

SAA LECTURE No S2

EARS, SINUSES & AIR FILLED SPACES



PHYSICS

Water presses from all sides – pressure

10 mtr = 2 bar pressure (two x surface)

30 mtr = 4 bar pressure (four x surface)

MORE DETAILED PHYSICS IN SAA LECTURE E1

BOYLES LAW

Pressure x Volume = Constant

At surface (1 bar) a 100 ccm balloon = 1 x 100ccm = 100

At 10 mtr (2 bar) the same balloon = 2 x 50 ccm = 100

AIR CONSUMPTION

Average of 25 litres per minute at surface

HUMAN BODY

Is made up of liquid and does not compress but we have spaces inside us that are full of air

LUNGS, STOMACH & INTESTINE Will adjust if you breathe normally

EARS & SINUSES

Must be equalised by either Frenzel , Toynbee, Valsalva or Edmonds manoeuvres. When you surface this should happen automatically, if not – go down slightly, equalise and try again to avoid reversed ear.

Avoid tight hoods and never wear earplugs.

MASK

Gently blow through nose into mask to equalise and prevent mask squeeze

TEETH

Regular dental check-ups for holes under fillings, notify dentist that you SCUBA dive.

DRY SUITS

Will need equalising, wet suits do not

BUOYANCY JACKETS

Similar effects as a dry suit – more information Lecture E4.

IMPORTANT

DO NOT DIVE with a cold, nasal or lung infection

Beware of nasal sprays

DO NOT WAIT FOR PAIN, equalise ears continuously during dive

BOYLE'S LAW

Volume changes are inversely proportional to ambient pressure

With an increase of 1 bar ambient pressure between the surface and 10m the volume has halved

The greatest volume change and therefore the greatest pressure change occurs in the final 10 m of ascent

The Effects of Boyle's Law on Divers

There are 2 types of areas in the body when discussing diving and Boyle's Law:

1. Compressible:

These are areas in the body that contain some air i.e. the lungs, middle ears, sinuses nasal passages, interior of hollow organs and any other air pockets that may not be known of (Tooth Cavity).

2. Non-Compressible:

Such organs are bone, muscle, blood and solid organs such as the kidneys, heart and liver are all non-compressible and therefore are not affected by the water pressure.

However, the compressible areas of the body do not behave according to Boyle's Law. The lungs are protected by the rib, cage, only part of the middle ears are exposed to the water etc...

Although Boyle's Law is still applicable to a SCUBA Diver, the consequences are different because SCUBA Divers breathe compressed air under water. First the amount of air in the compressible areas in a diver increases as the water pressure increases. Then the volume of the compressible areas remains constant throughout the dive at any depth, although the ambient pressure is increasing, the volume in any compressible space remains constant because the gas density is increased.

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PROCEDURES – EQUALISATION

In order to equalisation to be effective, the diver should be free of nasal or sinus infections or allergic reactions. The lining of the nose, throat and Eustachian tubes should be as normal as possible. If this is true, the following techniques are effective in reducing middle ear and sinus squeeze.

Prior to descent, whilst neutrally buoyant, with no air in your BCD, gently inflate the ears with one of the methods listed below. This gives you a little extra air in the middle ear and sinuses as you descend.

Descent feet first. This allows air to travel upward into the Eustachian tube and middle ear, a more natural direction. Use a descent line or the anchor line.

Inflate gently every two feet for the first ten to fifteen feet, and less frequently as you descend deeper.

Pain is not acceptable. If there is pain, you have descended without adequately equalising.

If you do not feel the ears opening, stop, try again, perhaps ascending slightly to diminish the surrounding pressure. Do not bounce up and down. Try to tilt the difficult ear upwards thus extending the Eustachian tube.

If you are unable to equalise, abort the dive. The consequences of descending without equalising could result in permanent damage and hearing loss.

With the agreement of your doctor, the use of decongestants and nasal sprays may be used prior to diving to reduce swelling in the nasal and sinus passages, as well as the Eustachian tube. Decongestants should be taken one to two hours before descent and last from eight to twelve hours. Nasal sprays should be taken thirty minutes before descent and usually last about twelve hours. Caution should be taken when using over-the-counter nasal sprays, since repeated use can cause a rebound reaction with worsening of congestion and possible reverse block on ascent. We must stress we cannot recommend the use of decongestants. As previously mentioned please consult your doctor if you intend to dive.

If at any time during the dive you feel pain, have vertigo or note sudden hearing loss, abort the dive. If these symptoms persist, do not dive again until you see your doctor.

Equalizing Techniques

Passive – requires no effort

Valsalva – increase nasopharynx pressure by holding nose and breathing against a closed glottis (throat)

Toynbee – swallowing with mouth and nose closed

Frenzel – Valsalva while contracting throat muscles with a closed glottis

Lowry – Valsalva plus Toynbee – holding nose closed, gently trying to blow air out of nose while swallowing

Edmonds – jutting jaw forward plus Valsalva and/or Frenzel

Miscellaneous – swallowing, wiggling jaws