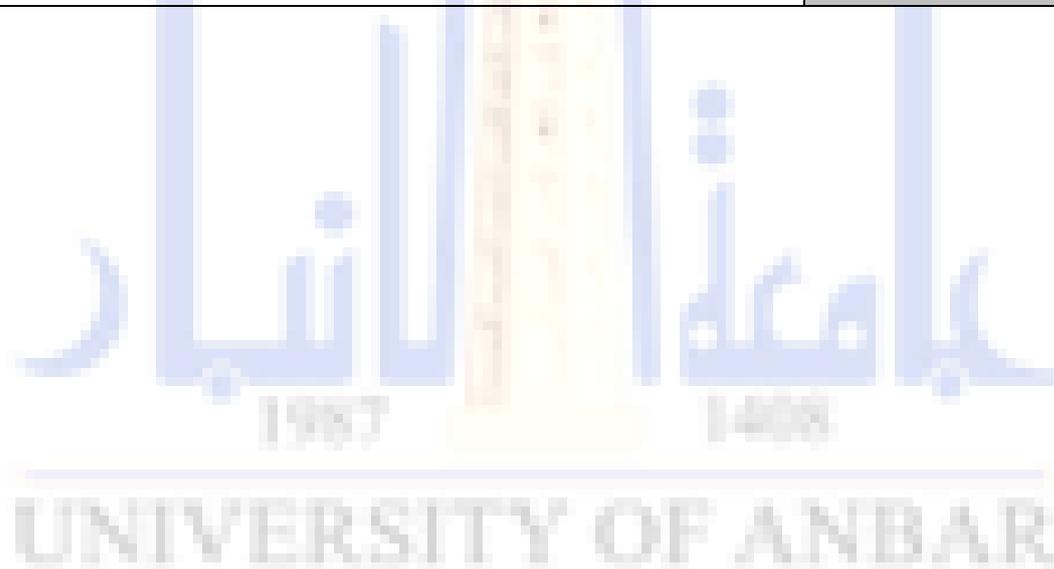


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الضغط في جسم الانسان	عنوان المحاضرة باللغة العربية
الخامسة	رقم المحاضرة
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Medical Physics

Lecture (5)

Pressure in the body

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Pressure

Definition:

Pressure is the amount of **force applied per unit area**. It describes how much force is distributed over a surface. In fluids (liquids and gases), pressure acts equally in all directions.

$$P = h \rho g$$
$$1 \text{ (atm) atmosphere} = 1.01 \times 10^7 \frac{N}{m^2}$$
$$= 760 \text{ mm of Hg}$$
$$= 1033 \text{ cm of H}_2\text{O}$$

Note: Hg density is equal to $13.6 \frac{g}{cm^3}$ and density of water $1 \frac{g}{cm^3}$.

Measurement of pressure in body

a) Pressure Inside the Skull

The brain and spinal cord are surrounded and protected by a special fluid known as **Cerebrospinal Fluid (CSF)**.

- **Volume of CSF:**
The human brain normally contains about **150 cm³** of CSF.
- **Production and Circulation:**
CSF is continuously produced inside the brain, mainly by the **choroid plexus** within the ventricles. From there, it flows through the ventricular system and circulates around both the brain and spinal cord within the **subarachnoid space**.
- **Functions of CSF:**
 1. Provides **mechanical protection** (cushions the brain against shocks and trauma).

2. Maintains a **stable chemical environment**.
3. Removes **waste products** from brain metabolism.
4. Helps maintain **intracranial pressure (ICP)**.

- **Intracranial Pressure (ICP):**

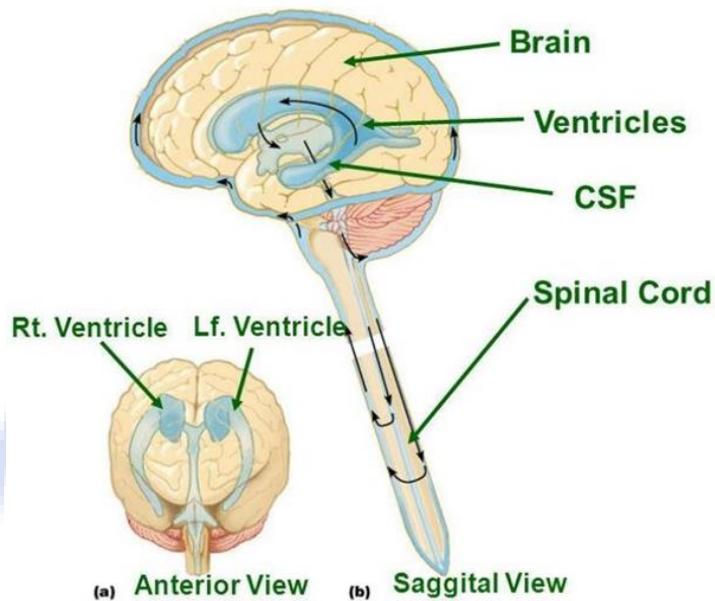
The pressure exerted by CSF inside the skull is called **intracranial pressure**.

- Normal range in adults: **7–15 mmHg** (when lying down).
- ICP above **20–25 mmHg** is considered elevated and can be dangerous.

- **Clinical Importance:**

- Increased ICP may result from **head injury, brain tumor, infection (meningitis), or hydrocephalus**.
- Symptoms include headache, vomiting, blurred vision, and changes in consciousness.
- Medical procedures like **lumbar puncture (spinal tap)** are used to measure CSF pressure and analyze its composition.

Cerebruspal Fluid



b) Fluid in the Eyeball (Intraocular Pressure)

The human eye maintains its **shape, size, and clarity of vision** through two internal fluids:

- **Aqueous Humor:** A clear, watery fluid located in the front chamber of the eye (between cornea and lens).
- **Vitreous Humor:** A gel-like fluid that fills the large space behind the lens, keeping the eyeball firm and round.

Together, these fluids create and maintain **intraocular pressure (IOP)**, which is essential for the structural stability of the eye.

Key Points about Eye Pressure

- Even a **small change of 0.1 mmHg** in pressure can significantly affect the clarity and quality of vision.
- The **normal range of eye pressure** is **12–23 mmHg**.

- The eye is in a constant cycle of producing aqueous humor and draining the excess through a specialized drainage system.

Clinical Aspect – Glaucoma

- If the **drainage system becomes blocked**, pressure inside the eye rises.
- Elevated eye pressure reduces blood supply to the retina and damages the **optic nerve**.
- This leads to a serious eye disease known as **glaucoma**, which is one of the leading causes of blindness worldwide.
- Early stages may not cause noticeable symptoms, which makes **regular eye check-ups essential**.

Measurement of Eye Pressure

- Eye pressure is measured using a device called a **Tonometer**.
- Types of tonometry include:
 - **Applanation tonometry** (most common, flattening the cornea to measure resistance).
 - **Non-contact tonometry** (air-puff test).
 - **Electronic tonometers** for continuous monitoring.

Summary:

Intraocular pressure is maintained by aqueous and vitreous humor. The normal range is 12–23 mmHg, and even tiny changes can impact vision. If drainage is blocked, pressure builds up, leading to **glaucoma**, a condition that can cause permanent vision loss.



Sphygmomanometer and Blood Pressure

A **sphygmomanometer** is the instrument used to measure **blood pressure (B.P.)**, one of the most important vital signs in medicine. It consists of an **inflatable cuff**, a **small gauge (manometer)**, and often a **stethoscope** for auscultation. The test is **simple, quick, and painless**.

When reporting blood pressure, doctors record two values:

1. Systolic Blood Pressure (Top Number)

- This is the pressure in the arteries **when the heart contracts** and pumps blood through the body.
- It represents the **maximum pressure** on the artery walls.
- **Normal systolic pressure:** less than **120 mmHg**.
- **Classification:**
 - **120–129 mmHg:** Elevated
 - **130–139 mmHg:** Stage 1 Hypertension
 - **≥140 mmHg:** Stage 2 Hypertension
 - **≥180 mmHg:** Hypertensive crisis (medical emergency)

2. Diastolic Blood Pressure (Bottom Number)

- This is the pressure in the arteries **when the heart is at rest** between beats and filling with blood.
- It represents the **minimum pressure** in the circulatory system.
- **Normal diastolic pressure:** less than **80 mmHg**.
- **Classification:**
 - **80–89 mmHg:** Stage 1 Hypertension
 - **≥90 mmHg:** Stage 2 Hypertension
 - **≥120 mmHg:** Hypertensive crisis (medical emergency)

How Blood Pressure is Measured

1. The cuff is wrapped around the **upper arm** (occasionally on the forearm or wrist, though less accurate).
2. The cuff is inflated to a pressure **higher than systolic blood pressure**, temporarily stopping blood flow.
3. As the cuff deflates:
 - The **first sound** heard (whooshing sound, Korotkoff sound) = **Systolic Pressure**.
 - The **disappearance of the sound** = **Diastolic Pressure**.
4. Blood pressure is written as **systolic/diastolic** (e.g., **120/80 mmHg**).

Summary

- **Systolic pressure** = pressure during heart contraction.
- **Diastolic pressure** = pressure during heart relaxation.
- **Normal B.P.** = around **120/80 mmHg**.
- Persistent elevation indicates **hypertension**, a major risk factor for heart disease, stroke, and kidney problems.

Blood Pressure Stages			
Blood Pressure Category	Systolic mm of Hg (upper)		Diastolic mm of Hg (lower)
Normal	Less than 120	and	Less than 80
Elevated	120-129	and	Less than 80
High Blood Pressure (hypertension) Stage 1	130-139	or	80-89
High Blood Pressure (Hypertension) Stage 2	140 or Higher	or	90 or Higher
Hypertensive Crisis (Seek Emergency Care)	Higher than 180	and/or	Higher than 120