Biopsies : Percutaneous Musculoskeletal Biopsies (PMSB)

Histopathological and bacteriological studies are often needed in musculoskeletal lesions to establish a definitive diagnosis. In such cases Percutaneous Musculoskeletal Biopsy (PMSB) has become a routine procedure.

1) introduction

Histopathological and bacteriological studies are often needed in musculoskeletal lesions to establish a definitive diagnosis. In such cases Percutaneous Musculoskeletal Biopsy (PMSB) has become a routine procedure.

Advantage of PMSB compared to surgical biopsy :

- No weakening of bone structures through the surgical removal. This is particularly true in weight-bearing bones and in children, thus avoiding imobilization or osteosynthesis.
- No limitation of activity.
- No or minimal soft-tissue injury. No extensive hospitalization, procedure on an out-patient basis.
- No general anesthesia, the PMSB can easily be performed under local anesthesia and neuroleptanalgesia.
- Minimal recovery time No scars Lower cost

2) Indications

Percutaneous bone biopsy is performed whenever pathologic, bacteriologic or biological examination is required for diagnosis or treatment.

The major indications are the following :

- Primary or secondary bone tumors
- Osteitis
- Septic Arthritis, discitis

3) contraindications

The expected results of biopsy should be significant compared to the risks of the procedure. Careful review of imaging findings and of previous studies should assist the radiologist in avoiding unnecessary biopsies. Well-known contraindications are the following :

- Bleeding diatheses

- Biopsies of inaccessible sites (odontoid process, anterior arch of C1)
- Soft tissue infection

4) material

- Sterile drapes, tampons
- 22-gauge needle, scalpel
- Surgical hammer may be required
- Biopsy needle, a drilling device may be required :
  - 2-mm-diameter hand drill
  - or 14-gauge Bonopty Penetration set (RADI Medical Systems Uppsala, Sweden)
  - or 14-gauge bone Ostycut biopsy needle (Ostycut, Angiomed / Bard, Karlsruhe, Germany)
  - or a 8-gauge trephine needle (Laredo type)
- Iodine, 1% lidocaine

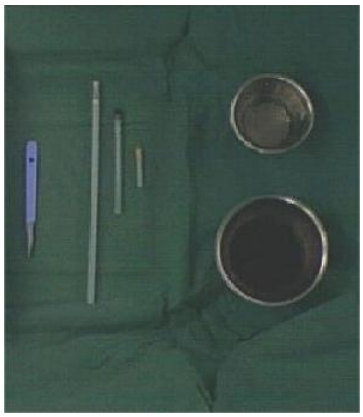


Fig 1: PBMS material 22-g. needle, scalpel, iodine, 1% lidocaine

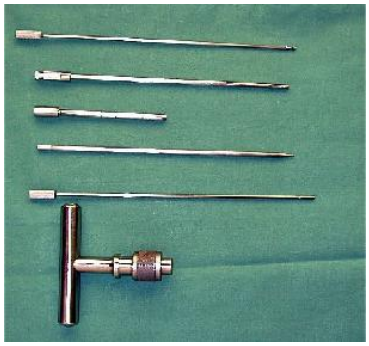


Fig 3: PBMS 8-gauge trephine needle

Fig 4: PBMS tip of the 8-gauge trefine needle

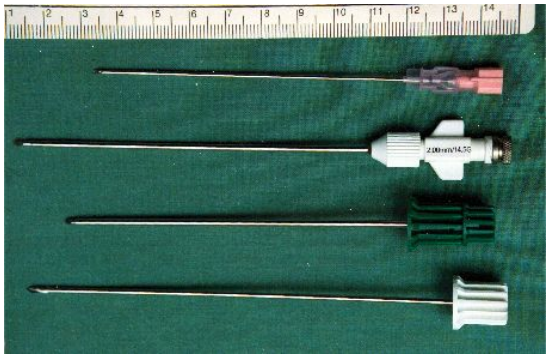


Fig 2: 18-gauge needle, 14-gauge bone Ostycut biopsy needle, 14-gauge Bonopty penetration set

5) pathway

Pathway: A CT scan is performed to localize precisely the lesion. The entry point and the pathway are determined by CT, avoiding nervous vascular and visceral structures.

- For peripheral long bone biopsy : the approach has to be orthogonal to the bone cortex. This approach angle avoids slippage with the tip of the needle. For minimizing as much as possible the tissue lesions during pass through, the shortest way should be chosen. The approach must avoid nervous, vascular, visceral, tendinous structures, and if possible muscular and, if not required, articular structures.
- For flat bones such as scapula, ribs, sternum and skull : we use an oblique approach angle of 30 to 60 degrees. This oblique approach angle is a compromise. The tangential approach is preferred to avoid damage to underlying structures whereas orthogonal angle avoids slippage with the tip of the needle. For the pelvic girdle we use a posterior approach avoiding sacral canal and nerves.
- For vertebral body biopsy : different approach routes can be selected depending on vertebral level : the anterior route for cervical level, the transpedicular and intercostovertebral route for the thoracic level, the posterolateral and the transpedicular route for the lumbar level. For the neural posterior arch we use a tangential approach to avoid the damages to underlying neural structures.

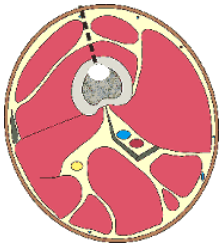


Fig 9: PMSB pathway

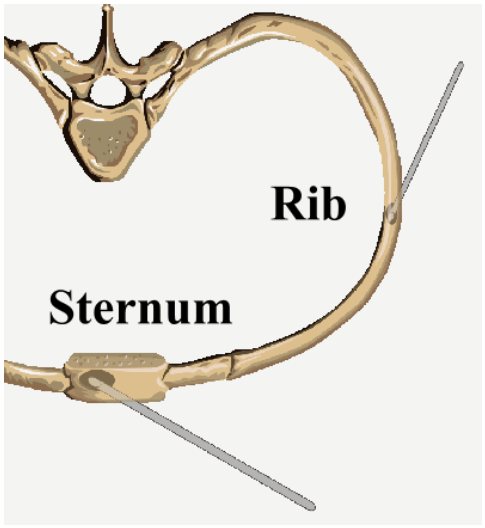


Fig 11: Rib oblique approach

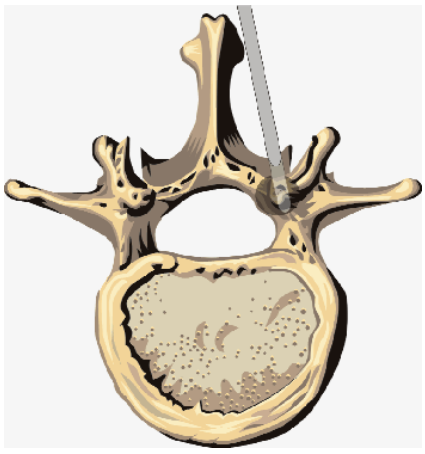


Fig 10: Posterior arch oblique approach

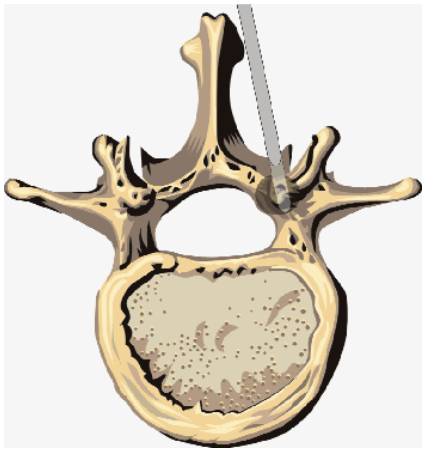


Fig 13: Transpedicular route

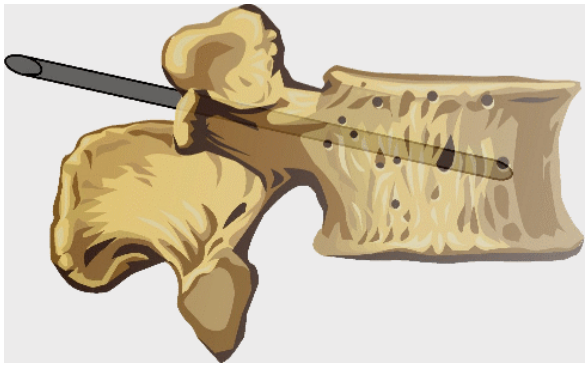


Fig 12: Transpedicular

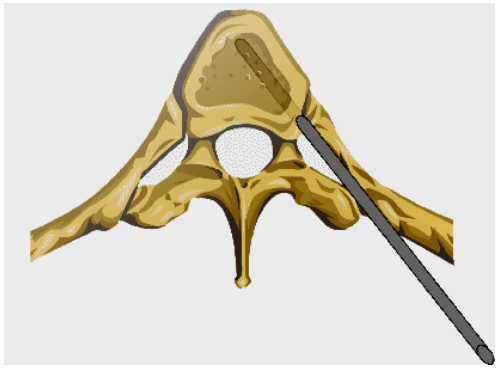


Fig 14: Intercostovertebral route

6) guidance

guidance : focus on dual guidance

- Bone biopsy, like other interventional procedures, is usually performed with a single imaging technique: fluoroscopy or CT, both of which have advantages and drawbacks.
- Fluoroscopy offers multiple planes and direct imaging with the disadvantages of poor soft-tissue contrast and non-negligible radiation exposure for both patient and operator. CT is well-suited for precise interventional needle guidance because it provides good visualization of bone and surrounding soft tissues. It also avoids damage to adjacent vascular, neurological, and visceral structures. The disadvantages of this method are single-plane and delayed imaging.
- To address these concerns on a routine basis, a combination of CT and fluoroscopy for interventional procedures has been recommended. For fluoroscopy, a mobile C-arm is used , positioned in front of the CT-gantry. By using a rotating fluoroscope and CT, the structure to be punctured can be visualized three dimensionally and with exact differentiation of anatomic structures, which in many cases is not possible with fluoroscopy alone. Two mobile monitors were placed in front of the physician, displaying the last stored image and the fluoroscopic image. The operator can switch from CT to fluoroscopy and vice versa at any time.
- In percutaneous biopsy, the intervention begins with CT and is continued with fluoroscopy. Fluoroscopy is associated to CT whenever drilling is necessary.

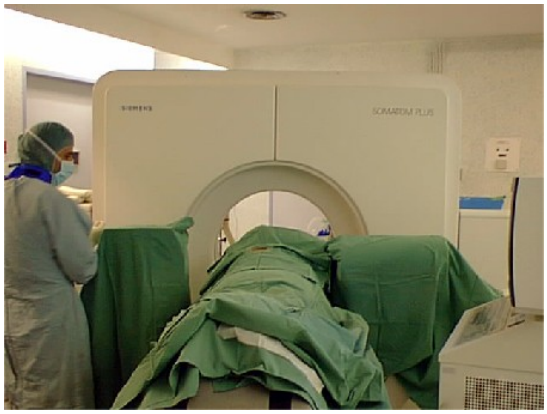


Fig 5: PMSB Dual guidance CT and fluoroscopy

Fig 6: PMSB Dual guidance fluoroscopy and CT

Fig 7: PMSB CT pathway

Fig 8: PMSB CT control

7) local anesthesia

Anesthesia and bone puncture

- Bone biopsy is usually performed under local anesthesia. Neuroleptanalgesia may be necessary for painful lesions. General anesthesia is used only in children .
- The procedure is carried out under strict sterility. The skin's subcutaneous layers, muscles and the periosteum are infiltrated by local anethesia (1% lidocaine) with a 22-gauge needle.
- The position of the 22-gauge needle is checked by fluoroscopy and CT. For bone puncture the biopsy needle is guided safely under CT guidance. Fluoroscopy is used in conjunction with CT whenever drilling is necessary.
- Cortical perforation may require the aid of a surgical hammer.

Fig 17: PMSB local anesthesia

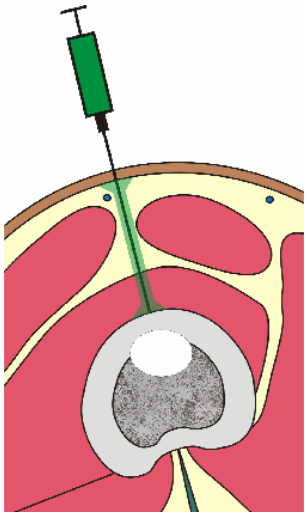


Fig 15:PMSB local anesthesia

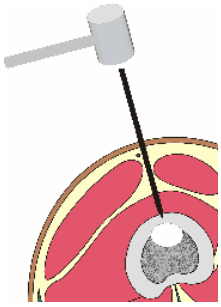


Fig 16: PMSB puncture

8) bone penetration

Biopsy needle and bone penetration

For peripheral bone biopsy Subperiostal or cortical lesions without ossification : they are directly punctured with a 14-gauge needle.

- In cases with mild ossification or small cortex surrounding the lesion we use a 14-gauge Ostycut bone biopsy needle and penetration is performed with a surgical hammer (Ostycut, Angiomed / Bard, Karlsruhe, Germany).
- In cases of mild condensation, and for primary tumors or lymphoma we use a 8-gauge trephine needle (Laredo type).
- In cases of dense ossification, or of dense cortical bone surrounding the lesion, drilling was necessary. In these cases we use a 2-mm diameter hand drill or a 14-gauge Bonopty Penetration set (Radi Medical Systems Uppsala, Sweden).

For vertebral body biopsy

- We use an Ostycut bone biopsy needle and penetration is carried out with a surgical hammer (Ostycut, Angiomed / Bard Karlsruhe, Germany).
- We use a 14 gauge needle in cervical thoracic and lombar level. In cases of mild condensation, and for primary tumors or lymphoma we use a 8-gauge trephine needle (Laredo type).
- In cases of dense ossification, surrounding the lesion, drilling is necessary. In these cases we use a 2-mm diameter hand drill or a 14-gauge Bonopty Penetration set (Radi Medical Systems, Uppsala, Sweden).

For soft tissue biopsies True cut 14 to 16-gauge needles are used (Temno allegiance)

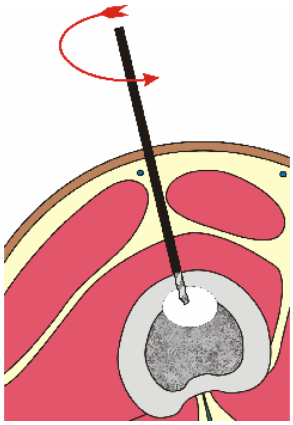
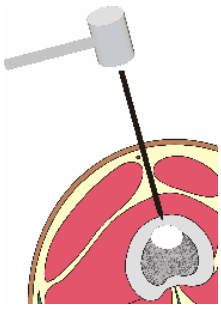
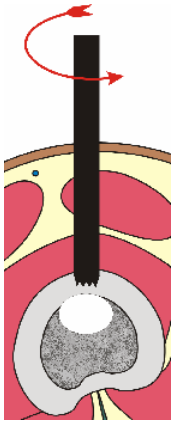


Fig 18: PMSB drilling with Bonopty penetration set



PMSB : Ostycut needle, penetration performed with surgical hammer



PMSB : trephine drilling

9) biopsy

CT images are repeated to confirm the correct placement of the needle tip. Then sampling is performed. For patholocical examination the specimen is fixed in 10% formalin. Material is sent for histology. If bacteriological analysis is necessary the specimens are not fixed and sent for culture.

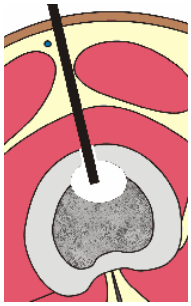


Fig 18: biopsy

10) complications

Complications of PMSB are very rare. Possible and reported complications are :

- The major complication is septic osteitis. To avoid this complication, severe sterility during the intervention is mandatory.
- Hematoma
- Reflex sympathetic dystrophy
- Neural and vascular injuries.
- Pneumothorax

Murphin et al, in a large review of 9500 percutaneous skeletal biopsies, identified 22 complications (0.2%). They reported 9 pneumothoraxes, 3 cases of menigitis, 5 spinal cord injuries. Serious neurological injury occured in 0.08% of procedures. Death occured in 0.02%. Only two complications were observed among our 180 patients These consisted of paravertebral hematomas which resolved spontaneously. This low level of complications seems to be related to the systematic use of dual guidance providing precise and real-time control.

11) results

From 1987 to 1999, 180 percutaneous musculoskeletal biopsies were performed on an out-patient basis. There were 63% female and 37% male patients ranging in age from 17 to 87 years (mean 58.4 years). Biopsy was performed in 55% of the cases for lytic lesions, in 24% of the cases for condensing or mixed lesions, in 18% of the cases for vertebral compression fractures. Biopsy was made in 68% of the cases for vertebral , in 17% of the cases for pelvic girdle and in 14% of the cases for peripheral long bone lesions. Vertebral lesions were at cervical in 3% of the cases, in 15% of the cases at thoracic level, in 45% of the cases at lumbar level and in 7% of the cases at sacral level. Only two complication were observed among our patients These consisted of paravertebral hematomas which resolved spontaneously. Specificity for diagnosis was 100 %, sensitivity was 93.9 %, positive predictive value was 100 %, negative predictive value was 87.5%.

Lesion type	Lytic	Condensing or mixed	Vertebral compression fractures	Other
Number %	55%	24%	18%	4%

Location	Vertebral	Pelvic guirdle	Peripheral long bones
Number %	68%	17%	14%

Level	Cervical	Thoracic	Lumbar	Sacrum
Number %	3%	45%	45%	7%

Results	
Sensitivity	**93.9 %**
Specificity	**100 %**
P.P.V.	**100 %**
N.P.V.	**87.5 %**

12) cases : bone biopsy Cases

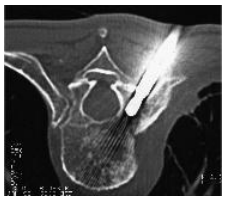
Case 1: Osteolytic metastasis, Osticut needle.

Case1 : CT pathway

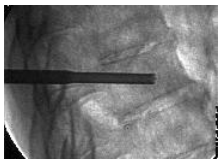
Case1 : biopsy, CT control

Case 2: Transpedicular trephine biopsy, lymphoma

Case 2 : local anesthesia



Case 2 : trephine, CT control



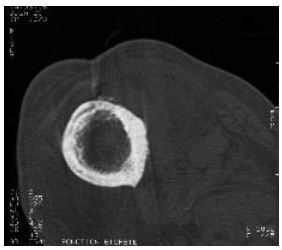
Case 2 : trephine, fluoroscopic control

Case 3: Diskal biopsy, discitis

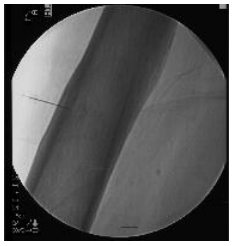
Case 3 : diskal biopsy CT control

Case 3 : diskal biopsy fluoroscopic control

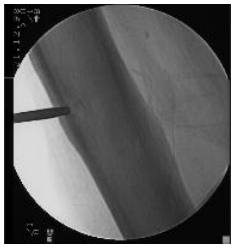
Case 4: Percutaneous biopsy. Indication : osteitis. Lesion of the femur. Technique : orthogonal route, 8-gauge trephine needle (Laredo type).



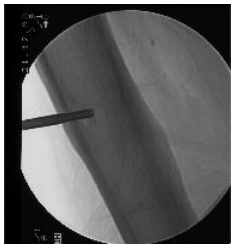
Case 4 : CT before biopsy



Case 4 : local anesthesia



Case 4 : trephine drill fluoroscopic control



Case 4 : sampling fluoroscopic control

Case 4 : sampling CT control

Case 5: Cervical vertebral biopsy, lateral approach. Result : eosinophilic granuloma

Case 5 : CT control

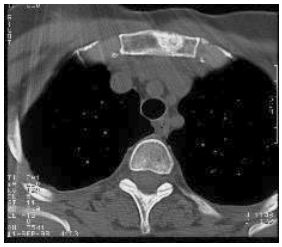
Case 5 : CT eosinophilic granuloma

Case 6 Percutaneous biopsy of an osteolytic lesion of rib. Technique : oblique route, Ostycut bone biopsy needle. Results : myeloma

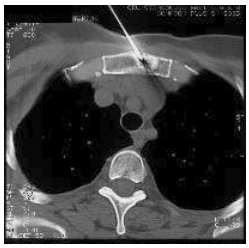
Case 6: CT osteolytic lesion of rib

Case 6: biopsy, CT control

Case 7 Percutaneous biopsy of an osteolsclerotic lesion of the sternum. Technique : oblique route, Ostycut bone biopsy needle. Results : breast cancer metastasis

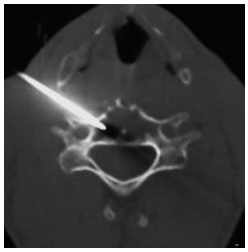


Case 7: CT osteolsclerotic lesion of the sternum

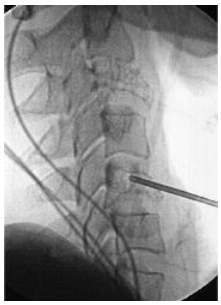


Case 7 : biopsy, CT control

Case 8 Cervical vertebral biopsy, antero-lateral approach. Result : myeloma



Case 8: CT control



Case 8: fluoroscopic control