PROCEDURAL ARTICLE

The occasional bone marrow biopsy

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INTRODUCTION

An 84-year-old patient has had unintended weight loss and weighs 53.2 kg (2 years ago she was 62.1). Routine blood work reveals blast cells on peripheral smear. These are never normal. The internist you consult by phone asks if you can do a bone marrow aspirate to speed diagnosis for your patient pending specialist appointment. It is something you might do only every few years, however, it is safe and can help your patient.

Putting a hole in the bone (trephination) is an ancient technique successfully performed by neolithic surgeons.[1] It is safe in modern times; a survey of 54,890 bone marrow biopsies (BMB) in the UK resulted in only 26 adverse events.[2] Local bleeding is common with prolonged bleeding more likely with thrombocytopenia. Local infections are rare but more common with leucopenia.

BMB and aspiration (BMA) help with the diagnosis of primary haematological and metastatic malignancies as well as other conditions including some anaemias, haemochromatosis and fever of unknown origin (FUO). While one often does both, the aspirate is simpler and may be all you need.

Discuss with your internist or pathologist which would be the most useful test. For FUO, for example, you will want culture, and examination for acid-fast bacteria and fungi, in addition to the biopsy, to look for lymphoma as well as solid tumours.

For the work-up of blast cells, you are interested in lymphomas and leukaemia. You will want to send your aspirate for pathology but also molecular, flow cytometric and cytogenetic studies.

EQUIPMENT

- Sterile drape and gloves
- Gauze
- Chlorhexidine solution
- 2% Xylocaine
- Scalpel handle with #11 or #15 blade
- 10 cc syringe and 25G 25 mm needle for freezing
- 15 G Aspirate or 11G 100 mm bone biopsy needle
- 20 cc syringe
- 6 glass slides
- Two formalin containers for pathology
- An assistant (usually a laboratory technician).

The choice of the needle depends on availability. Many rural doctors

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have experience and access to a powered needle such as EZ-IO (TM) or a manual 15G obturated needle for intraosseous access for the aspirate.

If you have an 11G needle, you can obtain a core of the bone marrow. If you are ordering needles, I would suggest a device that has a core-retaining feature such as an 11 gauge T-Lok (TM) needle (Argon Medical Devices catalogue DBMNJ1104TL) [Figure 1].

PROCEDURE

1. Pick your site. The posterior superior iliac crest (PSIC) is my preferred site for BMB as I feel it is safer and easier to access in most patients. The anterior iliac crest is an alternate location for BMB. Other sites may not be deep enough for biopsy but can be used for aspirate. Such sites include the sternum if over 12 years old. At birth, cellular (red) marrow is present in every bone, but with age, it gets replaced distally to proximally by fatty (yellow) marrow in the limbs.[3] Thus, for BMA, you can only use the proximal tibia for patients under 1 year of age
2. Have the patient go prone or in a lateral decubitus position. The PSIC can be landmarked by the pre-sacral dimples, the *'fossae lumbales laterale'*. Use a pen to mark in the middle of the cortex you can feel
3. Prepare your site with a surgical skin preparation such as chlorhexidine. Drape the site. First, use local anaesthetic such as 5 cc of lidocaine hydrochloride 2% to first bleb the skin over the site and then down to and including the periosteum diffusely, as you may not necessarily be doing a biopsy at the exact same spot. Consider intravenous sedation or other measures for additional pain control in an individualised approach[4]
4. A 5-mm stab incision just through the skin with a #11 or #15 scalpel will allow for easy passage of the larger biopsy needle, although it is not necessary for EZ-IO. Visualise the underlying structure to direct the needle. For the PSIC angle, the needle is 30° lateral from the parasagittal plane and 30° inferior from the transverse plane to sample the thickest part of the bone and avoid the sacroiliac joint (SI) [Figure 2]
5. Advance your needle to the periosteum. Then, with the stylet in place, rotate the needle clockwise and counterclockwise and apply firm pressure to penetrate through the cortex of the bone. Decreased resistance indicates you are in the bone marrow cavity. Ensure that the needle is solidly fixed in the bone. Remove the central obturator from your needle
6. If you are using the biopsy needle, it is common practice to first aspirate and reposition through the same incision to advance the needle to a new area of bone for the biopsy

ASPIRATE

7. To aspirate use a 20 cc or larger syringe to apply sufficient suction. Warn the patient that this will be painful, albeit briefly. Quickly draw only a 0.5 ml sample for immediate slide preparation. Avoid heparin for this sample, as this can alter cell morphol-

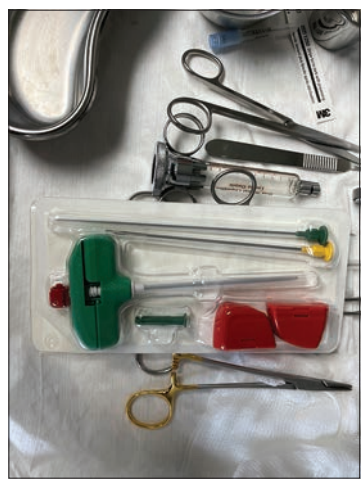

Figure 1: Equipment list

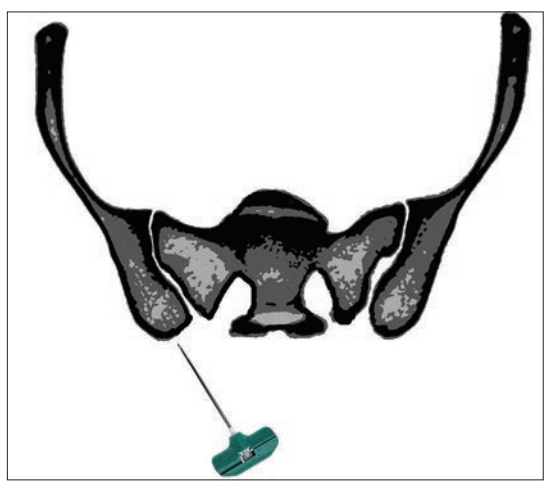

Figure 2: Axial section of PSIC with needle positioned 30° lateral

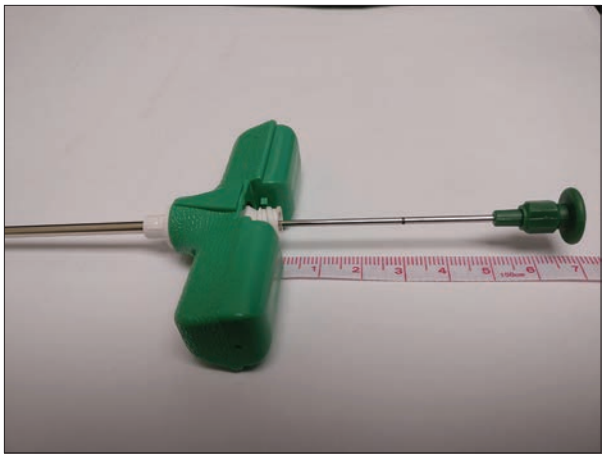

Figure 3: Core length probed at 30 mm

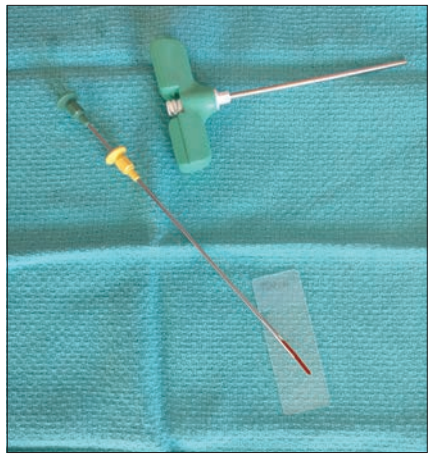

Figure 4: Removing the core

ogy. A small sample will reduce the chances of dilution with blood

8. Ideally, at this point, you have at hand a technician who is experienced in making peripheral blood smears. The techniques are the same and the sample needs to be processed before it clots
9. The presence of bone spicules and fat globules will indicate a proper sample. The pathologist will want you to enrich the sample for these elements. There are multiple ways to do this
10. A simple way is to first transfer a generous drop of the aspirate to each of six slides near the frosted end. That done, tilt each slide in turn and use the same syringe to suck up any excess thinner fluid
11. Have the assistant prepare the thin smear. The assistant will bring another slide at a 30°–45° angle backing up to the drop, allowing the drop to spread along the contact line of the two slides. Then, the upper (spreader) slide is quickly pushed toward the unfrosted end of the lower slide, dragging the drop to create a tongue-shaped smear with a feathered edge. Repeat for each of the slides. Let air dry. Place any residual aspirate (when clotted) into a formalin container
12. If you are looking for haematological cancers, further (larger) samples can then be drawn for other studies to be placed in blood tubes. If you do not know what tube to reach for, use the yellow top. The anticoagulant in yellow top tubes (acid-citrate-dextrose) keeps cells viable and does not interfere with any of the enzymes or reagents employed in molecular, flow cytometric or cytogenetic studies used for the diagnosis and characterisation of myeloma, non-Hodgkin's lymphomas and leukaemias
13. For FUO, you will also want additional aspirate for blood culture tubes, a transport medium and a sterile urine container.

BIOPSY

14. If you are also doing a biopsy, you will need to advance the needle with continued clockwise and counter-clockwise rotation a further 20–30 mm. For myeloma, lymphoma and metastasis aim for a longer specimen size, as marrow involvement is heterogeneous in those illnesses. Do not advance more than 50mm to limit the risk of exiting the bone through another cortex
15. Gently insert a probe into the back of the needle to check for the desired sample length
16. For the T-Lok (TM), the needle core length is the distance between the probe mark and the needle hub [Figure 3]. When the mark is equidistant from the needle hub and the plastic end of the probe, the core will be 20 mm long
17. Insert the extraction cannula into the needle without rotation to trap the core at this point. When fully inserted rotate the barrel of the needle a full 360° to sever the bone marrow core from its base. Now back the needle out with clockwise and counterclockwise rotation
18. As with most needles with a core retention feature, the core should exit from the operator's side of the device
19. Remove the extraction cannula and use the core probe from the operator's side of the extraction cannula to extract the core [Figure 4]

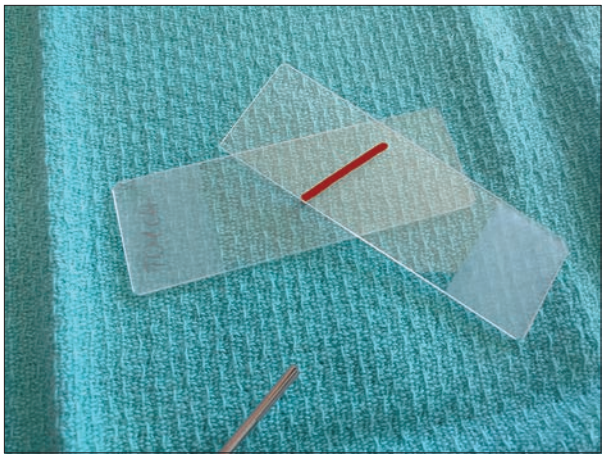

Figure 5: Touch samples

20. For older reusable BMB needles, the technique differs in that once you are at depth you have to rock the needle in several planes to break off the core at the region of the tip. Back off the needle and insert the blunt probe (failing that reinsert the trocar) to have the core exit from the patient's side of the needle
21. If your aspirate sample was thin or you are not sure, core touch samples are desired [Figure 5]. Use a glass slide to contact the core from several angles and let the air dry. When done place the core in formalin for histopathology processing
22. After the procedure, apply a strip of tape to close the skin and a pressure dressing. Have the patient lie on their back for 15–30 min to keep pressure on the area. The bandage can be removed in 24 h.

CONCLUSION

The bone marrow biopsy and aspirate are related procedures that can easily become part of a rural doctor's tool kit to improve access to timely diagnosis.

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