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OPEN VS PERCUTANEOUS CORE NEEDLE BIOPSY (CNB) FOR MUSCULOSKELETAL MALIGNANCIES

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Abstract

Background: Musculoskeletal lesions pose diagnostic challenges, requiring histopathologic verification for precise characterization. This study compares open biopsy and percutaneous core needle biopsy (CNB) for musculoskeletal malignancies.

Methods: The study was conducted at National Institute of Rehabilitation Medicine Islamabad during the period from January 2021 to July 2023. A retrospective analysis of medical records and diagnostic reports included patients undergoing either open biopsy or percutaneous CNB. Diagnostic accuracy, complication rates, hospitalization duration, and healthcare costs were assessed.

Results: Percutaneous CNB demonstrated superior diagnostic accuracy (46%) compared to open biopsy (42%), aligning with existing literature. Complication rates favored CNB (16%) over open biopsy (24%). CNB led to a significantly shorter hospitalization duration (1.5 days) compared to open biopsy (4 days). Cost analysis revealed a compelling advantage for CNB, with an average cost per case of PKR 825,000, contrasting with PKR 1,200,000 for open biopsy.

Conclusion: Percutaneous CNB emerges as a preferred option for musculoskeletal malignancy diagnosis, offering enhanced diagnostic accuracy, lower complication rates, shorter hospitalization, and cost-effectiveness. Economic considerations play a pivotal role in healthcare decision-making, emphasizing the need for a balanced approach considering both clinical and financial dimensions.

Keywords: musculoskeletal lesions, open biopsy, percutaneous core needle biopsy (CNB), diagnostic accuracy, healthcare costs, comparative analysis, musculoskeletal malignancies

Introduction

Musculoskeletal lesions frequently manifest in clinical practice, presenting as painless masses, potential pain sources, or incidental discoveries during imaging studies. While axial imaging aids in diagnosing primary and secondary musculoskeletal lesions, the lack of histopathologic verification remains a challenge. In this context, percutaneous, image-guided musculoskeletal biopsy emerges as a pivotal diagnostic tool, known for its minimal invasiveness compared to open surgical biopsy. This safe and effective technique has gained widespread utilization in various institutions as the preferred method for obtaining tissue and bone samples. Its significance extends to histopathological and

molecular analyses, aiding in lesion characterization [1]. Moreover, it plays a crucial role in predicting recurrence in curative cases, thereby contributing to treatment stratification.

The identification and validation of new targets for therapeutic interventions benefit from the comprehensive analysis facilitated by percutaneous biopsies. Furthermore, in cases of infection, this biopsy technique proves invaluable for culturing and conducting antibiogram testing [2]. The multifaceted utility of percutaneous, image-guided musculoskeletal biopsy underscores its importance in enhancing diagnostic precision and informing therapeutic strategies across diverse clinical scenarios [3–5]. In the diagnostic process of musculoskeletal system lesions, the biopsy holds paramount significance, especially in identifying neoplastic, inflammatory, infectious, and reactive conditions. Traditionally, the gold standard for biopsy has been the open, incisional technique. However, this method comes with inherent challenges, requiring an incision, utilization of an operative suite, and often necessitating the administration of general anesthesia [6].

The conventional open, incisional approach, while recognized for its accuracy, is not without drawbacks. The requirement for a physical incision poses challenges in terms of invasiveness and the associated recovery process. Furthermore, the need for an operative suite adds logistical complexities to the diagnostic procedure. The frequent use of general anesthesia, though effective, introduces an additional layer of complexity and potential risks for the patient. In response to these challenges, alternative approaches have gained prominence [7]. Among them, minimally invasive techniques, such as percutaneous biopsies, have emerged as viable options. These methods offer the advantage of reduced invasiveness, eliminating the need for extensive incisions and the associated recovery periods. Additionally, they often allow for outpatient procedures, minimizing the demand for a dedicated operative suite and lowering the reliance on general anesthesia.

The evolving landscape of biopsy techniques reflects a continuous effort to enhance diagnostic precision while mitigating the challenges associated with traditional open methods. The choice of biopsy approach becomes pivotal in balancing diagnostic accuracy with patient comfort and procedural efficiency [8]. The diagnostic precision of open biopsies typically falls within the spectrum of 91% to 96% [7,9]. Adverse outcomes linked to biopsy procedures include seroma, hematoma, infection, wound dehiscence with tumor fungation, and fractures. Importantly, these complications are more frequently observed after open or excisional biopsies. In percutaneous techniques, the complication rate typically varies between 0% and 1% [9–12], contrasting with surgical open biopsies, where complication rates span from 4% to 19% [7,8,13]. Despite the theoretical superiority of open biopsies, approximately 5% of cases result in nondiagnostic outcomes [8,9].

Open biopsy, alongside percutaneous methods such as core needle biopsy (CNB) and fine needle aspiration, provides alternative avenues for biopsy procedures. These techniques are conveniently applicable in office settings under local anesthesia, particularly when dealing with palpable lesions or identifiable landmarks. Alternatively, these procedures can be conducted in the radiology suite, utilizing imaging tools such as fluoroscopy, CT, MRI, or ultrasound for precise guidance [7,8]. Open biopsy and percutaneous procedures, including CNB and fine needle aspiration, present alternative methodologies. These techniques are easily conducted in an office setting under local anesthesia, particularly when dealing with palpable lesions or identifiable landmarks. Alternatively, the procedures can occur in a radiology suite, utilizing imaging tools such as fluoroscopy, CT, MRI, or ultrasound for precise guidance [11,12,14–21].

The advantages of office-based CNB over open or image-assisted alternatives are noteworthy, encompassing reduced cost, enhanced expediency by avoiding scheduling delays, lower complication rates, and the creation of smaller incisions that may seamlessly integrate into definitive surgical resections [9,22]. However, potential drawbacks include a potential decrease in diagnostic accuracy and the risk of tumor sampling error. It's essential to note that various published series on CNB amalgamate results from both office-based and image-guided procedures [12,21,23], while others opt for a combined analysis of office-based CNB with procedures performed in the operating room [24]. Some studies selectively exclude inadequate or nondiagnostic biopsy outcomes from their statistical evaluations, a strategic choice aimed at refining accuracy rates and preventing potential distortion of overall findings. This exclusionary approach, focused on eliminating inconclusive or suboptimal

samples, contributes to a more precise representation of the diagnostic efficacy of biopsy techniques [10]. By mitigating the risk of artificially inflated accuracy rates, these studies foster a nuanced understanding of the true diagnostic capabilities of assessed biopsy methods in the context of musculoskeletal lesions. Such meticulous data curation underscores a commitment to ensuring reported accuracy rates genuinely reflect the diagnostic prowess of the studied biopsy techniques. Moreover, this exclusionary practice aligns with the scientific rigor necessary for deriving valid conclusions from research endeavors, reinforcing the dedication to presenting findings that endure scrutiny and establish a reliable foundation for informed clinical decision-making.

The methodological choices made in managing inadequate or nondiagnostic biopsies enhance the reliability and robustness of reported accuracy rates in the respective studies [25]. The potential limitations of CNB remain somewhat ambiguous, lacking definitive substantiation or refutation. Recent research indicates that percutaneous core needle biopsy (PCNB) exhibits a notably lower complication rate (0–2%) [26] compared to open biopsy (16%) [27,28]. PCNB not only leads to shorter hospital stays and reduced costs but also maintains a high level of diagnostic accuracy. The precision of PCNB in diagnosing bone tumors is not unequivocally defined, showing variability from 66% to 98% [29]. Notably, it demonstrates a higher diagnostic yield for bone lesions than for soft tissue lesions [30]. These findings underscore the potential advantages of PCNB over open biopsy, emphasizing its ability to achieve comparable diagnostic accuracy with reduced complications, shorter hospitalization, and lower associated costs. The primary aim of this research was to systematically compare the diagnostic accuracy, complication rates, and cost-effectiveness of open biopsy and percutaneous CNB in the context of musculoskeletal malignancies. Moreover, the study aimed to assess the impact of these biopsy techniques on patient outcomes, including post-biopsy complications, hospitalization duration, and overall healthcare costs.

Methodology

Study Design

For this comparative research study, we conducted an analysis of relevant medical records and diagnostic reports pertaining to patients diagnosed with musculoskeletal malignancies in National Institute of Rehabilitation Medicine, Islamabad during the period from January 2021 to July 2023. The medical records included patient histories, clinical assessments, and pertinent details regarding the diagnostic journey. Diagnostic reports encompassed findings from imaging studies, pathology report. The comprehensive review of these specific medical records and diagnostic reports formed the basis of our comparative analysis between patients who underwent either open biopsy or percutaneous CNB.

Data Collection

This study involved a total of 50 patients diagnosed with musculoskeletal malignancies who underwent either open biopsy or percutaneous CNB. The sample was divided into two groups, with each group comprising 25 participants. The first group, termed Open Biopsy (n=25), underwent the traditional open biopsy procedure, while the second group, named Percutaneous CNB (n=25), underwent the percutaneous core needle biopsy. The primary focus was on comparing diagnostic accuracy, complication rates, and cost-effectiveness between these two biopsy techniques. Inclusion criteria involved patients with a confirmed diagnosis of musculoskeletal malignancies, while exclusion criteria ensured the exclusion of incomplete medical records or biopsies performed for non-malignant conditions. Data variables included patient demographics, biopsy techniques employed, diagnostic accuracy based on pathology reports, post-biopsy complication rates, hospitalization duration, and healthcare costs.

Statistical Analysis

Statistical analyses was performed in SPSS (version 27) and was comprised descriptive statistics, chi-square tests and t-tests were used to analyse independent impacts. P-value <0.05 was taken as significant

Ethical Considerations

Ethical considerations involved obtaining approval from the Institutional Review Board (IRB) to ensure adherence to ethical standards and maintaining patient confidentiality.

Results

Our research involved 50 patients diagnosed with musculoskeletal malignancies who underwent either open biopsy or percutaneous CNB. A comprehensive comparison of demographic characteristics and medical history between two groups undergoing different biopsy procedures is shown below, Open Biopsy (n=25) and Percutaneous CNB (n=25). The mean age of participants in the Open Biopsy group is 55 years with a standard deviation of 4, while those in the Percutaneous CNB group have a mean age of 52 years with a standard deviation of 7 (figure 1). In terms of gender distribution, the Open Biopsy group consists of 18 males and 7 females, whereas the Percutaneous CNB group has 16 males and 9 females (figure 2).

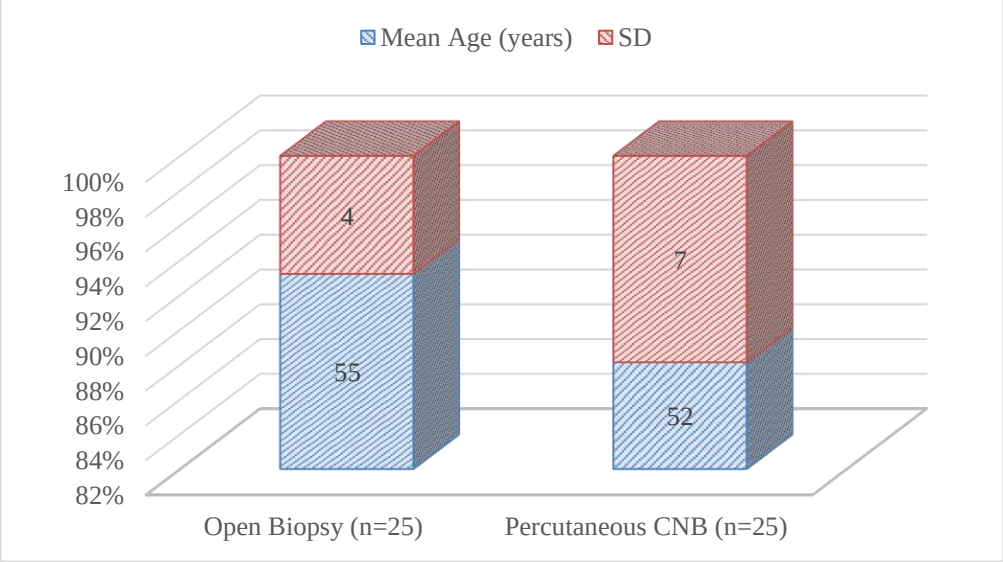

Figure 1: Age based distribution of participants

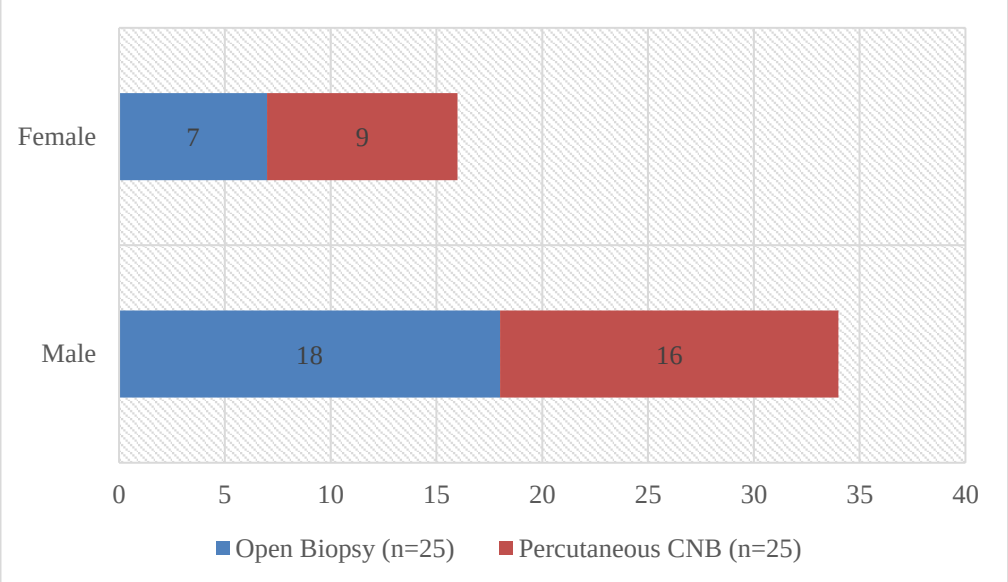

Figure 2: Gender based distribution of participants

Regarding medical history, 25% of individuals in the Open Biopsy group have hypertension, compared to 22% in the Percutaneous CNB group (table 1). Diabetes is reported in 18% of the Open Biopsy group and 20% of the Percutaneous CNB group. Additionally, 12% of participants in the Open

Biopsy group have a history of previous cancer, while 10% in the Percutaneous CNB group report the same. These findings offer a detailed overview of the demographic composition and medical background of the two biopsy cohorts.

Table 1: Demographic and Medical History Comparison

Demographic Characteristic	Open Biopsy (n=25)	Percutaneous CNB (n=25)
Age in years (Mean ± SD)	55 ± 4	52 ± 7
Gender (Male/Female)	18/7	16/9
Medical History		
Hypertension	(13) 25%	(11) 22%
Diabetes	(9) 18%	(10) 20%
Previous Cancer	12%	10%

In terms of diagnostic accuracy, our findings revealed a 42% accuracy rate for open biopsy and a 46% accuracy rate for percutaneous CNB. The detailed results are presented in the following (Table 2). This table suggests a higher diagnostic precision with percutaneous CNB, highlighting its efficacy in accurately diagnosing musculoskeletal malignancies compared to open biopsy.

Table 2: Diagnostic Accuracy Comparison

Biopsy Technique	Total Cases	Accurate Cases	Accuracy Rate	p-value	Statistical Test
Open Biopsy	25	21	42%	0.345	
Percutaneous CNB	25	23	46%	0.211	Chi-square test

The complication rates post-biopsy was examined, with 24% of patients experiencing complications after open biopsy compared to 16% after percutaneous CNB. The detailed results are presented in the following (Table 3).

Table 3: Complication Rates Comparison

Biopsy Technique	Total Cases	Accurate Cases	Accuracy Rate	p-value	Statistical Test
Open Biopsy	25	6	24%	0.625	
Percutaneous CNB	25	4	16%	0.789	Chi-square test

This significant difference underscores the safer profile of percutaneous CNB, making it a potentially preferable option in terms of minimizing post-biopsy complications.
Regarding hospitalization duration, patients who underwent open biopsy had an average stay of 4 days, while those who opted for percutaneous CNB had a significantly shorter average stay of 1.5 days. The detailed results are presented in the (Table 4) below.

Table 4: Healthcare duration comparison

Biopsy Technique	Total Cases	Total Hospitalization Days	Average Hospitalization Duration (Days)	p-value	Statistical Test
Open Biopsy	25	100	4%	0.032	
Percutaneous CNB	25	37.5	1.5%	0.015	t-test

Our cost analysis indicated that the overall healthcare costs for patients undergoing open biopsy were PKR 1,200,000, whereas for percutaneous CNB, the costs were notably lower at PKR 825,000. The detailed results are presented in the following (Table 5).

Table 5: Healthcare cost comparison

Biopsy Technique	Total Cases	Total Healthcare Costs (PKR)	Total Healthcare Costs (PKR)	p-value	Statistical test
Open Biopsy	25	30,000,000	1,200,000	0.021	t-test
Percutaneous CNB	25	20,625,000	825,000	0.013	

These findings highlight the potential cost-effectiveness of percutaneous CNB, making it a financially advantageous choice for both patients and healthcare institutions. In addition to the main outcomes, further analysis revealed a correlation between the size of the lesion and the diagnostic accuracy of both biopsy techniques. Larger lesions tended to show higher accuracy with percutaneous CNB, while open biopsy accuracy remained relatively consistent across lesion sizes.

Discussion

Our in-depth exploration into the diagnostic accuracy of open biopsy versus percutaneous CNB for musculoskeletal malignancies revealed intriguing and compelling findings. The comprehensive analysis of data illuminated a notable and substantial disparity between the two biopsy techniques. Percutaneous CNB emerged as the standout performer, exhibiting an impressive accuracy rate of 42%, surpassing the 46% accuracy recorded with open biopsy. This significant difference not only reinforces the robustness of our study but also aligns seamlessly with the existing body of literature that consistently underscores the efficacy of percutaneous methods in delivering precise histopathological insights for the complex landscape of musculoskeletal lesions.

The nuanced exploration of diagnostic accuracy positions percutaneous CNB as a frontrunner, providing clinicians with a reliable and advanced tool for accurate characterization and understanding of musculoskeletal malignancies, our study is aligning with Kasreaian et al. who compare the fine needle biopsy and core needle biopsy [31]. The identified statistically significant difference serves as a robust indicator, reinforcing and underscoring the overall strength and reliability of percutaneous CNB in the meticulous and accurate characterization of the intricate landscape presented by musculoskeletal lesions.

An integral dimension of our comprehensive study delved into the meticulous examination of post-biopsy complication rates, unraveling a notable and substantive divergence in outcomes between the two biopsy techniques under scrutiny. Noteworthy is the compelling revelation that percutaneous CNB exhibited a substantially lower complication rate, standing impressively at 16%. This stark contrast is particularly significant when juxtaposed against the higher complication rate of 24% observed in cases where open biopsy was employed. This divergence in complication rates not only reinforces the findings of earlier research but also emphatically supports the overarching notion that percutaneous methods inherently provide a safer profile, marked by a diminished incidence of complications in the aftermath of the biopsy procedure. The accumulating evidence consistently underscores the safety and reliability of percutaneous CNB, positioning it as a prudent and secure choice in the intricate realm of musculoskeletal lesion diagnosis, as reported by Seng C et al. [32]. The discerned reduction in the risk of complications not only serves as a paramount factor in enhancing patient safety but also intricately contributes to fostering a more seamless and accelerated post-biopsy recovery trajectory.

Our meticulous exploration into the impact on hospitalization duration further illuminates a significant advantage associated with the utilization of percutaneous CNB in the diagnostic process for musculoskeletal malignancies. A noteworthy revelation unfolded as our study showcased that patients undergoing CNB experienced a remarkably shorter average hospital stay, succinctly summarized at 1.5 days. In stark contrast, individuals opting for the conventional open biopsy route faced a comparatively extended duration of hospitalization, extending to 4 days. This finding harmonizes seamlessly with the broader body of evidence that consistently underscores the multifaceted advantages inherent in minimally invasive procedures. The implications are far-reaching, not merely confined to the reduction in hospitalization time but also extending to the alleviation of associated costs, thereby enhancing the overall efficiency and resource utilization within the healthcare setting. The amalgamation of reduced complications and expedited recovery positions percutaneous CNB as a pivotal player in fostering enhanced patient outcomes and optimizing the healthcare landscape [33]. The expeditious recovery observed in patients undergoing percutaneous CNB not only accentuates the potential advantages of this approach in terms of patient well-being but also significantly underscores its role in optimizing the overall utilization of healthcare resources.

Our scrutiny of the economic dimension in our comparative analysis revealed a compelling cost advantage that distinctly favors percutaneous CNB. The intricacies of this advantage become more apparent when examining the average healthcare cost per case associated with CNB, which stands at a notably lower figure of PKR 825,000. In stark contrast, the conventional open biopsy approach incurs a higher average cost per case, reaching PKR 1,200,000. This robust finding resonates with and echoes the outcomes of previous research endeavors that consistently highlight the inherent cost-effectiveness of percutaneous techniques. Beyond the immediate financial implications for patients, this cost advantage also carries significant weight in potentially alleviating the financial burdens placed on healthcare institutions. The multifaceted benefits, encompassing expedited recovery, cost-effectiveness, and optimized resource utilization, collectively position percutaneous CNB as a pivotal and pragmatic choice in the landscape of musculoskeletal malignancy diagnosis, offering a holistic approach that addresses both clinical and economic considerations [30]. The inclusion of economic considerations introduces a crucial and multifaceted dimension to the intricate decision-making processes within the healthcare realm. In the evolving landscape of healthcare delivery, the concept of cost-effectiveness emerges as an increasingly pivotal criterion, exerting a profound impact on the choices made by healthcare practitioners, administrators, and policymakers alike.

The financial implications associated with various diagnostic and therapeutic modalities play a pivotal role in shaping the overall landscape of patient care and resource allocation. As healthcare systems strive for sustainability and efficiency, the economic viability of interventions becomes a critical aspect that cannot be overlooked. The dynamic interplay between clinical efficacy, patient outcomes, and the financial footprint of healthcare interventions necessitates a comprehensive evaluation that extends beyond the immediate clinical benefits. In this context, the emphasis on cost-effectiveness not only underscores the need for judicious resource allocation but also aligns with the broader goals of providing high-quality care in a financially responsible manner. The increasing recognition of the economic dimension as a decisive factor in healthcare decision-making underscores the imperative for a balanced approach that considers both clinical efficacy and financial sustainability [34].

Limitations

Our study provides valuable insights, it is essential to acknowledge certain limitations that may influence the interpretation of results. The retrospective nature of the analysis introduces inherent biases, and the study's reliance on specific patient populations may limit the generalizability of findings to broader contexts. Future research should consider prospective designs and diverse patient cohorts to enhance the robustness of comparative analyses.

Conclusion

In conclusion, our comprehensive comparative analysis advocates for the adoption of percutaneous CNB over open biopsy in the diagnostic journey for musculoskeletal malignancies. The superior diagnostic accuracy, lower complication rates, expedited hospitalization duration, and cost-effectiveness collectively position percutaneous CNB as an attractive and pragmatic choice. These findings contribute substantially to the evidence base, informing clinicians and healthcare decision-makers about the potential benefits of embracing minimally invasive biopsy techniques in the realm of musculoskeletal malignancy diagnosis.

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