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CLINICAL RESEARCH

Histologic Examinations of Arthroplasty Specimens are not Cost-effective

A Retrospective Cohort Study

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Abstract

Background Many hospitals require all operative specimens be sent to pathologists for routine examination. Although previous studies indicate this practice increases medical cost, it remains unclear whether it alters patient management and whether it is cost-effective.

Questions/purposes We therefore (1) determined the rate of discordance between clinical and histologic examinations of routine operative specimens during elective primary arthroplasties, (2) determined the cost of routine histologic screening, and (3) estimated its cost-effectiveness in terms of cost per quality-adjusted life year gained, as compared with gross examination or no examination.

Methods We retrospectively reviewed medical records of 1247 patients who underwent 1363 routine elective primary total joint arthroplasties between January 18, 2006 and March 15, 2010. We compared preoperative, postoperative, and histologic diagnoses for each patient and categorized them into three classes: concordant (clinical and histologic diagnoses agreed), discrepant (diagnoses differed but with no resultant change in treatment), and discordant (diagnoses differed with resultant change in treatment). Medicare reimbursements were determined through the pathology department's administrative office.

Results In 1363 cases, 1335 (97.9%) clinical and histologic diagnoses were concordant, 28 (2.1%) were discrepant, and none were discordant. Total reimbursement for routine pathological examination was $139,532, or $102.37 per specimen. The average cost to identify each discrepant case was $4983.29. Routine histologic examination did not alter patient management, and there was no direct gain in quality-adjusted life years.

Conclusions Our observations show routine histologic examinations of routine operative specimens during elective primary arthroplasties increase medical cost but rarely alter patient management and are not cost-effective.

Level of evidence Level I, economic and decision analyses. See Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution approved or waived approval for the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.
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Introduction

Many hospitals require all operative specimens be sent to pathologists for routine examination, regardless of the diagnosis [4, 15, 17, 20]. The Joint Commission on

Accreditation of Healthcare Organizations (JCAHO) also mandates this practice, with few exceptions [12]. In addition, the College of American Pathologists, an organization that accredits most hospital pathology laboratories, requires histologic examination of all surgical specimens, with some exemptions, not including specimens from total joint arthroplasties [18, 21]. Histologic examination of routine surgical specimens is believed to improve diagnostic accuracy, support quality assurance, and provide documentation of the procedure [12]. However, in response to increasing healthcare costs, the necessity of this measure has been questioned in certain circumstances [3–7, 9, 10, 14, 15, 17–20, 23–28, 32–34].

Previous publications found routine histologic examination rarely identified a new diagnosis that alters patient care in hip, knee, or thumb arthroplasty, lumbar discectomy, knee and shoulder arthroscopies, hallux valgus surgery, and wrist ganglion excision [3–7, 9, 10, 14, 15, 17–20, 23–28, 32–34]. These studies were performed in various settings, and the authors found 0% to 9.5% of clinical and histologic diagnoses differed. Even fewer (0% to 0.6%) differed enough to result in a change in patient management. Although one study found no discrepancies in thousands of patient medical records [18], another estimated that almost 10% of histologic diagnoses differ from clinical diagnoses [26]. Obtaining an accurate estimate is important because the practice of routine histologic examination consumes valuable time and resources that may be better spent on other cases. Additionally, previous studies [3–7, 9, 10, 14, 15, 17–20, 23–28, 32–34] used cost-identification methods but did not quantify health benefits of this practice using standard metrics, such as the quality-adjusted life year (QALY). Measuring cost and QALYs allows health economists to evaluate the relative value of routine histologic examination as it compares with other medical interventions. The QALY is a standardized measure that allows for evaluation of quality and quantity of life, often used for determining the value of a medical intervention. One additional year of life in perfect health is valued at 1.0 QALY, and the value assigned to that year decreases with severity of illness, to the point that a value of 0.0 is assigned for death. A threshold of $50,000/QALY is commonly cited in health economics literature as a reasonable price, whereas $100,000 or more per QALY is considered unaffordable [29]. However, in an alternative approach to determining what practices are cost-effective, the World Health Organization (WHO) uses a rule of thumb that cost-effective interventions cost less than three times annual per-person income per QALY [8, 30]. For example, in a country where annual per-person income averages $40,000, a cost-effective intervention would cost less than $120,000. Although these numbers are not definite cutoffs, they provide a context in which the cost-effectiveness of routine pathological examinations can be considered in relation to other interventions.

We (1) determined the rate of discordance between clinical and histologic examinations of routine operative specimens during elective primary arthroplasty, (2) determined the cost of routine histologic screening, and (3) estimated its cost-effectiveness in terms of cost per QALY gained, as compared with gross examination or no examination.

Patients and Methods

We retrospectively reviewed the medical records of all 1322 patients who underwent elective primary total knee, hip, shoulder, elbow, and carpometacarpal arthroplasties between January 18, 2006 and March 15, 2010. We identified patients by current procedural terminology (CPT) codes for TKA (27442, 27443, 27445, 27446, and 27447), THA (27130), total shoulder arthroplasty (23472), total elbow arthroplasty (24363), and carpometacarpal arthroplasty (CMC) (25447). During the study period, 1438 total joint arthroplasties (868 knees, 463 hips, 65 CMCs, 37 shoulders, and five elbows) were performed in 1322 patients (819 knees, 408 hips, 60 CMCs, 32 shoulders, and three elbows) (Fig. 1). There were 35 arthroplasties (2.4%) in which no specimens were examined (three knees, one hip, 27 CMCs, and four shoulders). We excluded 40 additional cases (2.8%) (27 revision arthroplasties [17 knees, three hips, two CMCs, three shoulders, and two elbows]; 11 knee arthroplasties with known prior diagnosis of sarcoma; two THAs with preoperative suspicion of infection attributable to patients undergoing revision arthroplasty or having preoperative question of neoplasia or infection that warranted histologic examination, as their cases were no longer routine). The final study cohort consisted of 1363 arthroplasties (837 knees, 457 hips, 36 CMCs, 30 shoulders, and three elbows) in 1247 patients. We had prior approval of our institutional review board.

We compared preoperative, postoperative, and histologic diagnoses for each patient and excluded patients if no specimen was sent for histologic examination (these patients are described separately in Results). Immunohistochemistry examinations were performed in 11 specimens (0.8%), and a total of 56 antibody tests were performed. There were two Group II (noninfectious) special stains. One patient underwent flow cytometry analysis in which 11 markers were performed. For each patient, we categorized the diagnoses into three classes: concordant (clinical and histologic diagnoses agreed), discrepant (clinical and histologic diagnoses differed with no resultant change in treatment), and discordant (clinical and histologic diagnoses differed with resultant change in treatment). We then

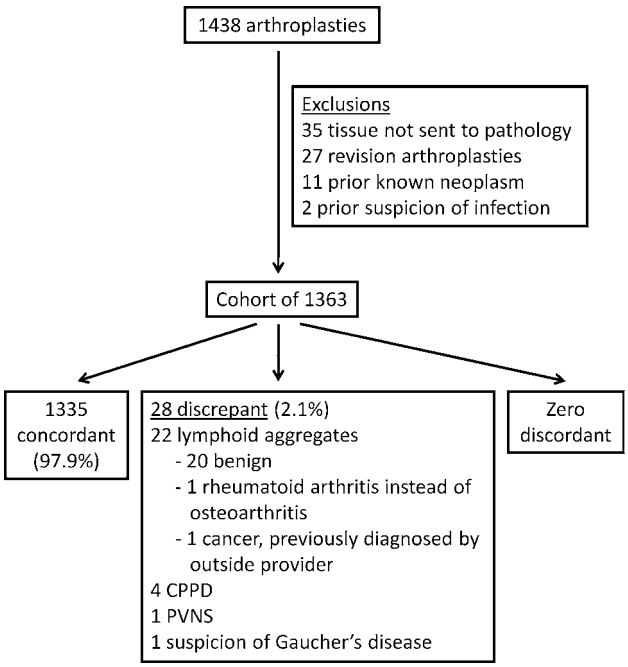

Fig. 1 A summary of the study design and results is shown. CPPD = calcium pyrophosphate dihydrate deposition disease; PVNS = pigmented villonodular synovitis.

reported rates of concordant, discrepant, and discordant diagnoses with 95% confidence intervals (CI). All pathologists were board-certified and had access to patients' medical records; they were not blinded to operative diagnoses.

We identified reimbursement in 2010-adjusted United States dollars for routine pathologic examinations of specimens obtained during total joint arthroplasties during the study period. Through the pathology department's administrative office, Medicare Part A (technical) and Medicare Part B (professional) reimbursements were determined according to the Centers for Medicare and Medicaid Services (CMS) reimbursements for CPT codes (88184, 88185, 88188, 88300, 88304, 88305, 88311, 88313, and 88342). We calculated the cost to identify each discrepant and discordant diagnosis by dividing the total reimbursements for pathologic examinations by the number of cases. These metrics were determined to allow for comparison with previously published results.

To determine the cost-effectiveness of routine histologic examination in terms of QALYs, for each discordant case, we first determined when or if the disease diagnosed by pathology would normally be diagnosed by other means (assuming a routine histologic examination was not performed after the surgery). These values were determined using a literature review and consultation with expert physicians familiar with the normal course and diagnosis of these cases. Those sources and the WHO's disability weights for diseases [31] were used to estimate the quality and quantity of life expected in the cases of performing and not performing routine histologic examinations that detect a diagnosis that is discordant with the clinical diagnosis. As a simplified illustrative example, consider a patient who has a hip replacement because of a clinical diagnosis of osteoarthritis (OA). There are three possible states, based on whether the patient has previously undiagnosed cancer and whether histologic examination is performed after hip replacement: (1) the patient has no cancer, histology is or is not performed after hip replacement; (2) the patient has cancer, histology is performed after hip replacement, and therefore cancer is diagnosed; and (3) the patient has cancer, histology is not performed after hip replacement, and therefore cancer is not diagnosed. We are interested in discordant cases, as represented by state 2. To determine the benefit of performing histology, we compare the QALY gain of state 2 over state 3. Concordant cases fall under the category of state 1, in which performing histologic examination does not provide any QALY benefit. We compare state 2 with state 3 because these are both states in which the patient has cancer, and they differ only in whether histologic examination is performed. We are careful not to compare state 1 with state 3, as these differ not just in whether histologic examination is performed but also in whether the patient has cancer; it is clear that a patient without cancer has higher QALY expectancy than a patient with cancer. Assuming the pathology department found a malignant tumor indicative of a discordant diagnosis, we then would consult the literature and physician experts to determine when the same diagnosis would likely to have been made if histologic examination had not been performed (for example, a one year delay in diagnosis). If routine pathological examination detected cancer at an early stage (when patient survival would be at least 5 years with a 0.8 quality of life rating), we could compare this condition with the expected survival if the histologic examination had not been performed and the disease was detected one year later. This estimation would add living one year with a 0.5 quality of life rating (diagnosis unknown) with the expected survival of 3 years with a 0.6 quality of life rating because the diagnosis was made at a later stage. The benefit of routine histologic examination in this case would be $[5 \times 0.8] - [1 \times 0.5 + 3 \times 0.6] = 2.7$ QALYs. After analyzing all the data, the total pathology cost was to be divided by the sum of QALYs gained to calculate the cost per QALY gained metric of cost-effectiveness. We determined the minimum resulting direct gain in QALYs for a given cost of routine histologic screening that would make this practice cost-effective at various cost-effectiveness thresholds (Fig. 2). To achieve this, for each cost-effectiveness threshold (x-axis, independent variable), the y-axis dependent variable was calculated by dividing the total cost of routine histologic screening by the

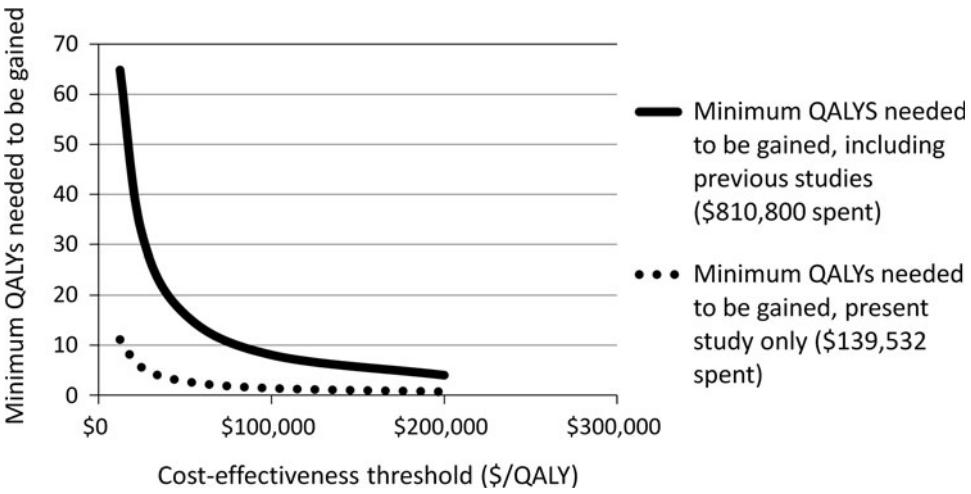

Fig. 2 The graph shows the minimum QALYs needed to be gained versus cost-effectiveness threshold.

cost-effectiveness threshold. The calculation of cost divided by cost per QALY yielded a result in terms of QALYs.

Results

Of the 1363 arthroplasties, 1335 had diagnoses that were concordant with the preoperative diagnoses (97.9%; 95% CI = 97.1%, 98.6%), 28 had discrepant diagnoses (2.1%; 95% CI = 1.4%, 3.0%), and none had a discordant diagnosis. In four of the TKAs with discrepant diagnoses, patients had a histologic diagnosis of calcium pyrophosphate dihydrate deposition disease (CPPD) that was not clinically suspected. In one additional TKA, a patient with a discrepant diagnosis had a histologic diagnosis of pigmented villonodular synovitis (PVNS). We did not consider these five cases discordant because the diagnoses of CPPD and PVNS did not alter patient management. Another 22 discrepant pathology reports (two knees, 19 hips, one shoulder) found lymphoid aggregates, and 11 of these patients (all had THAs) had additional immunohistochemistry examinations to evaluate for potential lymphoproliferative disorders (eg, CD3, CD5, CD10, CD20, Bcl-1). Twenty (90.9%) of these 22 cases resulted in a diagnosis of benign lymphoid aggregates and did not alter patient management. However, for one 84-year-old man who had a THA, the pathology report showed a kappa-restricted B-cell lymphoproliferative disorder. This diagnosis was made after additional flow cytometry immunophenotyping was performed to supplement the original immunohistochemistry examination. An outside provider at a different hospital knew of the disorder before the operation, but it was unknown to the surgeon at the time of the THA. The second discrepant case involved a 79-year-old woman undergoing THA for OA. The histologic evaluation suggested a possible additional diagnosis of rheumatoid arthritis (RA). Thus, both of these cases resulted in no change in clinical care, and we classified them as discrepant. The final discrepant case involved a new histologic diagnosis of Gaucher's disease in a 62-year-old man undergoing TKA. However, because there were no notes or reports before or after the pathology examination that indicated any care related to Gaucher's disease, we categorized this case as discrepant instead of discordant. When consulted 3.5 years after the procedure, the orthopaedic surgeon who performed the arthroplasty confirmed that the patient did not have a clinical diagnosis of Gaucher's disease. We did not perform any further investigation.

The total reimbursement for routine histologic examinations was $139,532, or $102.37 per specimen. The average cost to identify each discrepant case was $4983.29. CMS reimbursements for technical and professional pathology services varied depending on specimen type and services rendered (Table 1). All 1363 specimens were decalcified (CPT code 88311). Of these, 1352 (99%) were classified using nonfracture surgical pathology with gross and microscopic examination (CPT code 88304). Eleven specimens with fractures (seven knees, three hips, one elbow) were classified as such (CPT code 88305). Based on a CPT 88300 reimbursement of $29.14 for 1363 cases, gross examination would cost $39,718. Performing no pathological examination would have zero cost.

Because no instance of routine histologic examination led to direct change in patient management, there was no direct diagnostic value, and no QALYs were gained as a direct result of this practice. Considering our data using a $100,000/QALY threshold, routine histologic examination would have to produce a 1.4 QALYs gain to justify its $139,532 in cost. The practice of routine histologic screening was dominated by gross examination only and no examination strategies because all three of these strategies produce no direct health benefit for patients, and routine histologic screening has the highest cost. Even with the new knowledge of these discrepant diagnoses, patient management was not affected because total arthroplasty of the affected joint represented

Table 1. CMS reimbursement for pathological services

CPT code	Description	Part A (technical) reimbursement	Part B (professional) reimbursement	Total reimbursement per case	Number of applicable instances	Total reimbursement for CPT code
88184	Flow cytometry, cell surface, cytoplasmic, or nuclear marker, technical component only; first marker	$99.49	N/A	$99.49	1	$99.49
88185	Flow cytometry, cell surface, cytoplasmic, or nuclear marker, technical component only; each additional marker (list separately in addition to code for first marker)	$59.43	N/A	$59.43	10	$594.30
88188	Flow cytometry, interpretation; 9 to 15 markers	N/A	$88.89	$88.89	1	$88.89
88300	Level I - surgical pathology, gross examination only	$24.50	$4.64	$29.14	0	$0.00
88304	Level III - surgical pathology, gross and microscopic examination (nonfracture)	$64.09	$11.70	$75.79	1352	$102,468.08
88305	Level IV - surgical pathology, gross and microscopic examination (fracture)	$83.65	$39.76	$123.41	11	$1357.51
88311	Decalcification procedure	$7.73	$12.91	$20.64	1363	$28,132.32
88313	Special stains; Group II, all other (eg, iron, trichrome), except immunocytochemistry and immunoperoxidase stains, including interpretation and report, each	$77.13	$12.45	$89.58	2	$179.16
88342	Immunohistochemistry (including tissue immunoperoxidase), each antibody	$73.40	$44.68	$118.08	56	$6612.48
Total reimbursement for all pathology services						$139,532.23

CMS = Centers for Medicare & Medicaid Services; CPT = current procedural terminology.

definitive treatment. We considered the fact that indirect QALY gain may result from potential earlier diagnosis of RA, CPPD, or PVNS in other joints if it develops in the future, given the knowledge provided by the histology results. However, we were unable to identify a manner in which 1.4 QALYs could be gained (the number needed to be cost-effective at a $100,000/QALY threshold) even indirectly, using the following logic that generously estimated an upper bound of QALY gain. The WHO disability weight for untreated RA is 0.233, and the disability weight for treated RA is 0.174, giving a treatment benefit of 0.059 QALY for every year that rheumatoid is arthritis is treated, in comparison to an untreated year [31]. We are not aware of published studies of disability weights for CPPD and PVNS, and therefore we estimated that these conditions have similar disability weights as RA, given their similar symptom presentation. In our clinical experience, we estimate that if a patient (who had not had routine histologic examination that produced a discrepant diagnosis of RA, CPPD, or PVNS) had polyarticular disease not already definitively treated by the arthroplasty described in our study, the upper boundary of time to diagnosis would be 2 years. By multiplying the six patients with RA, CPPD, or PVNS in our study, 2 years of earlier diagnosis, and 0.059 QALY benefit from treatment each year, we can estimate an upper boundary of 0.71 QALYs of indirect health benefits from the discrepant cases gained, which is short of the $100,000/QALY cost-effectiveness threshold of 1.4 QALYs gained [31].

Discussion

Although previous studies of histologic examinations of routine operative specimens during elective primary

arthroplasties have suggested that the practice increases medical cost, to date, it remains unclear whether it alters patient management and whether it is cost-effective. We (1) determined the rate of discordance between clinical and histologic examinations of routine operative specimens during elective primary arthroplasties, (2) determined the cost of routine histologic screening, and (3) estimated its cost-effectiveness in terms of cost per QALY gained, as compared with gross examination or no examination.

Our observations must be interpreted within the framework of the limitations. First, the number of cases may have been too small to detect rare, but clinically important, discordant cases in which routine histologic examination could lead to a large health gain. To address this, we combined our findings with those of similar studies. Second, a major limitation of measuring cost-effectiveness in terms of QALYs gained is that it is difficult to know what might have happened if routine pathologic examinations were not performed. The same disease may be diagnosed at a later date, but the benefits of an earlier diagnosis are uncertain. Perhaps the histologic diagnosis might have saved the patient from additional unnecessary testing or followup. Furthermore, QALY analysis does not attempt to determine the benefit of routine histologic examination in documenting surgery (as required by the Joint Commission) or in providing insight into the underlying molecular causes of disease [12]. Additionally, the value and sensitivity of parameters included in the analysis varies depending on specimen type and patient demographics. As the cost of histologic examinations, frequency of discordant diagnoses, gains in QALYs, and valuation of a QALY vary, the cost-effectiveness will fluctuate. This method is further complicated if the analysis includes legal implications or the consequences of not performing routine histologic examinations as defensive medicine. To avoid undue influence by limitations, we focused primarily on the direct benefits of routine histologic examinations in terms of changes in patient management, with secondary focus on the more subjective benefits such as the knowledge provided by routine histologic examinations that is not directly actionable. Furthermore, in our estimation of indirect health benefits from routine histologic examinations, we intentionally used values that would favor finding higher estimates of QALYs gained, but even so, the results were short of the number of QALYs needed to consider routine histologic examination cost-effective. Third, in this investigation, we could complete little analysis of cost-effectiveness because no case resulted in a change in patient management, and therefore no direct gain in QALY. To address this, we estimated the indirect gain in QALYs provided by the knowledge from routine histologic examinations, and we considered the findings of similar studies, to have a data set that included discordant diagnoses.

In our study of 1363 cases of total joint arthroplasties, 1335 (97.9%) clinical and histologic diagnoses were concordant, 28 (2.1%) were discrepant, and none were discordant. These findings support the hypothesis that routine histologic examination increases medical cost but rarely alters patient management. When our results were combined with those from previous studies (6745 arthroplasties, 1708 THAs, 5037 TKAs [4, 15, 17, 20, 24, 26]), 8108 cases were examined (Table 2). These investigations found similar results to those in our study: 1.5% (99/6745) of diagnoses were discrepant and 0.03% (2/6745) were discordant. In contrast to these findings, several studies of femoral heads intended for bone banking after THA found slightly higher incidences of discrepant diagnoses, ranging from 1.6% to 7.9% (Table 2). In case reports, gross inspection has been an adequate means to indicate the need for additional histologic examinations in tuberculosis of the knee [1], primary sarcoma of the femoral head [2], and metastatic breast carcinoma of the knee [13]. However, other diagnoses, including occult lymphoproliferative disease, hematopoietic neoplasms, and changes suggestive of RA, might not be apparent on gross inspection and would remain undetected if not for routine histologic examination [16].

We found that the 1363 cases of total joint arthroplasties we studied resulted in a total cost of $139,532, or $102.37 per specimen and $4983 per discrepant diagnosis. These findings are highly comparable to those of other studies, although previous studies have varied considerably in their estimates (Table 2).

We found no change in patient management was made as a result of routine histologic examination, and therefore no direct gain in QALYs was achieved. As a result, we concluded that routine histologic examination is not a cost-effective practice, as it essentially has infinite cost per QALY gained. The previous studies that reported discordant pathology-based diagnoses (Table 2) did not estimate the health benefits derived from early diagnosis of their findings of one case of granulomatous inflammation and one case of myeloid hyperplasia; the diagnostic value of routine histologic examination would depend on the difference between QALYs gained with earlier diagnosis compared with QALYs associated with later diagnosis. In the case of these particular diagnoses, we do not expect that early diagnosis has a sizable impact on morbidity or mortality. Nor do we expect that the duration between earlier pathology-based diagnosis and the counterfactual later diagnosis is especially long. Thus, the expected health benefits are probably small, and they most likely would not produce an 8.1 QALY gain that would be necessary to justify the approximately $810,800 (8108 specimens at $100/specimen) spent, if a generous $100,000/QALY cost-effectiveness threshold is applied. Because previous studies focused on cost-identification

Table 2. Review of similar studies

Study	Specimen type	Discrepant cases	Discordant cases	Cost/charges/ reimbursement
Total hip and knee arthroplasties				
Campbell et al. [4]	283 total hip and 432 total knee arthroplasties	0.8% (6/715) cases suggestive of neoplasia or rheumatoid arthritis not noted in preoperative and operative diagnoses, all failed to have any clinical significance	0	—
Kocher et al. [15]	471 total hip and 763 total knee arthroplasties	2.3% (28/1234) included rheumatoid arthritis, osteonecrosis, pseudogout, pigmented villonodular synovitis, hemochromatosis, hypercellular bone marrow, and gout	0.1% (1/1234, a case of unexpected and unexplained granulomatous inflammation)	Cost per discrepant diagnosis $4383; cost per discordant diagnosis $122,728 in 1998 dollars
Lawrence et al. [17]	562 total hip and 826 total knee arthroplasties	0.9% (13/1388, preoperative and intraoperative suspicion by surgeon in these 13 cases, needed histology to fully diagnose 12 malignant lesions and one case of pigmented villonodular synovitis)	0	Average charges of $196.27 and a mean total reimbursement of $102.59 per evaluation in 1998 dollars
Meding et al. [20]	313 total hip and 638 total knee arthroplasties	2.8% (27/951, in all cases, discrepancy was between a postoperative diagnosis of osteoarthritis and pathologic diagnosis of avascular necrosis).	0	—
Pagnano et al. [24]	2289 primary total knee arthroplasties	0.4% (10/2289)	0	—
Raab et al. [26]	79 total hip and 89 total knee arthroplasties	8.9% (15/168 discrepancies that did not affect the treatment)	0.6% (1/168 osteomyelitis that was later determined to be incorrect)	Cost per discrepant diagnosis $668.64; cost per discordant diagnosis $10,698.24 in 1996 dollars
Bone bank donation				
Palmer et al. [25]	1146 total hip replacements, femoral head would have been considered suitable for bone-bank donation	7.9% (91/1146), including chondrocalcinosis [63 cases], avascular necrosis [13 cases], osteomas [6 cases], and malignant tumors [1 low-grade chondrosarcoma, 2 well-differentiated lymphocytic lymphomas]). There were two with metabolic bone disease (Paget's disease and hyperparathyroid bone disease) and four with inflammatory (rheumatoid-like) arthritis.	Not applicable, did not assess whether patient management changed as a result of pathologic diagnosis	—
Sugihara et al. [28]	137 grafts of the femoral head for donation during total hip arthroplasty	3.6% (5/137) had abnormal histopathologic findings; three were highly suspicious for low-grade B-cell lymphoma, one for monoclonal plasmacytosis and the other for nonspecific inflammation of bone marrow		—
Zwitser et al. [34]	852 femoral heads removed at the time of primary total hip replacement, eligible for bone transplantation	1.6% (14/852) highly suspicious for low-grade B-cell non-Hodgkin lymphoma. At long-term followup, two patients had systemic malignant disease, one of whom needed medical treatment for her condition. Three other patients are evaluated on a yearly basis by a hematologist.		—

Table 2. continued

Study	Specimen type	Discrepant cases	Discordant cases	Cost/charges/ reimbursement
Arthroscopy				
Kirkley et al. [14]	1036 knee arthroscopies	3.7% (38/1036)	0.1% (1/1036 cases of pigmented villonodular synovitis instead of posttraumatic synovitis)	Cost per discordant diagnosis $234,147; cost per discrepant $6162; mean cost per case $226 in 1998 dollars
McClain et al. [18]	2144 consecutive shoulder arthroscopies	0	0	Average cost $74.88 per case, no estimate possible for cost per discrepant or discordant case in 2005 dollars
Current				
Current study	1363 arthroplasties (837 knees, 457 hips, 36 carpometacarpals, 30 shoulders, three elbows)	2.1% (28/1363)	0	Cost per specimen $102.37, cost per discordant diagnosis $4983

rather than cost-effectiveness and did not translate discrepant and discordant diagnoses into health benefits, they cannot be compared with our study's finding of zero direct QALY gain from routine histologic screening.

Our observations document that routine histologic examinations of routine operative specimens during elective primary arthroplasties produce 2.1% discrepant diagnoses, identify no discordant diagnoses, and increase medical cost by more than $100 per specimen. These findings are consistent with those in the literature. However, previous studies have not attempted to address cost-effectiveness. Our study showed that routine histologic examination produces zero direct gain in QALYs, suggesting that the practice is not cost-effective at any level of spending, and society would be better served by policies of gross examination or no examination. Interest in quantifying monetary and diagnostic values of routine histologic examination has been high in the area of joint arthroplasty, with tens of millions of dollars in projected savings by eliminating this practice [4]. The National Institutes of Health has estimated that 773,000 Americans have a hip or knee replaced each year [22]. Given our finding that routine histologic examination costs approximately $100 per specimen, eliminating this practice potentially could save $77.3 million. The use of routine gross examination also has been proposed as an alternative that would provide many of the benefits of routine histologic examination, at a fraction of the cost [5, 11]. Based on a CPT 88300 reimbursement of $29.14 for 1363 cases (Table 1), gross examination would cost 71.5% less ($39,718 versus $139,532 in this study), representing national savings of $55.3 million. Although the quality of patient care is the highest priority for healthcare providers, there are limits to resources available. Our findings suggest routine histologic examination of operative specimens during elective arthroplasty is not cost-effective. Its utility warrants further study.

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