SCBM343- Body fluid examination

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Objectives

1. Describe the definition and basic classification of body fluid.

2. Describe the macro- and microscopic appearance of body fluid.

3. Discuss the principles performance of body fluid analysis.
What is body fluid?

1. Cerebrospinal fluid
2. Serous fluid
3. Synovial fluid
4. Seminal fluid
5. Amniotic fluid
1. Cerebrospinal fluid

- Clear fluid, circulates in the brain and spinal cord
- Normal adult 90-150 ml and newborn 10-60 ml

**Function:**
- Buffer
- Regulates intracranial pressure
- Carries nutrients to the nervous system
- Excretory channel for metabolic wastes in the CNS
1. Cerebrospinal fluid

- Lumbar puncture was first introduced in 1891 by the German physician Heinrich Irenaeus Quincke (1842-1922).
Lumbar Puncture

- Indications for **lumbar puncture**
  - 1. Suspected involvement of the meninges by infection or malignancy
  - 2. Documentation of subarachnoid hemorrhage
  - 3. Diagnosis of infectious or inflammatory conditions involving brain or spinal cord
  - 4. Treatment of intracranial hypertension in pseudotumor cerebri
Lumbar Puncture

How the test is performed

• Lumbar puncture (spinal tap) is the most common site of collecting CSF.

• The patient are positioned on the side with knees curled up to abdomen and chin tucked into chest.

• The skin is scrubbed, and a local anesthetic is injected over the lower spine.
Lumbar Puncture

The spinal needle is inserted, usually between the 3\textsuperscript{rd} and 4\textsuperscript{th} lumbar vertebrae.
Tube 1: Cell count and differential
Tube 2: Gram stain, bacterial and viral cultures
Tube 3-4: Glucose, protein,
Tube 3 or 4 can be used for special tests or additional cultures
CSF color

- Normal CSF is crystal clear and the consistency of water
- Turbidity: indicate WBC, bacteria, excess protein or fat
- Radiographic dye will give the CSF an oily look
- Clotting may be from a traumatic tap

A. Normal
B. Blood (trauma or subarachnoid hemorrhage?)
C. Centrifuged CSF in a traumatic tap
D. CSF from a patient with subarachnoid hemorrhage. There is blood at the bottom of the tube and the supernatant is yellow (xanthochromic) as a result of breakdown of blood cells in the CSF before the lumbar puncture.

http://www.elsevierimages.com/images/vpv/000/000/027/27046-0550x0475.jpg
Cells in CSF

- Normally very few cells are found in CSF
  - No Rbc, 0-5 Wbc
  - PMN = bacterial infection
  - Lymphocytes = viral infection
- Usually counted manually, undiluted, when a cell count is over 30 white cells /mL a differential count is done
- Smear made from centrifuged sediment and stained

Macrophage  Lymphocytosis  Monocyte
Protein in CSF

- Normal range is 15 - 45 mg/dl (less than 1% of plasma conc.)
- Increased levels: Infections
- Decreased levels: Leakage of fluid from CNS
Glucose in CSF

- Usually about 60-80% of blood glucose, at the same time
- Decrease - bacterial meningitis
- Increase - diabetic coma

India ink stains for cryptococcus

Meningitis due to *Streptococcus pneumoniae*

• Pressure: 50 - 180 mm H₂O

• Appearance: clear, colorless

• CSF total protein: 15-45 mg/dl

• Gamma globulin: 3-12% of the total protein

• CSF glucose: 50-80 mg/dl (or approximately 2/3 of serum glucose level)

• CSF cell count: 0-5 WBC, no RBC

• Chloride: 110-125 mEq/L
2. SEROUS FLUIDS

- Pleural, pericardial and peritoneal: Fluids contained within closed cavities of the body
- Fluid fills space between layers of cells to lubricate the surfaces as they move against each other
- Fluids are formed and reabsorbed, volume is very small
- Increased volume is referred to as an effusion
EXAMINATION OF SEROUS FLUIDS: CELL COUNTS

Fig. 1: Hemacytometer

Etched Grid System

TOP View

Hemacytometer

coverslip

SIDE View

Bottom surface of chamber with etched grid system

1.0 mm

0.1 mm

RBC's @ 40X

Chamber of precise volume
= 0.10 cubic mm

2A

2B

2C
EXAMINATION OF SEROUS FLUIDS: CELL COUNTS

- Differential white cell count
- Microbiological
  - Gram stain
- Chemical analysis
  - Protein to distinguish exudate from transudate
  - Glucose - low levels could indicate bacterial infection
PLEURAL FLUID ANALYSIS

• A pleural effusion is an accumulation of fluid between the layers of the membrane that lines the lungs and chest cavity.

• Thoracentesis is a procedure to remove fluid from the space between the lungs and the chest wall called the pleural space.
Pleural fluid

- 1. Transudative effusions - congestive heart failure
- 2. Exudative effusions - Cancer, pneumonia, tuberculosis and other lung infections, drug
Pleural fluid appearance

- Clear
- Cloudy/Purulent
- Bloody

Herbal Tea
Pineapple Juice
Strawberry
Pericardiocentesis

- Pericardiocentesis involves the use of a needle to withdraw fluid from the pericardial sac (membrane that surrounds the heart).
Pericardial fluid analysis

- Abnormal results:
  - Pericarditis
  - Congestive heart failure
  - Cancer
  - Cardiac trauma
  - Rupture of a ventricular aneurysm

Clumps of tumor cells in pericardial fluid (metastatic breast cancer)
Peritoneal fluid analysis

- The peritoneum is the membrane lining the abdominal cavity. Examine fluid in the peritoneal space.
- The sample is obtained by an abdominal tap or ascitic tap or paracentesis.

http://astec.arizona.edu/sites/astec.arizona.edu/files/images/Abdominal%20Paracentesis.png
Peritoneal fluid analysis

Abnormal results:

- Milk-colored --- disease such as carcinoma, lymphoma, tuberculosis or infection
- Bloody fluid --- tumor or trauma
- Bile-stained fluid --- gallbladder problems
- High WBC --- peritonitis or cirrhosis
3. SYNOVIAL FLUID

- Fluid contained in joints
- Normal synovial fluid
  - Ultrafiltrate of plasma with extra hyaluronate
    - Lubricates the joints
    - More viscous than CSF
    - About 1 ml in each large joint
      - Wbc count <200 /ul, most are mononuclear
      - No Rbc or crystals
Synovial fluid analysis

- Collection and analysis
- Usually aspirated from joint
  - Swelling
  - Pain
- Analysis for cells and crystals
- Gram stain and culture

Acute gout (uric acid crystals)
Synovial fluid analysis

Non-inflammatory joint disease (Fluid is considered "non-inflammatory" if it contains less than 2000 cells/mm$^3$.)

Seen in osteoarthritis

- Traumatic arthritis
- Neurogenic joint disease
  - Clear and viscous
  - Low cell count
  - Glucose and protein normal

Colorless, clear synovial fluid from a patient with osteoarthritis accompanied by a low synovial-fluid white cell count.
Inflammatory joint disease (Fluid is considered "inflammatory" if it contains greater than 2000 cells/mm³.)

- Rheumatoid arthritis
- Lupus arthritis
  - Cloudy, yellow, low viscosity
  - Moderately high cell count
  - Glucose normal, protein high

These fluid cloudy but translucent inflammatory synovial fluid were taken from rheumatoid arthritis (left) and gout (right).
Synovial fluid analysis

Synovial infections

- Mostly bacterial infections
  - Cloudy, may be yellow or green and milky
  - Low viscosity
  - Very high cell count
  - Low glucose
  - Protein high

This fluid is a cloudy, pus-like fluid aspirated from a patient with acute bacterial infectious arthritis.
Synovial fluid analysis

Crystal induced effusion

- Gout
- Pseudogout
  - Yellow, cell count may be increased
  - Crystals
  - Monosodium urates seen in gout
  - Calcium pyrophosphate dehydrate in pseudogout
4. SEMINAL FLUID

Testing:

- Infertility
- Post vasectomy
- Forensic analysis
- Artificial insemination programs (การผสมเทียม)
Seminal fluid collection

- Abstinence 3 days
- Sterile container
- Room temperature and delivered within one hour
- Record collection and receipt time
- Standard precautions
Seminal fluid analysis

1. Macroscopic: Appearance, volume, viscosity, pH

2. Microscopic: Count, motility, morphology

3. Additional testing: Sperm viability, seminal fluid fructose, anti-sperm antibodies, microbial testing, chemical testing, post vasectomy analysis and sperm function tests
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<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Color</td>
<td>translucent gray white color</td>
</tr>
<tr>
<td>Volume</td>
<td>2 – 5 ml</td>
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<tr>
<td>Viscosity</td>
<td>Pours in droplets</td>
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<tr>
<td>pH</td>
<td>7.2 – 8.0</td>
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<tr>
<td>Count</td>
<td>20 – 160 million/ml</td>
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<tr>
<td>Motility</td>
<td>&gt;50% within one hour</td>
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<tr>
<td>Morphology</td>
<td>&gt;30% normal forms</td>
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<tr>
<td>WBC</td>
<td>&lt;1.0 million/ml</td>
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Reference
5. AMNIOTIC FLUID

- This fluid is a clear, slightly yellowish liquid that surrounds the unborn baby (fetus) during pregnancy -- it is contained in the amniotic sac.

- Protects the fetus from injury and temperature changes.

- Allow for freedom of fetal movement and permits musculoskeletal development.
Amniotic fluid

- During pregnancy the amniotic fluid increases in volume as the fetus grows.
- It is greatest (800 ml) at approximately 34 weeks of gestation,
- This fluid is constantly circulated by the baby swallowing and "inhaling" existing fluid and replacing it through "exhalation" and urination.
Amniotic fluid

- An excessive amount of amniotic fluid is called polyhydramnios. This condition may accompany multiple pregnancy (twins or triplets), congenital anomalies, or gestational diabetes.
Amniotic fluid

• An abnormally small amount of amniotic fluid is known as oligohydramnios. This condition may accompany post dates pregnancies, ruptured membranes, placental dysfunction, or fetal abnormalities.

• In amniocentesis a hollow needle is inserted into the mother's abdomen into the uterus, and amniotic fluid is drawn for analysis.
Amniotic fluid

Testing:

- Suspected chromosomal abnormalities
- Metabolic disorders
- Neural tube defects
- HDN - Hemolytic Disease of the Newborn
- Gestational age
- Infection
- Fetal maturity
Amniotic fluid collection

- Amniocentesis – needle aspiration
- 30 ml of fluid collected (maximum amount)
- Protect from light – collect in amber colored tubes
- Must be delivered to laboratory promptly
- Procedures perform immediately
- Temperature critical
- Filtration or centrifugation important
- Standard precautions should be taken
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Body fluid examination