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Original Article

Heterotopic ossification after hemiarthroplasty of the hip – A comparison of three common approaches

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ARTICLE INFO

Article history:

Received 21 August 2014

Accepted 24 November 2014

Available online 26 December 2014

Keywords:

Hemiarthroplasty

Heterotopic ossification

Operative approach

ABSTRACT

Objective: Heterotopic ossification (HO) about the hip after total hip arthroplasty and internal fixation of the hip, pelvis, and acetabulum has been linked to surgical approach. However, no study has investigated surgical approach and HO in patients undergoing hemiarthroplasty. We therefore aimed to explore the influence of operative approach in patients undergoing hemiarthroplasty.

Methods: Through a retrospective case series at an Urban level I trauma center, we found 80 patients over the age of 60 undergoing hemiarthroplasty for femoral neck fractures from 2000 to 2009. Patient charts, operative notes, and radiographs were reviewed for demographics, operative approach (anterior: A, anterior-lateral: AL, posterior: P), and any development of HO. Fisher's exact test compared rates of HO among the three approaches. Student's t-tests compared Brooker Classification levels of HO among the approaches.

Results: 82 hemiarthroplasties (26 A, 32 AL, 24 P) were included for analysis. 22 patients (27%) had HO. There was no significant difference in the development of HO based upon surgical approach: A: 19% (n = 5); AL: 34% (n = 11); P: 25% (n = 6). There was a significant difference in the grade of HO based on Brooker Classification (BC) with the posterior approach resulting in significantly lower grade of HO: A (BC: 2.60); AL (BC: 2.64); P (BC: 1.50) (p = 0.012).

Conclusions: Our data is the first to evaluate surgical approach and HO in patients with hemiarthroplasty. Patients have a significant risk of developing higher grade HO based on surgical approach (A or AL). Orthopedists should be mindful of these risks when considering A or AL approaches.

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<http://dx.doi.org/10.1016/j.jcot.2014.11.004>

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1. Introduction

Very little data in the literature explores the variables leading to heterotopic ossification (HO) in patients undergoing hemiarthroplasty of the hip. In comparison, many studies have investigated HO after both total hip arthroplasty (THA) and internal fixation (ORIF) of the hip, pelvis, and acetabulum. Upwards of 61% of THA patients develop HO postoperatively, whereas the incidence of HO in ORIF patients ranges from 8 to 42% of patients.^{1–5} Although multiple factors such as prior history of HO, hypertrophic osteoarthritis, ankylosing spondylitis, and male gender have been linked to the development of HO in both THA and ORIF patients, the incidence and causative factors of HO in hemiarthroplasty patients are largely unknown.^{1–8}

For example, Grevitt and colleagues investigated 22 cemented biarticular hemiarthroplasties in renal transplant patients with advanced osteonecrosis and found a 20% incidence of HO.⁹ Similarly, Chen et al retrospectively reviewed 451 cases of displaced intracapsular fractures and found an increased rate of HO in patients with cemented compared to uncemented hemiarthroplasty.¹⁰ In contrast to these two studies, Ozturkmen and colleagues found a 0% incidence of HO in 48 patients who were treated with cementless hemiarthroplasty for femoral neck fractures.¹¹

Although cementless hemiarthroplasty may be linked to decreased rates of HO in hemiarthroplasty, one modifiable factor that has been shown to affect HO rates in THA patients is surgical approach. Studies have specifically shown distinct ossification rates based on anterior, lateral, and posterior approaches in patients undergoing THA.^{1,3,12,13} However, no study to date has investigated the effect of operative approach on the development of HO in patients undergoing hemiarthroplasty. Therefore, it remains unknown whether hemiarthroplasty follows similar HO patterns as seen with THA based on surgical approach.

In this paper, we present the results of the first retrospective study to date investigating HO rates based on operative approach in a cohort of hemiarthroplasty patients. By investigating the overall incidence of postoperative HO and the average Brooker Classification Score associated with each approach, the practicing orthopedist may be better informed in choosing an operative approach that is less likely to result in HO.

2. Methods

After IRB approval, all patients over the age of 60 years undergoing hip hemiarthroplasties secondary to femoral neck fractures from Jan. 1 2000 to Jan. 1 2009 were identified through a CPT code search (27236 and 27125) of the institution's orthopedic database. Patients with previous ipsilateral hip surgery, current infection of the hip, and the presence of bony or soft tissue tumors around the hip were excluded from analysis. Furthermore, patients with fewer than 25 days of radiographic data were excluded.

Basic demographic information for the remaining patients were extracted from the electronic medical charts. Surgical

approach for each patient was noted as posterior (Kocher-Langenbeck), anterolateral (Hardinge), or anterior (Smith-Peterson) by reviewing individual operative reports. The diagnosis of heterotopic ossification was made by comparing the most recent anteroposterior (AP) pelvic radiograph in the patient's chart to an AP film taken in the immediate post-operative period. Brooker Classification Scores (BCS) were assigned to score the extent of heterotopic ossification for each patient (0: no heterotopic ossification; I: islands of bone within the soft tissues about the hip; II: bone spurs from the pelvis or the proximal end of the femur with at least 1 cm between the opposing bone surfaces; III: bone spurs that are within 1 cm between the opposing bone surfaces; IV: bone ankylosis of the hip).

A Fisher's exact test was used to determine whether any significant difference existed in the incidence of HO among the three surgical approaches. Analysis of variance was employed to compare the average BCS per approach. Pairwise t-tests were subsequently used to identify specific differences based on operative approach.

3. Results

235 patients were identified after our initial CPT code search, of which 168 met initial inclusion criteria. Of these 168 patients, 80 patients representing 82 hemiarthroplasties ultimately had complete medical records with greater than 25 days of postoperative radiographic data and therefore were included for analysis: 26 hips were treated with an anterior approach, 32 through an anterolateral approach, and 24 through a posterior approach.

Table 1 lists the demographics for patients by surgical approach. The average age of all patients was 79.0 ± 10.0 years. The majority of patients in each group were Caucasian and female, with an average BMI around 24 per approach. The majority of patients had an ASA score of 3 assigned at the time of surgery.

Table 2 provides the percentage of patients who developed HO and their average BCS based on operative approach. There was no significant difference ($p = 0.421$) in the percentage of patients who developed HO based on surgical approach. However, there was a significant difference in the average BCS based

Table 1 – Demographics based on surgical approach.

	Anterior	Anterior/lateral	Posterior
Average age (SD), yrs	78.5 (9.9)	77.3 (9.2)	81.7 (10.8)
Race			
Caucasian	25 (88%)	26 (84%)	21 (88%)
African American	2 (8%)	4 (13%)	2 (8%)
Other	1 (4%)	1 (3%)	1 (4%)
Gender			
Male	7 (28%)	10 (32%)	4 (17%)
Female	18 (72%)	21 (68%)	20 (83%)
Average BMI (SD)	23.4 (4.6)	23.0 (4.6)	24.5 (6.2)
ASA score			
2	2 (8%)	4 (13%)	2 (8%)
3	19 (76%)	23 (74%)	14 (58%)
4	4 (16%)	4 (13%)	8 (33%)

Table 2 – Percent of patients with HO and average BCS based on surgical approach.

Surgical approach	% Ossification (n)	Average Brooker Classification score $\pm$ SD
Anterior (n = 25)	19% (5/26)	2.60 $\pm$ 0.55
Anterior/lateral (n = 29)	34% (11/32)	2.64 $\pm$ 0.67
Posterior (n = 28)	25% (6/24)	1.50 $\pm$ 0.84
Total (n = 82)	27% (22/82)	2.32 $\pm$ 0.84
p-value	0.421	0.012

on approach ($p = 0.012$). More specifically, classification with the posterior approach resulted in a significantly lower grade of HO (1.50 ± 0.84) compared to anterior (2.60 ± 0.55 , $p = 0.033$) and anterior/lateral (2.64 ± 0.67 , $p = 0.008$) approaches.

Fig. 1 provides radiographic examples of patients from this study who developed HO.

4. Discussion

Our study is the first to show that among hemiarthroplasty patients, the overall incidence of postoperative HO did not differ based on surgical approach. However, in patients who do develop HO, lower grades of HO are seen with a posterior approach as determined by the Brooker Classification system compared to either an anterior or an anterior/lateral approach.

It is interesting to compare our results to studies that investigated surgical approach and subsequent HO development in THA patients. Only a handful of studies directly compared HO rates based on operative approach. For example, Bischoff and colleagues compared HO rates in 112 total hip arthroplasties based on posterior vs anterolateral approaches, and found that 30% of patients developed HO through a posterior approach compared to 78% in the anterolateral group.¹ Both Pavlou et al and Egli et al used multivariate regressions to demonstrate that lateral or anterolateral approaches were significantly associated with greater odds of HO.^{6,8} In contrast to these two studies, Morrey et al's study found no significant differences in HO among anterolateral, transtrochanteric, and posterior approaches, and Martin's group found no significant difference in an anterolateral minimally invasive approach compared to a traditional lateral approach in terms of 1-year HO rates.^{3,14}

In addition to these comparative studies, several additional studies have published HO rates in THA patients all treated by a single approach. For example, Li and colleagues reported in 2013 that out of 47 patients who underwent THA with a combined anterior and posterior approach through a single lateral incision, 13% developed HO.¹² Both Spinarelli et al and Harwin reported HO rates with direct lateral THA approaches, with Spinarelli et al finding a 7% rate of HO in 181 hips and Harwin reporting a 26% HO rate in 1420 THAs.^{7,15} Even within lateral approaches, the literature shows that there are considerable variations in HO rates.^{15–17}

Our results are most similar to those of Morrey et al's study considering that we also found no significant difference in the rate of HO based on surgical approach. Furthermore, our

results somewhat corroborate Bischoff et al's results in that a posterior approach resulted in an overall lower average grade of ossification compared to the other approaches. While Pavlou et al and Egli et al found anterolateral and lateral approaches were predictive of HO, we similarly found higher average Brooker Classification Scores with these two approaches. It is not surprising that our results are similar to those published for THA patients. Randomized controlled trials and large retrospective studies comparing outcomes between hemiarthroplasty and THA have found similar complication rates between these two surgeries given the significant overlaps in how each type of surgery is conducted.^{18–20} Therefore, HO rates may likewise be similar.

In terms of specific operative approach, a posterior approach is associated with reduced retraction and trauma to the hip abductors, gluteus medius tendon, and gluteus minimus tendon.^{21–24} Minimizing direct trauma to these muscles thereby leads to decreased muscle ischemia and decreased levels of blood loss. An anterior approach, in contrast, results in greater tissue dissection with possible damage to the gluteus medius muscle leading to greater risks of muscle ischemia.^{21–24} Greater amounts of soft tissue dissection and retraction, greater amounts of bone resection, and the presence of muscle ischemia have all been linked to the formation of HO.^{1–5,25,26} Given that a posterior approach is relatively spared of these risk factors compared to anterior and anterolateral approaches, our results are therefore consistent with the presumed surgical risk factors for HO.

HO of the hip is especially important to avoid when considering secondary complications and costs. HO has been shown to limit patient mobility and thereby decrease quality of life, result in soft tissue contractions causing intractable neurologic pain, and predispose patients towards fractures and osteoporosis secondary to joint disuse.²⁷ Therefore, optimizing postoperative outcomes in patients undergoing hemiarthroplasty is especially important by choosing the surgical approach (i.e. posterior) associated with the lowest risk of high-grade ossification. To prevent postoperative HO, multiple studies have investigated prophylactically treating THA and hip arthroscopy patients with either NSAIDs or radiation therapy.^{28–31} Both treatment modalities have been shown to have equal efficacy in reducing HO rates, although NSAIDs are significantly less costly.^{28–31} No study to date has specifically investigated prophylactic regimens in patients undergoing hemiarthroplasty, but given the results of our study it will be important to prevent the formation of HO either through NSAID prophylaxis or through other avenues.

Our study had some limitations. For one, given its retrospective nature, we are limited to the results from one level I trauma center. Because HO depends on the amount of tissue dissection and muscle ischemia, surgeon variation and surgical skill may have played an important role in the HO rates in our patients. Therefore the generalizability of our results may be limited. Furthermore, other studies have investigated the effects of various prosthetics (i.e. cemented vs. uncemented prosthetics) on subsequent HO formation. It will be important to note the effects of these other factors on HO rates in future studies to determine whether the relationship between operative approach and HO is confounded by one of these variables.

Fig. 1 – Examples of HO in hemiarthroplasty patients. Top left: BCS 1 (posterior); Bottom left: BCS 2 (anterior/lateral); Top right: BCS 3 (anterior/lateral); Bottom right: BCS 4 (anterior/lateral).

Nevertheless, our study shows that in hemiarthroplasty patients, while surgical approach yields no difference in the overall rates of HO, the degree of ossification significantly differs. Interestingly, our study also demonstrates similar rates of HO formation between THA and hemiarthroplasty patients. THA and hemiarthroplasty patients are both prone to developing higher grade HO based upon surgical approach. Based upon available literature, acetabular exposure and preparation does not seem to cause a significant variation in the rate of HO formation regardless of approach. By understanding the relationship between HO formation and surgical approach for both THA and hemiarthroplasty, orthopedists can better counsel patients and families preoperatively, predict its formation, and initiate earlier treatment.

Conflicts of interest and source of funding

Author William Obrebsky has previously consulted for biometrics; done expert testimony in legal matters, has a grant from the Department of Defense (W81XWH-10-2-0133), and has been a Board Member of the OTA and SEFC. For the remaining authors no conflicts of interest were declared.

Copyrighted material/Consent forms

This study used no previously-copyrighted materials or signed patient consent forms.

IRB approval

This study has approval from the Vanderbilt IRB.

Acknowledgments

Conflict of interest: One of our authors has previously consulted for biometrics and provided expert testimony in legal matters. His institution has received a grant from the Department of Defense. For the remaining authors none were declared.

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