation dose. Benchmark fluoroscopic times (FTs) have been published for ranges of body mass index (BMI), but trends in FT in FGLPs performed by neuroradiology trainees during their training have not been studied. The purpose of this study was to investigate the trends in FTs in FGLPs performed by neuroradiology fellows in an academic year.

Materials and Methods: We retrospectively reviewed FGLPs performed at our institution from July 2013 to June 2015 and determined the FT average and standard deviation of residents and non-neuroradiology fellows, neuroradiology fellows, and neuroradiology attendings. We used the Kruskal-Wallis test to evaluate group differences in FT in operator groups and academic quarters and by patient age, BMI, and needle length. Linear and Poisson regression analyses were performed to directly examine the relationship between the number of FGLPs performed and FTs.

Results: A total of 776 patients had successful FGLPs; 594 cases (77%) were performed by neuroradiology fellows ($n = 14$). The average FT and variance for neuroradiology fellows significantly decreased over the year ($P = 0.004$ and $P < 0.001$) with an estimated decrease of 0.01 minute of FT per FGLP. BMI, long needle length, and age ≥65 years old significantly affected the average FT ($P = 0.03$, $P < 0.001$, and $P < 0.001$) and FT decreased in all of these subgroups in the academic year.

Conclusions: FT in FGLP cases performed by neuroradiology fellows decreases during the year. Our data can be utilized by radiology training programs and practices as a benchmark to monitor individual operator FT.

Key Words: fluoroscopy-guided lumbar puncture; fluoroscopy time; trainee performance.

INTRODUCTION

Lumbar puncture (LP) is typically performed using anatomic landmarks (1); however, in some patients these methods are unsuccessful and image guidance is required, perhaps due to large body habitus or significant lumbar spondylosis. Fluoroscopy-guided lumbar puncture (FGLP) is an effective alternative to bedside LP as it can visualize the bony structures and guide the operator to accurately place the needle in the spinal canal in real time (2).

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The main disadvantage of FGLP is the use of ionizing radiation. Medical ionizing radiation exposure has increased in the general population over the years and has led to major improvements in the diagnosis and treatment of human diseases (3). Although these benefits are clear, their inappropriate use can lead to unnecessary or unintended radiation doses, potentially increasing the long-term risk of cancer (4) that may be influenced by cumulative radiation exposure. Diagnostic fluoroscopic studies are typically low-exposure techniques (4); however, FGLPs are operator dependent and do contribute to lifetime cumulative dose, such that the American College of Radiology recommends monitoring of fluoroscopic time (FT, an indirect marker for radiation dose) and comparison to benchmark figures (5,6).

Benchmark FTs have been published for ranges of body mass index (BMI) (7) and a range of average FTs have been reported (7–9), but trends in FT in FGLPs performed by neuroradiology trainees over the course of their training have not been studied. At academic centers, trainees are often the primary operators of FGLPs. Analyses of these trends are important as in 2011, the Joint Commission expressed concern about the American population's exposure to medical imaging ionizing radiation and recommended reviews of practices to reduce radiation exposure to as low as reasonably achievable, a central principle in radiation safety, without compromising patient care (10). In addition, proper FGLP training and monitoring of FT are important for trainees because FGLPs are now considered a core competency in diagnostic radiology residency and neuroradiology fellowship by the Accreditation Council for Graduate Medical Education and the American Board of Radiology (11–13) and the fact that radiology has supplanted other medical specialties as the top provider of LPs for Medicare patients in the United States (14). Diagnostic radiology training programs and neuroradiology fellowships typically record FGLP FT for trainees, yet there are no guidelines to determine if the trainees' FTs are improving. The objectives of this study were to investigate the trends in FTs in FGLPs performed by neuroradiology trainees over the course of an academic year and to establish baseline FTs per quarter of the academic year. We hypothesized that FGLP mean FT will decrease throughout the four quarters of the year including in potentially challenging cases such as in elderly patients and in patients with large body habitus.

MATERIALS AND METHODS

Institutional Review Board Approval and HIPAA (Health Insurance Portability and Accountability Act) Compliant

The present study was approved by the local institutional review board and is HIPAA compliant.

Patient Population

All patients who underwent FGLP at our institution from July 1, 2013, to June 30, 2015 (2 academic years) were respectively reviewed. FGLPs were performed in the neurointerventional suite on adult outpatients, inpatients, and emergency room patients. The primary indication to perform FGLP in patients was to administer intrathecal chemotherapy or sample the cerebrospinal fluid (CSF) to detect for malignancy, infection, CSF opening pressure, and other diseases. As per the standard policy in the radiology department, most of these patients had at least one failed attempt at bedside LP. Direct FGLP was available for patients requiring intrathecal chemotherapy and for patients with pre-existing conditions that could complicate non–image-guided LPs such as obesity, severe scoliosis, and prior lumbar surgery with underlying spinal fixation hardware.

Grouping of FGLP Cases by Months and Dates, BMI, Age, and Needle Length for Neuroradiology Fellows

Chronological Categorization of FT

FGLP cases performed by neuroradiology fellows in their first year of post-residency training from 2013 to 2014 and from 2014 to 2015 were combined and grouped together by quarter of the academic year: quarter 1, July–September (2013 and 2014); quarter 2, October–December (2013 and 2014); quarter 3, January–March (2014 and 2015); and quarter 4, April–June (2014 and 2015).

BMI, Age, and Needle Length

FGLP cases performed by neuroradiology fellows from 2013 to 2014 and from 2014 to 2015 were combined and grouped together on the basis of the patient's BMI according to the obesity guidelines of the National Heart, Lung, and Blood Institute (15): underweight (BMI < 18.5), normal (BMI 18.5–24.9), overweight (BMI 25–29.9), obese (BMI 30 – 39.9), and extremely obese (BMI > 40), and were bracketed together chronologically based on the months and dates of the FGLPs for each quarter of the year. Similarly, FGLP cases performed by fellows on patients 65 years and older and on patients requiring a 5-inch LP needle were bracketed together chronologically in quarters of the year.

Grouping of FGLP Cases by Quarters of the Year and Year of Training for Diagnostic Radiology Residents

FGLP cases performed by diagnostic radiology residents were grouped according to the year of training (PGY2–PGY5) and by quarter of the academic year in the same manner as detailed for the neuroradiology fellows.

Procedure Technique

Following a written informed consent for the diagnostic LP procedure, all patients underwent FGLP in the prone by using a standard biplanar fluoroscopy machine in a neurointerventional suite. FGLPs were performed by neuroradiology fellows ($n = 14$), radiology fellows from different subspecialties ($n = 2$), diagnostic radiology residents ($n = 28$), and residents from other medical specialties ($n = 4$) under the supervision of a neuroradiology attending or directly by attendings ($n = 16$; attending experience in FGLPs ranged from 1 to 20+ years; one attending was a second year neuroradiology fellow who functioned as an FGLP attending). FGLPs were performed by using techniques as dictated by the American Society of Neuroradiology guidelines and American College of Radiology–American Society of Neuroradiology–Society for Pediatric Radiology (ACR-ASNR-SPNR) parameters (16). On average, radiology fellows had performed approximately 0–10 FGLPs during residency and the other trainees had no prior experience in performing FGLPs at the beginning of the academic year. Under fluoroscopy, the X-ray tube was maneuvered to an oblique orientation to optimize the view of the lumbar interlaminar spaces. The lumbar spinal canal was accessed using strict aseptic technique mostly at the L2–L3 or L3–L4 level as instructed by the ACR-ASNR-SPR practice parameters. A 3.5-, 5.0-, or 7.0-inch beveled tip 20- or 22-gauge spinal needle was advanced into the lumbar spinal canal using intermittent pulsed fluoroscopy. Access into the thecal sac was confirmed on egress of the CSF after the removal of the stylet.