MORPHOLOGY OF BONE MARROW ASPIRATES

Dr. Prasanna N Kumar
Head – Department of Pathology,
Oman Medical College, Oman
<table>
<thead>
<tr>
<th>BLOOD SMEAR</th>
<th>ASPIRATE SMEARS</th>
<th>CRUSH PREP</th>
<th>TOUCH PREP</th>
<th>BIOPSY</th>
<th>CLOT SECTION</th>
<th>(ASPIRATE SMEARS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B06-6192</td>
<td>Flower, Kristopher</td>
<td>MRN: 3211608</td>
<td>8/22/2006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B06-6192</td>
<td>Flower, Kristopher</td>
<td>MRN: 3211608</td>
<td>8/22/2006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B06-6192</td>
<td>Flower, Kristopher</td>
<td>MRN: 1186637</td>
<td>8/22/2006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B06-6192</td>
<td>Flower, Kristopher</td>
<td>MRN: 3211608</td>
<td>8/22/2006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B05-6192</td>
<td>Flower, Kristopher</td>
<td>MRN: 3211608</td>
<td>8/22/2006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B05-6192</td>
<td>Flower, Kristopher</td>
<td>MRN: 3211608</td>
<td>8/22/2006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B05-6192</td>
<td>Flower, Kristopher</td>
<td>MRN: 3211608</td>
<td>8/22/2006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B05-6192</td>
<td>Flower, Kristopher</td>
<td>MRN: 3211608</td>
<td>8/22/2006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B05-6192</td>
<td>Flower, Kristopher</td>
<td>MRN: 3211608</td>
<td>8/22/2006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B05-6192</td>
<td>Flower, Kristopher</td>
<td>MRN: 3211608</td>
<td>8/22/2006</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Wright-Giemsa stain
- Prussian Blue
- hematoxylin and eosin (H&E)
- unstained
BONE MARROW ASPIRATION

- Sites
  - Sternum
  - Anterior or posterior iliac spines
- Aspiration from multiple sites may be needed
  eg: in aplastic anaemia – partial involvement of the bone marrow
Do not aspirate more than 0.3 ml of marrow fluid from a single site for morphological examination as this increases peripheral blood dilution.
APPROACH TO A MAROW ASPIRATE

- Macroscopic evaluation – check for presence of particles
- Check that there is no dilution with peripheral blood - leads to an erroneous increase in lymphocytes and neutrophils
ESTIMATION OF CELLULARITY

- Critical information – age of patient
- A young child – about 80% of intertrabecular space occupied by haemopoietic cells
- A 75-year-old the average has about 30%
- Semiquantitative assessments of cellularity – hypoplasia, within normal limits, hyperplasia
- Better assessment with biopsy
COMPARING NORMO, HYPER, & HYPOCELLULAR MARROWS
LOW POWER – A SNEAK PREVIEW OF THE MARROW!

Look at:

- Cellularity of the marrow
- Identify megakaryocytes
- Look for aggregates of abnormal cells – eg: granulomas, metastatic deposits
- Identify macrohages
BONE MARROW GRANULOMAS
LOW POWER

- Films without fragments are worth examining.
- However, assessment of cellularity and megakaryocyte numbers is unreliable and dilution with peripheral blood may lead to lymphocytes and neutrophils being over-represented in the differential count.
ARTEFACTS

Process of slide preparation - bare nuclei.
D/D – monotonous cells of malignancy
BONE MARROW AT HIGHER POWERS

Higher power (x40, x100)
- Identify all stages of maturation of myeloid and erythroid cells.
- Determine the M:E ratio
- Perform a differential count
- Look for areas of BM necrosis.
- Assess the iron content.
M:E RATIO

- Expression of relative proportions of myeloid (granulocytic and monocytic cells) to erythroid cells
- Rough comparative index – exclude eosinophils, basophils, lymphocytes, plasma cells
- Must comment on lymphocytes and plasma cells
- Ratio of limited use if both series are equally depressed or stimulated (normal M:E)
- Significant if ratio is off by >2X= eg >5:1 or less than 1.2:1
Not routinely necessary but an excellent practice – good for a beginner to familiarise with the marrow cells

Study morphology in fields that are evenly dispersed – scan many fields under LP and then oil
MARROW DIFFERENTIAL COUNT

- Count at least 200 cells and also note the smudge/unidentifiable cells.
- Any borderline abnormality - e.g. in the number of blasts, lymphocytes or plasma cells, perform a 500 cell differential count.
EVOLUTION OF HAEMATOPOIETIC CELLS
ERYTHROPOIESIS & MYELOPOIESIS
PROERYTHROBLAST

- Large cell, moderately to strongly basophilic cytoplasm, round nucleus, finely stippled chromatin pattern. Nucleoli are sometimes apparent.
- There may be a paler staining area of cytoplasm surrounding the nucleus.
ERYTHROID SERIES

- Early (basophilic) erythroblast - similar to a proerythroblast but smaller without visible nucleoli
- Intermediate (polychromatophilic) erythroblast and late erythroblast (orthochromatic) – cell size reduction, reduction in cytoplasmic basophilia and increase in chromatin clumping.
- Cytoplasm of the late erythroblast - pink tinge due to haemoglobin.
MULTINUCLEAR ERYTHROBLAST
NORMAL GRANULOCYTE PRECURSORS IN BONE MARROW

- **Myeloblast** - high nucleocytoplastmic ratio, diffuse chromatin pattern and nucleolus.
- **Promyelocyte** – larger, lower nucleocytoplastmic ratio, abundant azurophilic granules.
MYELOCYTES & METAMYELOCYTES

- Myelocytes - smaller than promyelocytes, contain specific granules that indicate whether they are of neutrophil, eosinophil or basophil lineage.

The nucleolus is no longer visible.

Some indentation of the nucleus in metamyelocytes
METAMYELOCYTES
BAND OR JUVENILE NEUTROPHILS

- Of neutrophil lineage with non-segmented nuclei.
- Band forms, stab forms
- Less mature than segmented neutrophils.
TIME LINE

- Maturation time from proerythroblast to reticulocyte - 5 days
- Maturation from myeloblast to neutrophil - 7 days
- At times of need the days are shortened.
MEGAKARYOCYTES

< 0.1% of all marrow cells
NONHAEMATOPOIETIC CELLS OF THE NORMAL MARROW

OSTEOCLASTS

OSTEOBLASTS

MAST CELLS STAINED WITH TOLUIDINE BLUE
BM IRON STORES

Storage iron - stains blue, assessed in bone marrow fragments.
ERYTHROID HYPERPLASIA
GRANULOCYTIC HYPERPLASIA
MEGALOBLASTIC ANAEMIA

Patient with anaemia, hyperpigmentation of knuckles, glossitis

Hb – 8g/dL
MCV – 110 fl
TWBC – 2.5 X 10⁹/l
PLT – 75 X 10⁹/l
ACUTE LEUKAEMIA

23-year-old male with lymphadenopathy and hepatosplenomegaly
MULTIPLE MYELOMA

66-year-old male with severe back pain, anaemic, ESR- 150 mm/hour PS - rouleaux
11-month-old baby with anaemia and hepatosplenomegaly
NEIMANN-PICK DISEASE
– FOAMY MACROPHAGES
1½ month female child with fever, abdominal distension, oliguria, altered sensorium, jaundice +, bilateral peripheral lymphadenopathy +, hepatosplenomegaly +

Another sibling had the same problem and succumbed

Familial haemophagocytic lymphohistiocytosis
A 16-year-old apparently healthy school boy comes for evaluation of his hepatosplenomegaly and hypercholesterolaemia. He had been diagnosed as having Niemann-Pick disease when he was 5 years old at another hospital. Serum cholesterol 154 mg/dl, triglycerides 227 mg/dl.
SEA BLUE HISTIOCYTES