Precision and Accuracy of Identification of Anatomical Surface Landmarks by 30 Expert Hip Arthroscopists


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**Take-Home Points**

- Surface landmarks are routinely used for physical examination and surgical technique.
- Common surface landmarks used in establishing arthroscopic portals may be more difficult to accurately identify than previously thought.
- The greater trochanter was the surface landmark most precisely identified by expert examiners.
- Ultrasound examination identified landmarks varied from landmarks identified by palpation alone.

Anatomical surface landmarks about the hip and lower abdomen are often referenced when placing arthroscopic portals and office-based injections. However, the degree to which these landmarks can be reproducibly identified using only visual inspection and palpation is unknown.

Safe access to the hip joint and surrounding structures during hip arthroscopy has been a focus in the orthopedic literature. Authors have described anatomical relationships of recommended portals to neurovascular and other anatomical structures. This information has been reported in millimeters to centimeters of safety based on cadaver dissection studies. We conducted a study to assess expert hip arthroscopists’ ability to identify, using only physical examination techniques, the anatomical structures used for reference when creating safe starting points for arthroscopic access. We hypothesized that variance in examiner-identified points would exceed safe distances from neurovascular structures for the most commonly used hip arthroscopic portals. The volunteer in this study provided written informed consent for print and electronic publication of this article.

**Methods**

In this study, we prospectively assessed 30 expert hip arthroscopic surgeons’ ability to identify commonly referenced surface landmarks on the adult male hip, using only inspection and manual palpation. Surgeons were defined as experts on the basis of their status as hip arthroscopy instructors at the Orthopaedic Learning Center (Rosemont, IL) for the Arthroscopy Association of North America and industry-sponsored hip arthroscopy education faculty (Arthrex). Five surface landmarks were selected for their relevance to publications on safe portal placement: anterior superior iliac spine (ASIS), tip of greater trochanter (GT), rectus origin (RO),...
The superficial inguinal ring (SIR), and psoas tendon (PT).

A healthy adult male volunteer was placed supine on an examination table and exposed distally from the mid abdomen, with the perineum and the genital area covered bikini-style. An expert musculoskeletal ultrasonographer used a handheld musculoskeletal ultrasound transducer (Sonosite) to identify the 5 landmarks. Short- and long-axis images of each structure were obtained. The examiner applied a round (1 cm in diameter), uniquely colored adhesive label to the skin over each location. A professional photographer using a Canon digital camera and fixed mounts made precise overhead and lateral images. The positional integrity and scale of these images were confirmed with referral to constant anatomical skin features. Images were archived for analysis (Figure 1A).

After the ultrasonographer's labels were removed, each of the 30 expert hip arthroscopic surgeons identified the structures by static physical examination (inspection and palpation only) and applied the same colored labels to the skin.

The volunteer was not allowed to communicate about label placement with examiners but was encouraged to report any safety-related concerns. The photographer made the same digital photographs of the labels for each examiner as for the ultrasonographer (Figure 1B).

Imaging software (Adobe Photoshop Creative Suite 5.1) was used to superimpose the digital images of the examiner labels on those of the ultrasound-verified anatomical labels (Figure 1C). Measurements were then taken with digital calipers to determine average distance from ultrasound label; accuracy within 10 mm of verified ultrasound label; true average location (TAL) determined by 95% confidence interval (CI); and interobserver variability calculated by 95% prediction interval, which determined the probability of where an additional examiner data point would lie.

In the second arm of the study, examiner data were compared with previously published data on arthroscopic portal safety.
Distances from surface landmarks have been used to create common arthroscopy portals.²⁻⁴ The risk of neurovascular injury resulting from errors in identifying surface landmarks for creating portals was calculated using the direction and distance of the examiner TAL and the nearest published direction and distance of the nearest neurovascular structure. Increased risk of injury resulting from inaccurate identification of surface landmarks was surmised if the TAL of the anatomical structure fell outside the safe distance and direction to the nearest neurovascular structure for each of 4 common portals: anterolateral portal (ALP), anterior portal (AP), posterolateral portal (PLP), and mid-anterior portal (MAP).

Results

Average absolute distance from examiner labels to ultrasonographer labels was 31 mm for ASIS, 24 mm for GT, 26 mm for RO, 19 mm for SIR, and 35 mm for PT (Figure 2).

Of the 30 surgeons, 1 (3%) came within 10 mm of the ultrasound for ASIS, 1 (3%) for GT, 4 (13%) for RO, 5 (17%) for SIR, and 1 (3%) for PT (Table 1).

TAL as determined by CI was 16 mm medial and 29 mm inferior for ASIS; 8 mm anterior and 22 mm superior for GT; 10 mm medial and 25 mm inferior for RO; 5 mm lateral and 5 mm inferior for SIR; and 28 mm medial and 16 mm inferior for PT (Figure 3, Table 2). Interobserver variability determined by prediction interval had a range of 18 mm medial to lateral × 36 mm proximal to distal for ASIS; 33 mm anterior to posterior × 48 mm superior to inferior for GT; 41 mm medial to distal × 54 mm proximal to distal for RO; 51 mm medial to lateral × 74 mm proximal to distal for SIR; and 49 mm medial to distal × 61 mm proximal to distal for PT.
Given the difference between examiner data (direction and distance from ultrasound labels) and published data (distance to significant neurovascular structures), inaccurate identification of surface landmarks has the potential to lead to AP and MAP damage (Table 3). The examiner GT and ASIS surface landmarks used for AP overlapped directly with the safe distances for the lateral femoral cutaneous nerve and the terminal branch of the lateral circumflex femoral artery.

Discussion

Others have investigated examiners’ use of palpation, compared with ultrasound, to identify common shoulder and knee structures. In a 2011 systematic review, Gilliland and colleagues confirmed that accuracy was improved with use of ultrasound (vs palpation) for injections in the shoulder, hip, knee, wrist, and ankle. Given the scarcity of data in this setting, we conducted the present study to assess the precision and accuracy of expert
arthroscopists in identifying common surface landmarks. We hypothesized that physical examination and ultrasound examination would differ significantly in precisely and accurately identifying these landmarks.

Working with a standard awake volunteer, our test group of examiners was consistently inaccurate when they accepted ultrasonographer-placed labels as the ideal. Precision within the group, however, trended toward close agreement; examiners consistently placed labels in the same direction and approximate magnitude away from ultrasonographer labels. This suggests that a discrepancy between the ultrasonographic surface structure definitions taught to ultrasonographers and the manually identified definitions taught to surgeons for arthroscopy (training bias) can generate differences in landmark identification.

Given reported low rates of complications in the creation of standard surface anatomy portals, more data is needed to correlate whether safe distance guidelines best apply to the points identified by hip experts or the points identified by ultrasonographers. In a 2013 systematic review, Harris and colleagues found a 7.5% overall complication rate, with temporary neuropraxia 1 of the 2 most common complications. Whether adding ultrasound to physical examination for the creation of some or all portals will reduce the incidence of these problems is unknown. Regardless of the anatomical area referenced by experts for portal creation, the tight grouping of examiner marks in our study supports a consensus regarding the location of the landmarks studied.

In our study of the use of surface anatomical landmarks for the creation of portals, we analyzed 4 previously described locations: ALP, AP, PLP, and MAP. ALP, AP, and PLP directly reference at least 1 surface anatomical structure; AP references 2 anatomical structures (ASIS, GT); and MAP indirectly references ASIS and GT and directly references ALP and AP. In cadaveric and radiographic studies, 7 neurovascular structures have been described in proximity to ALP, AP, MAP, and PLP: superior gluteal nerve, sciatic nerve, femoral nerve, lateral femoral cutaneous nerve, lateral circumflex femoral artery, and medial circumflex femoral artery. Our results showed that use of surface anatomy in AP and MAP creation most likely places structures at risk, given the overlap of examiner CIs and the previously published cadaveric and radiographic data.

Hua and colleagues confirmed the feasibility of using ultrasound for the creation of hip arthroscopy portals. More data is needed to assess how the standard palpation-and-fluoroscopy method described by Byrd compares with an ultrasound-guided technique in safety and cost. However, data from our study should not be used to justify a demand for ultrasound during arthroscopy portal establishment, as limitations do not permit such a recommendation.

With diagnostic injection remaining a mainstay of differential diagnosis and treatment about the hip, the data presented here suggest a potential for ultrasound in enhancing outcomes. There is evidence supporting the role of image guidance in improving palpation accuracy in the area of the biceps tendon in the forearm. Potentially, identification and treatment of specific extra-articular structures surrounding the hip could be made safer with more routine use of ultrasound.

**Limitations**

This study had several limitations. The surgeons were limited to palpation and static examination of a body in its natural state. Hip arthroscopic portals typically are created under traction and after a standard perineal post is placed for hip arthroscopy. In addition, in an awake injection setting, the clinician may receive patient feedback in the form of limb movement or speech. To what degree palpation or ultrasound will be affected in these scenarios is unknown.
Another limitation is the lack of serial examination by each examiner—intrarater variability could not be gauged. In addition, with only 1 ultrasonographic examination performed, there is the potential that adding ultrasonographic examinations, or having an examiner perform serial physical examinations, could better define the precision of each component. Given the practical limitations of our volunteer’s time and the schedules of 30 expert arthroscopists, we kept the chosen study design for its single setting.

**Conclusion**

Visual inspection and manual palpation are standard means of identifying common surface anatomical landmarks for the creation of arthroscopy portals and the placement of injections. Our study results showed variance in landmark identification between expert examiners and an ultrasonographer. The degree of variance exceeded established neurovascular safe zones, particularly for AP and MAP. This new evidence calls for further investigation into the best, safest means of performing hip arthroscopic techniques and injection-based interventions.

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**Key Info**

**Figures/Tables**

**References**

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**Multimedia**

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