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Original Article

Unsuspected Malignancies in Routine Femoral Head Histopathologic Examination During Primary Total Hip Arthroplasty: Cost-Effectiveness Analysis

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ABSTRACT

Background: Routine femoral head histopathology during primary total hip arthroplasty (THA) has been recently reported as a potentially useful screening tool for bone- and bone marrow–associated malignancies. However, cost-effectiveness of routine histopathology during THA remains unclear due to low prevalence of significant medical findings which alter patient management. The aim of this study was to evaluate the cost-effectiveness of routine histopathology in diagnosing unsuspected malignancy in patients undergoing primary THA.

Methods: From 1993 to 2011, we retrospectively analyzed routine histopathologic findings of 3200 femoral head specimens from 2725 patients that underwent primary THA. Preoperative and postoperative diagnoses were classified into concordant (clinical diagnosis concurred with pathologic diagnosis), discrepant (differing diagnosis with no resultant impact on patient management), and discordant (differing diagnosis with subsequent change in patient management). Cost-effectiveness analysis was performed using the incremental cost-utility ratio.

Results: A total of 3055 of 3200 pathologic samples were concordant with the preoperative diagnosis (95.4%), 140 of 3200 were discrepant (4.4%), and 5 of 3200 were discordant (0.2%). Routine histopathology revealed 1 unsuspected malignancy out of 640 (5 of 3200) femoral heads. The total cost of histopathologic screening was $614,664.80. The average cost to identify a discrepant case was $4390.46, and the cost to identify a discordant case was $122,932.96. The incremental cost-utility ratio was $49,569.74 per quality-adjusted life year (QALY) gained.

Conclusion: Our study indicates routine femoral head histopathology may be cost-effective in diagnosing unsuspected malignancy at $49,569.74/QALY gained (less than World Health Organization recommended threshold $159,000/QALY gained), providing useful clinical information for surgeons considering the value of routine femoral head histopathology in patients undergoing THA.

The incidence of total hip arthroplasty (THA) in the United States is high, with over 1 million THAs performed every year [1]. The number of primary THA procedures is expected to increase with aging of the "baby boomer" generation (individuals born between 1946 and 1964) as it will enable these individuals to regain mobility, improve quality of life, and continue their active lifestyles [2]. As of 2010, it is estimated that 2.5 million individuals (0.83% of the total US population) are living with a total hip prosthesis and the number of patients opting to undergo primary THA is projected to increase by 174% by 2030 [3].

Routine histopathology of femoral heads has been recently demonstrated as a potentially useful screening tool for bone- and bone marrow–associated illnesses in patients undergoing THA [4]. This is in contrast with previous studies which have reported significant population-based cost savings if femoral head histopathology is not performed during THA [5-7]. In addition, routine histopathology was determined to have limited cost-effectiveness

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due to the low prevalence of significant medical findings which altered patient management [6,8]. However, these studies were limited by low small numbers of femoral heads [5-7,9-11], and cost-effectiveness analysis (CEA) could not be performed due to the lack of discordant findings [8]. In contrast, studies which had larger sample sizes observed an increased number of discrepant diagnosis; however, CEA was not performed in those studies [4,12].

The anticipated increase in primary THA procedures, its associated hospitalization costs, and postoperative rehabilitation will add to the existing substantial economic burden. The cost-effectiveness of routine femoral head histopathologic examination during THA needs to be evaluated in light of current health care economics. It is currently unclear whether routine histopathologic examination of femoral heads from THA performed in preoperatively healthy patients is cost-effective. The aim of this study was to evaluate the cost-effectiveness of routine histopathology in diagnosing unsuspected malignancy in patients undergoing primary THA.

Methods

Routine Femoral Head Histopathologic Analysis

This study was approved by our institutional review board. We performed a retrospective review of our institution's joint replacement registry. From 1993 to 2011, we identified 3220 femoral head specimens from 2725 patients that were submitted for histopathologic analysis after THA (Table 1). Twenty patients were excluded due to prior known conditions, leaving 3200 primary THA for analysis. The preoperative clinical diagnosis was determined from clinical records which included history, physical examination, and radiographic analysis. The preoperative diagnoses included the following: osteoarthritis (83%), rheumatoid arthritis (9%), avascular necrosis (7%), and pseudogout (1%; Fig. 1).

Routine femoral head histopathologic specimens were evaluated systematically according to the guidelines of the College of American Pathology. The diagnosis was based on gross and histologic examination of the femoral head specimen. Depending on the preliminary histologic diagnosis, additional tests such as immunohistochemistry and/or flow cytometry were performed by the pathologist to provide confirmatory histopathologic diagnosis. Femoral head histopathology reports for all patients were obtained from the hospital's Research Patient Data Registry. A keyword search of pertinent abnormal diagnoses was performed. These included amyloidosis, cancer, calcium pyrophosphate disease, enchondroma, gout, leukemia, lymphoma, metastatic, malignancy, osteomyelitis, osteonecrosis, Paget disease, and tumor.

Preoperative and postoperative pathologic diagnoses were classified into 3 categories: concordant (clinical diagnosis concurred with pathologic diagnosis), discrepant (differing diagnoses with no resultant impact on patient management), and discordant (differing diagnoses with subsequent change in patient management). Patients with differing preoperative and pathologic diagnosis were further reviewed to determine their clinical outcomes [6,8].

Table 1
Patient Demographics.

Variable	n = 3200
Gender (%)	
Male	1558 (48.7%)
Female	1642 (51.3%)
Mean age in years (range)	63.8 ± 13.4 (16.8-97.0)
Race/ethnicity	
Asian	30 (0.9%)
Black	60 (1.9%)
Caucasian	2921 (91.3%)
Hispanic	26 (0.8%)
Other	163 (5.1%)
Preoperative diagnosis	
Osteoarthritis	2636 (82%)
Rheumatoid arthritis	288 (9%)
Avascular necrosis	243 (8%)
Pseudogout	33 (1%)
Operative details	
Unilateral THA	2709 (84.6%)
Bilateral THA	493 (15.4%)
Left THA	1518 (47.4%)
Right THA	1684 (52.6%)

THA, total hip arthroplasty.

Cost-Effectiveness Analysis Model

The gross cost for a single histologic analysis was obtained from our pathology department's administrative office and was based on 2013-adjusted US dollars. Costs of additional tests (immunohistochemistry and flow cytometry) were excluded from the analysis. The cost required to identify a discrepant or discordant diagnosis was derived by dividing the total cost of pathologic examinations by the number of cases. This allowed for comparison with previously published literature (Table 2).

CEA was performed using the incremental cost-utility ratio (ICUR). The ICUR is recommended as the first-choice analysis instrument in CEA [13] and is commonly used to calculate cost-effectiveness of leukemia treatment in the United States [14]. ICUR = {[Cost of histologic screening − cost of no screening]/[quality-adjusted life years (QALYs) gained in patient who underwent histologic screening−estimated QALYs gained in the same patient who did not undergo screening]}. The QALY is a measure of disease burden which quantifies both the quality and quantity of life lived, used frequently to determine the value of health care spending in terms of health outcomes achieved [15]. We used EuroQol health-related quality-of-life indices of discordant cases to determine their QALYs gained. EuroQol health-related quality-of-life indices are the most frequently used instrument for calculating QALYs based on measurements of patients' actual quality-of-life indices [16]. In accordance to World Health Organization (WHO) guidelines, we set the cost-effectiveness threshold at 3 times gross domestic product (GDP) per capita, that is, an intervention which costs less than $159,000/QALY would be considered cost-effective in the United States [17].

In order to estimate the anticipated QALYs gained for a discordant case that did not undergo screening, we determined the possibility of the disease being detected postoperatively. The anticipated QALYs gained were determined through a combination of literature review [18-23], WHO disability weights for diseases [24,25], and consultation with expert physicians familiar with the natural history of these diseases. For every discordant diagnosis of previously undetected malignancy that the pathology department reports, we would determine when the diagnosis would have been made if intraoperative histology was not performed, for example, diagnosis made in the following year.

For illustration, assuming intraoperative histology detected malignancy (chronic lymphocytic leukemia [CLL]) at an early state, first we calculate the QALYs gained from the actual survival years by quality of life of the patient diagnosed with CLL. Actual patient survival was recorded at 6 years with a 0.9 quality-of-life score each year, resulting in 6 × 0.9 = gain of 5.4 QALYs. This would be subsequently compared with a case in which the condition (CLL) was detected later. Second, median overall survival of the malignancy is determined using literature and expert opinion. In this case for CLL, it is 4 years. In our model, we have assumed the best case scenario for the cases with discordant diagnosis, that is, we used the longest