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Research Article

Routine histopathological examination of femoral heads and incidental metastatic bone disease in hip arthroplasty

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ABSTRACT

Objective: This study aimed to assess the necessity of routine pathological examination of femoral heads in detecting incidental metastatic bone disease in patients undergoing elective and emergency hip arthroplasty.

Methods: A retrospective review was conducted on medical records, operative notes, and histopathology reports of patients who underwent hip arthroplasty between 2016 and 2024. Patients without pathological evaluation or with known metastases were excluded. The study included patients with hip osteoarthritis undergoing total hip arthroplasty and those with femoral neck fractures undergoing bipolar hemiarthroplasty. Preoperative diagnoses, comorbidities, and operative and histopathological findings were analyzed.

Results: The study included 193 patients with femoral neck fractures (mean age: 76.8 years, age range=60 – 98 years) and 257 with osteoarthritis (mean age: 60.4 years, age range= 23 – 88). After excluding 22 femoral neck fracture and 90 osteoarthritis patients, 36 patients in the fracture group and 18 in the osteoarthritis group had a history of malignancy, with 10 and 2 patients, respectively, having known metastases. Incidental metastatic bone disease was identified in four femoral neck fracture patients, while no neoplastic findings were detected in the osteoarthritis group.

Conclusion: Routine pathological examination of femoral heads is particularly relevant in femoral neck fracture cases, where the risk of detecting metastatic disease is higher. While thorough preoperative assessments and meticulous intraoperative evaluations aid diagnosis, the decision to submit specimens for pathology should be guided by the surgeon's clinical judgment and patient-specific factors.

Level of Evidence: Level III, Diagnostic Study.

Introduction

Reimbursement for expensive orthopedic surgical interventions is increasingly limited by the financial status of a country.[1-3] Therefore, it is essential to utilize resources effectively and prioritize needs while avoiding unnecessary expenses. Total hip arthroplasty is one of the most commonly performed operations, with 262 369 procedures conducted in the United States in 2019.[4] Geriatric hip fractures are increasing globally due to aging population, and 6.26 million hip fractures are expected by the year 2050.[5] Routine pathological investigation involves the histopathological examination of excised femoral heads obtained during hip arthroplasty surgeries. This practice is performed to screen large bone segments frequently affected by metastases, providing diagnostic information to guide patient care, ensuring diagnostic quality assurance, documenting the removed tissue, and gaining insight into the pathoetiology of diseases.[6]

Bone is the second most common site of metastasis, following closely behind the liver. Metastatic bone disease is most frequently observed in patients with breast cancer (65%-75%), prostate cancer (65%-90%), and lung cancer (17%-64%).[7-10] Primary malignant bone tumors commonly affect the proximal femur, although they are less frequent than metastases.[11] Avascular necrosis, osteomyelitis, enchondromas, and Paget disease are among the most commonly reported histopathological diagnoses in the previous literature.

Several studies have questioned the utility of routine histopathological examination of femoral heads in hip arthroplasty.[12-14] Suchman et al[12] indicated that 47% of hip specimens are still undergoing histopathological examination despite the fact that current evidence neither supports nor refutes this practice, highlighting the need for large studies. A very large cohort study reviewed the discrepancy between histological and clinical diagnoses in total joint arthroplasties[15] and reported 27 incidental malignancies among these patients, where the clinician was not suspecting any pathology, illustrating the potential benefit of routine examinations from a cost-effectiveness perspective. Contrarily, Schermer suggested that a selective pathological examination could reduce discrepant diagnoses and costs, identifying clinically relevant diagnoses such as pathological fractures, perioperative abnormal macroscopic findings, history of malignancy, and suspected radiology (Figure 1).[16]

Given the economic hardship faced by healthcare systems, particularly in developing countries with limited resources, the routine pathological examination of femoral heads without clear clinical indications

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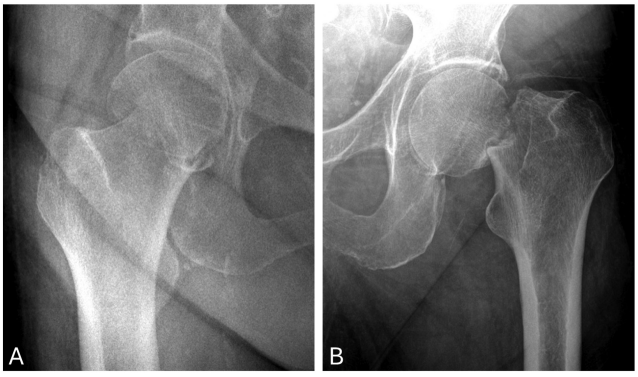


Figure 1. Preoperative radiographic images of (A) an 88-year-old female patient with a history of breast cancer and (B) a 71-year-old male patient with a history of prostate cancer, both diagnosed with incidental metastasis in the femoral head. Metastatic involvement does not always present with radiographic findings, such as sclerotic margins along the fracture line seen in patient B, and can be easily overlooked, as in patient A. A high index of suspicion should be maintained, particularly in patients with a history of malignancy.

could represent an unnecessary financial burden. There is a strong need for large and comprehensive studies that evaluate the necessity and benefits of this practice, especially in regions with constrained healthcare budgets.

The purpose of this study is to discuss the necessity of routinely sending the femoral head obtained during elective or emergency partial and total hip arthroplasty operations for histopathological examination to detect incidental metastatic bone disease. By comparing the incidence of unexpected findings in elective and emergent surgeries, the aim was to provide evidence-based recommendations for clinical practice.

Material and methods

Koç University Ethical Committee approval was obtained for the study (2024.266.IRB2.115, Date: July 07, 2024), ensuring that all patient data was handled confidentially and in accordance with relevant guidelines. Informed consent was read and signed by all patients who agreed to participate in the study.

The medical histories, operations, and histopathology reports of all patients who underwent hip arthroplasty between 2016 and 2024 were retrospectively reviewed. All patients had at least a routine preoperative pelvis X-ray, as well as anteroposterior (AP) and lateral X-rays of the affected hip joint. Computed tomography (CT) and magnetic resonance imaging (MRI) were performed when the patient had a history of malignancy or in case of suspicious X-ray findings. Patients who had no pathological investigation of the femoral head specimen and patients with known metastasis around the hip region were excluded to focus on the incidental diagnosis of metastatic bone disease in routine examinations. The patients were divided into 2 groups: patients with hip osteoarthritis who underwent total hip arthroplasty and patients with femoral neck fractures where a bipolar hemiarthroplasty was performed.

The preoperative diagnosis, comorbid diseases, operative findings, and histopathological findings were investigated in both groups.

HIGHLIGHTS

- The necessity of routine histopathological examination of the resected femoral heads in hip arthroplasty is still debated.
- A considerable incidence of unexpected malignancies was found in femoral neck fracture patients, which supports continuing routine pathological investigation in this subgroup.
- No incidental neoplastic diseases were found in elective osteoarthritis cases, supporting the cessation of routine examinations in these patients.
- Comprehensive preoperative information and meticulous intraoperative evaluation are crucial for accurate diagnosis.

Results

There were 193 patients with femoral neck fractures with a mean age of 76.8 (60-98) years and 257 patients with osteoarthritis with a mean age of 60.4 (23-88) years (Figure 2). Among the femoral neck fracture group, 132 patients underwent bipolar hemiarthroplasty and 61 patients were treated with total hip arthroplasty, including 2 tumor resection prostheses. Ninety patients with osteoarthritis and 22 patients with femoral neck fractures were excluded because the excised femoral head was not sent for pathological examination at the primary surgeon's discretion. Eighteen patients in the osteoarthritis group had a known history of malignancy, and 2 patients were excluded due to known metastasis, leaving 165 patients in the osteoarthritis group. In the femoral neck fracture group, 36 patients had a known history of malignancy, and 10 among them had a known metastasis to the hip region, leaving 161 remaining patients. Notably, 4 patients among the 36 with a previous history of malignancy, without any history or suspicion of metastasis, were diagnosed with metastatic bone disease due to the routine pathological examination of the femoral head.

No patient in the osteoarthritis group had an incidental neoplastic disease documented in routine investigation, including the 18 patients with a history of previous malignancy. Degenerative joint disease, avascular necrosis, osteoporosis, and chronic papillary synovitis were the most common pathological findings in both groups.

Forty-nine of the 161 included hip fracture patients (30.4%) were deceased during the study period, including 3 of the 4 incidental metastatic patients. Eleven of the 165 included osteoarthritis patients (6.6%) were deceased due to causes unrelated to their hip surgery.

Discussion

This study sought to investigate the necessity of routine pathological examinations of excised femoral heads in total or partial hip arthroplasty patients. The results did not support routine histopathological evaluation of the resected femoral head specimens in elective osteoarthritis patients. However, 4 incidental metastases in femoral neck fracture patients were documented, which endorses routine pathological investigation in this patient population (Figures 3 and 4).

Rising costs and decreasing reimbursements for orthopedic procedures have increased the demand for cost-effectiveness. Proposed measures to reduce costs include shortening hospital stays, standardizing prostheses and suppliers, increasing the volume of procedures using patient-specific instruments and preoperative planning, and establishing efficient clinical pathways.

The importance of routine pathologic examination of femoral heads during hip arthroplasty has been previously debated in the literature.[6,12,15,17] The largest series is by DiCarlo and Klein, who reviewed the discrepancy between histological and clinical diagnoses in 7968 hip arthroplasty patients.[15] They found that in 18.8% of the cases, the clinical and histological diagnoses of degenerative joint disease

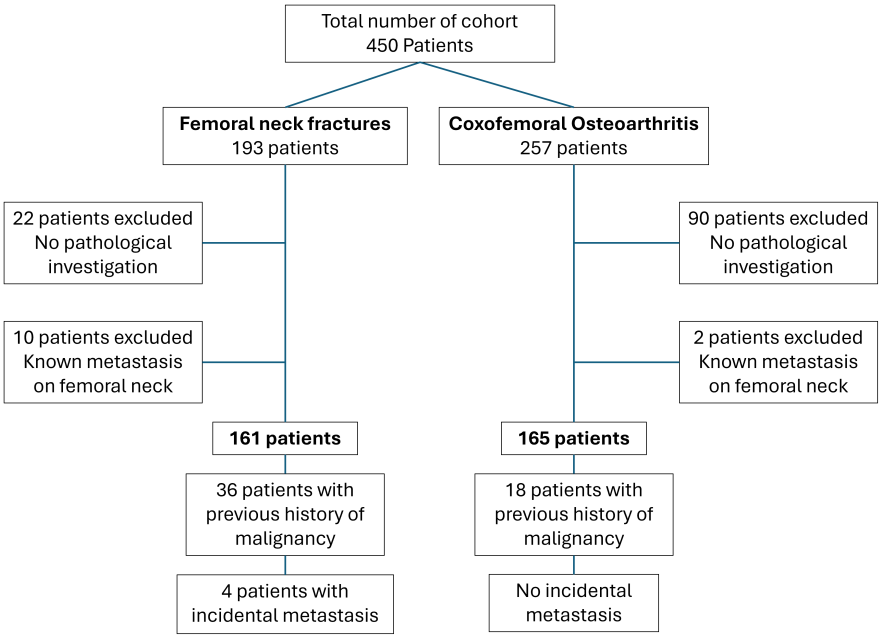


Figure 2. Flowchart illustrating patient selection into subgroups and exclusion criteria. Note that patients with known metastatic involvement in the femoral head were excluded from both groups to focus solely on incidental metastases.

subtypes did not match. Additionally, they reported 27 incidental malignancies among these patients, where the clinician was not suspecting any pathology. The authors highlighted the potential benefits of routine examinations in detecting unexpected pathologies, although it primarily emphasizes the discrepancies in degenerative joint disease diagnoses rather than malignancies.[15] Unexpected pathological findings have been reported in various case studies emphasizing the importance of routine histopathological investigations. Kahn and Blazina reported a case of metastatic breast carcinoma discovered during a routine examination.[18] Kheir published a case report of an incidental prostate adenocarcinoma found on routine pathology, where the authors did not suspect a neoplastic disease despite the insidious worsening of hip osteoarthritis.[19] Billings et al[20] reported 2 cases of incidentally discovered sarcomas during hip arthroplasty. These cases illustrate the clinical significance of routine histopathological examinations in uncovering unexpected pathologies. Liow et al[6] evaluated the cost-effectiveness of routine femoral head histopathology in a very large cohort of total hip replacement patients and concluded that despite a very low rate of discrepant diagnosis, it is cost-effective in diagnosing unsuspected malignancies and providing useful clinical information.

Nevertheless, subsequent studies have suggested that the rate of discrepancy was not significant and that this process is not cost-effective, particularly for developing countries with limited resources.[1,21] Kocher investigated the cost-efficiency of routine pathological

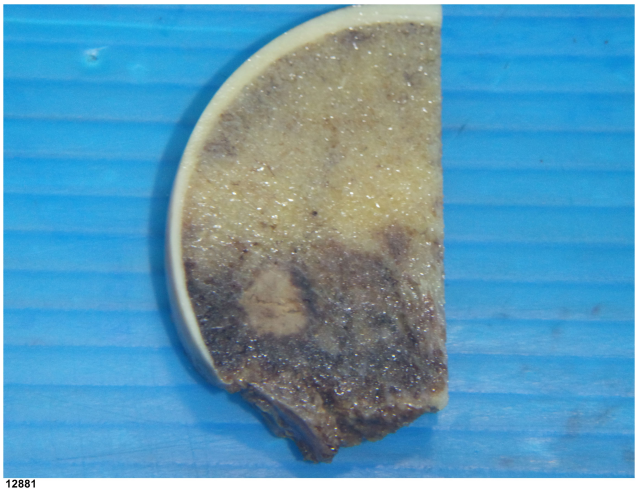


Figure 3. Macroscopic image of the femoral head specimen of a 71-year-old male patient with a history of prostate cancer (patient B in Figure 1). In the examined specimens, a well-circumscribed, irregular, white-beige area measuring 0.7 mm in diameter was observed in the medullary region. Immunohistochemical analysis revealed that the tumor cells exhibited a focal positive reaction to PSAP and NKX3.1, leading to the diagnosis of prostatic-type adenocarcinoma metastasis.

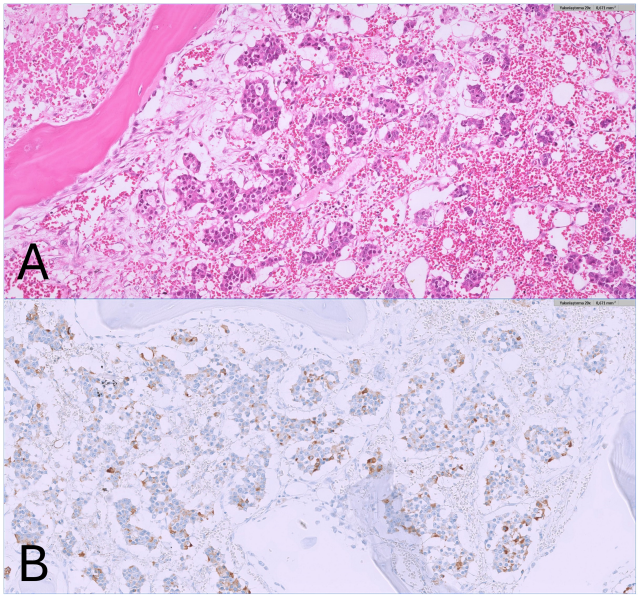


Figure 4. Histopathological views of the femoral head specimen of a 71-year-old male patient with a history of prostate cancer (patient B in figure 1). (A) Prostate adenocarcinoma metastasis is seen among mature bone lamellae. (H&E ×200) (B) IHC; PSAP stain is positive in tumoral infiltration (IHC ×200).

examination during hip and knee arthroplasty surgeries and found a very low prevalence of findings that modified patient management.[3] The authors concluded that routine pathological examination of arthroplasty specimens is not recommended, citing substantial potential cost savings from discontinuing this practice for patients clinically diagnosed with osteoarthritis.

The discrepancy ratio varies largely in the current literature. Campbell et al's[2] series reported a discrepancy rate of 0.84%, very close to Lawrence et al's[22] series which reported a rate of 0.80%, suggesting that the routine examination of arthroplasty specimens may not always be justified given the low rates of clinically significant discrepancies. Moreover, many incidental diagnostic discoveries between pathological and radiological diagnoses do not cause a significant change in patient management, such as avascular necrosis. However, the diagnosis should be documented for monitoring the contralateral side.

In this study, there was a discrepancy rate of 0% in the osteoarthritis group and 2.48% in the femoral neck fracture group. There was no surprising pathological finding in the elective hip arthroplasty group, warranting a complete cessation of routine investigation in this group. The hip fracture group, however, had a considerable incidence of unexpected malignancy (4 out of 161 patients). Several reasons endorse routine pathological examinations in femoral neck fracture patients, along with current study's findings. Metastatic infiltration is a significant cause of femoral neck fractures as it compromises bone integrity and weakens its structure.[23] Patients have better survival rates when presenting with impending fractures compared to those with actual pathological fractures.[24] Radiological findings of metastatic infiltration can be subtle or easily confused with simple osteoporotic femoral neck fractures. These fractures may mimic neoplastic radiolucencies, and in MRI, the similarities between metastatic infiltration and fracture hematoma can obscure the diagnosis of a metastatic fracture.[25-27] Therefore, a high level of suspicion should remain in patients with femoral neck fracture and routine histopathological investigation of the excised femoral head specimens could still be beneficial in this subgroup.

Despite many studies, no definitive consensus has been reached on the subject, but there are common recommendations.[17] First, unusual clinical or surgical findings should still warrant pathologic examination and should be submitted at the surgeon's discretion. Second, the decision to conduct routine histopathological examinations should balance immediate costs with the potential for improved long-term outcomes and overall healthcare savings. Lawrence suggested a surgeon-directed use of histological analysis, where the surgeon macroscopically evaluates the excised femoral head and proceeds with histopathological analysis only if unexpected findings are suspected. They claim that this method is more cost-effective and results in notable financial savings.[22] Similarly, Raab et al[14] reported that the course of treatment was modified in only 1 patient, where osteomyelitis was incidentally discovered among 79 specimens of hip replacements. Despite 16 patients with unexpected findings, Raab recommended discontinuing routine pathological examinations in osteoarthritis cases, provided the surgeon has a thorough understanding of the patient's history, laboratory results, and radiological findings. By gathering sufficient preoperative information and performing a diligent intraoperative macroscopic evaluation, accurate clinical foresight of the pathological diagnosis may be achieved.

This study's major limitation is the smaller patient population compared to previous studies. Layfield et al[28] documented 3 unrecognized neoplasms among 952 femoral head specimens. However, their series includes only 18 femoral neck fractures and mainly focused on the severity of osteoarthritis, comparing histological and clinical findings. This study focused on neoplastic involvement and included 161 femoral neck fractures as an essential subgroup, considering that the neoplastic involvement could increase the fragility of the bone, leading to fractures. Campbell et al[2] evaluated 283 hips and 432 knees, focusing similarly on neoplastic diseases as well as rheumatoid diseases that were not clinically documented. They found 6 incidental findings that did not change the course of treatment, referring to these as "disparate diagnoses."

Another limitation of the study is the absence of financial data to evaluate the cost-effectiveness of histopathological investigations. The challenge in quantifying the cost-effectiveness of routine pathological examination, particularly in the rare cases where an undiagnosed metastatic cancer is discovered in hip fracture patients, is acknowledged. While early cancer diagnosis is inherently valuable, the infrequency of such findings, even in large cohorts, complicates the assessment of cost-effectiveness. Given the absence of incidental findings that altered patient management in the study, it is reasonable to eliminate routine pathological investigations in cases where the outcome is predictably negative, especially in resource-limited settings of the country.

In conclusion, these findings emphasize the critical role of pathological examination of femoral head specimens, particularly in cases involving femoral head-neck fractures, which show a higher likelihood of detecting metastatic disease in pathological evaluations. This underscores the importance of sending specimens to pathology when fractures are present, even in patients without a known neoplastic disease history. However, the decision to send or not send any material for pathological examination remains the responsibility of the operating surgeon, who must rely on clinical judgment and individualized patient factors. Additionally, it remains challenging to predict the cost-effectiveness of submitting femoral heads for routine pathological evaluation. This study highlights the importance of balancing thorough examination with clinical discretion to ensure that potential pathologies are not overlooked.

Data availability statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics Committee Approval: This study was approved by the Ethics Committee of Koç University (Approval no.: 2024.266.IRB2.115 Date: July 07, 2024).

Informed Consent: Written informed consent was obtained from the patients/patient who agreed to take part in the study.

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References

1. Brown Z, Perry M, Killen C, Schmitt D, Wesolowski M, Brown NM. Evaluation of the cost effectiveness of routine histopathologic femoral head analysis in hip arthroplasty. *Hip Pelvis.* 2022;34(1):56-61. [CrossRef]

2. Campbell ML, Gregory AM, Mauerhan DR. Collection of surgical specimens in total joint arthroplasty. Is routine pathology cost effective? *J Arthroplasty*. 1997;12(1):60-63. [CrossRef]
3. Kocher MS, Erens G, Thornhill TS, Ready JE. Cost and effectiveness of routine pathological examination of operative specimens obtained during primary total hip and knee replacement in patients with osteoarthritis. *J Bone Joint Surg Am*. 2000;82(11):1531-1535. [CrossRef]
4. Shichman I, Roof M, Askew N, et al. Projections and epidemiology of primary hip and knee arthroplasty in medicare patients to 2040-2060. *JB JS Open Access*. 2023;8(1):e22.00112. [CrossRef]
5. Kavak M, Oğuz S, Akkoyun Z, İnan U. Predictive factors associated with thirty-day mortality in geriatric patients with hip fractures. *Acta Orthop Traumatol Turc*. 2022;56(4):240-244. [CrossRef]
6. Liow MHL, Agrawal K, Anderson DW, Freiberg AA, Rubash HE, Kwon YM. Unsuspected malignancies in routine femoral head histopathologic examination during primary total hip arthroplasty: cost-effectiveness analysis. *J Arthroplasty*. 2017;32(3):735-742. [CrossRef]
7. Coleman RE. Clinical features of metastatic bone disease and risk of skeletal morbidity. *Clin Cancer Res*. 2006;12(20 Pt 2):6243s-6249s. [CrossRef]
8. Shalata W, Abu Jama A, Abu Salman A, et al. Unexpected and rare sites of metastasis in oncologic patients. *J Clin Med*. 2023;12(20):6447. [CrossRef]
9. Tsukamoto S, Errani C, Kido A, Mavrogenis AF. What's new in the management of metastatic bone disease. *Eur J Orthop Surg Traumatol*. 2021;31(8):1547-1555. [CrossRef]
10. Riihimäki M, Thomsen H, Sundquist K, Sundquist J, Hemminki K. Clinical landscape of cancer metastases. *Cancer Med*. 2018;7(11):5534-5542. [CrossRef]
11. Görgün B, Özşahin MK, Tok O, Davulcu CD, Karaismailoğlu B, Hız M. Intralesional curettage and cementation of low-grade chondrosarcomas of the appendicular skeleton: long-term results from a single center. *Acta Orthop Traumatol Turc*. 2022;56(6):402-407. [CrossRef]
12. Suchman KI, Poeran J, Huang HH, et al. Are histological examinations of arthroplasty specimens performed consistently across the country? A large database study. *Clin Orthop Relat Res*. 2019;477(8):1815-1824. [CrossRef]
13. Rubin G, Krasnyansky S, Gavish I, Elmalah I, Ben-Lulu O, Rozen N. Meta-analysis of unexpected findings in routine histopathology during total joint replacement. *Isr Med Assoc J*. 2011;13(2):80-83.
14. Raab SS, Slagel DD, Robinson RA. The utility of histological examination of tissue removed during elective joint replacement. A preliminary assessment. *J Bone Joint Surg Am*. 1998;80(3):331-335. [CrossRef]
15. DiCarlo EF, Klein MJ. Comparison of clinical and histologic diagnoses in 16,587 total joint arthroplasties: implications for orthopedic and pathologic practices. *Am J Clin Pathol*. 2014;141(1):111-118. [CrossRef]
16. Schermer BA, Bénard MR, Kleeblad LJ, de Gast M, Mahdad R. Selective pathological examination following hip arthroplasty: a retrospective cohort study. *Orthop Traumatol Surg Res*. 2022;108(2):102942. [CrossRef]
17. Nandi S, Schwarzkopf R, Chen A, et al. Routine pathologic examination of femoral head specimens from total hip arthroplasty may not be indicated or cost-effective: a systematic review. *Arthroplast Today*. 2022;15:182-187.e3. [CrossRef]
18. Kahn DG, Blazina ME. Incidental metastatic mammary carcinoma in a total knee arthroplasty patient. *Clin Orthop Relat Res*. 1993;(295):142-145. [CrossRef]
19. Kheir MM, Bauer TW, Westrich GH. Diagnosis of prostate adenocarcinoma on routine pathology after a primary total hip arthroplasty. *Arthroplast Today*. 2022;15:19-23. [CrossRef]
20. Billings SD, Wurtz LD, Tejada E, Henley JD. Occult sarcoma of the femoral head in patients undergoing total hip arthroplasty. A report of two cases. *J Bone Joint Surg Am*. 2000;82(11):1536-1539. [CrossRef]
21. Lin MM, Goldsmith JD, Resch SC, DeAngelis JP, Ramappa AJ. Histologic examinations of arthroplasty specimens are not cost-effective: a retrospective cohort study. *Clin Orthop Relat Res*. 2012;470(5):1452-1460. [CrossRef]
22. Lawrence T, Moskal JT, Diduch DR. Analysis of routine histological evaluation of tissues removed during primary hip and knee arthroplasty. *J Bone Joint Surg Am*. 1999;81(7):926-931. [CrossRef]
23. Damron TA, Mann KA. Fracture risk assessment and clinical decision making for patients with metastatic bone disease. *J Orthop Res*. 2020;38(6):1175-1190. [CrossRef]
24. Mavrogenis AF, Pala E, Romagnoli C, Romantini M, Calabro T, Ruggieri P. Survival analysis of patients with femoral metastases. *J Surg Oncol*. 2012;105(2):135-141. [CrossRef]
25. O'Sullivan GJ, Carty FL, Cronin CG. Imaging of bone metastasis: an update. *World J Radiol*. 2015;7(8):202-211. [CrossRef]
26. Imren Y, Karslioğlu B, Semih Dedeoğlu S, Keskin A, Firat Berkay A, Cagri Tekin A. Feasibility of diagnosing osteoporosis using routine computed tomography scans for hip fractures: correlation with histopathological diagnosis of head and neck regions. *Acta Orthop Traumatol Turc*. 2023;57(6):384-388. [CrossRef]
27. Alsina AC, Sacchetti F, Kaya H, Yaman B, Tamsel İ, Sabah D. Impact of the unplanned excision on the oncological outcomes of patients with soft tissue sarcomas: a single-center retrospective review of 490 patients. *Acta Orthop Traumatol Turc*. 2022;56(4):272-277. [CrossRef]
28. Layfield LJ, Crim JR, Oserowsky A, Schmidt RL. Pathology assessment of femoral head resection specimens: an important quality assurance procedure. *Arch Pathol Lab Med*. 2020;144(5):580-585. [CrossRef]