Original Article

Diagnostic Yield of Image-Guided Percutaneous Core Needle Biopsy in Skeletal Lesions: A Retrospective Analysis

Mehreen Maqsood[1], Azad Ahmad Shah[2], Nadeem Ali[3]*, Bilal Ahmad Shiekh[1], Altaf Ahmad Kawoosa[4]

[1]Department of Pathology, Government Medical College, Srinagar, Jammu & Kashmir, India
[2]Department of Orthopedics, Hospital for Bone and Joint Surgery, Barzulla, Srinagar, Jammu & Kashmir, India
[3]District Hospital Bandipora, Bandipora, Jammu & Kashmir, India
[4]Department of Orthopedics, Government Medical College, Srinagar, Jammu & Kashmir, India

DOI: 10.21276/APALM.3479

***Corresponding Author**:
Dr Nadeem Ali
drnadeeem@gmail.com

Submitted: 20-Nov-2024
Final Revision: 28-Feb-2025
Acceptance: 08-Mar-2025
Publication: 31-Mar-2025

Abstract

Background: Despite advances in radiology and imaging, histological diagnosis is of paramount importance in the management of musculoskeletal lesions. Traditionally, open biopsies are considered the gold standard but are associated with tumor cell contamination and a high complication rate. These issues can be addressed with a minimally invasive approach using a percutaneous core needle biopsy. In this study, we evaluated the diagnostic yield of core needle biopsy of bone lesions at our institute.

Materials and Methods: This retrospective study of image-guided percutaneous core needle biopsy was conducted on 53 skeletal lesions, and the diagnostic yield of these biopsies was calculated based on the number of diagnostic and non-diagnostic core biopsies.

Results: Among 53 skeletal lesion core needle biopsies, 39 had concordance with final open biopsy or the clinical outcome, making a diagnostic yield of 73.58%. Cystic skeletal lesion biopsies constituted 64.29% of the non-diagnostic core needle biopsies. When cystic lesions were excluded and only solid skeletal lesions were considered, the diagnostic yield improved to 87.80%.

Conclusion: Percutaneous core needle biopsy of solid skeletal lesions is a cheap, less invasive, reliable, accurate, and cost-effective invasive procedure for histological diagnosis of skeletal lesions with the least complication rate. It should be considered as a first-line invasive diagnostic modality for the workup and management of skeletal lesions.

Keywords:

core needle biopsy; open biopsy; skeletal lesions; histopathology

Introduction

A preliminary diagnosis of a lesion involving the skeletal system can be made from clinical assessment and a complete radiological work-up. However, for management of such lesions, a histological diagnosis is required in view of clinico-radiological mimicry shown by different pathological entities [1]. Conventionally, obtaining a tissue specimen from the skeletal lesion by open techniques is considered as a gold standard for tissue diagnosis, with a diagnostic accuracy of around 98%, but is plagued with complications like bleeding, contamination of the wound with tumor cells, a pathological fracture, and wound infection. In addition, it needs to be performed under general or regional anesthesia, which requires hospital stay admissions, thus adding to

the financial burdens [2, 3].

Fine needle aspiration cytology (FNAC) has gained popularity in evaluation of soft tissue and visceral lesions, but its role in osseous lesions is limited due to limited experience, inadequate samples retrieved, difficulty in sampling sclerotic, fibrous and intramedullary lesions, difficulty in sub-typing the bone tumors, and loss of tissue architecture [4]. These limitations have been overcome by a percutaneous technique of obtaining a core of pathological tissue using a core biopsy needle. This has the advantage of being minimally invasive, can be done under local anesthesia as an outpatient procedure, preserves the tissue architecture, and also helps in sub-typing and grading the malignant lesions [5].

This study was conducted to evaluate the diagnostic accuracy of core needle biopsy in different osseous lesions at our institute.

Materials and Methods

This retrospective monocentric study was conducted in one of the units of an orthopedic referral institute over a period of two years, from June 2021 to May 2023. Percutaneous core needle biopsies (PCNB) of all the skeletal lesions, where the final diagnosis was confirmed by histopathology of open biopsy, excised specimen, curetted material, or amputated extremity, were included in this study. Those cases where the diagnosis was established by history, clinical follow-up, and supporting investigations were also included. For example, a patient with a history of primary malignancy elsewhere and core biopsy of the skeletal lesion showing metastasis of the same to the bone; a patient with core biopsy showing features of multiple myeloma and serum electrophoresis confirming it with presence of M band or bone marrow biopsy; and similarly, a case of aneurysmal bone cyst diagnosed on histopathology showing clinical and radiological healing with repeated intra-lesional sclerotherapy. Biopsies where insufficient material was obtained for pathological diagnosis were excluded from the study. Cases associated with radiological treatment or cases that had previous biopsy were also excluded.

The case sheets of the patients that underwent PCNB were assessed for clinical details, investigations, radiological work-up details, location of the lesion, assistance mode for PCNB (fluoroscopy / CT guided), nature of the lesion (cystic or solid), type of material obtained (wall scrapings / solid core), nature of the contents on aspiration of cystic lesions (blood / serous), pathologist's histopathological impression, complications, definitive treatment modality of the lesion, and histopathology report of the specimen obtained on definitive surgical treatment.

All the core biopsies were performed by a single experienced orthopedic surgeon. In the majority of the cases, biopsy was taken under local anesthesia, with regional and general anesthesia reserved for uncooperative patients and deep-seated lesions. Fluoroscopy was used to guide the surgeon for taking the core biopsy; however, for deep-seated, difficult lesions or small lesions which could not be picked up on fluoroscopy, a CT-guided biopsy was the preferred approach. All the core biopsies were taken using a Jamshidi bone biopsy needle with a size of 11 or 13 gauge, depending on the size of the bone involved. Before proceeding with the PCNB, an appropriate approach to the lesion was discussed so that the biopsy tract could be resected in future surgery to prevent recurrence along the biopsy tract.

A small stab incision was made in the skin at the selected site. The biopsy needle, along with its trocar inside, was advanced through the stab incision under fluoroscopic or CT guidance. A puncture was made in the bone overlying the intraosseous lesion by sustained clockwise and counter-clockwise motion until the trocar pierced the bone. The trocar was removed and the needle was progressed into the lesion, taking a core of tissue from the lesion. The needle was removed and the core biopsy specimen was retrieved using a stiletto (Figure 1). The procedure was repeated in a different direction inside the lesion through the same tract,

and a minimum of three core biopsy samples were obtained.

In cases of cystic lesions, where no tissue specimen could be obtained, scrapings were acquired from the wall of the lesion with suction pressure using a 20 ml syringe attached to the needle. Besides scrapings, small core biopsies were acquired from the wall of these cystic lesions. In cases where thick cortical bone could not be pierced with the needle, an appropriately sized K-wire mounted on a mechanized drill was used to pierce the bone to make an entry point for the biopsy needle. The core biopsy specimen or scrapings were fixed in 10% formalin and sent to the pathologist for histopathology.

Core biopsy results were categorized as diagnostic or non-diagnostic based on pathological and/or clinical follow-up data. A biopsy was read as diagnostic if a definitive pathological diagnosis was determined, or the result was clinically useful and no subsequent tissue sample was required for confirmation [Figure 2], [Figure 3], and [Figure 4]. The diagnostic yield of the PCNB was calculated by dividing the number of diagnostic biopsies by the total number of core biopsies. Complications like iatrogenic fracture, neurovascular injury, infection, local hematoma, or seroma after the procedure were also recorded.

Over a period of two years, 86 core needle biopsies were performed in our orthopedic unit, out of which only 53 met the selection criteria. In the remaining 33 cases, an appropriate tissue sample could not be obtained, or a final diagnosis could not be established in view of loss to follow-up or referral to higher centers, and hence were excluded from this study.

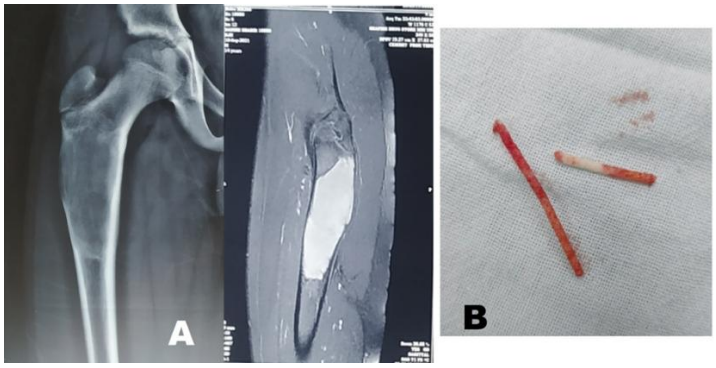

Figure 1: A. Radiograph and an MRI showing lesion in the proximal femoral diaphysis. B. Two core needle biopsy samples acquired from the lesion.

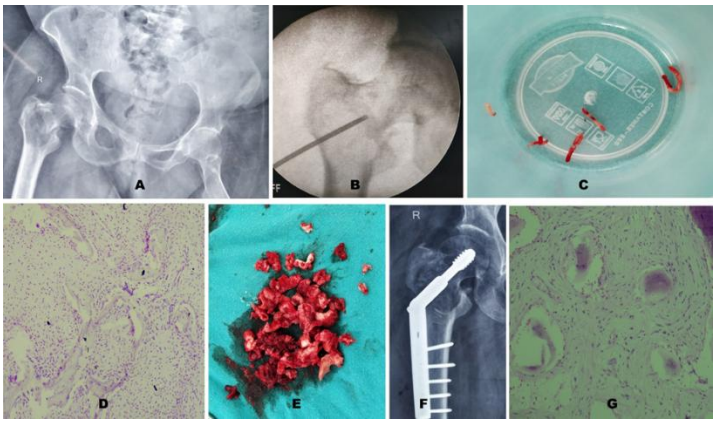

Figure 2: A. Basicervical pathological fracture. B. Image guided core needle biopsy. C. Core biopsy samples. D. Histopathology of core specimen (fibrous dysplasia). E. Intra-operative curettage specimen. F. Bone grafting of lesion and fixation with dynamic hip screw. G. Histopathology of curetted material (fibrous dysplasia).

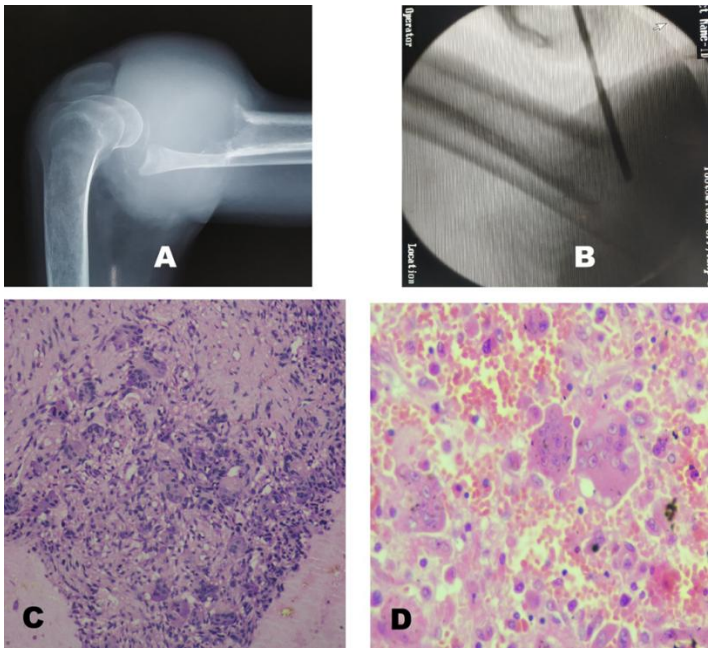

Figure 3: A. Aggressive lytic lesion of proximal tibia. B. Image guided core needle biopsy. C. Histopathology of core needle biopsy showing features of giant cell tumor. D. Histopathology after above knee amputation confirming the diagnosis of giant cell tumor of bone

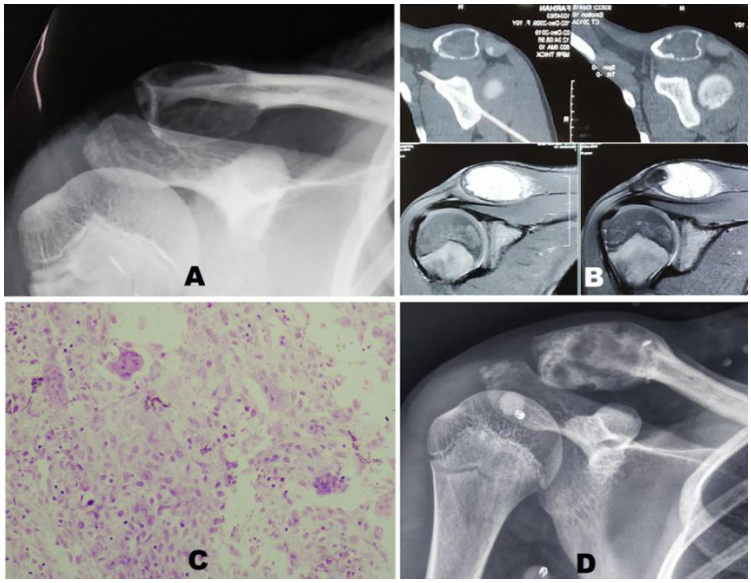

Figure 4: A. Radiograph showing lytic expansile lesion of lateral end clavicle. B. CT and MRI imaging showing a cystic fluid filled expansile lesion. C. Histopathology of wall scrapings obtained by core biopsy needle showing features of aneurysmal bone cyst. D.

Results

A total of 53 cases of PCNBs were included in this study. The mean age of the patients was 27.80 (SD = 18.65) years, with the youngest patient 17 months of age and the oldest 65 years of age. There were 24 male patients and 29 female patients. Leg bones

(tibia and fibula) were the most common site of skeletal lesions (16 patients), followed by the femur (15 patients). The distribution of the lesions is tabulated below [Table 1].

Table 1: Distribution of skeletal lesions.

Site of lesion	Number of patients	Percentage
Long bones of leg (Tibia and fibula)	16	30.19 %
Femur	15	28.30 %
Hand	5	9.43 %
Foot	4	7.55 %
Humerus	4	7.55 %
Spine	3	5.66 %
Forearm bones (radius and ulna)	3	5.66 %
Pelvis	2	3.77 %
Clavicle	1	1.87 %
Total	53	100 %

Local anesthesia was used in 47 (88.68%) biopsies, whereas general anesthesia or regional anesthesia was required in the remaining. Core biopsy was carried out under fluoroscopic guidance in 48 lesions, and a CT-guided biopsy was obtained in only five patients.

The core biopsy histopathology was concordant with the final open biopsy or with the clinical outcome in 39 cases, making a diagnostic yield of 73.58% [Table 2]. Of the 14 biopsies that were non-diagnostic, 9 lesions were cystic in nature, and the remaining five were solid with a soft tissue component. Among the non-diagnostic cystic lesion biopsies, 5 turned out to be aneurysmal bone cysts (ABCs), 2 were simple bone cysts (SBCs), and 2 were cases of chronic osteomyelitis. In non-diagnostic solid lesion biopsies, two cases were later diagnosed as fibrous dysplasia, and one case each of enchondroma, intraosseous lipoma, and adamantinoma. In thirteen non-diagnostic biopsies, the histopathology report was descriptive but inconclusive, and one biopsy that was diagnosed as a case of giant cell tumor was later diagnosed as ABC on intraoperative finding and final histopathology report of the curated material.

Table 2: Skeletal lesion pathology at final follow up and diagnostic accuracy of initial PCNB

Pathology	No. of cases	No. of Diagnostic PCNBs	Diagnostic yield
Giant Cell Tumor	7	7	100 %
Fibrous Dysplasia	7	5	71.43 %
Aneurysmal Bone Cyst	7	2	28.57 %
Osteomyelitis	6	4	66.67 %
Enchondroma	4	3	75 %
Ewing's Sarcoma	3	3	100 %
Skeletal Metastasis	3	3	100 %
Chondrosarcoma	2	2	100 %
Chondroblastoma	2	2	100 %
Non-ossifying Fibroma	2	2	100 %
Plasmacytoma	2	2	100 %
Simple Bone Cyst	2	0	0 %
Osteosarcoma	2	2	100 %
Osteochondroma	1	1	100 %
Adamantinoma	1	0	0 %
Intra-osseous Lipoma	1	0	0 %
Fibrous Metaphyseal Defect	1	1	100 %
Total	53	39	73.58 %

Twelve lesions from the study were lytic and cystic in nature. The remaining 41 lesions were solid in the form of intraosseous lesions or in the form of extra-osseous growths. Out of 12 cystic lesions, core biopsy was diagnostic in only three cases, making a diagnostic yield of 25% only. The lesions with non-diagnostic biopsy included six SBCs, two SBCs, and one case of osteomyelitis. The diagnostic yield in solid lesions was 87.80%, with 36 lesions out of 41 having a concordance of PCNB and final histopathology. The non-diagnostic CNB among solid lesions included two cases of fibrous dysplasia and one case each of enchondroma, adamantinoma, and intraosseous lipoma.

There was one case of local hematoma formation, which settled by itself in two weeks, and one case of superficial infection that was managed with intravenous antibiotics. There was no case of iatrogenic fracture or any neurovascular injury during the procedure.

Discussion

Though open biopsy of the skeletal lesions is still considered a gold standard, it is plagued with complications like contamination with tumor cells, tumor, iatrogenic fracture, wound dehiscence, tumor fungation, and infection. Besides these complications, open biopsy may need general or regional anesthesia and may also have financial implications. To overcome these, a minimally invasive fine needle aspiration and core needle percutaneous biopsy (PCNB) of the skeletal lesions is a good alternative [2, 6]. Fine needle aspiration biopsy, though minimally invasive, can only differentiate between benign and malignant nature of the lesion. Its role in definitive tissue diagnosis of skeletal lesions is limited because of absent tissue architecture, which is an important feature for histological diagnosis of these lesions [7]. To overcome this limitation, PCNB was introduced, which, besides being minimally invasive, preserved the tissue architecture of the chunk of tissue obtained, allowing histological diagnosis, tumor grading, and ancillary analysis. PCNB is also useful in obtaining an image-guided biopsy in deep-seated difficult lesions of the spine and pelvis, where open biopsy is difficult and has a higher rate of complications [8, 9].

The diagnostic yield of biopsy of bone tumors is an important parameter that can influence their management. In the literature, the diagnostic yield of open bone biopsy ranges from 91% to 96%, and for PCNB the range is 66% to 98% [10, 11]. Srisawat P et al. (2014), in their comparative study of open incisional biopsy versus closed needle biopsy in musculoskeletal sarcomas, obtained a diagnostic yield of 98.13% and 97.94%, respectively [6]. The success or the diagnostic yield of PCNB is dependent on multiple factors like size of the lesion, site of the lesion, degree of sclerosis, presence of necrosis, histological nature of the lesion, and number of core specimens taken. Lesions that are small and those seated deep at difficult sites may have difficulty in obtaining the pathological tissue. Presence of sclerosis reduces the diagnostic yield due to the presence of reactive new bone and relatively lower tumor cellularity. Similarly, necrotic tumor tissue specimens also hamper the histopathological diagnosis [12, 13, 14].

The diagnostic yield of 73.58% in our study is consistent with that of the international literature but was on the lower side when compared to other studies (Table 3). On evaluation of our non-diagnostic biopsies, 64.29% of our non-diagnostic biopsy lesions were cystic in nature. Overall, the diagnostic yield from a total of 14 cystic lesions from our study was only 20%. When these cystic lesions were excluded, the diagnostic yield of the remaining solid lesions improved to 87.80%. The cystic lesions in our study were either bone cysts or osteomyelitis. There is no study in the literature where diagnostic yield or accuracy of PCNB in the bone cysts has been studied. Mohaidat ZM et al. (2019), in their study on 25 cases of aneurysmal bone cysts, had core needle biopsy in seven patients and found it to be diagnostic in only two (28.57%) patients. In two patients, PCNB was inadequate, and in the remaining three patients, the lesions were misdiagnosed as simple bone cyst, non-ossifying fibroma, and giant cell tumor of the bone [22].

Table 3: Review of literature showing diagnostic yield of different studies

Study (year)	Study Type	No. of Biopsies	Diagnostic Yield (%)
Sung KS (2009) [15]	Retrospective	167	91.6 %
Omura MC (2011) [16]	Retrospective	219	78 %
Didolkar MM (2013) [17]	Retrospective	423	67 %
Saleem H (2015) [18]	Retrospective	50	82 %
Taupin T (2016) [19]	Retrospective (diagnosis of osteosarcoma)	73	93.2 %
Govindan NO (2017) [20]	-	90	80 %
Suh CH (2019) [11]	Meta-analysis (sclerotic bone lesions)	969	74 %
Khan I (2020) [21]	Retrospective	100	91 %
Crenn V (2021) [2]	Retrospective	196	84.7 %
Present Study	Retrospective	53	73.58 %

Besides cystic lesions, sclerotic skeletal lesions have a poor diagnostic yield as compared to pure lytic lesions. Suh CH et al. (2019), in their meta-analysis of core needle biopsy of 969 sclerotic skeletal lesions, found a diagnostic yield of 74% [11]. Li Y et al. (2014), in their study of CT-guided PCNB on 155 patients with bone lesions, had a diagnostic yield of 89.9% for lytic lesions and only 48.5% for sclerotic bone lesions [23]. This poor yield has been explained on the basis of low tumor cellularity because of masking of the pathological tissue by reactive sclerosis [14].

Complications are part of every procedure, and the same holds true for PCNB. In the literature, the complication rate of PCNB is less than 5%, which is negligible as compared to 16% associated with open bone biopsy. Clinically significant complication rate in PCNB is less than 1%, and procedure-related mortality does not exceed 0.05% [5, 24, 25]. Various complications that have been reported by the authors in the literature include hematoma formation, an iatrogenic pathological fracture, infection, neural injury, organ damage, or biopsy needle breakage [25, 26]. We only had two (3.78%) minor complications in the form of local hematoma and superficial infection in this study, which settled without any intervention.

Conclusion

Image-guided percutaneous core needle biopsy is an easy, safe, cost-effective, reliable, and accurate procedure for tissue diagnosis of skeletal lesions with a very low complication rate, which makes it a first-line invasive diagnostic modality in bone lesions. Though diagnostic yield in cystic lesions like simple bone cysts, aneurysmal bone cysts, and osteomyelitis is low, in solid bone lesions it is as good as open biopsy. Moreover, if core needle biopsy is non-diagnostic, the option of repeat needle biopsy or an open biopsy is still reserved.

Conflict of Interest: We do not have any conflict of interest in publishing this research article.

Funding Source: No funding source of any kind.

Acknowledgement: None.

References

1. Osborne RL. The differential radiologic diagnosis of bone tumors. CA Cancer J Clin. 1974;24(4):194-211.
2. Crenn V, Vezole L, Bouhamama A, et al. Percutaneous core needle biopsy can efficiently and safely diagnose most primary bone tumors. Diagnostics (Basel). 2021;11(9):1552.
3. Errani C, Traina F, Perna F, Calamelli C, Faldini C. Current concepts in the biopsy of musculoskeletal tumors. ScientificWorldJournal. 2013;2013:538152.

4. Chakrabarti S, Datta AS, Hira M. Critical evaluation of fine needle aspiration cytology as a diagnostic technique in bone tumors and tumor-like lesions. Asian Pac J Cancer Prev. 2012;13(7):3031-5.
5. Tomasian A, Hillen TJ, Jennings JW. Bone biopsies: what radiologists need to know. AJR Am J Roentgenol. 2020;215(3):523-33.
6. Srisawat P, Veeraphun P, Punyaratabandhu T, et al. Comparative study of diagnostic accuracy between office-based closed needle biopsy and open incisional biopsy in patients with musculoskeletal sarcomas. J Med Assoc Thai. 2014;97(Suppl 2):S30-8.
7. Mohit, Dixit S, Sharma R, Sharma P, Kumar P. Evaluation of FNAC in bone lesions. Ann Int Med Den Res. 2019;5(1):PT12-5.
8. Guedes A, Nakagawa SA. Biopsy of bone tumors: a literature review. Rev Assoc Med Bras (1992). 2024;70(Suppl 1):e2024S131.
9. Puri A, Shingade VU, Agarwal MG, et al. CT-guided percutaneous core needle biopsy in deep seated musculoskeletal lesions: a prospective study of 128 cases. Skeletal Radiol. 2006;35(3):138-43.
10. Adams SC, Potter BK, Pitcher DJ, Temple HT. Office-based core needle biopsy of bone and soft tissue malignancies: an accurate alternative to open biopsy with infrequent complications. Clin Orthop Relat Res. 2010;468(10):2774-80.
11. Suh CH, Yun SJ. Diagnostic outcome of image-guided percutaneous core needle biopsy of sclerotic bone lesions: a meta-analysis. AJR Am J Roentgenol. 2019;212(3):625-31.
12. Ozdemir ZM, Kahraman AS, Baysal T, et al. Image-guided percutaneous bone biopsy with a simulated van Sonnenberg removable hub system. Eurasian J Med. 2015;47(1):1-12.
13. Saifuddin A, Clarke AW. Biopsy of bone and soft tissue sarcomas. In: Bentley G, editor. European surgical orthopaedics and traumatology. Berlin, Heidelberg: Springer; 2014.
14. Ní Mhuircheartaigh J, McMahon C, Lin YC, Wu J. Diagnostic yield of percutaneous biopsy for sclerotic bone lesions: influence of mean Hounsfield units. Clin Imaging. 2017;46:53-6.
15. Sung KS, Seo SW, Shon MS. The diagnostic value of needle biopsy for musculoskeletal lesions. Int Orthop. 2009;33(6):1701-6.
16. Omura MC, Motamedi K, UyBico S, Nelson SD, Seeger LL. Revisiting CT-guided percutaneous core needle biopsy of musculoskeletal lesions: contributors to biopsy success. AJR Am J Roentgenol. 2011;197(2):457-61.
17. Didolkar MM, Anderson ME, Hochman MG, Rissmiller JG, Goldsmith JD, Gebhardt MG, et al. Image guided core needle biopsy of musculoskeletal lesions: are nondiagnostic results clinically useful? Clin Orthop Relat Res. 2013;471(11):3601-9.
18. Saleem H, Rana AI, Kiani EM, Ramzan MM, Naseem S, Chahudhary MY. Role of non coaxial bone marrow biopsy needle and bone biopsy needle in CT guided core needle biopsies. J Postgrad Med Inst. 2015;29(4):231-6.
19. Taupin T, Decouvelaere AV, Vaz G, Thiesse P. Accuracy of core needle biopsy for the diagnosis of osteosarcoma: a retrospective analysis of 73 patients. Diagn Interv Imaging. 2016;97(3):327-31.
20. Govindan NO, Prasanth J, Gopakumar TS, et al. A study on core cut biopsy in bone lesions. Int J Orthop Sci. 2017;3(1):9-13.
21. Khan I, Saleem MJ, Khan Z, Ahmad I, Saeed M, Khan A. Diagnostic accuracy of core needle biopsy in bone tumors. Results of 100 consecutive cases from a sarcoma unit in Pakistan. EC Orthop. 2020;11(2):1-6.
22. Mohaidat ZM, Al-Gharaibeh SR, Aljararhih ON, Nusairat MT, Al-Omari AA. Challenges in the diagnosis and treatment of aneurysmal bone cyst in patients with unusual features. Adv Orthop. 2019;2019:2905671.
23. Li Y, Du Y, Luo TY, et al. Factors influencing diagnostic yield of CT-guided percutaneous core needle biopsy for bone lesions. Clin Radiol. 2014;69(1):e43-7.
24. Espinosa LA, Jamadar DA, Jacobson JA, et al. CT-guided biopsy of bone: a radiologist's perspective. AJR Am J Roentgenol. 2008;190(5):W283-9.
25. Filippiadis DK, Charalampopoulos G, Mazioti A, Keramida K, Kelekis A. Bone and soft-tissue biopsies: what you need to know. Semin Intervent Radiol. 2018;35(4):215-20.
26. Moerenhout K, Gkagkalis G, Omoumi P, Cherix S. Acute leg compartment syndrome after CT-guided core needle biopsy of a giant cell tumor of the proximal fibula. Acta Orthop Belg. 2020;86(4):624-7.