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# A Medial Portal for Hip Arthroscopy in Children With Septic Arthritis: A Safety Study

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**Background:** Prompt open arthrotomy is historically utilized to treat pediatric septic arthritis of the hip, but arthroscopy has been described as a valid alternative to prevent long-term sequelae. Standard hip arthroscopy in adolescents and adults utilizes lateral-based portals, but successful irrigation in infants may necessitate a medial portal due to the smaller joint size. The purpose of this study was to determine the safety of a medial hip portal in children based on its anatomic relation to neurovascular structures.

**Methods:** A retrospective review of children 6 years of age or below with septic hip arthritis who obtained a preoperative magnetic resonance imaging (MRI) between 2009 and 2015 was performed. Multiple measures were recorded from the MRI to create a 3D cone with the vertex just posterior to the adductor longus at the convergence of the gluteal and inguinal creases—a previously described posteromedial portal—with the cone base being a circle defined as the central joint diameter. The distance to the femoral vessels and nerve were then recorded. An adult cadaver was then utilized to replicate the proposed portal starting point and trajectory to confirm that it could be reproducible in a clinical setting.

**Results:** After applying criteria, 47 MRI were evaluated (21 boys, 26 girls) demonstrating a mean distance to femoral vessels and nerve: at insertion, 18.9 mm (minimum 10.5 mm) and at the hip joint, 11.1 mm (minimum 5.2 mm). Girls and boys did not differ significantly, but there was a significant correlation of both age ($r = 0.75$) and body weight ($r = 0.84$) to the measured distance ($P < 0.001$). Imaging of the cadaver confirmed that the starting point could be replicated.

**Conclusions:** There is a direct relation to size of the child and the distance from the neurovascular structures to the cannula trajectory, but even the smallest of children have at least 5.5 mm of adductor longus to protect the femoral structures. A medial-based portal that utilizes a medial needle for initial aspiration features a wide margin of safety for children requiring treatment for septic hip arthritis.

**Level of Evidence:** Level IV.

**Key Words:** hip, arthroscopy, medial portal, infant, septic, MRI

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Using arthroscopy for the diagnosis and treatment of hip pathologies is a growing modality in orthopaedic surgery. Many portals have been described in the literature, but they have mainly been lateral-based portals.[1–3] Medial-based portals have not been widely used because of its proximity to many neurovascular structures such as the obturator nerve and the medial circumflex artery.[4] However, access through a medial hip portal could be beneficial in hip pathologies that require a direct

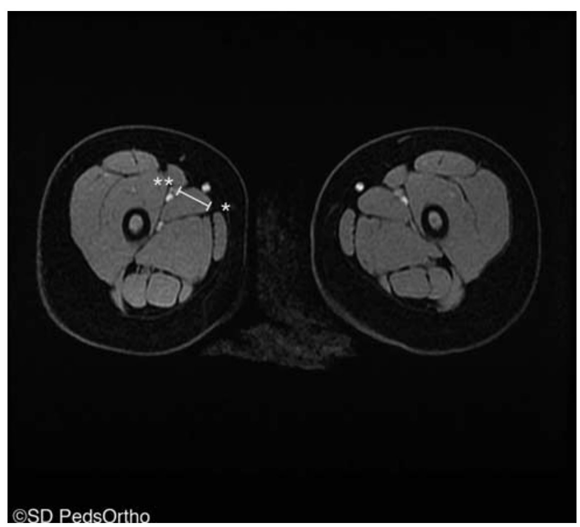


**FIGURE 1.** Axial magnetic resonance imaging sequence demonstrating the line drawn to measure the distance from the needle insertion (*) (or the cone vertex) to the femoral neurovascular structures (**).


**FIGURE 2.** Coronal magnetic resonance imaging of the cadaver demonstrating the wood dowel starting at the convergence of the skin creases (*) (cone vertex) and traveling toward the hip joint.

approach to the medial aspect of the hip, such as 2 portal irrigation and debridement in children with septic arthritis.

Chung et al[5] have documented the use of arthroscopy in children and they utilized either an anterolateral or medial portal and contested that the anterolateral portal was preferred for safety reasons. The utilization of a medial portal has been described to mirror the utilization of a needle for aspiration of the joint in this clinic setting. It is placed immediately posterior to the adductor longus muscle with the hip positioned in flexion, abduction, and external rotation. Teloken et al[6] described an inferomedial approach in an adult. This portal was positioned posterior to the adductor longus muscle with the hip in extension and abduction. Polesello et al[4] described 3 different medial portals (anteromedial, posteromedial, and distal posteromedial) for hip arthroscopy using adult cadavers.

To our knowledge, no study has evaluated the safety of using these various medial portals in children. The size of an infant precludes the need to have an inferomedial, posteromedial, and anteromedial portal and the convention of placing a needle for aspiration below, or posterior, to the adductor longus to minimize risk to the saphenous vessel and anterior branch of the obturator nerve suggests that the posteromedial is the most viable approach for a medial hip portal. Although previous cadaver studies have been performed in adults to this end, the availability of infant cadavers precludes the possibility of this assessment.[7] The purpose of this study was to utilize magnetic resonance imaging (MRI) of a pediatric population to determine the safety of a medial portal placement for arthroscopic drainage of septic hip. Our hypothesis is that the medial portals are safe and will not cause any injury to the main neurovascular structures in children with this condition.

## METHODS

A retrospective review of children with the diagnosis of septic hip arthritis was performed to include children below the age of 7 between January 2009 and March 2015. Exclusion criteria included those without a preoperative MRI, those with MRI but insufficient images to achieve the required measures, or poor quality imaging due to patient position (even though the thigh is placed in a slightly flexed and abducted position during surgery, this position within the MRI scanner created poor quality images because the sagittal, coronal, and axial cuts were not adjusted to match the position of the thigh as the orders were for imaging of the affected hip joint).

Previous reports on medial hip portals utilized discrete measures from bony landmarks on adults, but to adjust for the variation in size of this study population, a definition of the insertion point was developed. Knowing that the insertion would be posterior to the adductor longus, the measures of insertion to the femoral vessels and nerve (FNV) was made at the medial border of

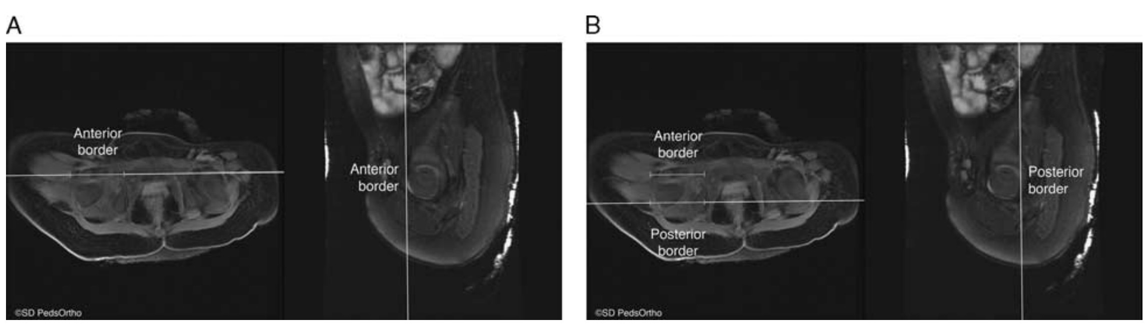


**FIGURE 3.** Axial (left image) and sagittal (right image) in sync magnetic resonance images demonstrating how the anterior border of the joint is identified (A), followed by the posterior border of the joint (B).

 

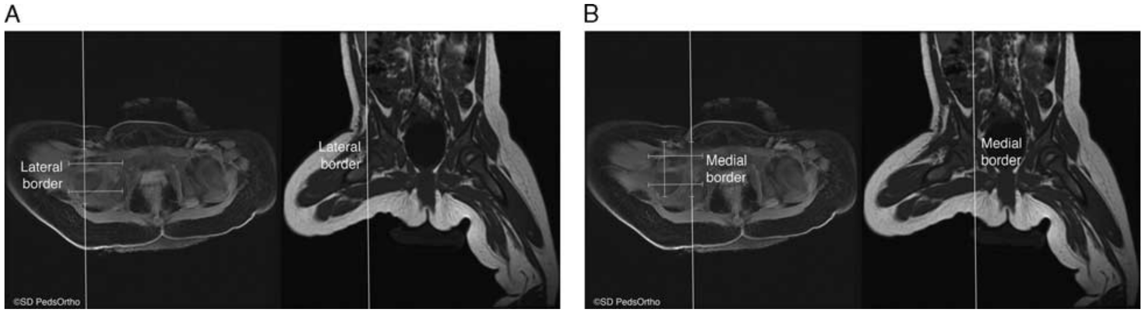


**FIGURE 4.** Axial (left image) and coronal (right image) in sync magnetic resonance images demonstrating how the lateral aspect of the joint on coronal is drawn on the axial sequence (A), followed by the medial aspect of the joint (B).

adductor longus at the cleft between it and the adductor magnus. The insertion was further defined in regards to distance from the hip joint by the convergence of the gluteal and inguinal creases at the aforementioned posteromedial location behind the adductor longus (Fig. 1). This location was consistently seen on MRI, and it was used on the adult cadaver within this study to confirm that our radiographic measures could be reproduced ex vivo.

A wooden dowel (diameter 4.8 mm) was placed utilizing these landmarks, and the adult cadaver was imaged (1.5T MRI, GE Discovery MR450; GE Healthcare, UK) to confirm that our landmarks represented what could be identified on the infant MRI. With the cadaver images validating our landmarks, the vertex of our cone could then be defined (Fig. 2).

We then evaluated the collected images and utilized the following protocol to define the base of the cone. The cone would then reflect possible variation in the trajectory of the needle being placed for the cannulated medial arthroscopy portal.

The images utilized for the study were the best available sequences that allowed a side-by-side comparison for coronal, axial, and sagittal images. These included T1, T2, and postintravenous contrast sequences. All measures were made utilizing Merge PACS (Merge Healthcare Inc., Chicago, IL). To establish the base of the cone, an axial image is discovered that represented the center of the joint based on referencing the other 2 sequences. This image then served to store all the measurements so that the diameter could define the circular base of the cone and then the distance to the FNV could

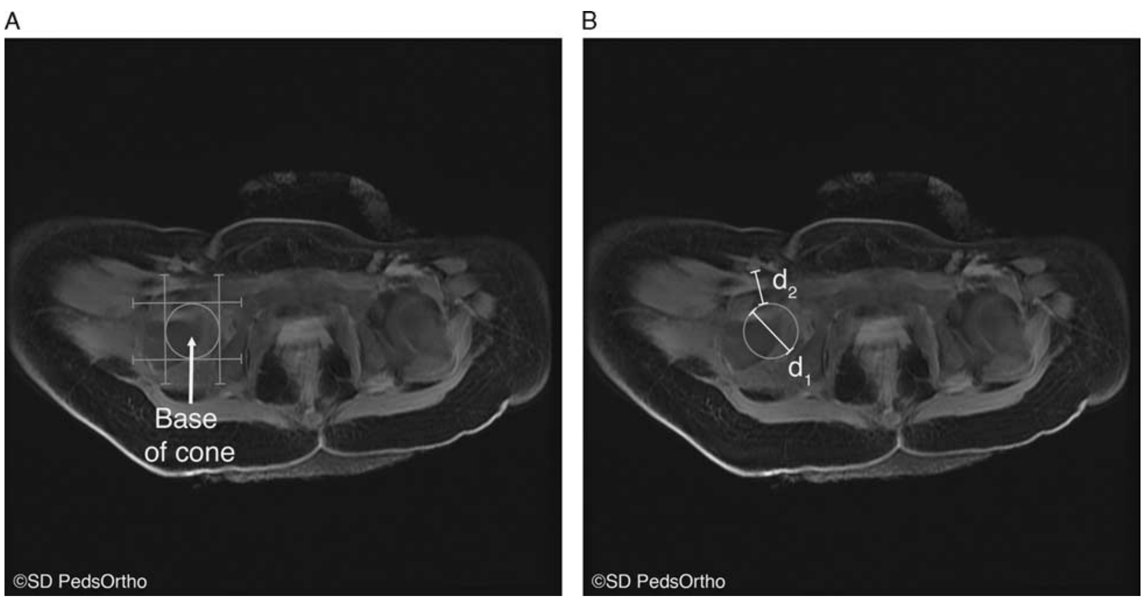


**FIGURE 5.** A, The same axial magnetic resonance image from previous figures with the 4 borders outlined, with a fit to match circle embedded. The circle makes up the base of the cone. B, Measurements can then be made of the base of cone diameter ($d_1$) and the distance from the base of the cone to the FNV ($d_2$).

**TABLE 1.** Mean Measurements (mm) for Each Age Group (Years), Both Sexes Included

| | | Cone Base Diameter | | Base to Femoral Vessel Distance | | Cone Vertex to Femoral Vessels | |
|---|---|---|---|---|---|---|---|
| Age | n | Mean ± SD | Range | Mean ± SD | Range | Mean ± SD | Range |
| 1 | 5 | 27.8 ± 3.2 | 23.7-31.9 | 8.0 ± 2.7 | 5.2-12 | 14 ± 3.9 | 10.9-20.8 |
| 2 | 11 | 25.5 ± 2.4 | 20.7-28.6 | 10.8 ± 2.7 | 7.0-16.8 | 15.4 ± 3.9 | 10.5-21.4 |
| 3 | 10 | 25.8 ± 2.3 | 21.5-29.0 | 9.4 ± 1.7 | 6.6-11.3 | 15.0 ± 4.0 | 10.9-23.8 |
| 4 | 6 | 29.8 ± 2.8 | 25.0-32.7 | 10.7 ± 3.1 | 6.3-13.7 | 19.9 ± 1.9 | 17.7-22.7 |
| 5 | 10 | 30.2 ± 3.0 | 25.8-35.1 | 13.7 ± 2.5 | 9.2-17.7 | 22.9 ± 3.0 | 18.0-28.8 |
| 6 | 5 | 33.8 ± 4.1 | 26.7-36.4 | 13.8 ± 1.4 | 12.1-15.8 | 30.3 ± 6.3 | 22.4-35.4 |
| Total | 47 | 28.3 ± 3.9 | 20.7-36.4 | 11.1 ± 3.0 | 5.2-17.7 | 18.9 ± 6.3 | 10.5-35.4 |

be recorded. Before measurements could be made, we identified the center images on the sagittal and the coronal sequences and recorded those as well. Starting with the sagittal center sequence the anterior border of the joint was identified and recorded (Fig. 3A) and then the posterior border (Fig. 3B). Then the coronal sequence was utilized to define the lateral and medial borders (Figs. 4A, B), and a circle was drawn into the center of that square (Fig. 5A). This circle is the base of the cone, with the insertion point of the arthroscope being the vertex of the cone. From this the diameter and distance to the FNV could be measured (Fig. 5B).

Patient age, sex, height, and weight were recorded. Size and distance measurements were recorded in millimeters for each patient. The Shapiro-Wilk test of normality was performed on all data before analysis. Descriptive statistics were reported. Analysis of variance and Mann-Whitney tests were used to compare means among boys and girls. Simple linear regression analysis was used to evaluate the relationship between age and weight and distance to vessels. The data analysis was performed using SPSS (version 12; SPSS Inc., Chicago, IL).

## RESULTS

An initial search for children with a septic hip treated within the Institutional Review Board approval window yielded 107 subjects. In total, 42 subjects were excluded because they did not have a diagnostic MRI, 14 subjects were excluded because they were 7 years of age or above, 1 subject was excluded for being below 1 year of age, and 3 subjects were excluded because their MRI was taken with the hip flexed (n = 2) or abducted (n = 1). A total of 47 children were included. The cohort included 21 boys and 26 girls. Table 1 demonstrates the distribution of measures based on sex and age, and the mean distances to the FNV were as follows: at insertion, 18.9 ± 6.3 mm (minimum 10.5 mm) and at the hip joint, 11.1 ± 3.0 mm (minimum 5.2 mm).

We found no significant difference in cone base diameter ($P = 0.46$), base to femoral vessel distance ($P = 0.76$), or cone vertex to femoral vessel distance ($P = 0.99$) based on sex of the child. Instead, differences in cone base diameter, base to femoral vessel distance, or cone vertex to femoral vessel distance were found to be related to changes in age and body weight (Table 2).

## DISCUSSION

Despite the fact that arthroscopy is a valid alternative to open treatment of septic arthritis in the knee with shorter hospitalizations and its minimally invasive nature with little soft tissue disruption,[8] hip arthroscopy has not replaced open arthrotomy in the treatment of infantile septic hip arthritis. Although the technique was first described as a successful case series about a quarter century before this study,[5] there have not been any comparative studies. One of the factors likely contributing to this lack of popularity is that standard hip arthroscopy requires traction and therefore utilizes only lateral-sided portals. Unfortunately, both of these make "standard" hip arthroscopy difficult to perform in infants. However, even as described by Chung and colleagues, traction is not required for those below the age of 6 years. Yet, they only used a single portal in washing out their series of infants. Even though evidence for using 1 versus 2 portals is nonexistent, the advantage of having 2 portals (as described in other joints where this technique has grown in favor) cannot be understated.[8] Therefore, the importance of determining how to develop 2 portals in the infant hip is paramount to the safety of those portals. The ability to look into the joint with a camera is not been previously identified as an important aspect of septic hip

**TABLE 2.** Correlation Between Measurements and Age and Weight

| | Cone Base Diameter | | Base to Femoral Vessel Distance | | Cone Vertex to Femoral Vessels | |
|---|---|---|---|---|---|---|
| | *r* | *P* | *r* | *P* | *r* | *P* |
| Age | 0.603 | < 0.001 | 0.568 | 0.004 | 0.754 | < 0.001 |
| Weight | 0.669 | < 0.001 | 0.382 | < 0.001 | 0.835 | < 0.001 |

*r* = Pearson correlation.

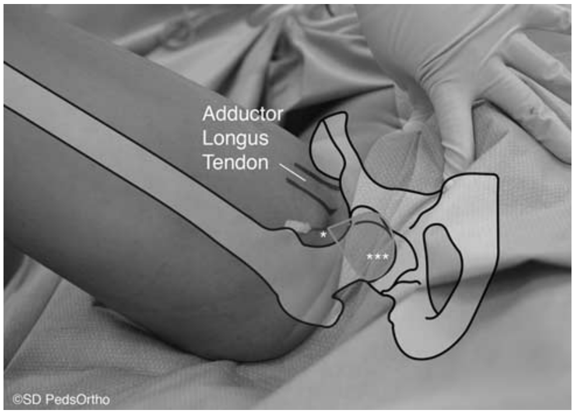


**FIGURE 6.** Intraoperative clinical photograph demonstrating the insertion point of the posteromedial needle for aspiration in a child with presumed septic hip arthritis, the inguinal and gluteal creases are marked with a 3D rendering of the cone defined by our measurements and its relationship to the femoral nerve and vessels overlaid on the photograph. *indicates the vertex of the cone. ***indicates the base of the cone.

irrigation. This study identifies that a medial-based portal could be utilized in a safe fashion, as it relates to the femoral neurological and vascular structures.

Previous cadaver work in adult specimens has confirmed that the posteromedial portal is safe and that both the proximal and distal versions are a mean 10 mm from the profundis femoral artery.[4] Without doubt, the obturator nerve is close to this portal, but the posterior branch is the structure at risk and it is at no greater risk than when this site is utilized for needle aspiration of the joint. Despite the smaller sizes of our specimens, our MRI data suggest that the distance to the FNV is approximately the same as that seen in the adult cadaver.

Moreover, the methodology of our review helps define a safe starting point for the medial portal utilizing the gluteal and inguinal crease convergence to identify the distance from the pelvis to make the vertex of the cone of entry. When this landmark is utilized, then risk to the FNV structures is minimized (Fig. 6). The margin for safety is a mean 18.9 mm at the insertion of the needle and 11.1 mm at the hip joint utilizing these landmarks, as the needle passes posteromedial to the femoral neurovascular structures. The choice of arthroscopy cannula size is at the discretion of the operating surgeon, but the standard scope diameters for children tend to be 2.7 and 4.5 mm, so these radii would diminish the margin of safety by approximately 1.3 to 2.3 mm, respectively. However, it is important to note that insertion of a cannula over a guide wire (which would be the standard technique for insertion of a cannula into the hip joint) will push structures away from the cannula rather than risking penetration of the structures, as is the case with a needle insertion.

The greatest limitation of this study is the inability to have true 3D reconstructions of the MRI. This would have made for digital pediatric cadavers that could have been utilized in place of actual cadavers that are difficult to obtain in this age group. However, the methodology of our measurements helps give a good approximation of the safety of this type of hip portal. Moreover, the resolution of the 1.5T MRI limited the ability to identify all the potential structures at risk such as the posterior branch of the obturator nerve, as mentioned previously.

There is a direct relation to size of the child and the distance from the neurovascular structures at the vertex to the cannula trajectory, but even the smallest of children have at least 5.5 mm of adductor longus to protect the femoral structures. A medial-based portal that utilizes a medial needle for initial aspiration features a wide margin of safety for children requiring treatment for septic hip arthritis. Future study on the clinical success of this portal to effectively and safely treat septic arthritis of the infant hip can now be undertaken.

## REFERENCES

1. Dienst M, Gödde S, Seil R, et al. Hip arthroscopy without traction: in vivo anatomy of the peripheral hip joint cavity. *Arthroscopy*. 2001;17:924–931.
2. Byrd JW, Pappas JN, Pedley MJ. Hip arthroscopy: an anatomic study of portal placement and relationship to the extra-articular structures. *Arthroscopy*. 1995;11:418–423.
3. Robertson WJ, Kelly BT. The safe zone for hip arthroscopy: a cadaveric assessment of central, peripheral, and lateral compartment portal placement. *Arthroscopy*. 2008;24:1019–1026.
4. Polesello GC, Omine Fernandes AE, de Oliveira LP, et al. Medial hip arthroscopy portals: an anatomic study. *Arthroscopy*. 2014;30:55–59.
5. Chung WK, Slater GL, Bates EH. Treatment of septic arthritis of the hip by arthroscopic lavage. *J Pediatr Orthop*. 1993;13:444–446.
6. Teloken MA, Schmietd I, Tomlinson DP. Hip arthroscopy: a unique inferomedial approach to bullet removal. *Arthroscopy*. 2002;18:E21.
7. Thorey F, Ezechieli M, Ettinger M, et al. Access to the hip joint from standard arthroscopic portals: a cadaveric study. *Arthroscopy*. 2013;29:1297–1307.
8. Skyhar MJ, Mubarak SJ. Arthroscopic treatment of septic knees in children. *J Pediatr Orthop*. 1987;7:647–651.