



CAPS 422

Diving
&
The Respiratory System

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In southern Japan women free-divers (ama /sea women) have been collecting the flora & fauna of the sea for 2000 years.

Major Physiologic Stresses Associated with Diving

1. \uparrow barometric pressure (P_B)
2. \downarrow gravity
3. hypothermia
4. sensory impairment

severity of stress is associated with:

1. depth of dive
2. length of dive
3. breath hold vs breathing apparatus (scuba)

Physical Principles: Gas Pressures During Diving

For @ 10m (33ft) descent there is an ↑ in P_B by 1 atmosphere
e.g. at 10m depth, $P_B = 760 + 760 = 1520$ mmHg

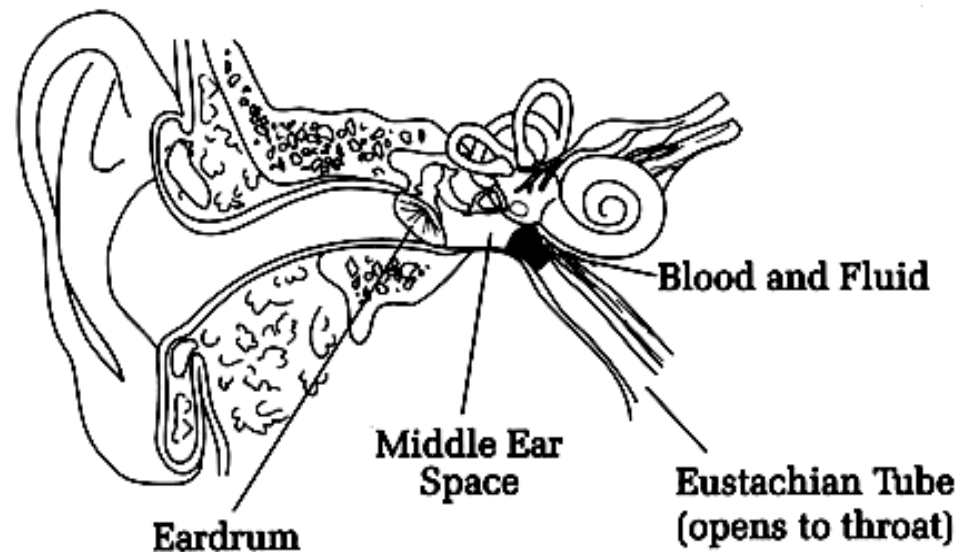
If the gas filled cavities [lungs, middle ear, intracranial sinuses] fail to communicate with outside ambient pressure, the pressure difference can result in compression on descent & over expansion on ascent.

Barotrauma

Barotrauma of Descent-- “The Squeeze”

If eustachian tubes are clogged, middle ear pressure is less relative to ambient pressure-- ear drum bulges inward & may rupture

solution: force air from pharynx into the eustachian tubes by Valsalva maneuver (exhale against a closed airway by closing one's mouth & pinching one's nose shut with moderate exhalation)

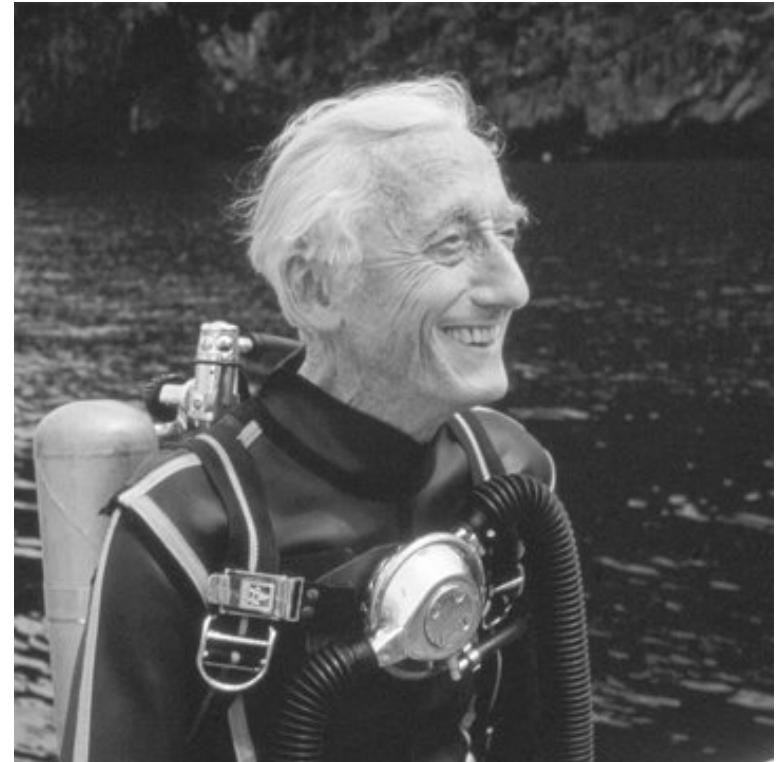


nb. no problems encountered in ascent because the one-way flutter valve between the middle ear & pharynx opens towards the pharynx

Barotrauma of Ascent

Gas trapped during ascent expands. Divers exhale as they ascend, if they don't lungs expand & may rupture allowing air to enter between the:

1. pleura (pneumothorax)
2. the lungs (mediastinal air)
3. in the blood stream (air embolism)
which in turn may lodge in CNS-
potentially fatal



Jacques Cousteau's, the co-inventor scuba gear fractured his ribs and had a pneumothorax in a car accident in 1936. Today, anyone with a history of traumatic pneumothorax would be advised not to take up scuba diving, because of the risk of another pneumothorax and possible air embolism. Fortunately Cousteau never got this advice and went on to pioneer the sport in the 1940s.

What do you think happens to trapped air in the GI tract?

→ Abdominal discomfort, flatulus, eructation

What do you think happens to trapped air in poorly filled teeth?

→ toothache

Decompression Sickness

During descent : \uparrow PN_2 forces this poorly soluble gas into solution in body tissues, especially fat then ...

Upon ascent

if ascent is too fast, N_2 comes out of solution, bubbles are formed

[similar to uncorking a bottle of champagne or opening a bottle of coke]

- bubbles in the joints: “the bends”, painful
- bubbles in the pulmonary circulation- “the chokes” [dyspnea, chest pain, cough]
- bubbles in the cerebral circulation \rightarrow obstruct blood flow [deafness, loss of vision, paralysis]

Decompression Sickness

Treatment

Immediate recompression & slow decompression in a hyperbaric chamber

Prevention

1. gradual ascent (tables based on WWII empiric data recommend series of stepwise ascent)
2. substitute He for N₂ in breathing tank- half the solubility
3. avoid flying airplane within hours of dive

Nitrogen Narcosis

- $\uparrow P_{N_2}$ affects the CNS
- Depth of 50 m \rightarrow euphoria, “raptures of the deep”, similar to having a few tequilas



- Greater depths \rightarrow loss of coordination
 - \rightarrow disorientation
 - \rightarrow unconsciousness
 - \rightarrow coma



Free Diving

Breath Hold & Deep Descent

NO LIMIT- weight sled for descent to predetermined depth; inflatable balloon for ascent to surface.



Jacques Cousteau-Ferreras-Mestre

50 m 1962 Enzo Maiorca

162m 2000 Pipin Ferreras

171m 2002 Audrey Meste dies delayed ascent,
8 min without oxygen

214 m 2007-Gerbert Nitsch

Ferreras negligence & reemergence in 2013

Nitsch's 2012 nitrogen narcosis.