

Non-Pulmonary Barotrauma



Edmond Kay, MD, FAAFP

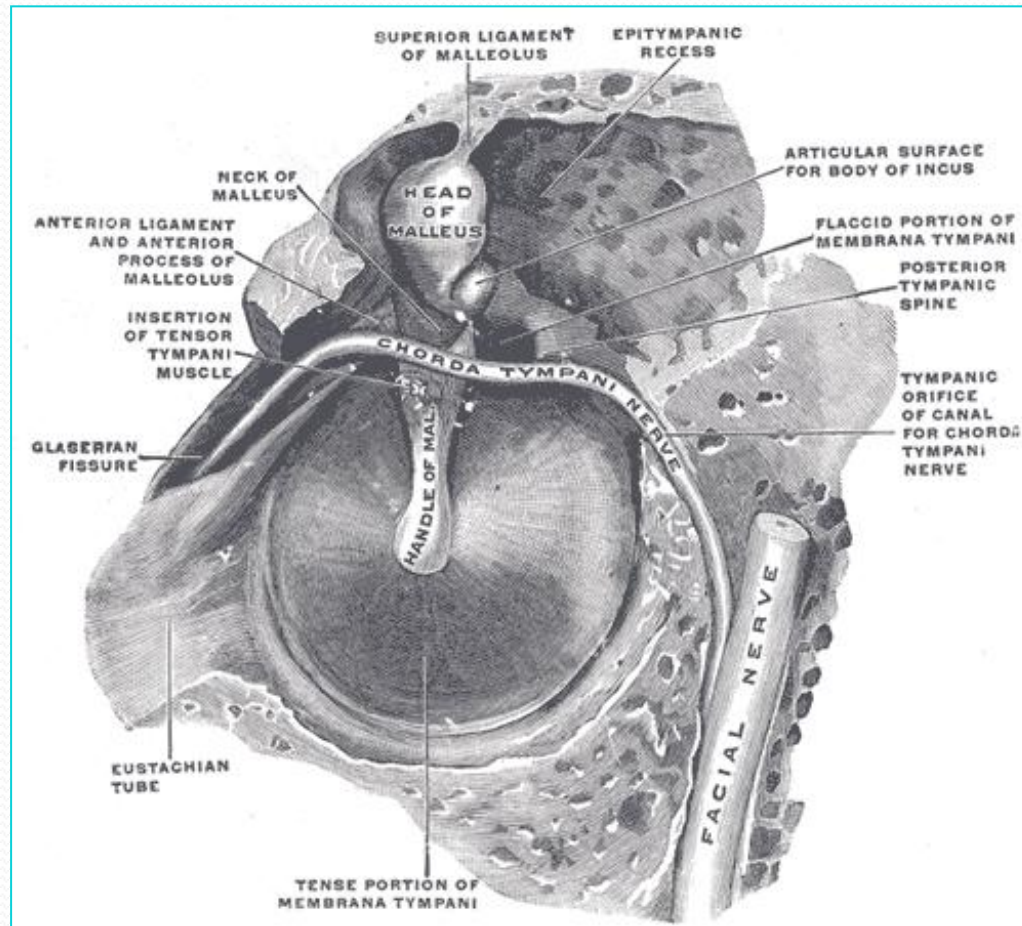
Diving Medical Officer, UW Diving Program
Director of Hyperbaric Medicine,
HealthForce Partners - Occupational Medicine

Doc's Preferred View



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TM -Back side



Middle Ear Effusion

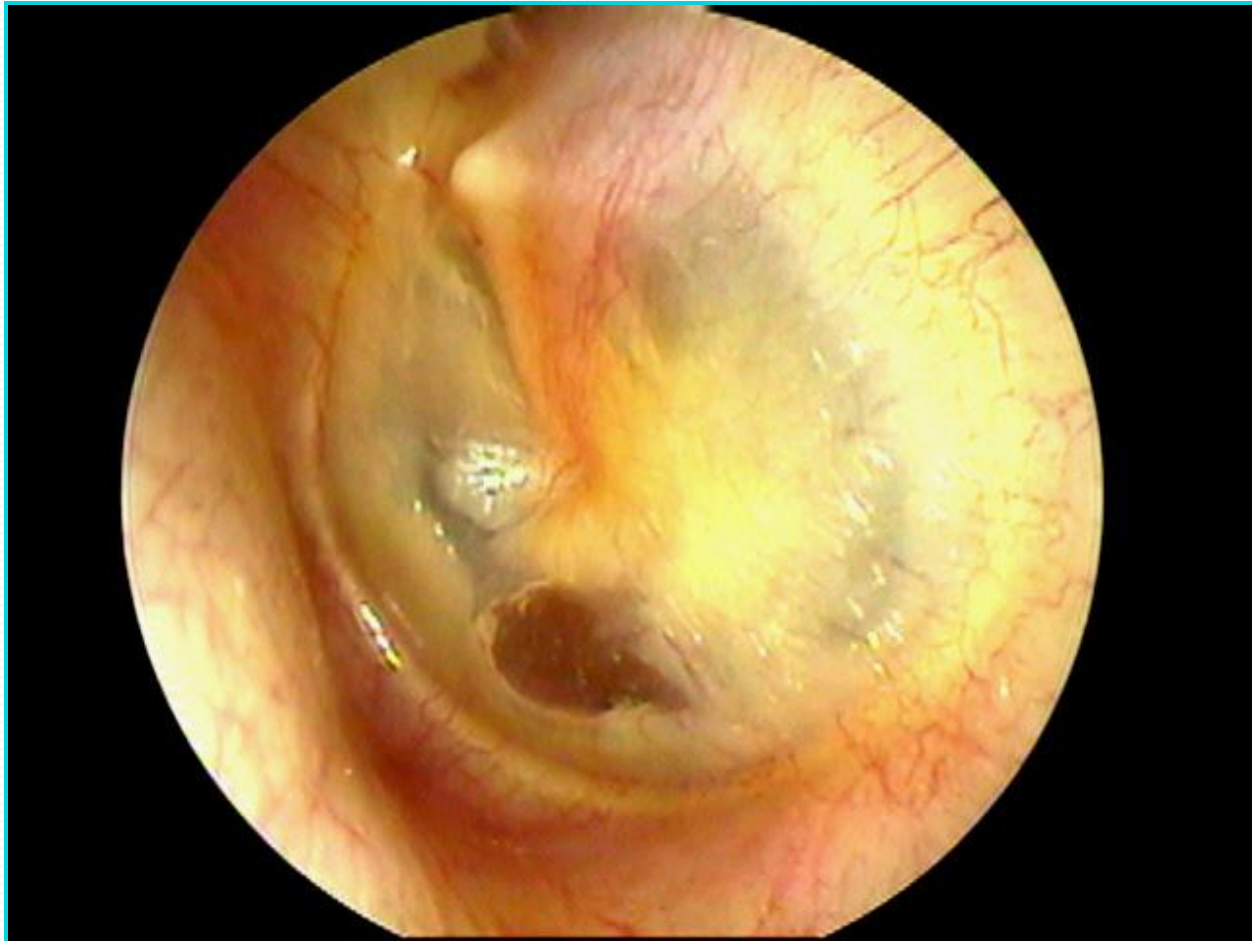


Perforation (acute)



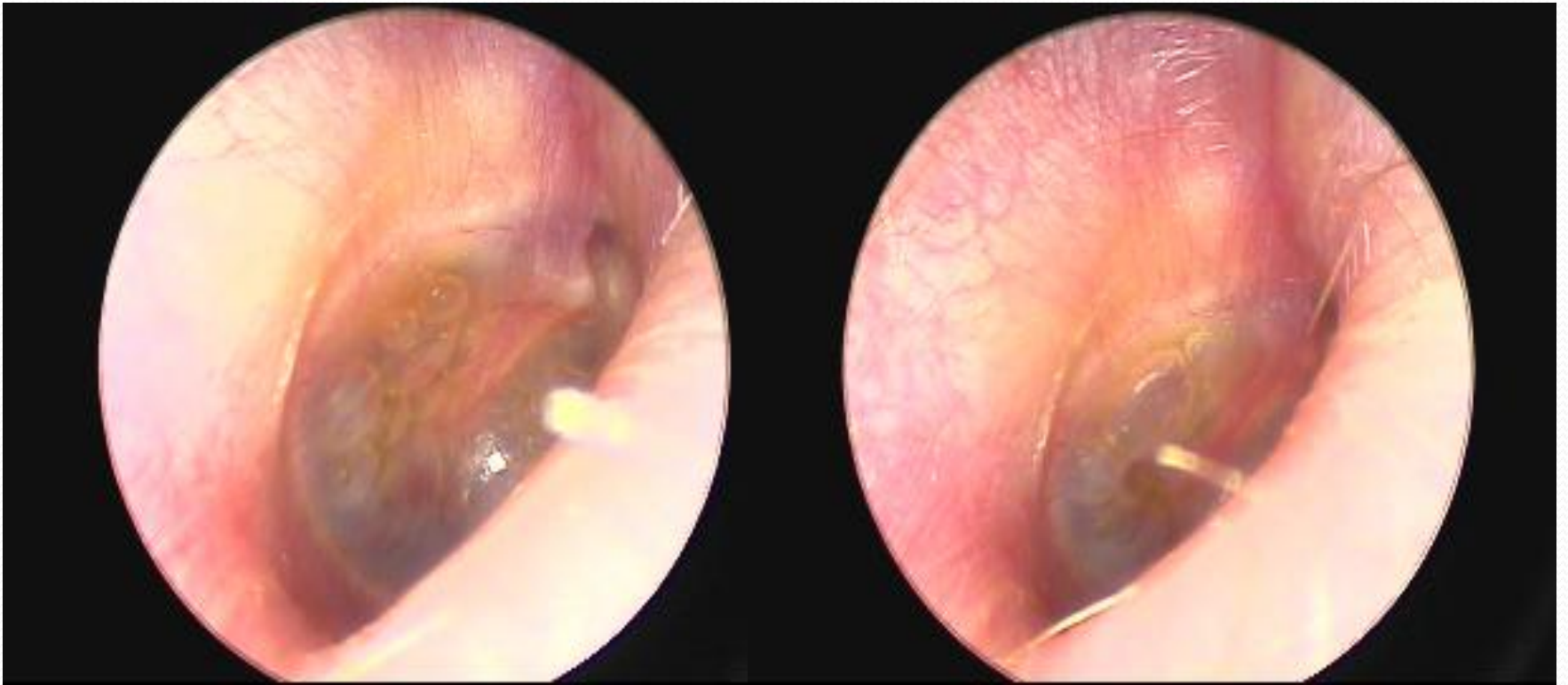
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Perforation (healed)

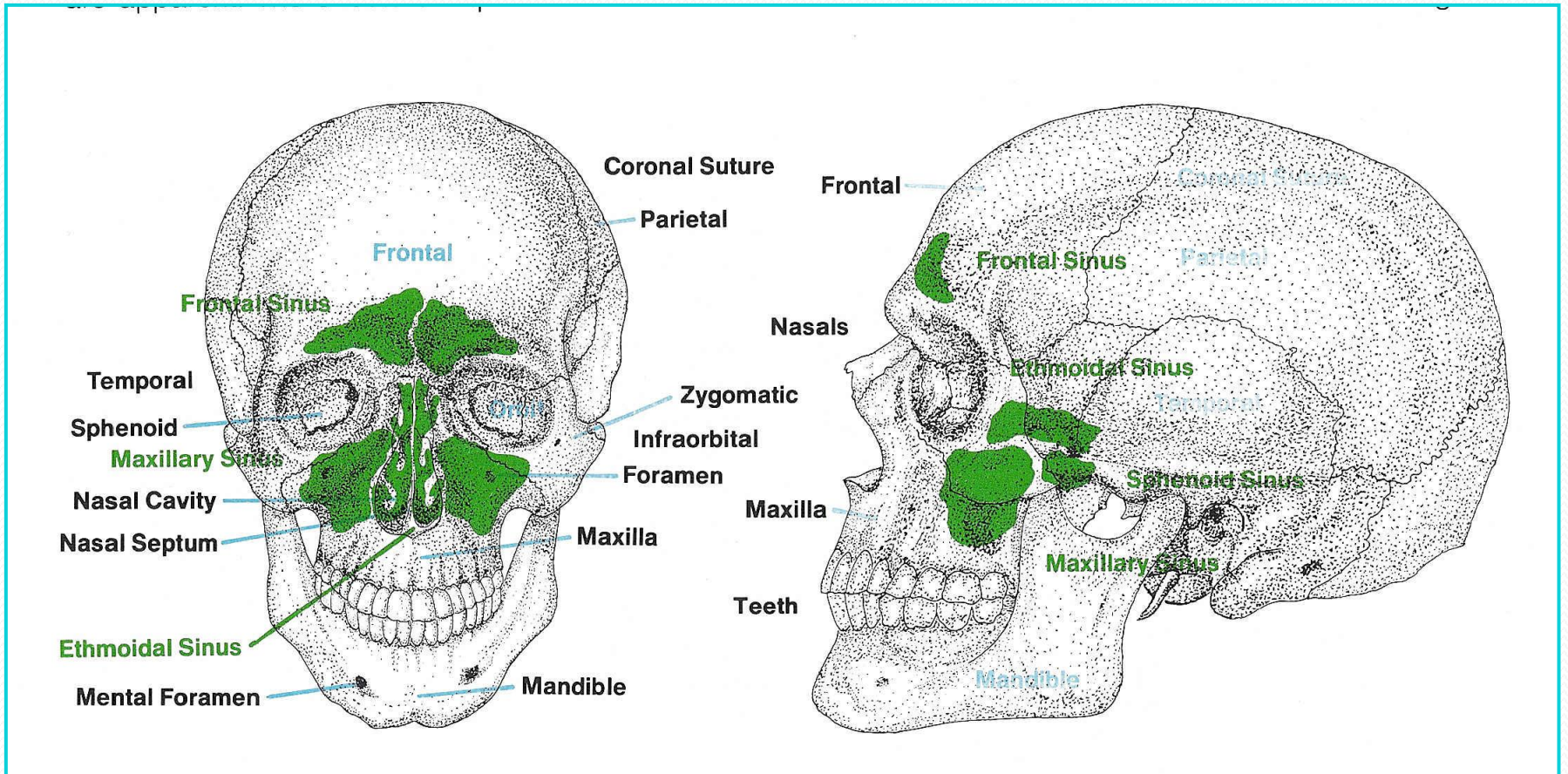


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Video Otoscopy



Sinus Barotrauma



Case Report

- 24 y/o student diver with minor URI
 - slight sinus and ear squeeze on descent
 - 30 ft for 40 minutes in KM Superlite
- Upon surfacing was in obvious agony
 - forehead grotesquely deformed
- Transported to nearest hyperbaric unit VM
 - examining emergency physician found nothing wrong
 - all symptoms spontaneously disappeared

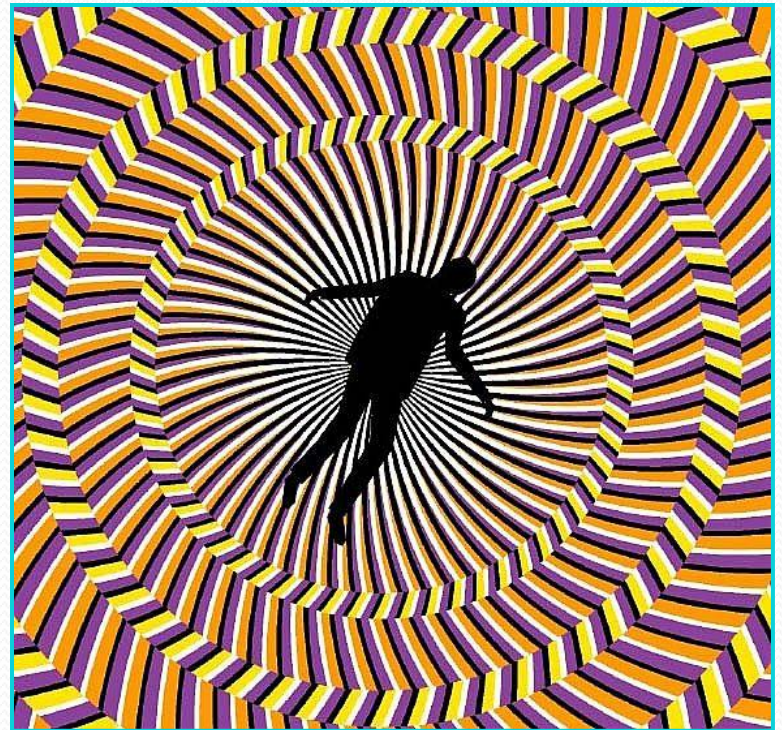
Pneumosinus Dilatans

- Nightmare reverse block
- Acute painful expansion of the aerated frontal sinus
- Visible, distressing forehead bossing
 - one-way-valve
 - ball-valve
 - check-valve
 - trap-door
- Acute barotrauma induced pressurization
 - lasts minutes to hours

} all equivalent terms

Alternobaric Vertigo

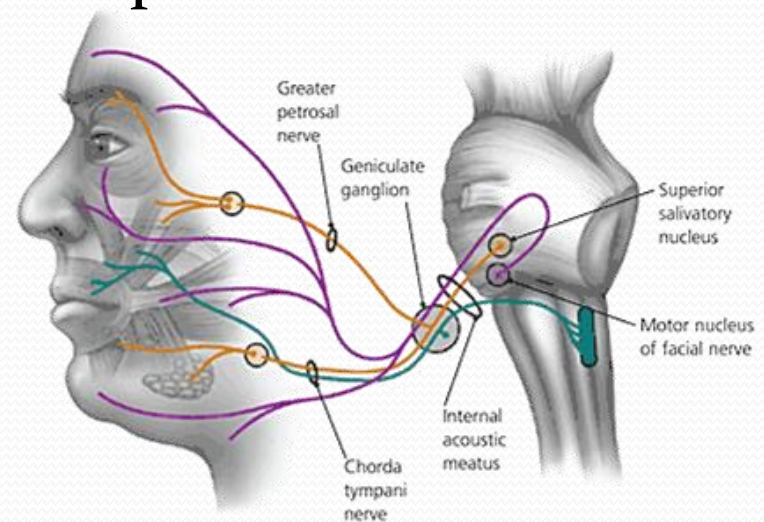
- “le syndrome de Lundgren” 1965
- Objective vertigo, nausea, vomiting
- Most common on ascent
- Unilateral barotrauma
- Asymmetrical pressure stimulation of vestibular apparatus



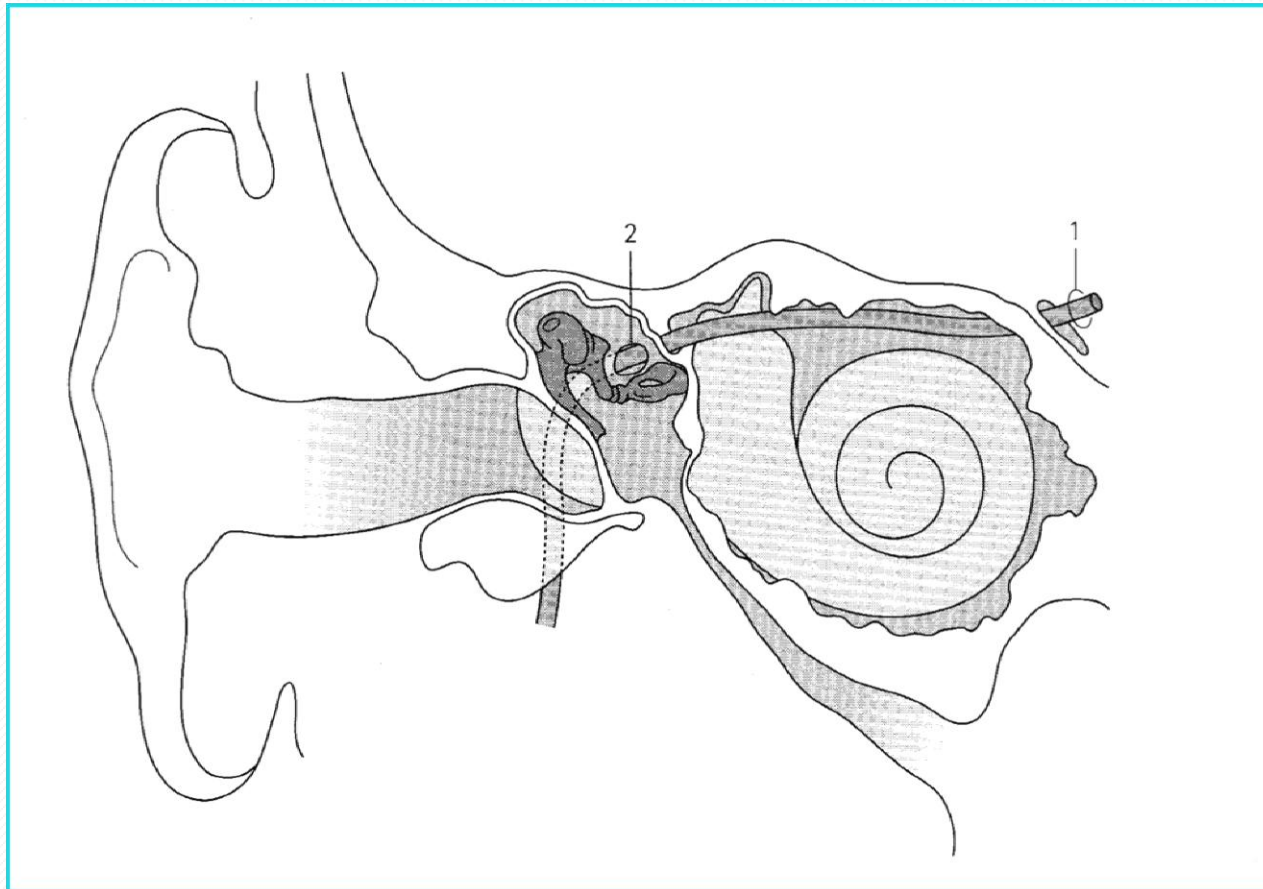
Alternobaric Facial Palsy

(AKA: Facial Baroparesis)

- Defects in bony canal of Facial Nerve through the temporal bone in the middle ear
- Nerve exposed to pressures exceeding capillary pressure lead to ischemic neuropraxia
 - fullness, plugging
 - mouth weakness
 - cannot close eye
 - decreased taste



Defects in Temporal Bone (57%)



Middle Ear Barotrauma

- Most frequent diving injury
- Common in novice divers
- Poor understanding of equalization technique
- Ear damage (Barotrauma) is...



PREVENTABLE

Teach Technique

- Recognize “Ear Fear”
- Recognize a “Dysfunctional Valsalva”
- Teach “Eustachian Tube Awareness”
- Learn to “Calibrate Pressurization Effort”

What is “Ear Fear”?

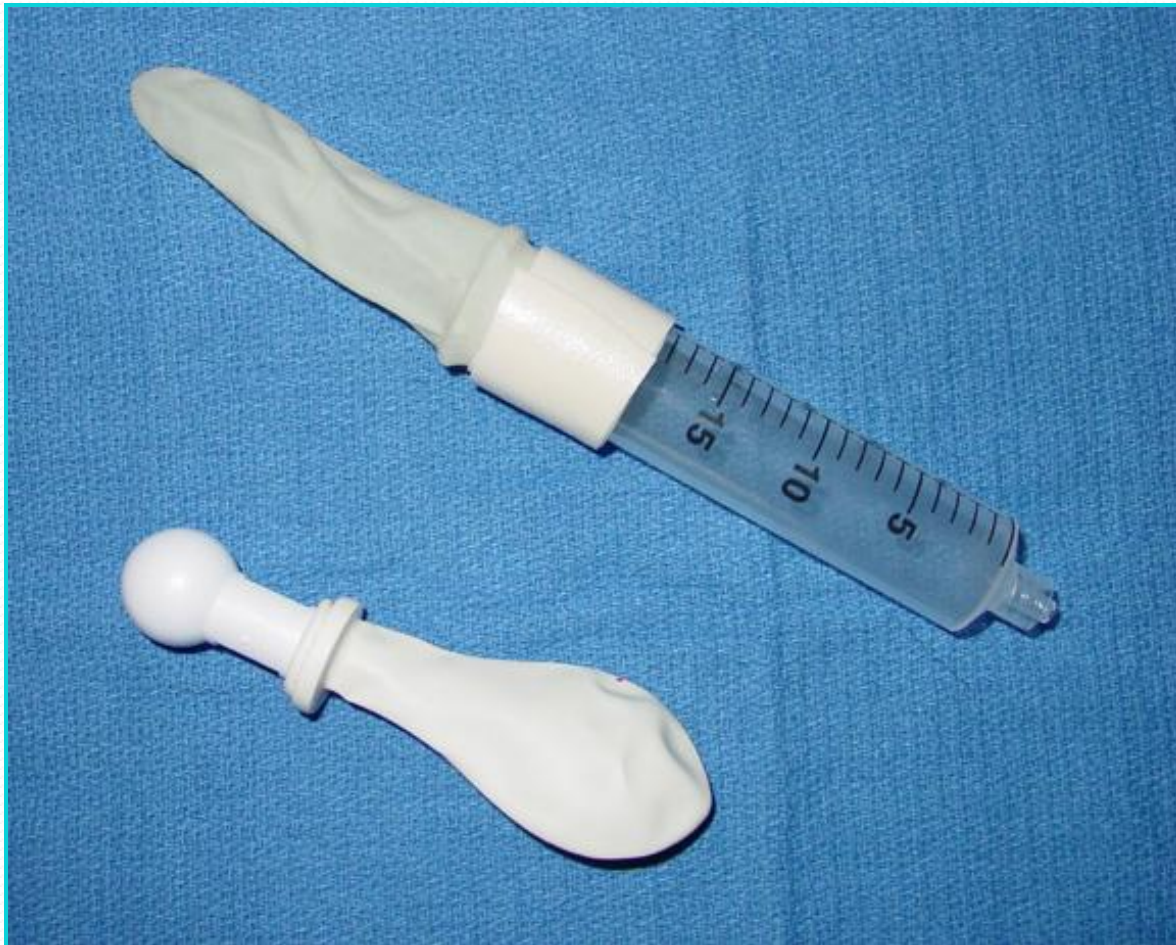
- Pressure perceived as “*uncomfortable*”
- Childhood pain \Rightarrow adult fear
- Retrograde tear duct inflation
- Confusion over instructions

How hard is too hard?

Calibrating Pressurization Effort

- *Watch The Nose Inflate!*
- Fingers low on nose
- Palpate firmness of inflation and compare it to your own pressurization effort
- Asses effectiveness of pressurization
- Tailor the “compensation” technique to the individual

Bazooka vs Otovent



Eustachian Tube Awareness

- Listen to the sounds the ear makes
- Tubal opening “crackle” (tiny sound)
- Middle ear pressurization “BLOOP”



Pressurization Techniques

- Valsalva Maneuver (1704)
- Frenzel Maneuver (1932)
- Combination Techniques (1950s)
 - Pressurize and swallow
 - Pressurize and yawn

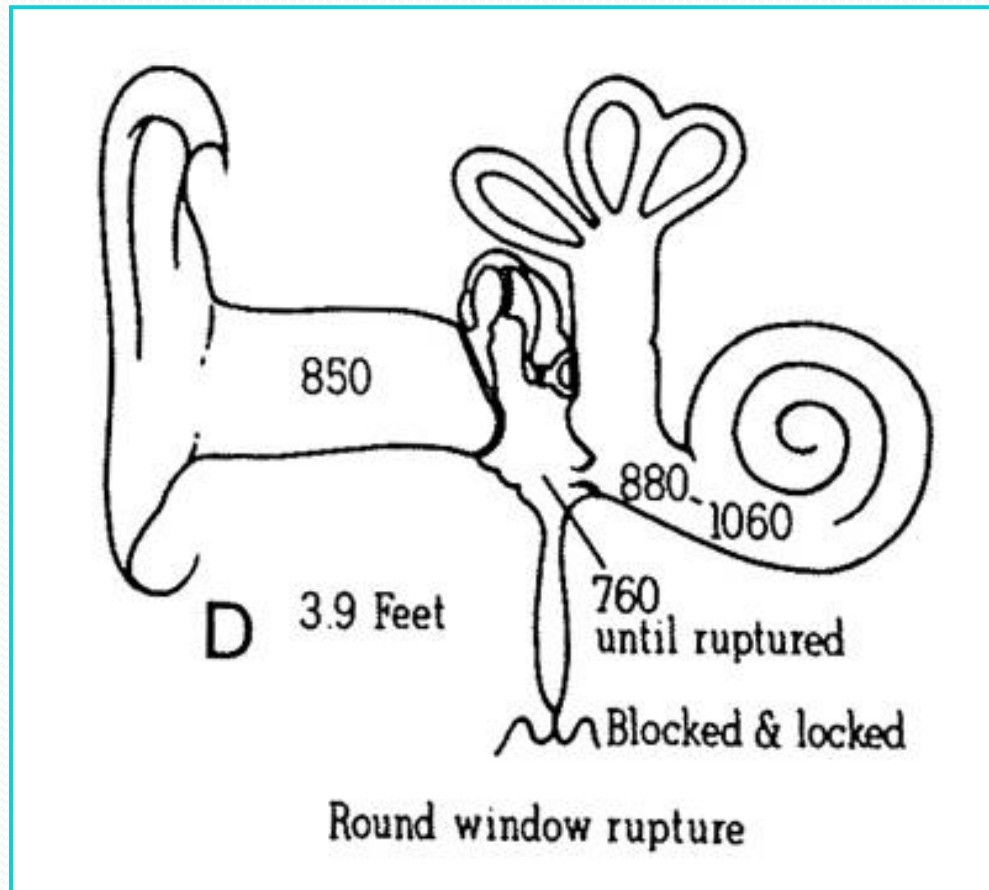
Assessing Equalization Effort

- The Doc's Technique:
- Watch The Nose Inflate!
- Occluding fingers low on nose
- Palpate firmness of inflation
and compare it to your own equalization effort

Antonio Valsalva

- Pinch nostrils closed
- Increase pressure in chest
- Cheeks tight, not puffed out
- Start from the surface
- Brisk upstroke, hold for a second, let go
- Repeat as needed all the way down

Forceful Valsalva



Much Maligned Valsalva

- Too Timid
- Too Forceful
- Too Quick (Pressure Spike)
- Too Prolonged (venous engorgement, cardiac return)
- Wrong phase (never on ascent for reverse block)
- Wrong time (never to relieve a bad squeeze)
- Disfunctional (nasopharynx never pressurized)

Dr. Herman Frenzel

Luftwaffe Commander, 1938

(Marcante-Odaglia in Italy)

- “The Throat Piston”
- Close vocal cords
- Pinch nostrils closed
- Raise the larynx and back third of tongue
- Feel “Adams Apple” elevate

Béance Tubaire Volontaire

- First described by G. Delonca, 1980
 - La plongée Santé-Sécurité
- **Distilled Yawn or Modified Retching**
(soft palate maximally elevated)
- Tongue tensed (canoe shaped) or -
- Tongue tensed, curling it back, brushing the roof of mouth in an attempt to touch the soft palate.
- Uvula tipped forward (practice in mirror)
- Control the Levator Palatini & Tensor Palatini

Tubal Aerobics

- Nasopharyngeal-eustachian exercises
- Reinforce and synchronize anatomical structures
- Impart awareness, competency & control
- Tongue - Jaw – Soft palate – Chest
- Breathing – Swallowing – Vocalizing
- 10 – 15 minutes /day until proficient

	Valsalva	Frenzel	Toynbee	B.T.V.
Nose	Pinched	Pinched	Pinched	No Restriction
Mouth	Closed	No Restriction	Closed	No Restriction
Glottis	Opened	Closed	Closed	No Restriction
Action	Puff in the nose	Throat piston	Swallow	Tubal Opening
Air Flow	Active	Active	Passive	Passive
Result	Overpressure From Lungs	Overpressure From Nasopharynx	Sinusoidal Pressure Changes	Balanced Pressure
Achievement	Easy	Moderate	Easy	Difficult
Safety	Danger	Good	Good	Excellent
Complications	Hypotension, TM or Round Window Rupture	None	Flatus	None

Summary

- “Ear Fear” think Dysfunctional Valsalva
 - pressure never reaches the nasopharynx
 - pressure too low to open the e tube
- Watch the nose inflate
- Bob your Adams Apple
- Pre-pressurize prior to descent
- Never pressurize on ascent

ENT Contraindications (succinct)

- Not susceptible to barotrauma
- No disease present that diving could make worse

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