Bone Marrow

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Bone Marrow Examination

- Adults:
  - 3.4% to 5.9% of body weight
  - 1600-3700 g or 20 to 50 mL/kg
  - Produces roughly 6 billion blood cells per kg per day

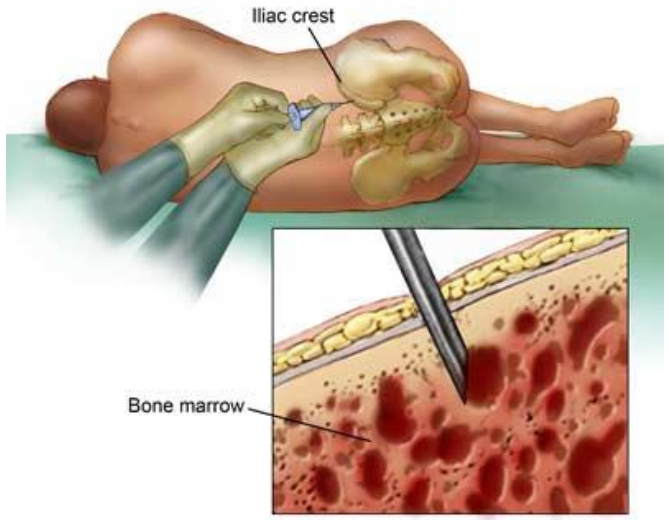
- Adipocytes (yellow marrow) occupy approximately 50% of red hematopoietic marrow space in a 30-70-year-old adult
  - Fatty metamorphosis increases approximately 10% per decade after age 70

Indications for Bone Marrow Biopsy

- Abnormal findings in CBC w/Diff (Hematologic Diseases)
  - Anemia or erythrocytosis
  - Leukopenia or Leukocytosis
  - Thrombocytopenia or thrombocytosis
  - Immature or abnormal cells in differential (circulating blasts)
  - Pancytopenia
- Systemic Diseases may affect BM secondarily
  - Solid malignant tumors arising elsewhere in the body may metastasize to BM
    - Lymphoma, Carcinoma, Sarcoma
  - “Fever of Unknown Origin”
    - Infection within the BM
    - TB, Fungal, Bacterial
- Ongoing evaluation of treatment of hematologic disease
- Bone marrow harvest for BM transplant

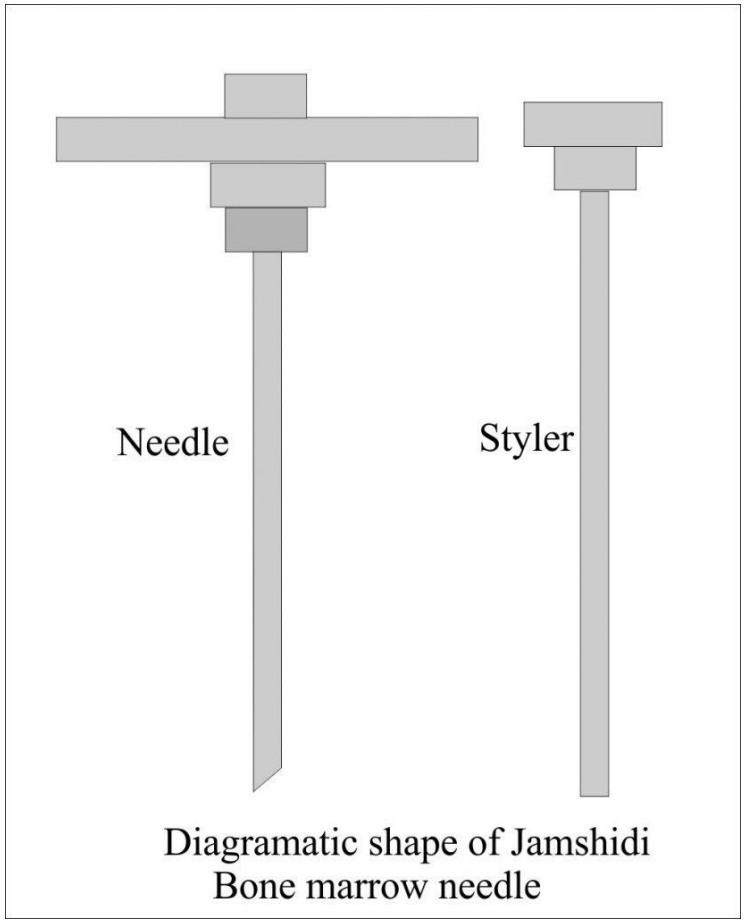
Bone Marrow Collection

- General Information
  - Risks for possible hemorrhage, pain or infection
  - Sterile procedure
  - Performed bedside, CT guided, OR for pediatric patients
  - Physician, PA or NP perform with assistance from MLS
- Aspirate – liquid portion examined to identify types and proportions of hematologic cells and to look for morphologic variance
- Biopsy – solid portion examined to demonstrate bone marrow architecture and is used to estimate cellularity
- Most common site for collection is posterior superior iliac crest of pelvis



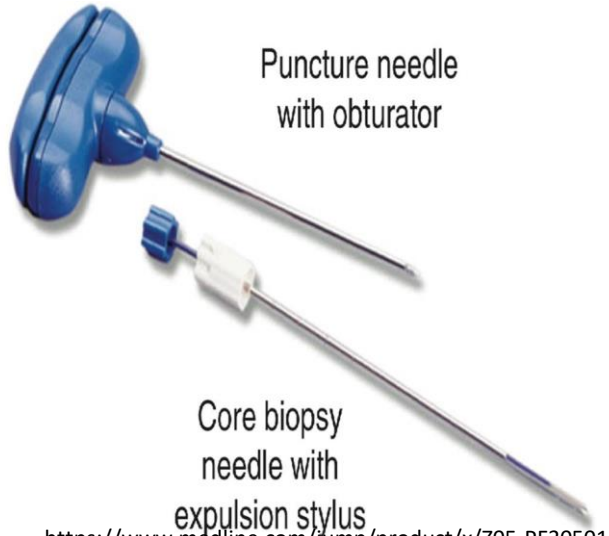
Equipment Needed

- Bone Marrow Biopsy Needle
  - Jamshidi
- Syringes
- Microscope Slides
- Anticoagulants (depends on the test)
- Formalin
- Anesthetic (lidocaine)



Diagramatic shape of Jamshidi Bone marrow needle

www.labpedia.net/bone-marrow-trephine-biopsy-bone-biopsy-part-2



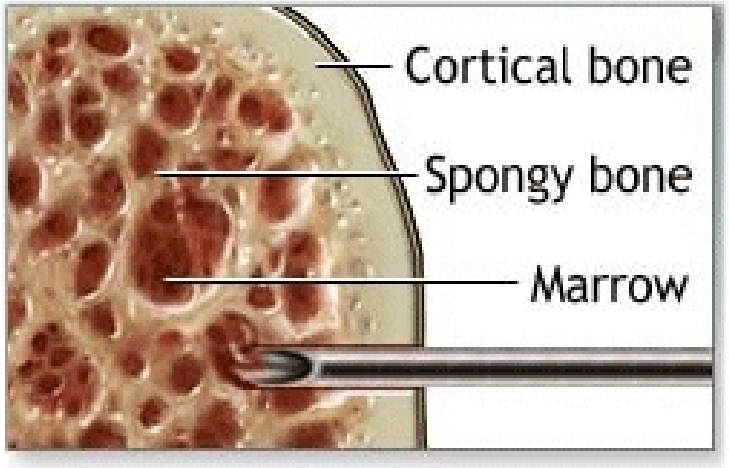
https://www.medline.com/jump/product/x/Z05-PF30501


https://www.teleflex.com/la/en/product-areas/interventional/bone-access/oncontrol/

Bone Marrow Procedure

- Patient may be premedicated (here at CCF) with Percoset, Ativan, Morphine
- Patient usually lying on side with legs drawn
- Physician palpates and finds the site on PIC
- Cleansing of the site (alcohol and iodine)
- Site draped to keep site sterile
- Doctor anaesthetizes the site with lidocaine
  - Skin (small needle) and cortex of bone (long flexible needle)
    - Interior of bone unable to be anaesthitized

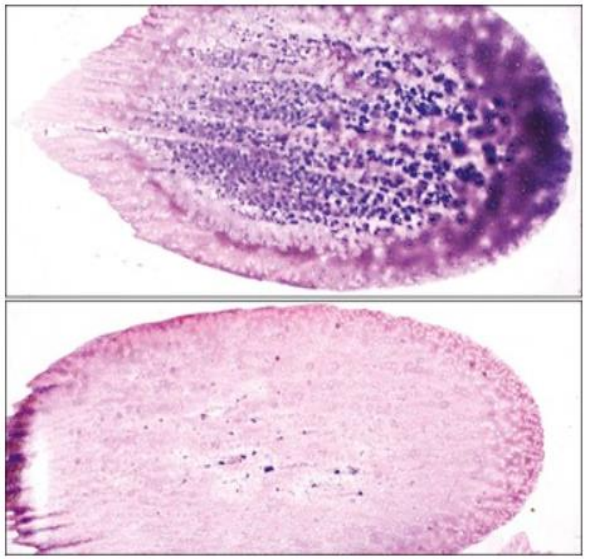
- Biopsy needle passed through skin and bone into bone marrow cavity
- Syringe attached to needle and small amount of bone marrow aspirate obtained



https://plapath.com/bone-marrow-collection/

Bone Marrow Procedure Continued…

- Bone marrow aspirate passed to MLS and slides are prepared
  - MLS judges specimen and looks for presence of spicules
- Other specimens such as aspirate for Flow cytometry, Cytogenetics, Molecular studies, etc
- Physician repositions needle and obtains solid core biopsy
- MLS measures biopsy and makes “touch preps”, places biopsy in Formalin, gathers slides and specimens, returns to lab to process specimen and present to pathologist for review



https://veteriankey.com/bone-marrow-examination/

https://jcp.bmj.com/content/66/8/718

Importance of Smear Technique

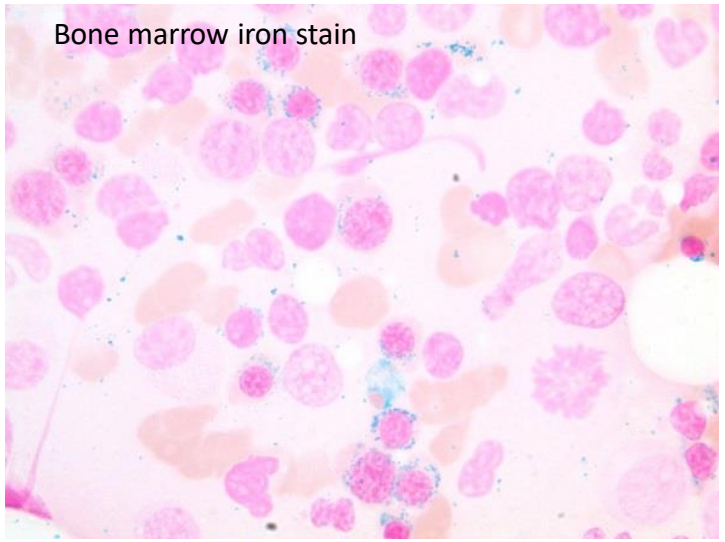
- Direct films: A drop of marrow is placed on a slide a short distance away from one end. A film 3 to 5 cm long is made with a spreader, dragging the particles behind but not squashing them. A trail of cells is left behind each particle.
- Imprints: One or more visible particles (or the core biopsy) is/are picked up with a capillary pipet, the broken end of a wooden applicator, or a toothpick, and are transferred immediately to a slide and made to stick to it by a gentle smearing motion. The slide is air dried rapidly by waving, and then it is stained.

Back to the Lab

- Aspirate (volume and anticoagulant depends on testing ordered) sent to appropriate labs
- Aspirate slides (direct films): usually 10-12 slides
- Touch prep slides (imprints): usually 4 slides
  - Aspirate and touch prep slides stained with Wright stain
- Core biopsy in formalin
- Clot section of aspirate in formalin
  - Histology receives both Core biopsy and Clot section of aspirate for processing

Interpretation of Bone Marrow

- Aspirate smears reviewed:
  - Marrow cellularity is estimate of blood cells to fat cells
    - 50% +/- 10% in 30 to 70 y/o
    - 80% in childhood
    - Hypocellularity = primarily fat and connective tissue cells and very little to no hematopoietic cells
    - Hypercellularity = 100% hematopoietic cells
  - M:E (Myeloid to Erythroid) ratio (2.3:1)
  - BM Differential Count
  - Iron Stores (Prussian Blue iron stain)
- Core Biopsy Evaluated in Histology
  - Results given to staff pathologist (most common stain is H&E stain)



Bone marrow iron stain

Courtesy of Dr. Ondrejka, Staff Hematopathologist

Specialized Bone Marrow Testing

- Flow cytometry- collect aspirate in heparin or EDTA
- Cytogenetics – collect aspirate in sodium heparin or preservative free heparin
- FISH – EDTA or cytogenetics pellet
- DNA/RNA – EDTA
- Special stains on dried aspirate smears (cytochemistries): myeloperoxidase, Sudan black B, naphthol AS-D chloroacetate esterase, nonspecific esterases, acid phosphatases, leukocyte alkaline phosphatase, periodic acid–Schiff stain

References

- Rodak’s Hematology, Clinical Principles and Applications 6th Edition
- Additional material courtesy of Dr. Eric Hsi and Dr. James Cook
- Andrew Zelasco MLS(ASCP)