Urinalysis and Body Fluids

Unit 4

Synovial Fluid

- Composition and formation
  - Secreted by cells of synovial membrane
  - Very viscous, clear ultrafiltrate of plasma
  - Contains
    - Hyaluronic acid
    - Mucopolysaccharides
    - Limited amount of plasma protein
    - Glucose & uric acid levels equivalent to plasma

- Functions
  - Supplies nutrients
  - Lubrication of joint

- Reasons for analysis
  - Infection
  - Hemorrhage
  - Degenerative disorders (arthritis)
  - Inflammatory disease (SLE)
Synovial Fluid

• Collection
  • Arthrocentesis

Synovial Fluid

• Collection
  • Tubes
    • Heparin - chemistries, immunological tests
    • Sterile tube - culturing and crystal evaluation
    • EDTA - hematology

Laboratory Testing

<table>
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<tr>
<th>Macroscopic</th>
<th>Microscopic</th>
<th>Chemical</th>
<th>Other</th>
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<tr>
<td>Volume</td>
<td>Cell counts</td>
<td>Protein</td>
<td>Aerobic culture</td>
</tr>
<tr>
<td>Color &amp; Clarity</td>
<td>Differential</td>
<td>Glucose</td>
<td>Anaerobic culture</td>
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<tr>
<td>Inclusions</td>
<td>Crystals</td>
<td>Uric Acid</td>
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<tr>
<td>Viscosity</td>
<td>Cytology</td>
<td>Lactic Acid</td>
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<tr>
<td>Clotting</td>
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<td>LDH</td>
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<tr>
<td>Mucin Clot</td>
<td></td>
<td>Rheumatoid Factor</td>
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</tbody>
</table>
Classification of Synovial Fluid

- Normal
- Non-Inflammatory
  - Degenerative joint diseases
- Inflammatory
  - Immunologic disorders (i.e., lupus, RA, gout crystals, etc.)
- Septic
  - Microbial infections
- Hemorrhagic
  - Traumatic injury, tumors, hemophilia, anticoagulant overdose, etc.

Synovial Fluid - Laboratory procedures

- Hematology
- Physical properties
  - Color & clarity = light yellow / straw & clear
    - Abnormal colors/ clarity as for other fluids *
  - Bloody
    - Hemarthrosis
    - Traumatic tap
  - White / opaque with turbidity
    - Indicate pus cells or debris
  - Xanthrochromia term not used!

- Viscosity
  - Screening - ‘String Test’ drop from pipette
    - Evaluates viscosity
      - Normal = @ 5 cm long before breaking
    - Rope’s test for mucin clot
      - measures degree of hyaluronate polymerization
      - Good / normal = tight ropey mass
      - Poor = appears friable or fails to form
Synovial Fluid - Laboratory procedures

- **Hematology**
  - Cell counts
    - 0 RBCs / µL
    - <200 WBC / µL
  - Must let hemacytometer sit longer to allow cells to settle before counting.
  - If dilution needed must use saline.

  If you use diluent with an acid, such as Unopettes, the sample will clot.

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Synovial Fluid - Laboratory procedures

- **Cell differential - Wright’s stain**
  - Cells of peripheral circulation
    - Neutrophils 7%,
    - Lymphocytes 24%,
    - Monocytes 48%, macrophages 10%,
    - and synovial lining cells 4%.

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Synovial Fluid - Laboratory procedures

- **Synovial lining cells**
  - (look somewhat similar to mesothelial cells)
Synovial Fluid - Laboratory procedures

• LE cells

• Tart cells

Synovial Fluid - Laboratory procedures

• Other cells
  - Reiter cells
  - Malignant cells
  - Organisms

Synovial Fluid - Laboratory procedures

• Microscopic exam for crystals
  - Use regular and polarized light
  - Crystals may be intra-cellular or extra-cellular
    - Monosodium urate - gout artheritis
    - Calcium pyrophosphate - pseudo gout
    - Cholesterol - non specific; chronic inflammatory
    - Apatite - calcific artheritis (mineral change in cartilage)
    - Corticosteroid - drug injections
Synovial Fluid - Laboratory procedures

- **Chemistries**
  - Total protein NV = 1.07 - 2.13 g/dL
    - Increases seen in inflammatory conditions and following joint hemorrhage.
  - Glucose - similar to current blood level
    - Decreased in inflammation or sepsis
  - Lactate - assist in differentiation of septic and inflammatory arthritis
  - Uric acid - increased in gouty arthritis.
    - if gout is suspected, but no crystals, may need uric acid level.

- **Microbiology**
  - Gram stain, acid fast stain & cultures
  - Certain organisms associated with age groups
    - Children - H. influenzae
    - Adults 16-50 - Staph., Strep. Pneumoniae, Strep pyogenes, Neisseria gonorrhea
    - Adults > 50 - Staph. aureus

- **Serology**
  - Serum results more reliable, so not often done for diagnosis of RA or LE
  - Autoantibodies
  - Complement levels
  - QC - no commercial controls available, use serum controls if appropriate
Synovial fluid classification

<table>
<thead>
<tr>
<th>Classification of Synovial Fluid by Test Results</th>
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<tbody>
<tr>
<td>Normal</td>
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<tr>
<td>--------</td>
</tr>
<tr>
<td>Volume</td>
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<tr>
<td>Color</td>
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<tr>
<td>Clarity</td>
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<tr>
<td>Viscosity</td>
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<tr>
<td>Cell count /uL</td>
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<tr>
<td>% PMNs</td>
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<tr>
<td>Gram stain /culture</td>
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<tr>
<td>Crystals</td>
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<tr>
<td>Associated condition</td>
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</tbody>
</table>

Review of Key Points

- **Synovial fluid analysis**
  - Plasma ultrafiltrate secreted by synovial membrane
  - Hyaluronic acid and mucopolysaccharides make it viscous
  - Lubricates and nourishes joints
  - Infection, hemorrhage, degenerative & inflammatory diseases are reasons for analysis
  - Collection is by arthrocentesis
  - EDTA (hematology), heparinized (chemistries and serology) and sterile (cultures and crystals) are collected
  - Straw yellow, clear and viscous are normal characteristics
  - 0 RBC and < 200 WBC/ul, are normal
  - Cell counts requiring dilution must be made with saline.
  - Any peripheral circulating cell can be seen as well as synovial lining cells in normal patients.
  - Abnormals are classified as non-inflammatory, inflammatory, septic or hemorrhagic

Synovial Fluid - Laboratory procedures

- 1989 CAP CM 23 Synovial fluid, segs, & macrophages
Synovial Fluid - Laboratory procedures

- Lupus erythematosus (LE) cells
  - Just below center of field
  - Neutrophil has engulfed a homogenous nuclear mass.
  - ASCP 130 synovial fluid with LE cell

- Lupus erythematosus cell - far right side @ 3 o'clock

- 1993 CAP CM 21 synovial fluid. Segs and leukophage
Synovial Fluid - Laboratory procedures

- 1993 CAP CM 20 synovial fluid. Monosodium urate crystals

Microscopic Analysis: Crystals-Uric Acid

Synovial fluid with acute inflammation and monosodium urate crystals. (Wright-Giemsa stain and polarized light).

Synovial fluid with acute inflammation and monosodium urate crystals. The needle-shaped crystals demonstrate negative birefringence, because they are yellow when aligned with the compensator filter and blue when perpendicular to the filter (Wright-Giemsa stain and polarized/compensated light).

Synovial Fluid - Laboratory procedures

- Left - needle shaped monosodium urate crystals seen in a patient with gouty arthritis
- Right 1987 CAP CM 18B synovial fluid. Monosodium urate crystals
**Synovial Fluid - Laboratory procedures**

- 1989 CAP CM 24 synovial fluid. Calcium pyrophosphate - polarized

![Image](image1.png)

**Microscopic Analysis: Crystals-other**

![Image](image2.png)

Synovial fluid with acute inflammation and calcium pyrophosphate dihydrate crystals (Wright-Giemsa stain and polarized light).

Synovial fluid with acute inflammation and calcium pyrophosphate dihydrate crystals. The rhomboidal intracellular crystal (center) demonstrated positive birefringence, because it is blue when aligned with the compensator filter (Wright-Giemsa stain and polarized/compensated light).