An Illustrated Guide to Performing the Bone Marrow Aspiration and Biopsy

Notice!

This paper describes a common medical procedure and is intended only for medical personnel. Only trained, experienced, and credentialed individuals are permitted to perform the bone marrow aspiration and biopsy. The opinions expressed are entirely those of the authors and do not represent their respective institutions.

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The bone marrow aspiration and biopsy are usually regarded by the public and physicians as a brutal, extremely painful procedure which is difficult to master. However, with knowledge and some experience, successful marrow procedures can be repeatedly performed with minimal discomfort to the patient. This paper reflects the collective knowledge and experience of a hematopathologist (RSR), hematologist/oncologist/pathologist (TFH), pathology residents (DRP, RF, DM), an internal medicine resident (LW) and a medical technologist (ES) in this area. This paper was adapted from a lecture series originally developed for residents by TFH.

Clinical Indications for the Bone Marrow Examination

Peripheral blood examination and other routine laboratory assays do not always provide enough information for the diagnosis of hematologic disease. In some patients direct microscopic examination of the bone marrow is required for confirmation of a suspected clinical diagnosis or monitoring the course of medical therapy. Occasional patients also require bone marrow collection for special studies, such as cytogenetic analysis, flow cytometry, molecular studies, or microbiologic cultures.

A bone marrow examination is a critical part of the evaluation of patients with a variety of hematopoietic and non-hematopoietic diseases. It is performed for diagnostic purposes in patients with splenomegaly, dysproteinemias, suspected lysosomal storage disease, an unexplained deficiency or excess of peripheral blood leukocytes or platelets, or the presence of immature or morphologically atypical cells in the peripheral blood. Anemic patients are seldom subject to bone marrow examinations unless the cause is not apparent after a variety of other laboratory assays have been performed, or the disease does not respond to appropriate therapy. The bone marrow examination may also be requested to obtain material for microbiologic culture in patients with unexplained fever (“fever of unknown origin”), HIV infection and AIDS, or other diseases, and to search for infectious organisms, neoplasms, granulomatous disease, or other lesions in these patients. Bone marrow examination is also part of the staging process for newly diagnosed patients with lymphoproliferative diseases and certain non-hematopoietic malignancies such as neuroblastoma and other childhood tumors. Examination of the bone marrow is performed to determine the extent of marrow damage in patients exposed to radiation, drugs, chemicals, and other myelotoxic agents. Moreover, marrow evaluation is essential to determine the efficacy of treatment and to monitor the recovery process in patients undergoing bone marrow transplantation or marrow-ablative chemotherapy. Common indications for bone marrow aspiration and biopsy are listed in Fig. 1.

Fig. 1. Clinical indications for a bone marrow evaluation. Data from 286 bone marrow procedures performed at the Medical College of Virginia Hospitals, January-June, 1998.

There are relatively few contraindications to the bone marrow procedure. Acquired or congenital coagulation factor deficiencies and other coagulation abnormalities are considered a contraindication by some physicians by not by others. Factor replacement therapy prior to the bone marrow examination and hospital observation for 24 hours after the procedure may be indicated in these patients. Patients receiving anticoagulants should have prothrombin time (PT) or activated partial thromboplastin time (aPTT) values within the therapeutic range for warfarin or heparin. Isolated thrombocytopenia is not a contraindication to the bone marrow examination if the procedure is properly performed and technical difficulties are not encountered. Other contraindications include infection or previous radiation therapy at the sample site and poor patient cooperation. Sternal bone marrow aspiration is completely contraindicated in patients with diseases associated with bone resorption, including multiple myeloma.
Preparing for a Bone Marrow Examination

Obtaining Patient Medical Information

A successful bone marrow evaluation requires knowledge of the patient and the reason(s) the study was requested. The following information should be obtained when the laboratory is first contacted to schedule the marrow study:

- Patient name
- Patient age and gender
- Patient location/requested time of examination
- Primary diagnosis
- Clinical indication(s) for examination
- Allergies (especially to povidone iodine and lidocaine)
- Recent chemotherapy, radiation therapy, bone marrow transplantation, or blood transfusions
- Dietary, racial, and family history
- Medications (iron, B12/folate, G-CSF, aspirin, coumadin, heparin, antibiotics, etc.)
- Special studies requested (immunophenotypic analysis, cytogenetic analysis, culture, etc.)
- Special medical problems that may preclude procurement or written consent or complicate the procedure (i.e., unresponsive or mentally incompetent patient, adversity to medical procedures, anxiety, pain intolerance, disease or recent surgery involving the pelvic bone, hemophilia or other bleeding disorder, severe cardiac or pulmonary disease, morbid obesity etc.)
- Name/pager #/telephone # of person requesting examination
- Name of attending physician

The request for a bone marrow procedure should be validated by reviewing pertinent laboratory data, the patient’s medical record, and a recent peripheral blood smear. It is not unusual for junior doctors to overlook a less invasive diagnostic procedure before requesting a bone marrow examination. For example, a CBC, serum iron studies, and a serum ferritin assay should be performed on a patient with suspected iron deficiency anemia, but a bone marrow examination would be an unusual request. If the request seems inappropriate, the requesting physician should be contacted for verification. Some hospitals require a formal consultation from the Hematology/Oncology Service to justify a request from another department, since the bone marrow examination is an invasive, expensive, and labor intense procedure. If the procedure is requested as part of a research protocol, a detailed list of the required specimens, specimen preparation directives, and transportation directions should be obtained. Arrangements for pain medication of other special patient needs should be made by the requesting physician prior to the arrival of the marrow procurement team. At a minimum, this should include an “as needed” (i.e., “PRN”) medication order placed on the patient’s chart.

Supplies and Equipment

Since bone marrow procedures are usually performed in the clinic or at the bedside, appropriate supplies and equipment must be carried to the site. A compartmentalized plastic or wooden tray is usually used for this purpose, or the equipment may be carried in a wheeled cart with a flat work surface for preparing the marrow slides. Adequate routine supplies to perform several bone marrow examinations should be carried in the tray, as well as any special tubes, preservative solutions, etc. The items included in the bone marrow tray at the Medical College of Virginia are included in Appendix #1,
Reviewing the Patient’s Medical Record

The patient’s chart should be reviewed upon arriving at the location of the marrow procedure to verify the information previously provided to the laboratory. Do not assume that this information is complete or correct. The following facts should be verified:

- Is the patient identification correct? Use hospital numbers in addition to names.
- Is the request for a marrow procedure justified?
- Can the patient give written consent for the procedure? If not, obtain the name and telephone number of the person giving consent.

Does the patient have special medical problems which may complicate the procedure? These may include disease or recent surgery involving the pelvic bone, bleeding, severe cardiac or pulmonary disease, unusual sensitivity to pain, adversity to medical procedures, allergies to iodine or lidocaine, extreme obesity, etc.

Once the chart review is completed, the nurse caring for the patient should be notified of the procedure and necessary assistance requested.

Meeting the Patient

The identification of the patient must be absolutely confirmed, preferably by verifying the hospital number and name from a wrist band or identification card. If such is not available, the patient should be asked to state their name and asked whether they were expecting to have a marrow performed. The marrow team should be introduced to the patient. The procedure must be explained to the patient, all questions answered to the satisfaction of the patient and family members, and written consent obtained from the patient. If the patient cannot provide written consent, it should be obtained from the next-of-kin. In the rare circumstance of an incapacitated patient without a family, a court order must be obtained. Under no circumstances should a bone marrow be obtained without written permission. Individuals performing a bone marrow procedure must also be thoroughly familiar with and follow all institutional policies regarding consent for medical procedures.

All questions should be answered completely and the patient should then be given the opportunity to sign the written consent form. Some patients are reluctant at first to grant consent and require further persuasion or time to consult with their family or attending physician. The attending physician should be notified if the patient refuses to grant written consent. Although the vast majority of patients do not require pharmacologic intervention other than local anesthesia, the procedure may need to be delayed until the proper type of sedation can be arranged.
General Considerations

Hematopoietically active bone marrow is distributed throughout the skeleton in children, but it is restricted to the axial bones of adults. Of the potential sites to obtain the bone marrow, the posterior iliac crest is optimal for reasons of safety and ease of performance. Alternative sites should be considered if the posterior iliac crest is diseased or inaccessible because of morbid obesity or inability to position the patient correctly. These alternative sites include the tibia (infants only), anterior iliac crest (children and adults), and sternum (adults only, aspiration only). Sternal marrow examination should be considered only if other sites are unacceptable, and is completely contraindicated in patients with diseases associated with bone resorption, including multiple myeloma (Foucar, 1995).

There is a continuing debate about adequate marrow sampling for various purposes. Most studies of multiple marrow sites have revealed marrow cellular content, cellular composition, and pathologic lesions to be rather uniformly distributed through the bone marrow. Therefore, most hematopathologists today consider an adequate sample from a single site acceptable in most patients. At the Medical College of Virginia, we try to obtain an aspirate specimen and two biopsy cores from a single site, with additional biopsy cores in patients where "focal" lesions are suspected, such as lymphoma, granulomata, and metastatic carcinoma. If radiographic studies suggest unilateral disease, sampling from that side is favored. We obtain a bilateral sample only if required by a treatment protocol.

The best sequence to obtain marrow specimens is also controversial. The biopsy may be altered by needle artifact if the aspirate is obtained first, while the aspirate specimen may clot if the biopsy is performed first and locally activates the coagulation system. However, Foucar (1995) feels that the sequence is unimportant, as long as different areas along the posterior iliac crest are sampled.

Fig 3. Diagram of posterior pelvic bone, illustrating the location of the right posterior iliac crest (arrow).

Positioning the Patient

The patient is positioned as follows, depending on the location of the procedure:

Posterior iliac crest (PIC) – The patient is placed in a right or left lateral decubitus position with their knees flexed, a pillow under their head, and their eyes away. The posterior iliac crest may be used in patients over one year of age.

Anterior iliac crest (AIC) - The patient is placed in a supine position, with their hips and knees flexed, and eyes averted away. This site is appropriate only in adults when the posterior iliac crest is inaccessible because of obesity, infection, injury, or inability to position the patient in the lateral decubitus position. The thick, hard cortical layer of the anterior iliac crest...
makes satisfactory specimens more difficult to obtain and the
needle can enter the peritoneal cavity. In addition, needle
biopsy of anterior superior iliac spine has been reported to be
more painful, and to produce samples of smaller length and
area than biopsies of the posterior superior iliac spine.

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area than biopsies of the posterior superior iliac spine.

Sternum - Supine position, head and eyes away, light
towel over face “to keep things sterile” and cover eyes.
Sternal aspiration should be performed only if the posterior
and anterior iliac crests are inaccessible or unsuitable for
the procedure. Furthermore, sternal aspiration should be
attempted only in adolescents and adults, since there is
a higher incidence of serious complications in infants and
children.

Tibia – Marrow aspiration from the anteromedial surface of the
tibia is performed only in children less than 18 months of age.
The tibia is an unsatisfactory site in older individuals because
of variable cellularity and the hardness of the cortical bone.

A continuing conversation should be began with the patient and
continued throughout the entire procedure. This is necessary to
inform the patient about anticipated discomfort from the procedure,
to assess the patients feeling of pain, and to obtain early warning of
complications such as a vasovagal reaction.

Nonsterile latex “examination” gloves and a plastic procedure gown
or other protective clothing should be worn. The patient’s back
should be carefully palpated to identify anatomical landmarks and
the appropriate anatomic site for marrow procurement. To identify
the chosen site after the area is cleaned with povidone-iodine soap, it
can first be highlighted with an indelible pen or by making a shallow
impression in the skin with the tip of a plastic ear speculum. One of
the following locations is chosen.

PIC - Center of posterior superior iliac spine
AIC - Center of prominence of anterior superior iliac spine,
just under lip of crest
Sternum - Second intercostal space in midline

The skin surrounding the procedure site should be cleaned as follows:

Use three sterile, disposable swabs soaked with 10%
povidone-iodine solution (Betadine Solution, Purdue Frederick
Company). For individuals allergic to iodine, chlorhexidine
gluconate, 4% (Betasept Surgical Scrub, Purdue Frederick
Company) may be utilized.

With each of the three swabs, wash the skin in a circular
motion beginning with the marked site and working outward
approximately four inches.

Remove the povidone-iodine in the center of the washed area
with a single swipe of a sterile isopropyl-soaked swab.

Most patients who are anxious at first are adapting well to the
experience by this time, but the anxiety level actually increases in a
few patients. occasional patients may require conscious sedation to
permit proper marrow procurement. Drugs commonly used for the
bone marrow procedure are listed in Table I.

Anxious patients who have an intravenous (IV) line in place can be
given diazepam (“Valium”) by the assisting nurse or physician. This
should be slowly hand-pushed (1 mg/min) into a rapidly running IV
until the patient’s speech is slurred (keep the patient talking!). This
may require 5-20 mg of diazepam over 5-10 minutes. The patient
usually falls asleep and snores, but can be aroused. This sedation
lasts 20 min to 2 hours and usually produces desirable amnesia for
the procedure. Be sure to have Ambu-Bag nearby, just in case! ... But
it wouldn’t be needed.

Place a sterile drape with a fenestrated opening over the area to be
sampled.

Administering Local Anesthesia

Once a sterile site has been achieved, a local anesthetic is utilized to
“numb” the skin and periosteum over the chosen area of the posterior
iliac crest. Lidocaine or a similar local anesthetic can be used,
providing the patient has no history of an allergic reaction to this
medication (BE SURE TO ASK!). During this process, local anesthetic
is first infiltrated into the skin and subcutaneous tissue to anesthetize
an area approximately 1 cm. in diameter.
Table I
Medications for pain and anxiety reduction

<table>
<thead>
<tr>
<th>Agent</th>
<th>Route</th>
<th>Adult Dosage*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ativan (Lorazepam)</td>
<td>IM, IV, PO</td>
<td>0.044 mg/kg IM, IV 2-5 mg PO</td>
</tr>
<tr>
<td>Demerol (Merperidine)</td>
<td>IM</td>
<td>50-100 mg</td>
</tr>
<tr>
<td>Versed (Midazolam)</td>
<td>IM, IV</td>
<td>**</td>
</tr>
<tr>
<td>Vistaril (Hydroxyzene)</td>
<td>IM, PO</td>
<td>25-100 mg IM 50-100 mg PO</td>
</tr>
<tr>
<td>Valium (Diazepam)</td>
<td>IV, PO</td>
<td></td>
</tr>
</tbody>
</table>

* Dosages vary with weight, age, etc. and should be adjusted to the individual patient and desired level of sedation.

** Midazolam may cause severe respiratory depression and should only be used in situations where heavy sedation is required. Consult PDR for current dosing recommendations.

After the skin is numb, lidocaine is infiltrated directly over the periosteum to numb an area approximately 2-3 cm in diameter. Discomfort can be avoided during the remainder of the procedure if adequate time is taken to assure good anesthesia. Local anesthesia is administered as follows:

Aspirate 2 mL of 1% sterile sodium bicarbonate solution (to reduce the burning effect of the acidic lidocaine solution) and 8 mL 1% lidocaine hydrochloride (Xylocaine, Astra Pharmaceuticals) into a 10 mL syringe.

Slowly infiltrate the skin with the buffered lidocaine, raising a “dime-sized” intradermal wheal with 26-gauge needle.

Infiltrate the subcutaneous tissue and periosteum, using a 22-gauge needle (or spinal needle for overweight patients). This usually requires 2-5 mL of buffered lidocaine. Assess the thickness of the subcutaneous tissue and the depth to the periosteum for later reference.

Determine the adequacy of local anesthesia after several minutes by gently tapping the periosteum with the sharp point of the numbing needle. If sharp pain is still experienced, the injection of additional lidocaine is required. Unbuffered lidocaine is used for this purpose.

Caution! - Adverse reactions of a neurologic, cardiovascular, and allergic nature can occur to lidocaine. The maximum recommended dose of lidocaine with epinephrine for healthy adults is approximately 7 mg/kg or 500 mg total dose (50 mL of 1% lidocaine).

Alternative local anesthetics can be used in patients who have a known hypersensitivity to lidocaine. These include chloroprocaine (Nesacaine, Astra Pharmaceutical) and bupivacaine hydrochloride (Sensorcaine, Astra Pharmaceuticals). Another alternative in patients who are allergic to lidocaine is administer methylprednisone (40 mg) and benadryl (50 mg) intravenously immediately prior to the injection of lidocaine, followed by oral prednisone (1 mg/kg) in two divided doses over 24 hours after the procedure (Saul Yanovich, M.D., personal communication). Since anaphylactic reactions can occur in patients without previous history of an allergic reaction, an emergency kit with an airway and injectable epinephrine and hydrocortisone should be available for immediate use (53).

Fig 4. Subcutaneous infiltration of 1% buffered lidocaine, using a 26-gauge needle.
Fig 5. Infiltration of 1% lidocaine into the periosteum of the posterior iliac spine, using a 10 mL syringe with a 3 1/2 in. spinal needle.

Obtaining a bone marrow specimen is relatively easy to perform if adequate care has been taken to locate the periosteum and infiltrate an adequate area with a local anesthetic. We routinely obtain the bone marrow aspirate specimen first.

**Bone Marrow Aspiration Technique**

**Marrow Aspiration: AIC, PIC**

Marrow aspiration from the posterior or anterior iliac crest is performed as follows:

Fill the necessary number of 10 mL syringes with heparin solution or other anticoagulant as required. Regardless of the suspected diagnosis or purpose of the study, it is best to obtain at least one heparin-anticoagulated tube of marrow aspirate, “just in case” it is needed for special studies (i.e., microbiologic culture, immunophenotypic analysis, cytogenetic analysis, molecular biology studies, etc.).

Obtain the desired marrow aspirate needle from the assistant and inspect for signs of manufacturing defects. Remove the plastic guard from the needle (if one is present). Loosen and remove the obturator to make certain that it can be removed with ease. Insert obturator and relock. Hold the needle with index finger near needle tip to control the depth of penetration.

Hold needle horizontally (for a patient lying on their side) or vertically (if supine) to puncture the anesthetized skin. If the skin is tough, make a small incision with a sterile scalpel.

Advance the needle with steady pressure and a slight twisting motion to the center of the posterior iliac prominence (PIC) or to the bone (AIC). Angle the needle 15 degrees caudad (PIC) or cephalad (AIC).

Fig 6. Bone marrow aspiration. A 16 gauge Illinois sternal/Iliac aspiration needle has been placed into the marrow cavity. The obturator is being removed.
Rotate the needle back and forth (90°-180°) and carefully apply pressure to advance the needle through the cortical bone. The consistency of the bone varies considerably from patient to patient, but may have significance as follows:

Soft ("Swiss cheese") consistency = osteoporotic bone (elderly patient, multiple myeloma, renal failure, some post-chemotherapy patients), firm ("pine board") consistency = Normal for young athletic individuals, very hard ("oak board") consistency = possible hyperostosis.

Decreased resistance (Usually!) indicates penetration of cortex and entry into the marrow cavity.

Advance needle about 1 cm into the marrow cavity. Unlock and slowly remove the obturator. Some patients may notice pain if the obturator is not removed carefully.

Fig 7. Bone marrow aspiration. The obturator of the Illinois sternal/Iliac aspiration needle has been removed and a 10 mL syringe attached to the hub. Suction is being applied to the syringe, with successful aspiration of marrow.

Fig 8. Preparing aspiration smears. An experienced medical technologist is preparing smears from small drops of the bone marrow aspirate placed on glass microscope slides.

Attach a 10 ml syringe to the aspirate needle. Quickly (<5 seconds) aspirate 1.0 mL marrow into the 10 mL syringe (more than this dilutes the specimen with peripheral blood). BEWARE! The sudden sharp pain may cause the patient to shout, move suddenly, or even try to strike you! Remain alert, try to maintain sterility, and calm the patient quickly if this happens.

Quickly give the syringe to the technical assistant to prepare specimen slides. Hold a finger over needle opening to prevent blood flow while the technician prepares slides and evaluates for the presence of spicules.

If spicules are present, extra marrow specimen(s) for special studies can be obtained. Aspirate approximately 2 mL of marrow into a syringe containing 1 mL of heparin solution.

If a "dry tap" (no fluid, no sharp pain) occurs, then reposition needle (depth, angle or location) and try again. As a "last
resort” touch preparations can be prepared from the core biopsy. Try the opposite side if necessary.

Remove aspiration needle and apply pressure with a sterile sponge until bleeding ceases.

Perform a bone marrow biopsy or place a folded piece of gauze over the site, apply a pressure bandage, and have patient lie supine for at least 30 minutes (see “Finishing Up” below).

**Marrow Aspiration: Sternum**

Marrow aspiration from the sternum is usually performed only when the posterior and anterior iliac crests are severely diseased or inaccessible as a result of massive obesity. In addition to the rare, but very serious complication of entering the mediastinum during the procedure, the sternum is an unsuitable site for biopsy procurement. If a sternal aspiration is necessary, the following procedure is used.

- Use “Illinois” needle with guard.
- Assess subcutaneous thickness during local anesthetic.
- Adjust guard to 5-10 mm depth.
- Hold needle perpendicular to skin; insert down to bone.
- Rotate needle and advance.
- Decrease in resistance (usually!) indicates entry into marrow cavity.
- Avoid penetrating the posterior table of the sternum (if the needle enters the mediastinum, you may see fluid bubbles as the patient breathes when the stylus is removed).
- Aspirate marrow specimen as above.

**Bone Marrow Biopsy Technique**

The bone marrow biopsy is obtained through the same skin incision site used for the marrow aspiration, but the needle is angled differently from the aspirate needle in order to sample a different area. Due to the larger caliber of the bone marrow biopsy needle, more force is usually required than with the aspirate needle. In addition, some patients complain of an uncomfortable dull (“pressure”) sensation as the needle is advanced, which is not relieved by local anesthetic. Bone marrow biopsies are obtained from the PIC or AIC, **NEVER THE STERNUM**!

- Obtain a biopsy needle and inspect for bent, loose, or almost-broken parts. Remove obturator and inspect. Reinsert obturator and lock with a twist.
- Hold biopsy needle with hub in palm, index finger tip on skin to control needle penetration. Insert through skin incision site.
- Using steady pressure, advance biopsy needle to the bone. At bone, advance needle through cortex with forceful rotating movement -- decreased resistance (usually) indicates entry into marrow cavity.
- Remove obturator when needle is firmly anchored in bone. Advance needle 1-2 cm more with continued “back and forth” rotation. To determine the length of the biopsy specimen in the needle, the obturator can be carefully reinserted into the needle. An ideal biopsy core is 2 cm or greater in length.
- Break off the biopsy specimen from the surrounding bone by vigorously rotating the needle 360 degrees several times while applying slight pressure. Decreased resistance to rotation usually indicates detachment of the core from the surrounding bone. If difficulty is encountered, withdraw the needle slightly (2-3 mm, do not replace obturator), redirect tip at new angle, and readvance 2-3 mm with rotation, to break off the biopsy core.
- Rotate needle during withdrawal through bone, periosteum, and skin. Apply pressure to biopsy site until bleeding and oozing ceases.
Fig 9. Determining length of biopsy core in needle by carefully reinserting obturator. Ideally, the core length should be 2 cm or greater.

Use the small blunt obturator included with each biopsy needle to remove the biopsy core. Hold the needle vertically with the beveled (distal) end up and the hub approximately 2 cm above a clean glass microscope slide or piece of sterile gauze held by the technical assistant. Insert the obturator through the distal end of the needle and gently force the biopsy through the hub of the needle unto the glass slide or gauze.

In patients with extremely dense bone, the tip of the beveled end of the needle may be bent during the biopsy procedure, making it difficult to insert the obturator. Several attempts may be necessary. Be careful not to puncture your gloves!

Inspect the biopsy for adequacy and atypical features. A normal biopsy core is dark red with a fine white trabecular network. In patients with a markedly hypocellular marrow the trabecular network remains but reddish marrow is not visible. Cartilage is homogenous, white, and glistening, while cortical bone is white. A mottled appearance may indicate focal replacement with tumor or granulomas.

Additional biopsy cores should be obtained if the specimen is inadequate in size or has an atypical gross appearance. Several touch imprints of the biopsy core should be obtained.

No biopsy specimen? Is it inside the skin incision? can it be withdrawn with forceps? Repeat several times until specimen obtained. Try “tricks” to obtain core -- syringe with gentle vacuum over needle hub as you withdraw, firmly rock needle back and forth before withdrawing, try new needle, etc.

Fig 10. Delivery of biopsy core unto a glass microscope slide. The core has been forced through the hub of the needle using a small blunt obturator.

Finishing Up

After procurement of the marrow specimens, bleeding must be stopped, the procedure site must be cleaned up, needles properly disposed of in a Sharps container, and the site bandaged. A procedure note must be placed on the patient’s chart.
Apply pressure with thumb or fingers to procedure site until bleeding has completely ceased. Gently remove and dispose of the fenestrated drape.

Completely remove povidone-iodine from the skin with alcohol swabs. Residual povidone-iodine may cause itching and lead to a future allergic response.

Double gauze square an place over the procedure site. Cover the area with at least two pieces of surgical tape approximately 2-3 inches in length. Pressure tape should be used if unusual oozing was encountered during the procedure, and in patients with thrombocytopenia or a history of a hemostatic disorder.

Advise the patient to remove the dressing the following day, after first wetting the tape to make removal easier. Have the patient lie supine, putting pressure on the procedure site for at least 30 minutes. Advise the patient to contact their physician if tenderness or bleeding is noted at the procedure site during the next few days. Thank the patient for their cooperation.

Carefully dispose of the syringes and needles in a sharps container. Advise the patient’s nurse or physician that you have completed the procedure and remind them to keep the patient supine for 30 minutes.

Place a note on the patient’s chart. This is required for medicolegal and billing purposes, as well as to alert the patient care team to the performance of the procedure and any complications that were encountered.

References & Additional Reading


Block, M. Bone marrow examination: aspiration or core biopsy, smear or section, hematoxylin-eosin or Romanowsky stain which combination? Arch. Pathol. Lab. Med. 100(9): 454-456, 1976.


### Appendix I

**Equipment and Supplies for Bone Marrow Procurement**

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Supplies and Equipment</th>
</tr>
</thead>
</table>
| **Obtaining written consent** | Ballpoint pen  
Clipboard  
Patient consent forms                                                                                                                                 |
| **Site preparation**         | Alcohol prep pads, 2 ply, large  
Betadine (povidone iodine, 10%) swabsticks  
Ear speculum plastic tips  
Gauge sponges, 3 x 4 in.  
Impervious gowns  
Isopropyl alcohol swabsticks  
Latex gloves, examination, non-sterile  
Latex gloves, sterile  
Lidocaine hydrochloride, Injection, 1%, 20 mL vials  
Needles, 22 gauge, 1 1/2”  
Fenestrated drapes, sterile, small (30” x 30” with 1 1/2” x 2” fenestration)  
Sodium bicarbonate solution, Injection, USP, 8.4% (1 mEq/mL), 50 mL vials  
Sodium heparin, Injection, 1000 USP Units/mL, 2 mL vials  
Spinal needles, 20 Guage, 3.5 in.  
Spinal needles, 20 Guage, 5 in. Sub-Q needles, 26 gauge, 5/8 in. |
| **Marrow procurement**       | AZF fixative, 10 mL sealed, labeled containers  
Blank labels  
Bone marrow aspiration needles, 15 or 16 gauge, several lengths  
Bone marrow biopsy needles, several lengths, 8 and 11 gauge  
Disposable plastic syringes, sterile U 20 cc.  
Disposable plastic syringes, sterile, 10 cc.  
Disposable scalpel, 25 kGy (2.5 mrad)  
Green-top (sodium heparin) vacutainers  
Microscope slides, 1” x 3”, frosted  
Plastic bags, zip-lock  
Purple-top vacutainers  
Safety flow lancet |
| **Wound care**               | Bandage scissors  
Elastic tape (Elastikon, J&J)  
Transpore tape (3M) |
| **Other supplies**           | Safety flow lancet |

### Appendix II

**Commercial Sources of Bone Marrow Aspiration and Biopsy Needles in the United States**

<table>
<thead>
<tr>
<th>Company</th>
<th>Available Needles</th>
</tr>
</thead>
</table>
| Allegiance Healthcare Corporation      | Jamshidi needles  
Iliac crest aspiration needles  
Illinois sternal/iliac aspiration/ intrasosseous infusion needles  
Pharmaseal bone marrow biopsy and aspiration trays |
| Dyna Medical Corp.                     | Goldenberg SNARECOIL bone marrow biopsy needle  
Extensive line of reusable aspiration and biopsy needles |
| Gallini U.S. Medical Devices            | BIOMID bone marrow biopsy needles  
ISAN and ACRI bone marrow biopsy needles  
BIOSYSTEM bone marrow biopsy needles with core-trapping device |
| Kendall Healthcare                      | Goldenberg SNARECOIL bone marrow biopsy needle  
Monoject bone marrow aspiration and biopsy needles  
Bone marrow procedure trays |
| Lee Medical Ltd.                        | Lee Lok Bone Marrow Biopsy and Harvest Needle |
| Popper & Sons, Inc.                     | Extensive line of reusable marrow needles |
| Ranfac Corporation                      | Goldenberg SNARECOIL bone marrow biopsy needle  
"I" Type Aspiration Needle  
Ranfac Bone Marrow Biopsy and Aspiration Tray  
Reusable Bone Marrow Needles |
| Worldwide Medical Technologies          | Core-Lock Bone Marrow Biopsy Systems  
"J" Style Coring Needles  
"J" Style Aspiration Needles  
Marrow Procedure Trays |