



Evaluation of the Cost Effectiveness of Routine Histopathologic Femoral Head Analysis in Hip Arthroplasty

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Purpose: Histopathologic analysis of femoral head specimens following total hip arthroplasty (THA) is a routine practice that represents a significant use of health care resources. However, it occasionally results in discovery of undiagnosed hematopoietic malignancy and other discrepant diagnoses such as avascular necrosis. The purpose of this study was to determine the rate of discordant and discrepant diagnoses discovered from routine histopathological evaluation of femoral heads following THA and perform a cost analysis of this practice.

Materials and Methods: A review of patients undergoing primary THA between 2004-2017 was conducted. A comparison of the surgeon's preoperative and postoperative diagnosis, and the histopathologic diagnosis was performed. In cases where the clinical and histopathology differed, a review determined whether this resulted in a change in clinical management. Medicare reimbursement and previously published cost data corrected for inflation were utilized for cost calculations.

Results: A review of 2,134 procedures was performed. The pathologic diagnosis matched the postoperative diagnosis in 96.0% of cases. Eighty-three cases (4.0%) had a discrepant diagnosis where treatment was not substantially altered. There was one case of discordant diagnosis where lymphoma was diagnosed and subsequently treated. The cost per discrepant diagnosis was \$141,880 and per discordant diagnosis was \$1,669 when using 100% Medicare reimbursement and Current Procedural Terminology (CPT) code combination 88304+88311.

Conclusion: Histopathologic analysis of femoral head specimens in THAs showed an association with high costs given the rarity of discordant diagnoses. Routine use of the practice should be at the discretion of individual hospitals with consideration for cost and utility thresholds.

Key Words: Arthroplasty, Femoral head histopathology, Hip replacement, Insurance

Submitted: June 22, 2021 **1st revision:** September 18, 2021

Final acceptance: November 5, 2021

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INTRODUCTION

As reimbursement methods change for the healthcare field, investigating how to provide the highest quality care while being mindful of resource utilization is important. Pathological testing accounts for approximately 2.5% of the budget of the overall medical system; however, its results have a decisive role in patient care, informing management and treatment techniques¹. Use of the convention of routine histopathologic analysis of femoral head specimens collected during total hip arthroplasty (THA) continues in many institutions. Sending all resected specimens from THA for histological evaluation is often hospital policy; however, in other institutions, the need for analysis may be determined according to the directive of the operating surgeon. Because 125,000 THAs are performed each year by surgeons in the United States, determining whether examination of excised specimens yields discordant diagnoses at a rate high enough to justify the cost burden is imperative².

The practice of specimen review is supported by multiple reports of neoplasms or other alternative diagnoses discovered in the routine histopathologic analysis of bone following arthroplasty³⁻⁵. The study by Besser⁶, which reported unsuspected tuberculosis detected during a total knee replacement, is often cited as justification for the practice, and additional studies such as a review of 1,794 femoral heads by DiCarlo et al.⁷ reported discrepancies between operative and pathological diagnosis in 5.4% of cases, as well as the discovery of seven morbid conditions not noted clinically. A recent study by Layfield et al.⁸, which noted a significant percentage of patients undergoing hip arthroplasty where significant pathological changes were not recognized preoperatively by the orthopaedic surgeon, advocated for the continued use of pathology for diagnosis.

However, a large number of conflicting studies evaluating the cost-effectiveness of histopathological analysis of surgical specimens by pathology have been reported; in many of these studies it has been regarded as a redundant process⁹⁻¹¹. A meta-analysis published by Rubin et al.¹⁰ in 2011 concluded that routine histological examination was not cost-effective^{9,11,12}. Studies conducted in other surgical fields have reported similar analyses on hernia sacs, intervertebral discs, adenoid tissue, and gallbladders with mixed results on the cost effectiveness¹³. For example, The College of American Pathologists¹⁴ continues to recommend microscopic examination of abdominal hernias, but has now left submission of inguinal hernias up to the discretion of the pathologist¹⁵. Similarly, submission of gallbladder specimens to

detect the presence of gallbladder carcinoma is still standard procedure; however, because many patients with cancer are captured either preoperatively or intraoperatively, the process is falling out of favor¹⁶. Based on the available literature, it is unclear whether routine pathology for femoral heads is necessary following THA. In addition, this continues as routine practice in many hospitals.

The purpose of this study was to determine the rate of discordant and discrepant diagnoses discovered from routine histopathological evaluation of femoral heads following hip arthroplasty and perform a cost analysis of this practice at one large academic medical center.

MATERIALS AND METHODS

Following Institutional Review Board of Loyola University Medical Center approval (No. 210762), 1,865 patients who underwent 2,134 THA (98.8%) (CPT 21730) and 25 hemiarthroplasty (1.2%) (CPT 27125) procedures at one institution were identified from a data request for the time period between 2004 and 2017 at Loyola University Medical Center. The initial list of patients was queried for Current Procedural Terminology (CPT) codes for femoral head specimens for histopathologic analysis. Twenty five patients (1.3%) with known malignancy for which the arthroplasty was performed were excluded, leaving 1,840 patients with 2,134 surgical procedures. Histopathology reports of macroscopic and microscopic findings for the femoral head were queried for abnormal diagnoses including amyloidosis, cancer, calcium pyrophosphate disease, enchondroma, gout, leukemia, lymphoma, metastatic malignancy, osteomyelitis, osteonecrosis, Paget disease, or tumor. The preoperative, postoperative findings and pathology report were compared for each chart. A chart was considered concordant if the postoperative and pathology report were in agreement, discrepant if the reports differed but there was no change in patient management, and discordant if the postoperative and pathological reports differed and resulted in subsequent changes in patient management based on the condition identified.

Reimbursement cost data are reported for two health insurance payer scenarios: 100% Medicare, and 50% Medicare-50% other payers. Medicare reimbursement data was obtained using the U.S. Centers for Medicare & Medicaid Services (CMS) Physician Fee Schedule Search Tool. Reimbursement cost data for other payers was estimated from the Kocher et al.¹⁵ estimate for total reimbursement from other payers per total hip replacement case, and was adjusted for infla-

tion using the Consumer Price Index (CPI) inflation calculator. Dollar amounts reported are for 2019 Medicare physician fee schedule reimbursements and 2019 CPI-inflated other payer reimbursements. The reimbursement costs reported were calculated for the following combinations of CPT codes: 88311 and 88304, 88311 and 88305, and 88311 with the average Medicare reimbursement for CPT codes 88304 and 88305. A cost benefit analysis was performed for the routine histopathologic analysis for the cohort as a whole, cohort of discrepant diagnoses, and for the single discordant patient identified in the study. Cost per health-effect was determined by dividing the cost of discordant diagnosis over the number of study participants. The remainder of the analysis was descriptive statistics reported as percentages and means with standard deviation.

Table 1. Summary of Patient Preoperative, Postoperative, and Pathology Diagnoses

Variable	n (%)
Preoperative diagnosis	
Hip AVN	187 (8.8)
Hip fracture	173 (8.1)
Hip OA	1,742 (81.6)
Hip RA	28 (1.3)
Hip osteomyelitis	1 (0.05)
Hip septic arthritis	1 (0.05)
Psoriatic arthritis	2 (0.1)
Postoperative diagnosis	
Hip AVN	186 (8.7)
Hip fracture	174 (8.2)
Hip OA	1,742 (81.6)
Hip RA	28 (1.3)
Hip osteomyelitis	1 (0.05)
Hip septic arthritis	1 (0.05)
Psoriatic arthritis	2 (0.1)
Pathology diagnosis	
Hip AVN	148 (6.9)
Hip fracture	173 (8.1)
Hip OA	1,784 (83.6)
Hip OA+benign osseous metaplasia	1 (0.05)
Hip OA+lymphoma	2 (0.1)
Hip RA	22 (1.0)
Hip osteomyelitis	1 (0.05)
Hip septic arthritis	1 (0.05)
Psoriatic arthritis	2 (0.1)
Difference between postoperative & pathology diagnoses	
Yes	84 (4.0)
No	2,056 (96.0)

AVN: avascular necrosis, OA: osteoarthritis, RA: rheumatoid arthritis.

RESULTS

The sample of patients undergoing hip arthroplasty with subsequent histopathologic analysis of the femoral head from 2004 to 2017 consisted of n=1,840 unique patients and k=2,134 unique surgical procedures. There were 1,052 females (57.2%) with a mean age of 63.0±12.4 years. Ethnicity included: 1,505 white (81.8%), 245 black (13.3%), 75 other (4.1%), nine Asian (0.5%), four Hispanic (0.2%), one multiracial (0.05%), and one Native Hawaiian or other Pacific Islander (0.05%). Of the 2,134 surgeries performed, 2,109 (98.8%) were THAs and 25 (1.2%) were hemiarthroplasties.

Preoperative diagnoses included 1,498 osteoarthritis (OA; 81.4%), 162 avascular necrosis (AVN; 8.8%), 147 fracture (8.0%), 24 rheumatoid arthritis (RA; 1.3%), and nine other (0.5%). For 2,056 procedures (96.1%) there was no change between postoperative and pathological diagnoses. Eighty-four patients (3.9%) presented with a discrepant (n=83) or discordant (n=1) diagnosis (Table 1). Discrepant diagnoses included 19 OA to AVN (22.6%), 57 AVN to OA (67.9%), six RA to OA (7.1%), and one OA to OA+benign osseous metaplasia (1.2%) (Table 2). Only one procedure (0.05%) presented with a discordant diagnosis resulting in a substantial change in therapy. This patient received a preoperative diagnosis of hip OA, while pathologic analysis indicated hip OA with lymphoma malignancy.

Details regarding the overall cost of 2,134 histopathologic exams of the femoral head utilizing various payment scenarios are shown in Table 3. Taking 100% Medicare reimbursement as one example and CPT code 88304, the sum total for all surgeries was \$141,880. As there was only one discordant diagnosis, the cost incurred per intervention in clinical management was \$141,880. In this payer circumstance, the cost per diagnosis discrepancy regarding the distinction between hip OA and hip AVN was \$1,866.

Table 2. Cases with Different Postoperative and Pathology Diagnoses

Postoperative diagnosis	Pathology diagnosis	n (%)
Hip AVN	Hip OA	57 (67.9)
Hip OA	Hip AVN	19 (22.6)
Hip OA	Hip OA+lymphoma malignancy	1 (1.2)
Hip RA	Hip OA	6 (7.1)

AVN: avascular necrosis, OA: osteoarthritis, RA: rheumatoid arthritis.

Table 3. Costs of Femoral Head Histopathologic Examination, Overall and per Discordant Diagnosis

Reimbursement	CPT code* combination	Level of cost	Dollar amount (\$)
100% Medicare	88304+88311	Overall	141,880
		Per discordant diagnosis	141,880
		Per hip OA/AVN diagnosis discrepancy	1,866
		Per discordant or discrepant diagnosis	1,669
100% Medicare	88305+88311	Overall	206,324
		Per discordant diagnosis	206,324
		Per hip OA/AVN diagnosis discrepancy	2,714
		Per discordant diagnosis	2,427
100% Medicare	(mean of 88304 & 88305)+88311	Overall	174,112
		Per discordant diagnosis	174,112
		Per hip OA/AVN diagnosis discrepancy	2,290
		Per discordant or discrepant diagnosis	2,048
50% Medicare/50% other payers	88304	Overall	216,052
		Per discordant diagnosis	216,052
		Per hip OA/AVN diagnosis discrepancy	2,842
		Per discordant or discrepant diagnosis	2,541
50% Medicare/50% other payers	88305	Overall	248,273
		Per discordant diagnosis	248,273
		Per hip OA/AVN diagnosis discrepancy	3,267
		Per discordant or discrepant diagnosis	2,920
50% Medicare/50% other payers	88304 & 88305 (mean)	Overall	232,168
		Per discordant diagnosis	232,168
		Per hip OA/AVN diagnosis Discrepancy	3,054
		Per discrepant diagnosis	2,763

CPT: Current Procedural Terminology.

* 88304: Level III - Surgical pathology, gross and microscopic examination. 88305: Level IV - Surgical pathology, gross and microscopic examination. 88311: Surgical pathology, preparation of tissue for examination by removing any calcium present.

DISCUSSION

This retrospective review of routine histopathology following hip arthroplasty at one academic institution found that the pathology report differed from the surgeon’s post-operative diagnosis in 84 of 2,134 (3.9%) cases; however, only one case was determined to be discordant and resulted in significant change in patient management. The cost per discordant diagnosis was \$141,880 and per discrepant diagnosis was \$1,669 when using 100% Medicare reimbursement.

These findings are highly comparable to those found in the existing literature on discrepancies in diagnosis and cost thresholds. A 2,000 study conducted by Kocher et al.¹³⁾ on 471 total hip and 763 total knee arthroplasties reported a discrepant case ratio of 28/1,234 (2.3%), with 1/1,234 cases (0.1%) discordant. With the cost per discrepant diagnosis (\$4,383) and discordant diagnosis (\$122,728), the Kocher et al.’s study¹³⁾ used a value-based pathology system in which the utility of the specimen examination set the cost-effectiveness threshold. They determined that routine

examination was not justified for patients with a clinical diagnosis of OA. Similarly low rates of discrepancy have been reported in other studies, such as that by Lawrence et al.¹¹⁾ and Meding et al.¹²⁾. Lawrence et al.¹¹⁾, who reviewed 1,388 primary THA and TKA specimens, found discrepancies between the preoperative and intraoperative diagnoses in 11 cases. The intraoperative diagnosis was determined to be correct in each case, leading the group to conclude that experienced surgeons can exclude the possibility of malignancies or other conditions that may alter patient management. With a discretionary policy in place, total charges for specimen examination would have been reduced by \$269,871¹¹⁾. A review of primary THAs by Meding et al.¹²⁾ noted that 16 of the 313 primary THAs (5.1%) had conflicting postoperative and pathologic diagnoses, but all cases were determined to be OA to AVN, which did not impact patient care.

The main limitations to this study are in the determination of cost-effectiveness as this can be viewed from the perspective of society, the government, the insurance company, the hospital, or the patient. These perspectives are often at odds

with each other. Hospital costs are not the same as charges, what is charged is not always collected, fixed versus variable costs are not necessarily accounted for, and quantification of societal benefit is difficult. Additionally, determination of value is difficult as any individual person would likely pay \$142,000 to save their own life with an early detection of lymphoma. However, there is no definitive economic answer as to whether this cost is reasonable and sustainable for a hospital or insurer. The average Medicare surgeon and facility fee is \$13,636 and the fee for pathologic evaluation ranges from \$66 to \$116. This is a small fraction of the total cost but with the high volume of hip replacements it becomes a substantial expense.

CPT code reimbursement was used in the current study, which is best viewed as government/insurer/societal cost. A hospital requires a pathology department, therefore from a hospital perspective if government reimbursement exceeds variable costs, it is in the hospital's interest to continue with routine pathology. The question is then whether sending routine femoral heads is sensible from a societal perspective. This is typically determined based on value per quality adjusted life year. In the United States, benchmarks for value have ranged between \$50,000-150,000 per year, while these numbers are lower in the UK and other countries¹⁶⁻¹⁸⁾. Considering that only one patient had a discordant diagnosis, making definitive recommendations based on the data in this study is difficult; however, if this one patient lived an extra 1-3 years of quality life due to the histopathologic diagnosis it would be considered cost effective. In addition, while the discrepant diagnoses did not result in a direct change in patient management, a correct diagnosis may be helpful for treatment of patients in the future. For example, a diagnosis of AVN may prompt closer surveillance of other joints.

Further limitations to this study include its retrospective nature and dependency on accurate documentation of pre-operative suspected diagnoses. Because complete billing records were not available two CPT codes were utilized. Medicare patients represent variable fractions of the population depending on the hospital and geographic area. Further, some institutions may save the resected femoral heads and use them for allograft, which may defray the cost of analysis. Finally, the potential value of legal protection by verifying the diagnosis was not factored in.

CONCLUSION

Overall, histopathologic analysis of femoral head speci-

mens in hip arthroplasty showed an association with rare discordant diagnoses and relatively high costs. The routine use of this practice should be at the discretion of individual hospitals with consideration for cost and utility thresholds. However, given the relatively high cost of routine pathologic evaluation, some surgeons will selectively send femoral heads based on intraoperative visual inspection.

CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest relevant to this article.

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