Fluoroscopically Guided Lateral Approach Hip Injection

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A retrospective comparison study of the anterior-oblique and lateral approach to hip injection procedures suggests that the lateral approach may be a valuable interventional skill for those performing hip injections.

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Hip injections are performed as diagnostic and therapeutic interventions across a variety of medical subspecialties, including but not limited to those practicing physical medicine and rehabilitation, pain medicine, sports medicine, orthopedic surgery, and radiology. Traditional image-guided intra-articular hip injection commonly uses an anterior-oblique approach from a starting point on the anterior groin traversing soft tissue anterior to the femoral neck to the target needle placement at the femoral head-neck junction.

In fluoroscopic procedures, a coaxial technique for needles placement is used for safe and precise insertion of needles. An X-ray beam is angled in line with the projected path of the needle from skin entry point to injection target. Coaxial, en face technique (also called EF, parallel, hub view, down the barrel, or barrel view) appears as a single radiopaque dot over the target injection site.[1] This technique minimizes needle redirection for correction of the injection path and minimal disturbance of surrounding tissue on the approach to the intended target.

Noncoaxial technique, as used in the anterior-oblique approach, intentionally directs the needle away from a skin entry point, the needle barrel traversing the X-ray beam toward an injection target. Clinical challenges to injection with the anterior-oblique approach include using a noncoaxial technique. Additional challenges to the anterior-oblique (also referred to as anterior) approach are body habitus and pannus, proximity to neurovascular structures, and patient positioning. By understanding the risks and benefits of varied technical approaches to accomplish a clinical goal and outcome, trainees are better able to select the technique most appropriate for a varied patient population.

Common risks to patients for all intra-articular interventions include bleeding, infection, and pain. Risk of damage to nearby structures is often mentioned as part of a standard informed consent process as it relates to the femoral vein, artery, and nerve that are in close anatomical proximity to the target injection site. When prior studies have examined the risk of complications resulting from intra-articular hip injections, a common conclusion is that despite a relatively low-risk profile for skilled interventionalists, efforts to avoid needle placement in the medial 50% of the femoral head on antero-posterior imaging is recommended.[2]

The anterior technique is a commonly described approach, and the same can be used for both ultrasound-guided and fluoroscopically guided hip injections.[3] Using ultrasound guidance, the anterior technique can be performed with in-plane direct visualization of the needle throughout the procedure. With fluoroscopic guidance, the anterior approach is performed out-of-plane, using the noncoaxial technique. This requires the interventionalist to use tactile and anatomic guidance to the target injection site. The anterior approach for hip injection is one of few interventions where coaxial technique is not used for the procedure, making the instruction for a learner less concrete and potentially more challenging related to the needle path not under direct visualization in plane with the X-ray beam.

Technical guidance and detailed instruction for the lateral approach is infrequently described in fluoroscopic interventional texts. Reference to a lateral approach hip injection was made as early as the 1970s,

without detail provided on the technique, with respect to the advantage of visualization of the hip joint for needle placement when hardware is in place.[4] A more recent article described a lateral approach technique involving the patient in a decubitus (lateral) supine position, which presents limitations in consistent fluoroscopic imaging and can be a challenging static position for the patient to maintain.[5]

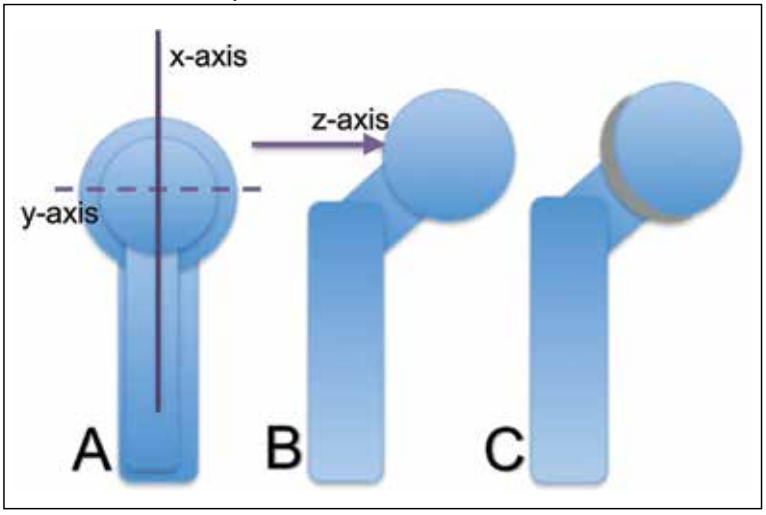
The retrospective review of anterior-oblique and lateral approach procedures in this study aims to demonstrate that there is no significant difference in radiation exposure, rate of successful intra-articular injection, or complication rate. If proven as a noninferior technique, the lateral approach may be a valuable interventional skill to those performing hip injections. Potential benefits to the patient and provider include options for the provider to access the joint using either technique. Additionally, the approach can be added to the instructional plan for those practitioners providing technical instruction to trainees within their health care system.

METHODS

The institutional review board at the VA Ann Arbor Healthcare System reviewed and granted approval for this study. One of 5 interventional pain physician staff members at the VA Ann Arbor Healthcare System performed fluoroscopically guided hip injections. Interventional pain fellows under the direct supervision of board-certified physicians performed the procedures for the study cases. Supervising physicians included both physiatrists and anesthesiologists. Images were reviewed and evaluated without corresponding patient biographic data.

For cases using the lateral approach, the patients were positioned supine on the fluoroscopy table. In anterior-posterior and lateral views, trajectory lines are drawn using a long metal marking rod held adjacent to the patient. With pulsed low-dose fluoroscopy, transverse lines are drawn to identify midpoint of the femoral head in lateral view (Figure 1A, x-axis) and the most direct line from skin to lateral femoral head neck junction joint target (Figure 1B, z-axis). Also confirmed in lateral view, the z-axis marked line drawn on the skin is used to confirm that this transverse plane crosses the overlapping femoral heads (Figure 1A, y-axis).

FIGURE 1 Anatomic Drawings of Antero-Posterior and Lateral Fluoroscopic Landmarks

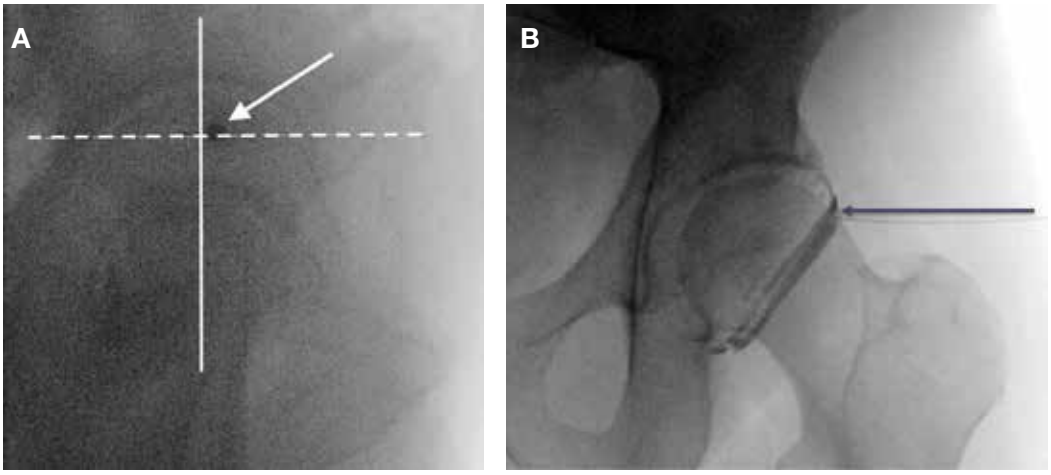


(A) lateral view with marker line transecting overlapping femoral heads for x-axis (solid line) and y-axis (dashed line); (B) anterior view with marker line (arrow); (C) anterior view with contrast enhancement.

The cross-section of these transverse and coronal plane lines identifies the starting point for the most direct approach from skin to injection target at femoral head-neck junction. Using the coaxial technique in the lateral view, the needle is introduced and advanced using intermittent fluoroscopic images to the lateral joint target. Continuing in this view, the interventionalist can ensure that advancing the needle to the osseous endpoint will place the tip at the midpoint of the femoral head at the target on the lateral surface, avoiding inadvertent advance of the needle anterior or posterior the femoral head. Final needle placement confirmation is then completed in antero-posterior view (Figure 2A). Contrast enhancement is used to confirm intra-articular spread (Figure 2B).

Cases included in the study were performed over an 8-month period in 2017. Case images recorded in IntelliSpace PACS Radiology software (Andover, MA) were included by creating a list of all cases performed and documented using the major joint injection procedure code. The cases reviewed began with the most recent cases. Two research team members (1 radiologist and 1 interventional pain physician) reviewed the series of saved images for each patient and the associated procedure report.

FIGURE 2 Fluoroscopic Images for Needle Placement



(A) lateral: marker lines as drawn, transecting femoral heads in x-axis (solid line) and y-axis (dashed line), arrow points to 22-gauge spinal needle advanced to target at intersection of x- and y-axes; (B) anterior: marker line on z-axis (arrow) and 22-gauge spinal needle advanced to target at femoral head-neck junction, contrast enhancement seen within the joint space.

The research team members documented and recorded de-identified study data in Microsoft Excel (Redmond, WA).

Imaging reports, using the saved images and the associated procedure report, were classified for technical approach (anterior, lateral, or inconclusive), success of joint injection as evidenced by appropriate contrast enhancement within the joint space (successful, unsuccessful, or incomplete images), documented use of sedation (yes, no), patient positioning (supine, prone), radiation exposure dose, radiation exposure time, and additional comments, such as "notable pannus" or "hardware present" to annotate significant findings on imaging review.

Statistical Analysis

The distribution of 2 outcomes used to compare rates of complication, radiation dose, and exposure time was checked using the Shapiro-Wilk test. Power analysis determined that inclusion of 30 anterior and 30 lateral cases results in adequate power to detect a 1-point mean difference, assuming a standard deviation of 1.5 in each group. Both radiation dose and exposure time were found to be nonnormally distributed ($W = 0.65$, $P < .001$; $W = 0.86$, $P < .001$; respectively). Median and interquartile range (IQR) of dose and time in seconds for anterior and lateral approaches were computed. Median differences in radiation dose and exposure time between anterior and lateral approaches were assessed with the k-sample test of equality of medians. All analyses were conducted using Stata Version 14.1 (College Station, TX).

RESULTS

Between June 2017 and January 2018, 88 cases were reviewed as performed, with 30 anterior and 30 lateral approach cases included in this retrospective comparison study. A total of 28 cases were excluded from the study for using an inconclusive approach, multiple or bilateral procedures, cases without recorded dose and time data, and inadequately saved images to provide meaningful data (Figure 3).

Rate of successful intervention with needle placement confirmed within the articular space on contrast enhancement was not significantly different in the study groups with 96.7% (29 of 30) anterior approach cases reported as successful, 100% (30 of 30) lateral approach cases reported as successful. Overhanging pannus in the viewing area was reported in 5 anterior approach cases and 4 lateral cases. Hardware was noted in 2 lateral approach cases, none in anterior approach cases. Sedation was used for 3 of the anterior approach cases and none of the lateral approach cases.

Patients undergoing the lateral approach received a higher median radiation dose than did those undergoing the anterior

approach, but this was not statistically significant (P = .07) (Table). Those undergoing the lateral approach also had a longer median exposure time than did those undergoing the anterior approach, but this also was not statistically significant (P = .3). With no immediate complications reported in any of the studied interventions, there was no difference in complication rates between anterior and lateral approach cases.

TABLE Dose of Radiation and Time of Radiation Exposure for Anterior and Lateral Approaches

Variables	Anterior (n = 30)	Lateral (n = 30)	*P* Value
Dose, median, mGy (IR)	1 (2)	3 (2)	.07
Time, median, sec (IR)	4.8 (4.8)	7.8 (3)	.30

Abbreviation: IR, interquartile range.

DISCUSSION

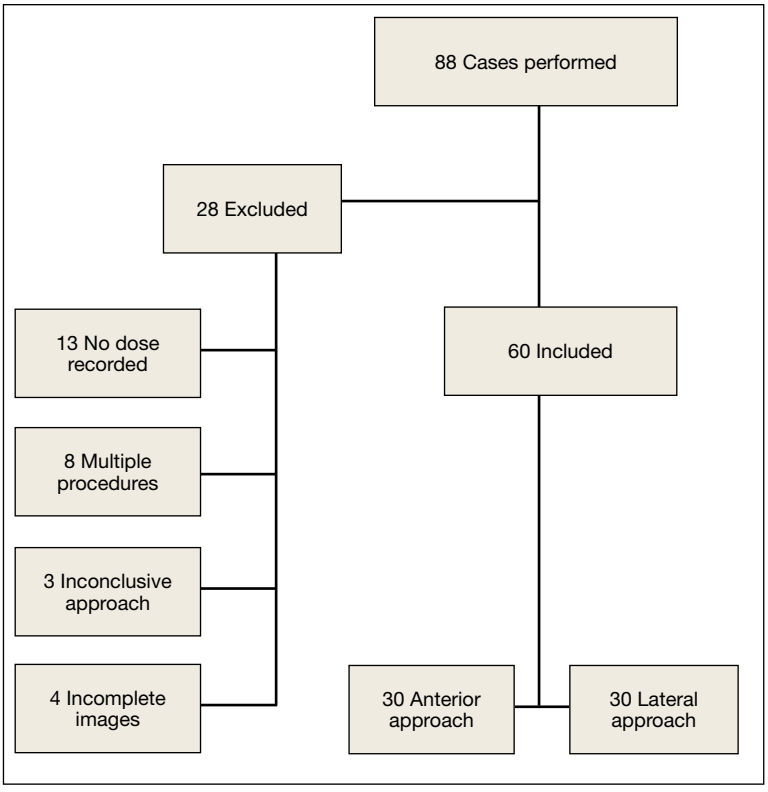
Pain medicine fellows who have previously completed residency in a variety of disciplines, often either anesthesiology or physical medicine and rehabilitation, perform fluoroscopically guided procedures and benefit from increased experience with coaxial technique as this improves needle depth and location awareness. Once mastered, this skill set can be applied to and useful for multiple interventional pain procedures. Similar technical instruction with an emphasis on coaxial technique for hip injections as performed in the anterior or anterolateral approach can be used in both fluoroscopic and ultrasound-guided procedures, including facet injection, transforaminal epidural steroid injection, and myriad other procedures performed to ameliorate pain. There are advantages to pursuing a similar approach with all image-guided procedures. Evaluated in this comparison study is an alternative technique that has potential for risk reduction benefit with reduced proximity to neurovascular structures, which ultimately leads to a safer procedure profile.

Using a lateral approach, the interventionalist determines a starting point, entering the skin at a greater distance from any overlying pannus and the elevated concentration of gram-negative and gram-positive bacteria contained within the inguinal skin.[6] A previous study demonstrated improved success of intra-articular needle tip placement without image guidance in patients with body mass index (BMI) < 30.[7] A prior study of anterior approach using anatomic landmarks as compared to lateral approach demonstrated the anterior approach pierced or contacted the femoral nerve in 27% of anterior cases and came within 5 mm of 60% of anterior cases.[2] Use of image guidance, whether ultrasound, fluoroscopy, or computed tomography (CT) is preferred related to reduced risk of contact with adjacent neurovascular structures. Anatomic surface landmarks have been described as an alternative injection technique, without the use of fluoroscopy for confirmatory initial, intraprocedure, and final placement.[8] Palpation of anatomic structures is required for this nonimage-guided technique, and although similar to the described technique in this study, the anatomically guided injection starting point is more lateral than the anterior approach but not in the most lateral position in the transverse plane that is used for this fluoroscopically guided lateral approach study.

Physiologic characteristics of subjects and technical aspects of fluoroscopy both can be factors in radiation dose and exposure times for hip injections. Patient BMI was not included in the data collection, but further study would seek to determine whether BMI is a significant risk for any increased radiation dose and exposure times using lateral approach injections. Use of lateral images for fluoroscopy requires penetration of X-ray beam through more tissue compared with that of anterior-posterior images. Further study of these techniques would benefit from comparing the pulse rate of fluoroscopic images and collimation (or focusing of the radiation beam over a smaller area of tissue) as factors in any observed increase in total radiation dose and exposure times.

Improving the safety profile of this procedure could have a positive impact on the patient population receiving fluoroscopic hip injections, both within the VA Ann Arbor Health System and elsewhere. While the study population was limited to the VA patient population seeking subspecialty nonsurgical joint care at a single tertiary care center, this technique is generalizable and can be used in most patients, as hip pain is a common condition necessitating nonoperative evaluation and treatment.

FIGURE 3 Inclusion/Exclusion Criteria



Radiation Exposures

As our analysis demonstrates, mean radiation dose exposure for each group was consistent with low (≤ 3 mSv) to moderate (> 3-20 mSv) annual effective doses in the general population.[7] Both anterior and lateral median radiation dose of 1 mGy and 3 mGy, respectively, are within the standard exposure for radiographs of the pelvis (1.31 mGy).[9] It is therefore reasonable to consider a lateral approach for hip injection, given the benefits of direct coaxial approach and avoiding needle entry through higher bacteria-concentrated skin.

The lateral approach did have increased radiation dose and exposure time, although it was not statistically significantly greater than the anterior approach. The difference between radiation dose and time to perform either technique was not clinically significant. One potential explanation for this is that the lateral technique has increased tissue to penetrate, which can be reduced with collimation and other fluoroscopic image adjustments. Additionally, as trainees progress in competency, fewer images should need to be obtained.[7] We hypothesize that as familiarity and comfort with this technique increase, the number of images necessary for successful injection would decrease, leading to decreased radiation dose and exposure time. We would expect that in the hands of a board-certified interventionalist, radiation dose and exposure time would be significantly decreased as compared to our current dataset, and this is an area of planned further study. With our existing dataset, the majority of procedures were performed with trainees, with inadequate information documented for comparison of dose over time and procedural experience under individual physicians.

Notable strengths of this study are the direct comparison of the anterior approach when compared to the lateral approach with regard to radiation dose and exposure time, which we have not seen described in the literature. A detailed description of the technique may result in increased utilization by other providers. Data were collected from multiple providers, as board-certified pain physicians and board-eligible interventional pain fellows performed the procedures. This variability in providers increases the generalizability of the findings, with a variety of providers, disciplines, years of experiences, and type of training represented.

Limitations

Limitations include the retrospective nature of the study and the relatively small sample size. However, even with this limitation, it is notable that no statistically significant differences were observed in mean radiation dose or fluoroscopy exposure time, making the lateral approach, at minimum, a noninferior technique. Combined with the improved safety profile, this technique is a viable alternative to the traditional anterior-oblique approach. Further study should be performed, such as a prospective, randomized control trial investigating the 2 techniques and following pain scores and functional ability after the procedure.

CONCLUSION

Given the decreased procedural risk related to proximity of neurovascular structures and coaxial technique for needle advancement, lateral approach for hip injection should be considered by those in any discipline

performing fluoroscopically guided procedures. Lateral technique may be particularly useful in technically challenging cases and when skin entry at the anterior groin is suboptimal, as a noninferior alternative to traditional anterior method.

Author disclosures

The authors report no actual or potential conflicts of interest with regard to this article.

Disclaimer

The opinions expressed herein are those of the authors and do not necessarily reflect those of *Federal Practitioner*, Frontline Medical Communications Inc., the US Government, or any of its agencies.

References

1. Cianfoni A, Boulter DJ, Rumboldt Z, Sapton T, Bonaldi G. Guidelines to imaging landmarks for interventional spine procedures: fluoroscopy and CT anatomy. *Neurographics.* 2011;1(1):39-48.
2. Leopold SS, Battista V, Oliverio JA. Safety and efficacy of intraarticular hip injection using anatomic landmarks. *Clin Orthop Relat Res.* 2001;(391):192-197.
3. Dodré E, Lefebvre G, Cockenpot E, Chastanet P, Cotten A. Interventional MSK procedures: the hip. *Br J Radiol.* 2016;89(1057):20150408.
4. Hankey S, McCall IW, Park WM, O'Connor BT. Technical problems in arthrography of the painful hip arthroplasty. *Clin Radiol.* 1979;30(6):653-656.
5. Yasar E, Singh JR, Hill J, Akuthota V. Image-guided injections of the hip. *J Nov Physiother Phys Rehabil.* 2014;1(2):39-48.
6. Aly R, Maibach HI. Aerobic microbial flora of intertrigenous skin. *Appl Environ Microbiol*. 1977;33(1):97-100.
7. Fazel R, Krumholz HM, Wang W, et al. Exposure to low-dose ionizing radiation from medical imaging procedures. *N Engl J Med.* 2009;361(9):849-857.
8. Masoud MA, Said HG. Intra-articular hip injection using anatomic surface landmarks. *Arthosc Tech.* 2013;2(2):e147-e149.
9. Ofori K, Gordon SW, Akrobortu E, Ampene AA, Darko EO. Estimation of adult patient doses for selected x-ray diagnostic examinations. *J Radiat Res Appl Sci.* 2014;7(4):459-462.