ISSN- O: 2458 - 868X, ISSN–P: 2458 – 8687
Index Copernicus Value: 68 . 16
PubMed - National Library of Medicine - ID: 101731606

International Journal of Medical Science and Innovative Research (IJMSIR)
IJMSIR : A Medical Publication Hub
Available Online at: www.ijmsir.com
Volume – 5, Issue – 6, November - 2020, Page No. : 46 - 54

Comparative study of Percutaneous Core Needle Biopsy [CNB] and a novel method Mini Curette Biopsy [MCB] for musculoskeletal lesions

[1]Dr Raj Kumar Bairwa, MS Orthopaedics, Resident, Department of Orthopaedics, S M S medical college and attached hospitals, Jaipur, Rajasthan, India,

[2]Dr Pankaj Jain, MS, DNB Orthopaedics, Professor, Department of orthopaedics, S M S medical college and attached hospitals, Jaipur, Rajasthan

[3]Dr Arpita Jindal, MD Pathology, Professor, Department of pathology, S M S medical college and attached hospitals, Jaipur, Rajasthan

Corresponding Author: Dr Pankaj Jain, MS, DNB Orthopaedics, Professor, Department of orthopaedics, S M S medical college and attached hospitals, Jaipur, Rajasthan

Citation this Article: Dr Raj Kumar Bairwa, Dr Pankaj Jain, Dr Arpita Jindal, "Comparative study of Percutaneous Core Needle Biopsy [CNB] and a novel method Mini Curette Biopsy [MCB] for musculoskeletal lesions", IJMSIR- November - 2020, Vol – 5, Issue - 6, P. No. 46 – 54.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Percutaneous core needle biopsy (CNB) is a minimal invasive diagnostic procedure for musculoskeletal tumors, but it has limitations of providing adequate amount of representative tissue. To get the adequate amount of representative tissue like in open biopsy, we studied a new minimal invasive procedure and termed it "*Mini curette biopsy* (MCB)".

Methods: 200 patients with musculoskeletal lesions were included in present study. All these patients underwent both CNB as well as MCB and compared with the final diagnosis made by open (incisional/excisional) biopsy.

Results**:** Out of 200 samples, 190 lesions in CNB and 194 lesions in MCB were determined to be adequate for histopathological examination. In diagnosis of malignant lesions, a total sensitivity of 98.21%was determined in MCB and 95.53% in CNB. Specificity and Positive Predictive Value (PPV) were 100% for both biopsy techniques. Negative Predictive Value (NPV) was 97.78% and 94.62% in group MCB and CNB respectively. The predictive values for correct histopathological diagnosis were 85.26% and 92.78% in CNB and MCB respectively. There were total 28 errors (5 major and 23 minor) in CNB and 14 errors (2 major and 12 minor) in MCB. There were no biopsy related complications.

Conclusion: In current study, authors concluded that MCB is also a promising early diagnostic minimal invasive technique for musculoskeletal tumors with minimal complications like CNB but it gives more adequate biopsy tissue than CNB and likewise open biopsy.

Keywords: Musculoskeletal tumors, Percutaneous Core Needle Biopsy, Mini Curette Biopsy, diagnosis, accuracy

Introduction

Recent literature has advocated the use of minimal invasive methods like Core needle biopsy [CNB] at an early stage for tissue diagnosis in musculoskeletal lesions[1].Previous studies suggested that biopsy is the critical step in management of musculoskeletal lesions/tumors [2,3] but how to take an adequate representative tissue and method to take biopsy in an atraumatic manner and also following the principles of limb salvage surgery is the topic of concern. The optimal technique for retrieval of the adequate tissue for diagnosis of musculoskeletal lesions remains controversial and is dictated by the preference of operating surgeon.

The diagnostic accuracy should be the most crucial factor in determining the choice of biopsy method. A pathological diagnosis should include nature, histological type, grade and results of ancillary studies on the tissue.Major limitation observed by authors in CNB procedure is failure to get adequate tissue in few cases for correct diagnosis of musculoskeletal lesions where histological morphology is not possible and it provides limited tissue for future references and ancillary studies. This remains the main object of several studies [4, 5]. Therefore, to improve the quality of a representative tissue for correct diagnosis, we studied a new method of biopsy which is associated with less complication rates than open biopsy and provide more adequate representative tissue compared to CNB. We named it "*Mini Curette biopsy* (MCB)".

Present Prospective hospital based interventional study was designed to compare the tissue yield and diagnostic accuracy of CNB with a Mini Curette biopsy [MCB] and its complications, while using the same incision and approach. According to our hypothesis, Mini Curette biopsy provides us better or at least equal tissue yield for better or similar diagnostic accuracy to that of CNB with almost no complications.

Material and Methods

In study, 200 patients were included as per eligibility criteria (all suspected Bone tumor/soft tissue tumor cases reported at hospital) except those cases which were not included to final excision/ incisional biopsy and managed conservatively or/not reported during the study from April 2016 to Nov 2019. Institutional review board approval was taken for the study and approved consent was obtained from the patient for participation in this study. Clinical details and necessary imaging findings were obtained from patient records. In this study, both MCB and CNB was done on each selected patient and the biopsies were fixed in 10%neutral buffered formalin solution as two separate biopsy specimens with blinding to the pathologist to biopsies were performed as per anatomical guidelines of biopsy. In alternate cases, CNB was performed first followed by MCB and vice versa through same incision (<1 cm in size). All MCB & CNB were performed at the same time and by the same surgeon with no additional anesthesia. Both in MCB and CNB, an average 3-5 passes were performed on each lesion in varied directions in fanned out manner from a single percutaneous access portal. Aim here was to obtain sufficient material for analysis throughout the tumor without breaking the far wall. Independent analysis of the specimens from MCB and CNB was performed. Immunohistochemical [IHC] tests were performed in cases where ever required. Histopathological results of both biopsies were compared to final incisional/excision biopsy in the line of treatment. Except in non-cooperative children, all biopsies were done under local anesthesia. All samples were sent for histopathological examination with attached details of

case history, clinical examination and relevant investigations (including x-ray and others) to the pathology department, SMS Medical College & attached hospitals.

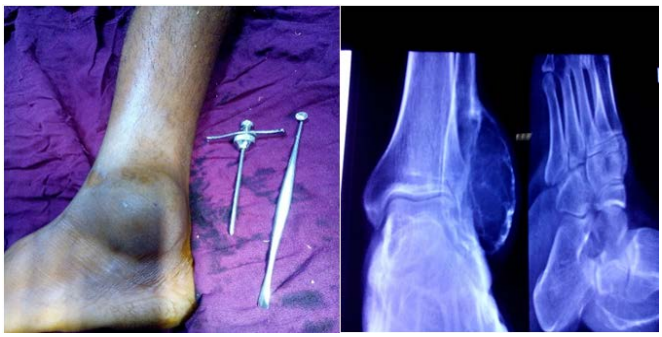

Fig 1: A 24yr old male with lytic lesion involving the lateral malleoli under went for both CNB and MCB with the help of J-needle and Mini Curette respectively

Fig 2: Both the biopsy samples marked as sample A and B which were taken with help of J-needle and Mini Curette, respectively

Histopathological results from both MCB and CNB were compared on the basis of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy. Further statistical analysis was performed using *Fisher's exact test* with 95% confidence interval.

Results

Out of 200 samples, adequate samples were received in 190 lesions (95%) by CNB and 194 lesions (97%) by MCB. Among 200 samples, only 16 were soft tissue tumors and rest was skeletal tumors. Insufficient sampling occurred in 6 soft tissue tumors, namely 4 Hemangiomas and 2 Hemorrhagic Schwannomas in both CNB and MCB. In total four patients of bone tumors namely 2 GCT and 2 Simple Bone Cysts, insufficient sampling occurred in CNB only.

In diagnosis of malignant lesions, a total sensitivity of 98.21% was determined in MCB while 95.53% in CNB. Specificity and PPV were 100% in both biopsy techniques. NPV was 97.78% and 94.62% in group MCB and CNB respectively (Table 1).In our study, the final diagnosis after surgical biopsy (incisional/excision) was 56% malignant (112 of 200 samples) and 44% non-malignant tumors (88of 200 samples). Among these malignant tumors: conventional osteosarcomas were 66 (58.92%) and Ewing's sarcomas were 16 (14.28%). While among benign tumors: Giant cell tumors were maximum with 42 cases (47.72%) followed by Osteochondroma with 10 cases (11.36%) (Table2).

In our study, highest number of cases were in age group of 0-20 years (53%) followed by 21-40 years age group (25%) with youngest being 6 years old and oldest being 65 years old (average age 27 years old). Males and females were 65% and 35% respectively. Most common site of tumor involvement was distal end of femur (32%) followed by upper end of tibia (26%) and humerus (15%). Concerning the diagnosis of sarcoma, 13out of 96 samples *(13.5%)* were classified as *malignant NOS(not otherwise specified) tumors* on CNB, whereas on MCB it was *9.3%* (9 of 96 samples).Out of total 200 cases, the accuracy of final diagnosis in CNB was 86% (172 of 200 sample), whereas93% (186 of 200 samples) in MCB. The predictive value for differential diagnosis between malignant and benign tumors were 97.5% (195 of 200 samples) in CNB, whereas 99% (198of 200 samples) in MCB. The predictive value for correct histopathological diagnosis was 85.26% (162 of 190

samples) and92.78% (180 of 194 samples) in CNB and MCB, respectively.

Table 1: Comparison between results of CNB and MCB for malignant criteria

CNB			MCB	
	Value (%)	95% Confidence interval	Value (%)	95% Confidence interval
Sensitivity	95.54	89.89 to 98.53	98.21	93.70 to 99.78
Specificity	100	95.89 to 100	100	95.89 to 100
PPV	100	-	100	-
NPV	94.62	88.20 to 97.64	97.78	91.76 to 99.43
Accuracy	97.50	94.26 to 99.18	99.00	96.43 to 99.88

Table 2: Definitive diagnosis of 200 bone and soft-tissue samples

Malignant tumor (N=112)	N	%	Non-Malignant tumor (N=88)	N	%
High grade spindle cell tumor	2	1.78	GCT**	42	47.72
Conventional osteosarcoma	66	58.92	Osteoid fibrous dysplasia	2	2.27
Ewing sarcoma	16	14.28	Osteochondroma	10	11.36
HGPUS/MFH(HG)*	2	1.70	Haemorrhagic schwannoma	4	4.5
Chondrosarcoma	8	7.14	Simple bone cyst	6	6.8
Plasma cell tumor	4	3.57	Fibrous dysplasia	6	6.8
Metastatic (small cell lung carcinoma)	10	8.90	ABC***	6	6.8
High grade fibrosarcoma	4	3.57	Chondromyxoid fibroma	2	2.27
			Haemangioma	6	6.8
			Adamantinoma	4	4.5
total	112	100		88	100

*****HGPUS/MFH (HG): High-grade pleomorphic undifferentiated sarcoma/Malignant fibrous histiocytoma (High grade)

**GCT: Giant cell tumor

***ABC: Aneurysmal bone cyst

Table 3: Comparison of major errors between CNB &MCB

Sn.	CNB diagnosis	Mini Curette biopsy diagnosis	Final diagnosis	Treatment
1	Non ossifying fibroma (NOF)	Nonossifying fibroma	Low grade osteosarcoma	WLE*
2	Fibroadipose tissue	Fibroadipose Tissue	Aggressive GCT	WLE
3	Hyperplasia	HGPUS/MFH(HG)	HGPUS/MFH (HG)	WLE
4	Fibroadipose tissue	HGPUS/MFH (HG)	HGPUS/MFH (HG)	WLE
5	Cartilaginous lesion	Chondrosarcoma (IG)**	Chondrosarcoma (IG)**	WLE

*WLE: Wide local excision

**IG: Intermediate grade

Table 4: Comparison of minor errors between CNB and MCB

No. of Patients (total 25)	CNB diagnosis	Mini Curette biopsy diagnosis	Final diagnosis on surgical (excisional/incisional) biopsy	Treatment
5	Malignant mesenchymal tumor	Malignant mesenchymal tumor	Osteogenic sarcoma	WLE
2	Malignant mesenchymal tumor	Malignant mesenchymal tumor	Chondrosarcoma	WLE
4	ABC	GCT	GCT	Extended curettage
1	Ewing's sarcoma	osteosarcoma	osteosarcoma	WLE
1	Malignant mesenchymal tumor	Metastatic squamous cell carcinoma	Metastatic squamous cell carcinoma	WLE
1	Chondromyxoid fibroma	Aneurysmal bone cyst	Chondromyxoid fibroma	WLE
1	Malignant mesenchymal tumor	Metastatic adenocarcinoma	Metastatic adenocarcinoma	WLE
1	Low grade osteogenic sarcoma	High grade osteogenic sarcoma	High grade osteogenic sarcoma	WLE
1	Malignant mesenchymal tumor	osteogenic sarcoma	osteogenic sarcoma	WLE
1	Malignant mesenchymal tumor	Malignant mesenchymal tumor	squamous cell carcinoma	WLE
1	Malignant mesenchymal tumor	chondrosarcoma	chondrosarcoma	WLE
2	High grade Malignant mesenchymal tumor	High grade Malignant mesenchymal tumor	High grade fibrosarcoma	WLE
1	ABC	Simple bone cyst	Simple bone cyst	Curettage
1	Malignant bone tumor	Ewing's sarcoma	Ewing's sarcoma	WLE
1	Malignant bone tumor	Osteogenic sarcoma	Osteogenic sarcoma	WLE
1	Fibrous cortical defect	Aneurysmal bone cyst	Fibrous cortical defect	Curettage

There were 28(14%) total errors on CNB, with 5(2.5%) major and 23(11.5%)minor, similarly on MCB, total 14(7%) errors with 2 major (1%) and 12(6%) minor (Table3&4). Two patients with major errors (low grade osteosarcoma and nonsalvagable aggressive GCT) were treated with wide local excision in one case and above

knee amputation in other [for definitive surgical treatment as per sarcoma principles].The remaining 3 patients were considered highly suspicious for malignancy by the treating surgeon and also, they were found malignant tumor in MCB, so these patients were treated with wide local excision without repeat biopsy. In our study, we have not observed any impaired wound healing following MCB and CNB. Complications, such as hematoma or wound infection, causing morbidity or require intervention or compromised the treatment outcome, also did not occur.

Discussion

Bone and soft tissue tumors are more frequent diagnosis now days due to increase awareness and high-tech diagnostic modalities. Recent advances of non-invasive methods (X-rays, MRI scan, CT scan, radioactive nuclear bone scans and PET CT scans) and invasive methods of image guided FNAC and CNB (biopsy), has taken over the traditional methods of open biopsy. Among these, biopsy is the most crucial step for diagnosis [2, 3].

Though open biopsy is still considered gold standard [3, 6, 7, 8] but its use is decreasing day by day because it is like a minor surgical intervention which requires necessity of sterility, an operating room setup and general/spinal anesthesia. Morbidity of biopsy surgical site, surgical complications like bleeding, hematoma, spreading of tumor cells and infection are anticipated with open biopsy. Tumor contamination and spreading of tumor cells is also an important issue as far as future limb salvage is concerned. Complications are greater with open biopsy however this procedure is likely to be associated with adequate sampling and tissues, required for further diagnostic studies like flow cytometry and cytogenetics. In line of this, CNB has many advantages over open biopsy and has been reported similar diagnostic results [2, 8, 9]. CNB is less invasive, less expensive and associated with fewer complications of bleeding, hematoma, morbidity and decreased cost as well as time consumption [10, 11, 12]. The major disadvantage with CNB is limited sample tissue and small tissue core which may be inadequate for accurate grading and additional studies. In efforts to overcome these problems of limited sample, small tissue core and to maintain the advantages of CNB, we used the new method and termed it *"Mini Curette biopsy"*. In our experience, the complication rates of MCB have been found similar to CNB but a better tissue yield.

In present study, we identified the diagnostic accuracy of 86% in CNB [4, 5, 9, 10, 13-19]. The correct histopathological diagnosis in CNB compared to open biopsy was obtained in 85.26% [9, 13, 19]. Whereas in MCB, we have found higher results than CNB as overall diagnostic accuracy of 93% and correct histopathological diagnosis in 92.78%.Comparing results of MCB and CNB in suspected malignant lesions, we have found slightly superior results for MCB (sensitivity 98.21% vs 95.53%, NPV 97.78% vs 94.62% for MCB and CNB respectively). The predictive value for diagnosis between malignant and non-malignant was 97.5%inCNB and 99% in MCB.

As reported earlier, the very heterogeneous and soft tissue fluctuant tumors like synovial sarcoma, haemangioma, liposarcoma and neurogenic tumors like schwannoma/lipoma are potentially difficult to be diagnosed by CNB [10, 20, 21]. There were 5% nondiagnostic results in CNB and 3% in MCB, showing superior results for MCB. We found tissue yield better with curette than core needle at most of the time, as CNB provided negative or insufficient collection. Both procedures (CNB and MCB) have

limitations of probably not able to get adequate tissue in few low-grade sarcomas and firm, hard benign tumors as these lesions contains more tightly packed collagen tissue and ossified matrix. More tissue is needed in such lesions to determine the histological diagnosis of malignancy (22). In present series information concerning the grading of tumor on CNB and MCB was missing for 16and 10 patients respectively, showing superior results for MCB. There were total 28 errors (5 major and 23 minor) on CNB while only 14 errors (2 major and 12 minor) on MCB. The concern for accuracy for CNB is usually because of the limited cores or tissue provided. The value of diagnostic accuracy is limited by the experience and the expertise of the pathologist interpreting the specimen. The wide spectrum of histomorphologic appearance of musculoskeletal tumors also presents a challenge to all and also to the most experienced musculoskeletal pathologists. Advantages of both procedures are almost similar as these procedures can be done in minor operation theatre or as outdoor procedures without admission required. Both are atraumatic when compared to the open biopsy procedure. In our technique, the CNB incision was not increased and same incision was used to insert the curette to take the biopsy tissue. In this study, complication rates in either of the biopsy techniques were not significant. In MCB, complication rates found similar to CNB (0% to 6%) [5, 8, 9, 14, 17, 20, 21, 23] as well as very less morbidity and fewer complications compared to open biopsy (0% to 15%) [8, 10, 14, 23-26].Theoretically, risk of hematoma formation and tumor dissemination is more in curette biopsies but in our study, we did not find any such risks and in most instances, we were able to control the bleeding by pressure only. The biopsy track created during biopsy was similar in both the methods and as a rule this track is considered contaminated with tumor tissue and was excised in final procedure. As compared to open procedure, we found these methods to be cost effective too. Another advantage of curette has been observed with lesions like ABC of bone where biopsy itself leads to *Curopsy*and may serve as a definitive treatment(27). Blunt/ round end of curette acts like a probe and also helps to palpate the opposite cortex or capsule and to collect the representative tissue from the cortex or wall of the tumor (not from center of the lesion which may be necrotic), so yield of representative tumor tissue is more with curette. Curette has also the advantage of less chances of perforation of the opposite cortex. This was observed especially in osteolytic lesions and soft tissue lesions. Round/Blunt end of the curette acts like a probe and halted/stopped at the opposite end of lesion by the soft tissue capsule or remaining cortex. This risk of perforation of opposite cortex and increased risk of tumor dissemination is theoretically possible with CNB especially when procedure done without image guide. This risk is more in lesions, especially osteolytic lesions or aggressive like ABC where opposite cortex was not palpable. This risk was minimized by the blunt end of the curette.

We re-emphasize the importance of communication between surgeon, radiologist and pathologist for accurate diagnosis of musculoskeletal lesions and to reach a final conclusion. A pathological diagnosis which doesn't match the clinico-radiological picture should always be reviewed or re-biopsied.

Limitations: In our study, total 16 patients has soft tissue tumor. Statistically we were notable to find any significant difference in results; possibly due to small count of patients with soft tissue tumors. A larger study

with a greater number of patients is needed for a clearer and definitive result.

Conclusion

We concluded that MCB is a minimal invasive procedure like CNB and provides more adequate biopsy core like open biopsy. Therefore, we propose that MCB is more useful and safe method for biopsy in management of musculoskeletal lesions. Although chances of spreading of tumor cells to the surrounding normal tissue while taking biopsy is a matter of concern and needs further study and evaluation.

Acknowledgement: The authors express their gratitude towards all study participants for their valuable time. Authors would like to extend their gratitude to the Staff of the department of Orthopaedics, SMS Medical College and Hospital, Jaipur for their contributions and technical supports.

Ethical Approval: The study was approved by institutional ethics committee.

References

1. Skrzynski MC, Biermann JS, Montag A, Simon MA. Diagnostic accuracy and charge-savings of outpatient core needle biopsy compared with open biopsy of musculoskeletal tumors. J Bone Joint Surg Am 1996, 78, 644–649

2. Sheila C. Adams MD, Benjamin K. Potter MD, David J. Pitcher MD, H. Thomas Temple MD. Office-based Core Needle Biopsy of Bone and Soft Tissue Malignancies. An Accurate Alternative to Open Biopsy with Infrequent Complications. Clin OrthopRelat Res (2010) 468:2774–2780

3. Bickels J, Jelinek JS, Shmookler BM, Neff RS, Malawer MM: Biopsy of musculoskeletal tumors. Current concepts. Clin OrthopRelat Res 1999, 368:212–219.

4. Altuntas AO, Slavin J, Smith PJ, Schlict SM, Powell GJ, Ngan S, Toner G,Choong PF: Accuracy of computed tomography guided core needle biopsy of musculoskeletal tumours. ANZ J Surg 2005, 75:187–191.

5. Torriani M, Etchebehere M, Amstalden E: Sonographically guided core needle biopsy of bone and soft tissue tumors. J Ultrasound Med 2002, 21:275–281.

6. Florian Pohlig, Chlodwig Kirchhoff, Ulrich Lenze, Johannes Schauwecker, Rainer Burgkart1, Hans Rechl1 and Ruediger von EisenhartRothe. Percutaneous core needle biopsy versus open biopsy in diagnostics of bone and soft tissue sarcoma: a retrospective study. Pohlig et al. European Journal of Medical Research 2012, 17:29

7. Pohlig F, Kirchhoff C, Gradinger R, von Eisenhart-Rothe R, Rechl H: Bone and soft tissue sarcoma: principles of biopsy. InFoOnkologie 2010, 13:34–37.

8. Mankin HJ, Mankin CJ, Simon MA: The hazards of the biopsy, evisited.Members of the musculoskeletal tumor society. J Bone Joint Surg Am 1996, 78:656–663.

9. Issakov J, Flusser G, Kollender Y, Merimsky O, Lifschitz-Mercer B, Meller I: Computed tomography-guided core needle biopsy for bone and soft tissue tumors. Isr Med Assoc J 2003, 5:28–30.

10. Lawrence Jr. W, Donegan WL, Natarajan N, Mettlin C, BeartR,Winchester D. Adult soft tissue sarcomas. A pattern of care survey of the American College of Surgeons. Ann Surg 1987, 205, 349–359.

11. Ball AB, Fisher C, Pittam M, Watkins RM, Westbury G. Diagnosis of soft tissue tumours by Tru-Cut biopsy. Br J Surg 1990, 77, 756–758

12. Kissin MW, Fisher C, Carter RL, Horton LW, Westbury G. Value of Tru-cut biopsy in the diagnosis of soft tissue tumours. Br J Surg 1986, 73, 742–744.

13. Mitsuyoshi G, Naito N, Kawai A, Kunisada T, Yoshida A, Yanai H, Dendo S, Yoshino T, Kanazawa S, Ozaki T: Accurate diagnosis of musculoskeletal lesions by core needle biopsy. J Surg Oncol 2006, 94:21–27.

14. Welker JA, Henshaw RM, Jelinek J, Shmookler BM, Malawer MM. The percutaneous needle biopsy is safe and recommended in the diagnosis of musculoskeletal masses. Cancer 2000, 89, 2677–268

15. Chen J, Niu Z, Yao L, Xiao M, Fan J: cDNA cloning and sequencing of MH2 domain of Smad2 from human dental pulp cells. Chin J Dent Res 1999, 2:14–18.

16. Barth Jr. RJ, Merino MJ, Solomon D, Yang JC, Baker AR. A prospective study of the value of core needle biopsy and fine needle aspiration in the diagnosis of soft tissue masses. Surgery 1992, 12, 536–543.

17. Moore TM, Meyers MH, Patzakis MJ, Terry R, Harvey Jr JP.Closed biopsy of musculoskeletal lesions. J Bone Joint Surg Am 1979, 61, 375–380.

18. Ayala AG, Zornosa J. Primary bone tumors: percutaneous needle biopsy. Radiologic-pathologic study of 222 biopsies. Radiology 1983, 149, 675–679.

19. Hoeber I, Spillane AJ, Fisher C, Thomas JM. Accuracy of biopsy techniques for limb and limb girdle soft tissue tumors. Ann Surg Oncol 2001, 8, 80–87.

20. Contreras O, Burdiles A: Diagnosis of bone lesions using image guided percutaneous biopsy. Rev Med Chil 2006, 134:1283–1287 [Article in Spanish].

21. Jelinek JS, Murphey MD, Welker JA, Henshaw RM, Kransdorf MJ, Shmookler BM, Malawer MM: Diagnosis of primary bone tumors with image-guided percutaneous biopsy: experience with 110 tumors. Radiology 2002, 223:731– 737.

22. Yang Y J, Damron TA: Comparison of Needle Core Biopsy and Fine needle Aspiration for Diagnostic Accuracy in Musculoskeletal Lesions. Arch pathol lab med-vol 128, July 2004 759-76

23. Kasraeian S, Allison DC, Ahlmann ER, Fedenko AN, Menendez LR: Acomparison of fine-needle aspiration, core biopsy, and surgical biopsy in the diagnosis of extremity soft tissue masses. Clin OrthopRelat Res 2010, 468:2992–3002

24. Simon MA: Biopsy of musculoskeletal tumors. J Bone Joint Surg Am 1982, 64:1253–1257.

25. Springfield DS, Rosenberg A. Biopsy: complicated and risky. J Bone Joint Surg Am 1996, 78, 639–643.

26. Delling G: Diagnosis of bone tumors Verh Dtsch Ges Pathol 1998, 82:121– 132

27. Reddy KI, Sinnaeve F, Gaston CL, Grimer RJ, Carter SR. Aneurysmal Bone cysts: Do Simple Treatments Work? Clin OrthopRelat Res 2014:472:1901-10