Ultrasound-guided bone lesions biopsies – a systematic review

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Abstract

Aims: Ultrasound (US) is a highly valuable imagistic tool used to guide numerous interventional procedures. The US guided bone lesions biopsy has not yet received a consensus or a guideline. We aimed to evaluate the evidence to support the US role in guiding bone lesions biopsies. Material and methods: A computer literature search of PubMed was conducted using the keywords “ultrasound” and “bone biopsy”, in order to detect relevant studies regarding the aim of our analysis. Records were screened for eligible studies and data were extracted and analyzed. Results: We included 23 studies (n=610 patients) in the final analysis. The specificity and diagnostic yield of US guided biopsy were very good (between 78-100%), depending on the type and dimensions of the bone lesions. The type of the biopsy – aspiration or cutting – influenced the results. The studies which included larger groups showed a better performance for cutting needles (83.3-100% vs 50-80.5% for aspiration). The size of the bone lesion influences the diagnostic yield of the US guided bone biopsy. Most of the studies reported nil post-procedural complications. Conclusion: Core needle biopsy provided better diagnostic yield compared to fine needle aspiration. The number of the passages of the cutting needle biopsies in order to achieve the best diagnostic yield was three. Further studies are needed in order to standardize US-guided bone lesions biopsy and increase its role in the diagnosis algorithm of the bone lesions.

Keywords: ultrasonography; US-guided biopsy; bone

Introduction

Bone lesions (BL) are recorded frequently in clinical practice, either as primary lesions [1,2] or more frequent as sites of metastasis [3-5]. BL are being commonly detected or confirmed by imaging techniques [6,7]. Histopathological diagnosis is mandatory for an appropriate management of cases. The pathological analysis of the tissue sample acquired through open surgical biopsies was considered the standard of reference for the diagnosis, but in many institutions a first actual approach is to obtain a tissue specimen by minimally invasive methods, such as radiological guided biopsy. The most frequent imaging guiding method used for bone biopsy is computed tomography (CT) [8-10].

Ultrasoundography (US) has a well-established role in clinical practice as part of the work-up in various fields of medicine, including musculoskeletal disease [11]. The role of US in guiding biopsy has been acknowledged for a long time now [12] and was established for many abdominal and extraabdominal organs or structures [13,14]. In bone pathology, the US is less used for diagnosis, including biopsy guiding. Studies concerning this area are few, even though the first bone biopsy was reported in 1931 [15] and the first published radiological guided bone biopsies were reported in mid 1970’s [16-21].

The literature data is limited with regard to US guided BL biopsy. The existing data on imaging guided bone biopsies are mainly represented by studies performed with
radiological techniques, such as fluoroscopy and/or computed tomography (CT) guidance [22-25]. The advantages of the US over CT are well known – availability, lack of irradiation, lower cost, high resolution imaging of superficial structures. Other new acquisitions of the method, that offer new advantages, are represented by the use of Doppler modes for the identification of vascularization, the possibility to use contrast agents, the real time visualization of needle during biopsy, the less time needed for invasive procedures [26,27]. Still, there is not yet a systematic review analyzing the role of US for guiding bone biopsies. The objective of this paper was to evaluate the evidence to support the role of the US in guiding BL biopsies.

**Material and method**

**Objective and methodology**
A systematic review was conducted in an attempt to evaluate the evidence to support the role of US in guiding BL. We followed PRISMA statement guidelines during the preparation of this review [28].

**Literature search**
We have performed multiple search strategies on PubMed, not limited to English language, from the beginning of recordings until March 2017. The search terms used were “ultrasonography”, “bone biopsy”, and “ultrasound guided bone biopsy”. The authors screened the title and the abstracts of the retrieved records for eligibility. The full-texts of the potentially eligible studies were reviewed for analysis.

**Inclusion and exclusion criteria**
In order to select the appropriate studies that could respond to the questions, we have considered in the analysis all original studies that reported US guided biopsy, irrespective of other types of imaging techniques used beside US. The full-text of the relevant studies that were identified was assessed using our inclusion and exclusion criteria. Initially 25 studies were included for initial analysis, but 4 studies were excluded, since they did not report part of the data that we considered essential to our analysis. After an additional search 2 other studies were included in the final analysis. In case of discrepancies in opinion regarding a study, a third member re-analyzed the respective study. A number of studies were excluded for various reasons: a) some were reviews and not original studies; b) case-reports; c) the authors did not mention the number of US guided biopsies (fig 1).

**Data extraction**
The extracted data included the following: 1) name of the first author; 2) year of publication; 3) type of study; 4) number of cases; 5) type of the needle; 6) number of passages/cores; 7) transducer and guiding technique; 8) results; 9) complications (and their type).

**Results**
Search strategy with keywords “ultrasonography” and “bone biopsy” yielded 54758 results while “ultrasound guided bone biopsy” returned 1293 results. Abstracts were all screened by (RIC) and (AC) and the full text of the article of the relevant ones was retrieved and analyzed.

**Characteristics of the included studies**
Finally 23 studies were included in the analysis [29-51]. Characteristics of the included studies are displayed in Table I. Few studies were prospective [3], as compared to non-specified [15] or retrospective [5]. The 23 studies included in our analysis enrolled 610 patients. The number of US guided biopsies were relatively low, as compared to CT guided biopsies in the studies of musculoskeletal biopsies. Some of those article included less than 15 US guided biopsies, the lowest number being only 4 [31]. Methodology of the US guided bone biopsy differed among authors. Some authors used only fine needle aspiration, others cutting needles or both techniques.

Different transducers were used: convex or linear with frequencies of 3.5-7.5MHz. Some authors used also specialized transducers with biopsy channel [29,32,35]. Regarding the guiding method, most studies were performed with “free hand” biopsy technique but needle guiding accessories were also used in some studies (Table II).

Many types of needles were used for US guided BL biopsy. Some authors used only fine needles – 20-21-
<table>
<thead>
<tr>
<th>First author, year, study type</th>
<th>N</th>
<th>Type of biopsy</th>
<th>Type of needle</th>
<th>No. of passages/cores</th>
<th>Transducer</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bazzocchi, 1988 (not shown) [29]</td>
<td>11</td>
<td>CNB</td>
<td>18-20 G</td>
<td>not shown</td>
<td>3.5, 5 MHz linear</td>
<td>All biopsies were diagnostic</td>
</tr>
<tr>
<td>Hsu, 1992 (not shown) [30]</td>
<td>11</td>
<td>FNA</td>
<td>21G (3.75 cm long)</td>
<td>not shown</td>
<td>3.75 MHz convex</td>
<td>All biopsies were diagnostic</td>
</tr>
<tr>
<td>Gupta, 1993 (not shown) [31]</td>
<td>4</td>
<td>FNA</td>
<td>20G</td>
<td>1 passage</td>
<td>5 MHz linear, 3.75 MHz convex</td>
<td>All biopsies were diagnostic</td>
</tr>
<tr>
<td>Targhetta, 1993 (prospective) [32]</td>
<td>16</td>
<td>FNA</td>
<td>20 G Westcott</td>
<td>not shown</td>
<td>3.5, 7.5 MHz, linear</td>
<td>Definitive specific histologic diagnosis was made 14/16 patients (87.5%) 1 FN result (7.1%)</td>
</tr>
<tr>
<td>Vogel, 1993 (not shown) [33]</td>
<td>63</td>
<td>FNA</td>
<td>needles used for im/ iv</td>
<td>not shown</td>
<td>3.5 MHz, linear</td>
<td>Diagnostic yield 98.4%* (62/63 biopsies)</td>
</tr>
<tr>
<td>Civardi, 1994 (not shown) [34]</td>
<td>30</td>
<td>FNA</td>
<td>20-22G Chiba or spinal</td>
<td>1-3</td>
<td>3.5-7.5 MHz, linear or convex</td>
<td>All biopsies were diagnostic</td>
</tr>
<tr>
<td>Astrom, 1995 (not shown) [35]</td>
<td>5</td>
<td>CNB</td>
<td>Biopsy-Cut; Monopty (1.2mm); Ostycut (2mm)</td>
<td>2-4 passages</td>
<td>linear</td>
<td>Diagnostic yield 80% * (4/5 lesions)</td>
</tr>
<tr>
<td>Konermann, 1995 (not shown) [36]</td>
<td>19</td>
<td>CNB</td>
<td>14G Crown Core Cut</td>
<td>3-5 cores</td>
<td>5-7.5 MHz linear</td>
<td>Not shown for US-guided bone biopsies separately Definitive diagnosis 90.2% * (37/41 all lesions)</td>
</tr>
<tr>
<td>Rubens, 1997 (retrospective) [37]</td>
<td>13</td>
<td>FNA</td>
<td>22 or 20G Chiba/ spinal, 20G or 18G, 1.1/2.3 cm throw, Bard Biopsy Gun</td>
<td>2-3 passes</td>
<td>3.5-7.5 MHz, linear or sectorial</td>
<td>All bone biopsies were diagnostic</td>
</tr>
<tr>
<td>Saitfudddin, 1998 (not shown) [38]</td>
<td>76</td>
<td>CNB</td>
<td>8.9 cm 14G Trucut or Tenno</td>
<td>not shown</td>
<td>5.75 MHz, linear or 3.5 curvilinear</td>
<td>All biopsies were diagnostic</td>
</tr>
<tr>
<td>Gupta, 1999 (not shown) [39]</td>
<td>29</td>
<td>FNA</td>
<td>22G spinal needle</td>
<td>1-2 passes</td>
<td>5 MHz convex or linear</td>
<td>Diagnostic yield 93.1% (27/29 lesions)</td>
</tr>
<tr>
<td>Konermann, 2000 (not shown) [40]</td>
<td>29</td>
<td>CNB</td>
<td>14G Crown Core Cut + BIP Biopsy Gun</td>
<td>3-5 cores</td>
<td>5 or 7.5 MHz linear</td>
<td>Diagnostic accuracy 86.2% (25/29 lesions), sensitivity 100% (29/29 lesions)*</td>
</tr>
<tr>
<td>Saitfudddin, 2000 [not shown] [41]</td>
<td>63</td>
<td>CNB</td>
<td>14G Trucut or Tenno</td>
<td>2-4 passes</td>
<td>3.5 MHz linear</td>
<td>Diagnostic accuracy – 98.4%; TP – 61, FN – 1, FP – 0, TN – 1</td>
</tr>
<tr>
<td>Gil-Sanchez, 2001 (not shown) [42]</td>
<td>65</td>
<td>FNA</td>
<td>CNB</td>
<td>1 pass in 1-2 cores</td>
<td>3.5 MHz convex, 7.5 MHz linear, 5 MHz micro convex</td>
<td>Global success rate 92.3% higher for core biopsy (83.3-100%) than cytology (50-80.5%) in different groups of bone lesions</td>
</tr>
<tr>
<td>Torriani, 2002 (prospective) [43]</td>
<td>27</td>
<td>CNB</td>
<td>14G Trucut Magnum (2.2 cm)</td>
<td>≥ 5 cores</td>
<td>5-10 MHz linear</td>
<td>Not shown for US-guided bone biopsies separately (was not the purpose of this study)</td>
</tr>
<tr>
<td>Ahrar,2004 (retrospective) [44]</td>
<td>23</td>
<td>CNB</td>
<td>14G Trucut Cook</td>
<td>1-4 cores</td>
<td>not shown</td>
<td>All US biopsies were diagnostic</td>
</tr>
<tr>
<td>Lopez, 2005 (not shown) [45]</td>
<td>15</td>
<td>CNB</td>
<td>18G BioPince, Trucut</td>
<td>average of 4 cores</td>
<td>5-10 MHz linear</td>
<td>Not shown for US-guided bone biopsies separately (was not the purpose of this study)</td>
</tr>
<tr>
<td>Liu, 2005# (not shown) [46]</td>
<td>64</td>
<td>CNB</td>
<td>14, 18 G Trucut</td>
<td>#</td>
<td>3.5, 7.5 MHz convex/linear</td>
<td>Diagnostic yield – 97% (62/64 lesions)</td>
</tr>
<tr>
<td>Wu, 2008 (prospective) [47]</td>
<td>18</td>
<td>CNB</td>
<td>14, 16, 18 G coaxial automated biopsy gun (Achieve)</td>
<td>1-6 cores</td>
<td>not shown</td>
<td>Diagnostic yield – 78% (14/18 lesions)</td>
</tr>
<tr>
<td>Datir, 2009 (retrospective) [48]</td>
<td>16</td>
<td>CNB</td>
<td>11, 13G Jamshidi or 14G Tru-cut/ Tenno</td>
<td>2-4 passes</td>
<td>not shown</td>
<td>Diagnostic yield – 93.7% (15/16 lesions)</td>
</tr>
<tr>
<td>Jakanani, 2013 (retrospective) [49]</td>
<td>8</td>
<td>CNB</td>
<td>14G Trucut/ Tenno; 11 G Jamshidi</td>
<td>2-5 cores</td>
<td>not shown</td>
<td>Not shown for US-guided bone biopsies separately (was not the purpose of this study)</td>
</tr>
<tr>
<td>Pressney, 2015 (retrospective) [50]</td>
<td>17</td>
<td>CNB</td>
<td>14G Trucut/ Tenno; 11G Jamshidi</td>
<td>2-5 cores</td>
<td>not shown</td>
<td>Not shown for US-guided bone biopsies separately (was not the purpose of this study)</td>
</tr>
<tr>
<td>Azrumelashvilil, 2016 (not shown) [51]</td>
<td>12</td>
<td>CNB</td>
<td>14.5G bone needle + 18G Trucut; 14.5G cutting aspiration bone needle + 16, 18G Trucut</td>
<td>1-3 passes</td>
<td>not shown</td>
<td>All biopsies were diagnostic (Diagnostic yield 100%)</td>
</tr>
</tbody>
</table>

N – number of US-guided bone biopsies, FN – false negative; FP – false positive; TN – true negative; TP – true positive; FNA – fine needle aspiration; CNB – core needle biopsy; US – ultrasonography; * – calculated from study data; # – full text article only in Chinese
Table II. Complications, type of guidance, peculiarities of the studies

<table>
<thead>
<tr>
<th>First author, year</th>
<th>Complications</th>
<th>Type of complications</th>
<th>Guidance</th>
<th>Other remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hsu, 1992 [30]</td>
<td>0</td>
<td>0</td>
<td>Free-hand</td>
<td>Reported results with the use of a 3.5 MHz convex transducer for assessing impalpable bone lesions.</td>
</tr>
<tr>
<td>Gupta, 1993 [31]</td>
<td>0</td>
<td>0</td>
<td>Free-hand</td>
<td>All 4 lesions were located on cervical spine (vertebrae).</td>
</tr>
<tr>
<td>Targhetta, 1993 [32]</td>
<td>0</td>
<td>0</td>
<td>Adapted transducer/ guide</td>
<td>9 of 16 patients had lung tumours invading the chest wall.</td>
</tr>
<tr>
<td>Vogel, 1993 [33]</td>
<td>0</td>
<td>0</td>
<td>Not reported</td>
<td>The study also compares US vs radiography in detecting osteolysis (ribs and sternum)</td>
</tr>
<tr>
<td>Civardi, 1994 [34]</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Adapted transducer/ guide/ free-hand</td>
<td>Underlies the role of US-FNA in lytic bone lesions, mainly for metastasis.</td>
</tr>
<tr>
<td>Astrom, 1995 [35]</td>
<td>0</td>
<td>0</td>
<td>Adapted transducer/ guide</td>
<td>The study also compares various types of needles, but small number of US guided biopsies.</td>
</tr>
<tr>
<td>Konermann, 1995 [36]</td>
<td>0</td>
<td>0</td>
<td>Free-hand</td>
<td>Postprocedural MRI revealed no significant bleeding.</td>
</tr>
<tr>
<td>Rubens, 1997 [37]</td>
<td>0</td>
<td>0</td>
<td>Guide/free-hand</td>
<td>The study investigated also soft tissue lesions US guided which represented the larger group. Bone lesions were destructive with disruption of the cortex.</td>
</tr>
<tr>
<td>Saifuddin, 1998 [38]</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Not reported</td>
<td>The study is a pictorial essay doubled by a study which assessed US-guided biopsy in 76 bone tumours.</td>
</tr>
<tr>
<td>Gupta, 1999 [39]</td>
<td>0</td>
<td>0</td>
<td>Free-hand</td>
<td>All US-guided bone biopsies were performed on vertebral lesions.</td>
</tr>
<tr>
<td>Konermann, 2000 [40]</td>
<td>0</td>
<td>0</td>
<td>Free-hand</td>
<td>The study included benign and malignant soft tissue or bone tumors.</td>
</tr>
<tr>
<td>Saifuddin, 2000 [41]</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Free-hand</td>
<td>The study compares US, CT and fluoroscopic biopsy guided procedures.</td>
</tr>
<tr>
<td>Gil-Sanchez, 2001 [42]</td>
<td>0</td>
<td>0</td>
<td>Guide/free-hand</td>
<td>The study compares success rates of cytology versus core biopsy in bone lesions, split in 4 categories.</td>
</tr>
<tr>
<td>Torriani, 2002 [43]</td>
<td>0</td>
<td>0</td>
<td>Not reported</td>
<td>The study also compares the final diagnosis obtained in 37 (out of the total 65 lesions: soft tissue and bone) resected specimens.</td>
</tr>
<tr>
<td>Ahrar, 2004 [44]</td>
<td>0</td>
<td>0</td>
<td>Not reported</td>
<td>US and CT guided biopsy of bone lesions suspicious for osteosarcoma were analysed.</td>
</tr>
<tr>
<td>Lopez, 2005 [45]</td>
<td>0</td>
<td>0</td>
<td>Free-hand</td>
<td>The study also reviews briefly studies of core biopsies in musculoskeletal tumours.</td>
</tr>
<tr>
<td>Liu, 2005# [46]</td>
<td>#</td>
<td>#</td>
<td>#</td>
<td>The study was performed under colour Doppler US guidance.</td>
</tr>
<tr>
<td>Wu, 2008 [47]</td>
<td>0</td>
<td>0</td>
<td>Not reported</td>
<td>Diagnostic yield for various soft tissues and bone lesions, different needles sizes were analysed.</td>
</tr>
<tr>
<td>Datir, 2009 [48]</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Not reported</td>
<td>US guidance used only for lesions with &gt;1cm extraosseous component. Recommends open biopsy for lesions with intact bone cortex or soft tissue component &lt;1cm.</td>
</tr>
<tr>
<td>Jakanani, 2013 [49]</td>
<td>0</td>
<td>0</td>
<td>Not reported</td>
<td>All lesions were confined to ribs. A comparison of those with/ without an extraosseous mass was performed.</td>
</tr>
<tr>
<td>Pressney, 2015 [50]</td>
<td>0</td>
<td>0</td>
<td>Not reported</td>
<td>The study also compares results of percutaneous needle biopsy vs. open biopsy (surgical excision/ curettage/reaming) of the clavicle. US-guidance was restricted to clavicle lesions with large extra-osseous components.</td>
</tr>
<tr>
<td>Azrumelashvili, 2016 [51]</td>
<td>0</td>
<td>0</td>
<td>Guide/free-hand</td>
<td>Bone lesions subdivided into with/ without disruption of the cortex.</td>
</tr>
</tbody>
</table>

# – Full article in Chinese
22G, with or without coaxial technique. Other authors performed biopsies with cutting needles (CNB) 14-15-16-18G, and some used first cutting needles followed by fine needle aspiration (FNA) in cases of unsuccessful cutting biopsy attempts (with or without coaxial technique).

The number of needle passes, needle cores, or fragments was not uniformly reported. The quality or length of the fragments were reported by some authors with custom-made scales: type 1 less 5mm, type 2 between 5-10mm and type 3 more than 10mm length (excluding the blood clot, if eventually present) [47].

Some authors classified the biopsied lesions according to their size into three categories: as < 2cm, 2-5cm, or >5cm [47,51].

Complications of the US guided BL biopsies are displayed in Table II, along with comments about certain peculiarities of the studies. The reported complication rate was nil in most of the studies.

**Discussions**

BLs that are confined to the bone and do not disrupt the cortex are not detected during a physical examination, the diagnosis being established using imaging techniques. If there is an extraosseous component, the clinical examination may detect, in some cases, local modifications [34,55]. Benign lesions are more frequent than primary malignant lesions [1,2,52] and bone metastasis are the most common malignant bone lesions [53,54]. Since the description of the potential use of US in assessing the BL, there have been studies using US as a guiding method for bone biopsy. An analysis of the accuracy of US guided biopsy is still missing. Many studies reported the diagnostic yield of US guided bone biopsies or accuracy but other parameters such as sensibility or specificity were commonly not specified. In many studies the results of the guided BL biopsies were irregularly reported. In some studies only the global accuracy or the diagnostic yield (CT and US guided biopsy are analyzed together) has been reported and data were not reported separately for the US guided biopsy.

The studies on musculoskeletal biopsies reported an accuracy of 72-99% [56-59] depending also on tissue type, target location, or biopsy type. Accuracy rates may be influenced also by the operator that performs the US guided biopsy [56]. There is an irregularity in the studies on the outcome, some studies reporting accuracy rates while others report the success of diagnosis.

The BL were divided into four types, according to the radiological report: 1) lytic with extraosseous component; 2) lytic with disrupted bone cortex; 3) sclerotic; and 4) without alteration of the bone cortex (visible only with radiological techniques), condition the guiding method and type of the needle [42]. US was mostly used for the first two types of BL (lytic) [42] when biopsy was performed with cutting or fine needles. Sclerotic lesions were associated with the lowest diagnostic yield indifferent of the guiding method (US or CT), and were biopsied with trephine needles – Jamshidi [48], Ostycut [35,42], Bonopty [60] – allowing drilling in the bone cortex, followed by cutting biopsy or aspiration with coaxial technique. For the last type of BL (without alteration of the bone cortex) biopsy was performed also with the trephine needles usually under radiological guidance, but also with US guidance in some studies [42]. Bone biopsy of benign lesions had a lower success rate compared with a biopsy from malignant lesions [60].

The type of the needle can be an important factor in obtaining a relevant tissue sample. FNA was preferred in older studies [30-34,39] and CNB in the more recent ones [49,51]. Few authors performed both types of biopsies [37,42]. One study compared the accuracy of FNA versus CNB and demonstrated a superior accuracy for the CNB [42]. Analyzing different groups of BL, global success rate for the core biopsy was 83.3-100% as compared to cytology – 50-80.5% [42].

Another technical factor correlated with the accuracy of US guided bone biopsy is the diameter of the needle. Only one study [47] analyzed the diagnostic yield of the different biopsy needle gauge (14-15-16-18G) and did not find a statistically significant different result between the sizes of the needle. A drawback of this study was a higher number of CT versus US guided biopsies. CT guidance was used in 133 patients and US guidance in 18 patients.

The number of the needle passages and the number of the cores procured varied among studies. Some authors analyzed this issue and found that a plateau was reached after three passages [47].

Sample size was also an important factor influencing diagnostic yield, revealed by the studies which analyzed this issue [47]. As expected, longer specimens were associated with better diagnostic yield (for length <5mm – 42%, 5-10mm – 61%, or 10mm – 82%). This data referred to samples obtained with both CT and US guided biopsy by Wu et al [47].

Size of the lesion influenced also the accuracy of the biopsy, as reported by one study [47]. The study reported mixed data of CT and US guided biopsy accuracy [47]. The largest lesions were best diagnosed with an imaging guided biopsy: for diameter <2cm – 54%, 2-5 cm – 75%, and >5cm – 86%, also with statistically significant differences [47]. There were some limitations, since the authors did not report accuracy only for US guided biopsy.
In the studies which reported results of only US guided BL biopsies, global accuracy was 87.5-100% [29-32,38], but the number of the lesions analyzed is relatively small in many studies [31,35]. In the studies which included more than 15 lesions, the diagnostic yield was still 78-100% [32-34,38,39,41,46]. Many studies did not calculate the accuracy or other parameters for the US guided biopsies included in their population [43-45,49,50].

The most important diagnostic issues to be solved by any type of biopsy is to distinguish benign to malignant lesions and to offer an accurate diagnostic of malignancy. US guided biopsy proved a very good sensitivity of 95-96% and optimal specificity (up to 100%) in differentiating benign from malignant lesions. Literature data demonstrated also a very good performance of US guided biopsy in the identification of the type of malignancy (83-98%) [40,43,61].

The rate of non-diagnostic biopsies was low (5-31%), being influenced by a series of technical factors such as: number of passages, type of needle, localization of the lesion, but the data derived mostly from CT-guided biopsies [48,60,62]. These results were useful in clinical practice in around 60% of the cases, and should not be considered flaws [60]. In a study it was showed that they were helpful mostly in asymptomatic versus symptomatic lesions (84% vs 55%), non-aggressive versus aggressive (72% vs 45%) and in case evaluated pre-biopsy as “likely to be benign” versus “suspicious for malignancy” (74% vs 40%) [60].

Complications of the image guided bone biopsy were rare, and in the selected cases which allowed US guidance are anecdotal. Most of the studies did not report any complications, probably due to multiple reasons: the lytic type of BL selected for US guided biopsy, a good visualization of the target and possibility to use color Doppler mode.

An interesting approach was proposed in a recent study [63], using a hybrid technique, combining US guided biopsy and fusion it with CT or MRI data, in order to analyze the potential improvement of the diagnostic yield of BL [63]. The study revealed multiple advantages of such an approach: a diagnostic yield and accuracy comparable to CT guidance but with faster scheduling and biopsy times and economic advantages – lower costs [63]. The authors analyzed 60 musculoskeletal biopsies of which 17 were BL, but they did not mention the guiding method used in those cases. We could not include in the study this review, but we considered it as having a potential impact on future developments of BL diagnosis.

Contrast agents (Sonovue®) were seldom used for US guidance of the BL biopsies. A pilot study [64] was designed to analyze the use of contrast agents in order to improve the accuracy of musculoskeletal biopsy. Though this study was not focused only on bone biopsies, it comprised also few bone lesions and showed 100% accuracy for the 25 musculoskeletal biopsies [64].

**Limitations**

Most of the studies included were retrospective or of a non-specified type. The number of the patients enrolled in some of the studies included in our review is relatively low. Inclusion of the patients was not randomized, and data were not reported in a systematic manner, making the interpretation of the data more difficult. Another important limitation is that many studies reported bone biopsy comprised in a group of musculoskeletal biopsies, and data were not reported separately for the US guided BL biopsies.

**Conclusions**

The size of the BL influences the diagnostic yield of the US guided bone biopsy. The diameter of the cutting needle seems not to be a significant technical factor. Core needle biopsy offered better diagnostic yield compared to fine needle aspiration. The number of the passages of the cutting needle biopsies in order to achieve a best diagnostic yield was three. A larger number of studies and US guided biopsies with a uniform report of the data are required in order to characterize an eventual better role of US guided BL biopsy for bone pathology.

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**References**