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L11. Pressure in body

Pressure in ear

The middle ear is one of the air cavities that exist within the body. For comfort the pressure in the middle ear should be equal to the pressure on the outside of the eardrum.

P middle ear =P outside eardrum

This equalized is produced by air flowing through the Eustachian tube; The Eustachian tubes connect the middle ear to the throat and allow us to equalize pressure in the middle ear to avoid an imbalance of force on the eardrum.
(It's function is mainly to keep the pressure in the middle ear equalized with pressure in the outside). Which is usually closed except during swallowing, chewing, and yawning.
Pressure in the middle ear can result in significant force on the eardrum if it differs greatly from atmospheric pressure, such as while scuba diving. The decrease in external pressure is also noticeable during plane flights (due to a decrease in the weight of air above relative to that at the Earth's surface).

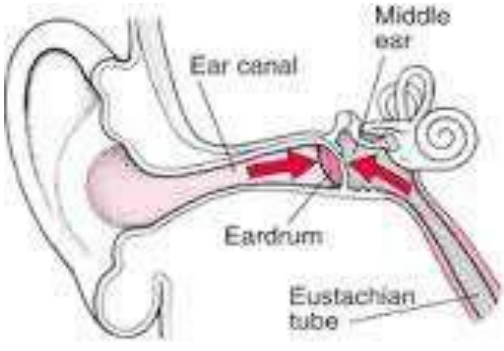
How ear pressure measured?

Tympanometry: A test that measures the air pressure in the middle ear. (tests how well your middle ear works by measuring eardrum movement.)

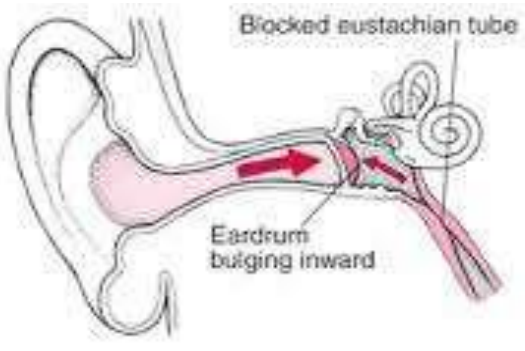
Tympanometer : The device a clinician uses to perform a tympanometry test.

Tympanogram: The test results plotted on a chart.

Normal middle ear pressure should be somewhere between +50 to –150 Pa (mm water).



Equal Air Pressure



Unequal Air Pressure

Pressure effects while diving

The body is composed primarily of solids and liquids, which are nearly incompressible. Pressure changes; do not greatly affect most of it . However, there are gas cavities in the body where sudden pressure changes can produce profound effects.

Boyles law

For a fixed quantity of gas and fixed temperature the product of the absolute pressure and volume is constant.

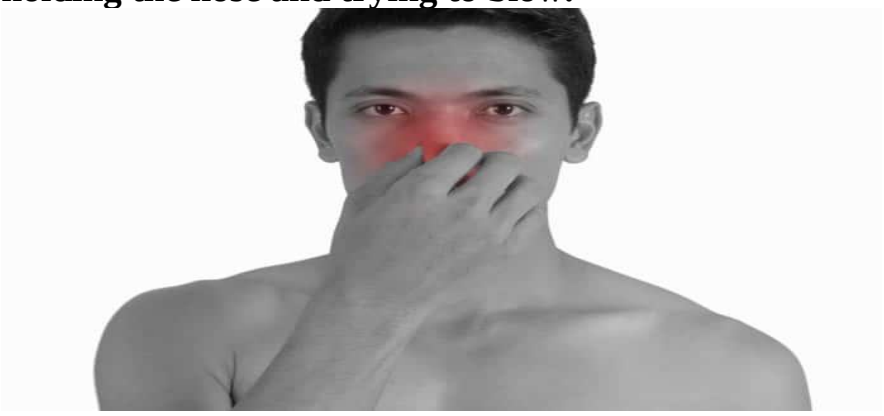
PV= constant

$$P_1 V_1 = P_2 V_2$$

That is, if the absolute pressure is doubled, the volume is halved.

When diving many people has difficulty obtaining pressure equalization and feels pressure on their ears. (120mmHg) across the eardrum , which can occur in about 1.7 m of water ,can cause damage (rupture) to the eardrum .

One method of equalization used by diver is to raise the pressure in the mouth by holding the nose and trying to blow.



Boyle's Law describes the role of water pressure in the dive environment. It applies and affects many aspects of scuba diving. Consider the following examples:

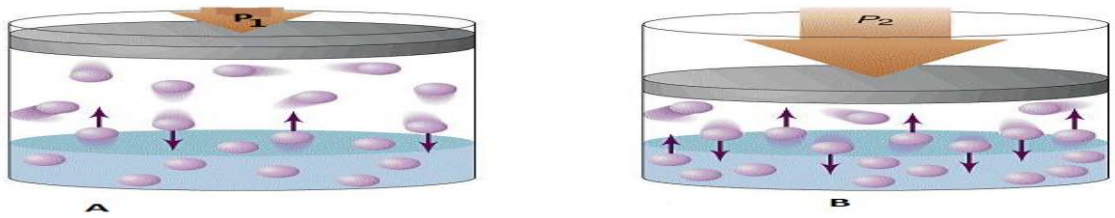
- **Descent - As a diver descends, the water pressure around him increases, causing air in his scuba equipment and body to occupy a smaller volume (compress).**
- **Ascent - As a diver ascends, water pressure decreases, so Boyle's Law states that the air in his gear and body expand to occupy a greater volume.**

The pressure in the lung

Pressure in the lung, at any depth , greater than the pressure in the lung at sea level. This means that the air in the lung is denser under water and that the partial pressure of all the air components is proportionately higher.

1. **The higher partial pressure of O_2 causes more O_2 molecules to be transformed into the blood, and oxygen poisoning results if the partial pressure of the O_2 gets high. Partial pressure of O_2 is 0.8 atm and absolute air pressure is 4 atm at depth of 30m.**
2. **Breathing air at a depth of 30m is also dangerous because it may result in excess N_2 in the blood and tissues, there is a possibility of having:**
   - **Nitrogen narcosis (intoxication effect)**
   - **The bends or decompression sickness (a scant problem).**

O_2 is attached to red blood cells, while N_2 is dissolved in the blood and tissues, according to Henrys law(The amount of gas that will dissolve in a liquid is proportional to the partial pressure of the gas in contact with the liquid).



Hyperbaric oxygen therapy (HOT)

The body normally lives in an atmosphere that is about one fifth O_2 and four-fifth N_2 . In some medical situations, it is beneficial to increase the proportion of O_2 in order to provide more O_2 to the tissue.

Hyperbaric oxygen therapy (HOT): the medical use of oxygen at an ambient pressure higher than atmospheric pressure. The equipment required for hyperbaric oxygen treatment consists of a pressure chamber, which may be of rigid or flexible construction, and a means of delivering 100% oxygen.

In a hyperbaric oxygen therapy chamber, the air pressure is increased two to three times higher than normal air pressure. Under these conditions, your lungs can gather much more oxygen than would be possible breathing pure oxygen at normal air pressure. When your blood carries this extra oxygen throughout your body, this helps fight bacteria and stimulate the release of substances called growth factors and stem cells, which promote healing.

1. **Gas gangrene:**

Gangrene refers to the death of body tissue due to either a lack of blood flow or a serious bacterial infection. Gangrene commonly affects the extremities, including your toes, fingers and limbs, but it can also occur in your muscles and internal organs.

The bacillus causes gas gangrene then it's treated with (HOT). That is due to bacillus cannot survive in the presence of oxygen. The oxygen saturates the infected tissues and thereby prevents the growth of the bacteria (bacillus) causes it.

1. **Carbon monoxide poisoning:**

The red blood cells cannot carry O_2 to the tissues because the carbon monoxide fasters to the hemoglobin at the places normally used by O_2 . Normally the amount of O_2 dissolved in the blood is about 2% of that carried on the red blood cells. By using the (HOT) technique, the partial pressure of O2 can be increased by a factor of 15 , permitting enough O2 to be dissolved to fill the body's needs

2. **Treatment of cancer:**

Hyperbaric oxygen may increase the amount of oxygen in cancer cells, which may make them easier to kill with radiation therapy and chemotherapy. It is a type of radiosensitizing agent and a type of chemosensitizing agent.

The theory was that more oxygen would make the poorly oxygenated radiation – resistant cell in the center of the tumor more susceptible to radiation damage. (HOT) with radiation is given to the patient in transparent plastic tank.