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RESEARCH ARTICLE

Management of septic arthritis of the pediatric hip

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Abstract: **Purpose** The purpose of this study was to compare outcomes and reoperation rate between open and arthroscopic treatment of a suspected isolated septic hip in the pediatric population. **Methods** Retrospective review was performed on two cohorts of pediatric patients who underwent surgical intervention for suspected isolated septic hip arthritis at a single institution. Patients were subdivided into two cohorts based on whether they underwent an open versus arthroscopic approach. Patients were excluded if they received an initial surgery from an outside institution, did not have an acute, active infection at presentation, defined as a hip aspiration leukocyte count <50,000 cells with <75% neutrophils, had extracaspular pathology or osteomyelitis, or had septic arthritis of a joint other than the hip. **Results** Fifty-six hips were included [Open group (n = 36); Arthroscopic group (n = 20)]. Six percent (2/36) of hips in the open group and 26% (5/19) of hips in the arthroscopy group had a positive tissue culture (p = 0.041). Eleven hips (31%) underwent postoperative immobilization in the open group compared to one hip (5%) in the arthroscopic group (p = 0.039). **Conclusions** In the setting of isolated arthritis, arthroscopy is a reasonable treatment modality with no observed additional risk compared to open arthrotomy. However, with concomitant osteomyelitis or soft tissue abscess, open arthrotomy should remain the mainstay approach to address all elements of the infection.

Level of Evidence: Level III

Keywords: septic hip, pediatric septic hip, scope *vs* open

1 Introduction

Acute pediatric septic arthritis of the hip is an important orthopedic diagnosis that requires timely diagnosis and treatment to minimize irreparable damage to the joint. Sequelae from inadequate or delayed treatment can lead to systemic spread of the infection and pathologic changes to the hip joint, including chondrolysis, coxa magna, avascular necrosis of the femoral head, chronic osteomyelitis, and premature osteoarthritis. A multidisciplinary approach utilizing radiologists, infectious disease specialists, and physical therapists can produce an efficient work up and process of care leading to quicker transition to oral antibiotics and shorter hospital stays.

It is a challenge to differentiate isolated septic arthritis from the numerous disease processes with similar clinical presentations. Kocher's criteria, presence of fever, non-weight bearing, leukocytosis and elevated erythrocyte sedimentation rate (ESR), is a widely used tool to distinguish between transient synovitis and septic arthritis of the hip. The addition of elevated c-reactive protein (CRP) has greatly increased the accuracy of the diagnosis[1–3]. Once a diagnosis of septic arthritis of the hip is suspected, urgent irrigation and drainage of the joint is recommended to reduce the sequelae, either by open or arthroscopic approach; but, current algorithms suggest that advanced imaging can play an important role in presurgical planning, especially in the setting of concomitant osteomyelitis, subperiosteal abscess or pyomyositis[4]. First described separately by Blitzer and Chung et al in 1993, arthroscopic lavage has been an attractive, less invasive alternative to the traditional open arthrotomy[5,6]. However, much of the literature is limited to case series' or are inclusive of other joint infections[7,8]. As more surgeons are trained using arthroscopy and their comfort levels (experience) improve, utilization of arthroscopy to treat these infections has become more attractive.

El-Sayed's 2008 study comparing the outcomes between arthroscopic and open lavage was performed with 10 children in each group and no advanced imaging to assess for concomitant pathology. The results of this previous work found no significant difference in overall outcomes, except for length of hospital stay and did not include information regarding repeat washout[9]. The pur-

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pose of the present study was to compare outcomes as well as the rate of reoperation between open and arthroscopic treatment of a suspected isolated septic hip in a larger patient cohort. Our null hypothesis was that there would be no observed difference in reoperation rate, hospital stay, or other outcomes in patients when treated with either open or arthroscopic lavage.

2 Methods

Institutional review board approval was obtained for this study. A retrospective review of children who underwent surgical intervention for suspected isolated septic hip arthritis at our hospital was performed. All suspected septic hip joints underwent an intra-articular hip aspiration under anesthesia in the operating room before proceeding with either open or arthroscopic irrigation and debridement. Suspected septic hip arthritis was defined as a hip aspiration leukocyte count >50,000 cells with >75% neutrophils or positive culture from the synovial fluid.

Patients were excluded if they received an initial surgery from an outside institution (n = 2), did not have an acute, active infection at presentation, defined as a hip aspiration leukocyte count <50,000 cells with <75% neutrophils (n = 5), had extracaspular pathology or osteomyelitis (n=9) or had septic arthritis of a joint other than the hip (n = 92).

Demographic data, clinical exam findings, laboratory values (white blood cell count, ESR, CRP, blood culture, synovial fluid culture, tissue culture) were recorded. Radiographic or advanced imaging changes on preoperative and postoperative imaging were documented. Children were discharged home after antibiotic regimen was adjusted for microbial growth and sensitivities, absence of fever for at least 24hrs, the drain was removed, pain was under control, and the CRP was found to be less than 2 mg/dL. Per hospital protocol defined by our Infectious Disease (ID) service, all children with septic arthritis were started on parenteral Clindamycin at the conclusion of initial surgical intervention. If the cultures were negative, then patients were discharged home on either Keflex (for Kingella kingae) or Clindamycin (for Staphylococcus aureus) per ID consult recommendations for possible culture negative bacteria. The duration of the antibiotic regimen was determined by the ID consult and was inherently patient dependent. Postoperative weight bearing status of patients was surgeon dependent.

Postoperative range of motion was defined as asymmetric if there was any indication of a difference in range of motion between the operative hip and contralateral hip on the final follow up visit from chart review. Any abnormal radiographic findings on final plain radiographs were documented, such as joint asymmetry, changes to the femur, acetabulum or soft tissue. Any reoperation or readmission was recorded.

2.1 Surgical technique

The decision to treat with open *vs* arthroscopic lavage was based on surgeon preference. Children that underwent open lavage of the joint were routinely treated through a Smith-Peterson approach utilizing a transverse skin incision that then proceeded through the sartorius-tensor fascia lata interval with retraction of the rectus femoris laterally and a capsular T incision.

The children who underwent an arthroscopic lavage, had a medial 18-gauge spinal needle placed (per aspiration protocol) adjacent to the adductor longus under fluoroscopy guidance to first aspirate for culture, but then to distend the joint with saline. A 5mm incision was then placed lateral on the thigh just proximal to the greater trochanter (the anterior peri-trochanteric portal location). A 2.7mm arthroscopic cannula with trocar was then placed through this incision under fluoroscopic guidance into the joint. If the child was large enough, then a second small joint cannula was placed medially at the location of the aspiration (posterior to the adductor longus). In smaller children, the 18-gauge needle was utilized as the inflow portal. The drain was always placed through the lateral peri-trochanteric portal. In older children (age 8 years and older), a hip arthroscopy table was utilized and the joint was distracted approximately 10 mm. Routine anterolateral peritrochanteric and mid-anterior portals were established into the central compartment of the joint using a spinal needle technique. The drain was typically placed through the anterolateral portal into the peripheral compartment of the joint after the traction had been let down.

Basic descriptive statistics are reported. All continuous data was evaluated for normality with the Shapiro-Wilk test and Levene's test for homogeneity of variances. Normally distributed continuous data was analyzed with analysis of variance (ANOVA), non-normally distributed data was analyzed with the Mann-Whitney U test. Categorical data was analyzed with Pearson's Chi-square or Fisher's exact test. No a priori power analysis was performed. All statistical analysis was performed using SPSS (version 24; IBM, New York, USA). Significance was defined as $p < 0.05$.

2.2 Ethics statement

This study was reviewed and approved by our Institutional Review Board and informed consent was not required for this study. All procedures performed in this

study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

3 Results

Fifty-six pediatric hips were included in this study. Thirty-six hips were treated with open arthrotomy and 20 hips underwent arthroscopic lavage. The mean age for the open and arthroscopic lavage groups was 6.6±3.9 years and 6.1±2.9 years respectively. The open group consisted primarily of females (22/36, 61%). The arthroscopic lavage group consisted of nine females and 11 males.

3.1 Open versus Arthroscopic Treatment

There was no significant difference in age, time of onset of symptoms to presentation, length of stay, or preoperative plasma WBC, CRP and ESR when comparing the open and arthroscopic treatment groups (Table 1). In addition, there was no significant difference when comparing the treatment groups when analyzing culture types (synovial fluid or blood), however, there was a significant difference between the groups when analyzing tissue culture (p = 0.041). There were 2 of 36 (6%) patients that had positive tissue culture from the hip joint in the open treatment group compared to 5 of 19 (26%) patients in the arthroscopy group (Table 2). Thirty-six percent of our cohort was found to have more than one positive culture, 11% in the open group and 25% in the arthroscopy group. Sixty-one percent of our cohort was found to be culture negative, 67% in the open treatment group and 50% in the arthroscopy group.

Table 1. Open *vs* arthroscopy – continuous demographic data and outcomes of interest

	Open (n=36)	Arthroscopy (n=20)	p value
Age (years)	6.6±3.9	6.1±2.9	0.589
Length of stay (days)	6.2±3.4*	6.4±3.2	0.660
Length of follow up (weeks)	43.7±70.1	13.0±10.7	0.110
Time from onset of symptoms to presentation (days)	2.4±2.5	2.9±1.7	0.083
Total WBC	13.6±3.9	14.0±6.4	0.657
Total percent PMNs	63.7±13.2**	65.0±15.0	0.602
Total ESR	35.9±18.1***	44.7±18.6	0.819
Total CRP	4.7±5.2**	7.4±5.9****	0.051
Synovial WBC	94.0k±57.7k†	95.4k±61.2k††	0.983

Note: ESR = estimated sedimentation rate in blood (nl 0-15 mm); CRP = C-Reactive Protein in blood (nl <0.8 mg/dl); WBC in blood (nl 6.0–14 k); Synovial WBC (k = x 1,000 cells) from synovial fluid aspiration; *n=33; **n=31; ***n=35; ****n=19; †n=32; ††n=16

There was no significant difference in the duration of the hospital stay (p = 0.66) or in the reoperation rate between open and arthroscopic treatment groups (p = 1.0). There was a statistically significant difference when comparing postoperative immobilization and/or weight bearing restrictions between the open and arthroscopy groups (p = 0.039). There were 11 hips (31%) who underwent postoperative immobilization in the open group compared to one hip (5%) in the arthroscopic group. We observed no difference among the arthroscopic and open arthrotomy groups in the proportion of asymmetric range of motion (p = 1.0) or post-operative x-ray findings (p = 1.0). There were three transient nerve palsies (two lateral femoral cutaneous nerve and one common peroneal nerve) that resolved by the final clinical visit in the open treatment group. There were no nerve injuries in the arthroscopy group.

Length of follow up was not statistically different between the open and arthroscopic groups (p = 0.11).

4 Discussion and conclusion

While open arthrotomy remains the gold standard for treatment of adult and pediatric septic arthritis, arthroscopic lavage is an acceptable alternative in the appropriate patient and adequately-trained surgeon[3,4,10,11]. In general, hip arthroscopy is technically challenging but its ease has improved with more fellowship-trained surgeons learning the procedure earlier in their careers as well as improvements in surgical instruments and techniques[8,12]. It is frequently utilized for noninfectious pathologies such as femoral acetabular impingement, ligamentum teres tears, chondral lesions and/or labral tears[13]. Some surgeons also report that the shallow hip joint and the greater laxity of the surrounding soft tissues in children makes hip arthroscopy easier than in adults. Our findings do not refute the potential benefits of hip arthroscopy for septic arthritis in this age group; but, it also does not make any suggestion that it is better than the gold-standard of open lavage.

The minimally invasive nature of arthroscopy aims to reduce the surgical morbidity and allow an easier postoperative course for patients[14]. Historically, some surgeons suggested a brief period of hip immobilization in abduction to prevent any contracture that could predispose to hip subluxation. In the current study, we observed a difference in immobilization or weight bearing status when comparing open *vs* arthroscopic treatment. One study by El-Sayed evaluated 20 patients following either arthroscopic or open treatment of early pediatric septic arthritis and reported no significant difference in complication rate, or ability to eradicate infection. Unlike the current study, El-Sayed found length of stay to be significantly longer in the open arthrotomy group than the arthroscopic group[9]. We believe that this was merely surgeon bias and not related to objective criteria for discharge, as utilized in the present study. Our larger sample size further delineated that surgical technique would achieve similar outcomes

Table 2. Open *vs* arthroscopy – categorical demographic data and outcomes of interest

		Open (n=36)	Arthroscopy (n=20)	p-value
Reoperation (ReOp) rate	ReOp [n(%)]	5 (14%)	2 (10%)	1
	No ReOp [n(%)]	31 (86%)	18 (90%)	
Blood culture	Positive [n(%)]	2 (6%)	3 (18%)	0.315
	Negative [n(%)]	33 (94%)	14 (82%)	
Synovial fluid culture	Positive [n(%)]	12 (33%)	8 (40%)	0.618
	Negative [n(%)]	24 (67%)	12 (60%)	
Tissue culture	Positive [n(%)]	2 (6%)	5 (26%)	0.041*
	Negative [n(%)]	34 (94%)	14 (74%)	
Postoperative range of motion	Symmetric [n(%)]	28 (82%)	15 (79%)	1
	Asymmetric [n(%)]	6 (18%)	4 (21%)	
Postoperative x-ray findings	Normal [n(%)]	34 (94%)	16 (94%)	1
	Abnormal [n(%)]	2 (6%)	1 (6%)	
Postoperative immobilization	Immobilization [n(%)]	11 (31%)	1 (5%)	0.039*
	No Immobilization [n(%)]	25 (69%)	19 (95%)	

Note: *$p<0.05$; Asymmetric Range of Motion (ROM) is defined as any noted difference in motion between the affected and unaffected side. Abnormal x-ray includes any change on x-ray to the operative hip including joint narrowing, asymmetric morphology of the proximal femur and/or acetabulum relative to the unaffected side, significant sclerosis about the proximal femur and/or acetabulum or heterotopic ossification.

related to bacterial growth in culture, trending of serum inflammatory markers and susceptibility to antibiotics.

Literature suggests that culture-negative septic arthritis does exist. Lyon and Evanich's 1999 study actually found a 70% culture-negative septic arthritis in their cohort of children[15]. So, the rate of 50% in the arthroscopic group and 67% in the Open group in the current study is not outside the realm of normal for this type of pathology.

Before the emergence of MRI, children who met Kocher criteria underwent hip aspiration to assist in the diagnosis of septic hip prior to surgical intervention[4,12]. The current study does not refute the study by Gottschalk et al. regarding the importance of MRI utilization in the work up of suspected septic hip arthritis[4] and notes that arthroscopy is not indicated when extracapsular pathologies are found on pre-operative MRI – we would suggest that they are in fact contra-indicated in this setting. In more austere environments, an open approach to the hip may be more beneficial as it allows for exploration of surrounding soft tissue planes (sub-periosteal abscess or pyomyositis) and decompression of the femoral neck (in the setting of metaphyseal osteomyelitis). Yet, if advanced imaging is available, and there is no identified extra-capsular pathology, then arthroscopic lavage of the septic arthritis is successful and viable with less restrictions on early mobilization of the joint.

Each child's case needs to be considered carefully when deciding to undertake surgery. We understand that each facility, the time of day the surgery is performed, the surgeon involved, and the operative team available, can all be factors that mitigate the observed benefits of either surgical technique. Therefore, the authors are not attempting to promote arthroscopy over an open arthrotomy procedure. The greatest limitation to this study is that we do not have outcomes that span decades of each child's life. We had concerns that the previous study directly comparing these two operative techniques failed to identify and therefore undertreated underlying osteomyelitis when it reported 3 of 20 cases with persistent hip pain at nearly 2 years follow-up. Without advanced imaging, it is difficult to surmise the truth. Our limitation, is that that we obtained the advanced imaging to prove that these were all cases of isolated septic arthritis, but we do not achieve great follow-up in our retrospective evaluation.

Similar to El-Sayed, the current study found no significant differences in outcomes regarding the management of septic arthritis, when comparing open versus arthroscopic approaches. Previous literature has demonstrated the utility of obtaining MRI in the routine pre-operative evaluation of suspected septic arthritis of the pediatric hip has positively impacted the management of the condition, and we do not refute these results especially if considering arthroscopy. In the isolated septic arthritis patient, arthroscopy is a valid alternative to open management for urgent lavage as it appears to have less risk for nerve palsy; and is generally accepted as less invasive (even though following unbiased discrete criteria for discharge home, seems to minimize these benefits). We did find a difference in post operative immobilization utilization between the two surgeries (wherein, the arthroscopic treated children were less likely to undergo post operative immobilization), but the benefits of this finding are yet to be elucidated. Our conclusion is that arthroscopic lavage (with current techniques and technology) can achieve comparable outcomes to open lavage, as we failed to reject our null hypothesis. Both techniques have their advantages, and depending on the pre-operative assessment, both have a place in the armamentarium of the modern day orthopedic surgeon managing pediatric septic arthritis of the hip.

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