Chapter 9

EAR BAROTRAUMA

ANATOMY OF THE EAR

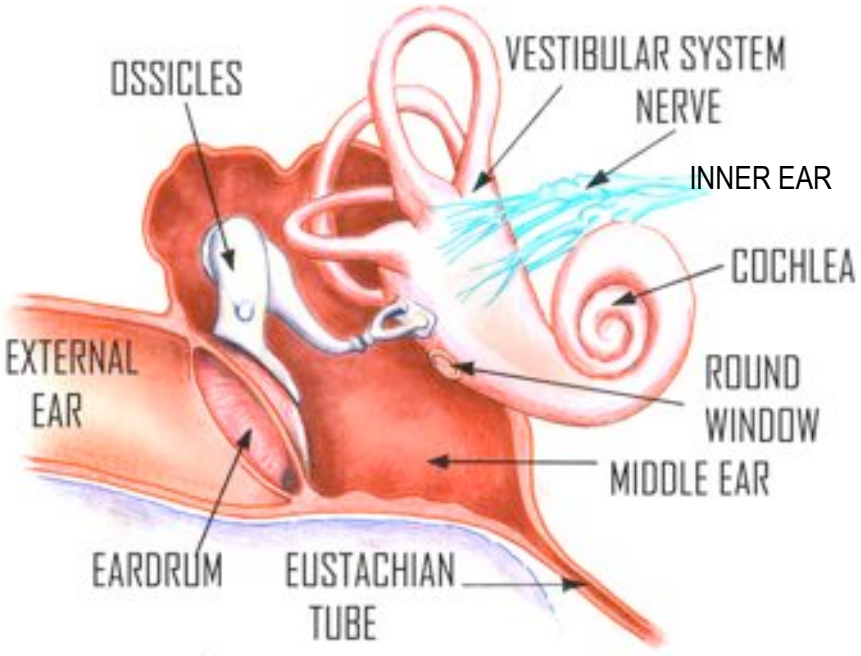

Fig. 9.1
Anatomy of the Ear

The ear is divided anatomically into the outer (external), the middle and the inner ear.

The **Outer Ear** comprises the visible part of the ear (the pinna) and the external ear canal. The pinna gathers sound waves and reflects them into the ear canal and onto the ear drum.

The **Middle Ear** is a pea sized cavity enclosed in a solid bony part of the skull. It is separated from the ear canal by the paper thin **ear drum**. There are several structures opening into the middle ear space.

• The **Eustachian Tube** joins the middle ear with the throat, allowing air to enter the middle ear cavity.

• The **Mastoid Sinus** (air pockets in the mastoid bone) also come off the middle ear.

There are two openings on the inner bony surface of the middle ear space called the **Round** and **Oval Windows,** because of their shape. These openings connect the middle to the inner ear. The oval window is a tough membrane attached to the end of one of the three interconnecting middle ear bones (ossicles), while the round window is closed by a thin delicate membrane.

The **Ear Drum (or Tympanic Membrane)** is connected by the three tiny ear bones or *ossicles* - the malleus, incus and stapes - to the oval window across the middle ear space. This bony chain, which is barely visible to the naked eye, transmits the sound vibrations from the ear drum to the inner ear.

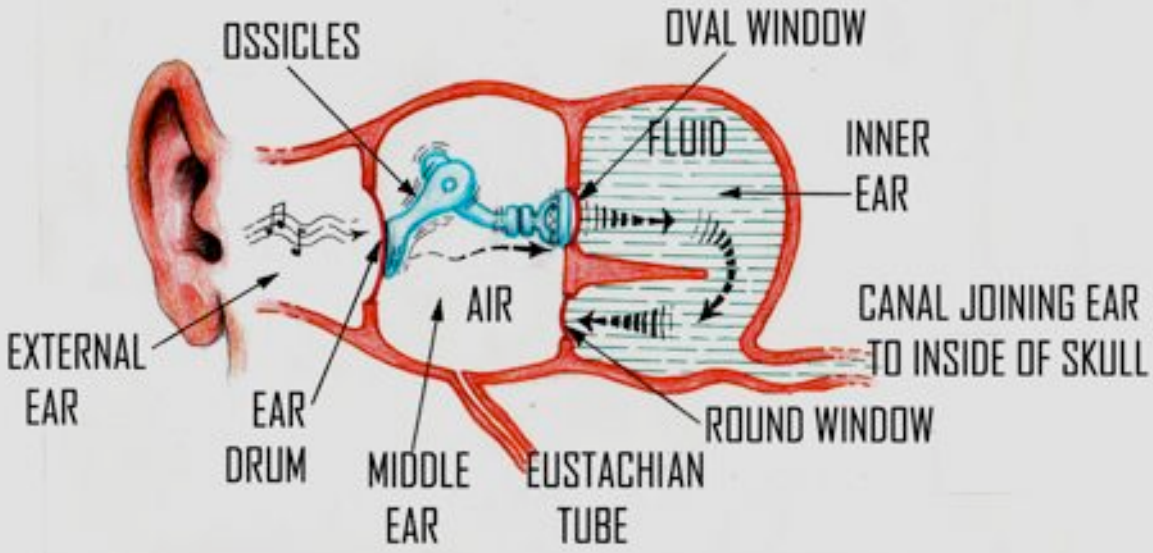

Fig. 9.2
Middle ear communicates with external and inner ear
Transmitting sound from the exterior to the inner ear

The **Inner Ear** contains the **Hearing** and **Balance organs**. It is entirely encased in bone and filled with fluid. The hearing organ (the **Cochlea**) is a spiral shaped structure containing fluid which surrounds nerve cells sensitive to sound vibrations.

A system of **3 semi–circular canals** is also filled with this fluid, and is the balance organ which is sensitive to position and movement. It is also called the **Vestibular System** (or **Vestibular Apparatus).**

THE MECHANISM OF HEARING

The hearing system works in an ingenious way. Sound vibrations, caught and reflected by the pinna, are directed down the ear canal causing the ear drum, at the end of the ear canal, to

vibrate. These vibrations are transmitted and magnified by the bony chain system of levers, to the oval window. The outer (air) and middle ears (ossicles) thus **conduct** sound waves to the inner ear.

Damage to the outer and middle ears interferes with the conduction of sound waves to the inner ear, and so causes **conductive deafness**. This affects the low frequency sounds (those commonly used with speech, 250-4000 Hz).

At the oval window, the sound waves are converted to pressure waves in the hydraulic fluid in the cochlea. As fluid is incompressible, the inward and outward vibrations of the oval window are compensated for by the round window bulging outward and inward, respectively.

The cochlea is tuned so that vibrations of various frequencies transmitted through it resonate in specific areas, allowing the ear to distinguish between differing frequencies of sound. This stimulates sensory nerve fibres within the cochlea and the impulses are perceived as sound when they reach the brain. Damage to this system causes **sensori-neural deafness.**

EXTERNAL EAR BAROTRAUMA

(EXTERNAL EAR SQUEEZE)

If the external ear canal is obstructed, the enclosed gas will be compressed and so reduce in volume during descent (Boyle's Law, again!). This will cause an outward bulging of the eardrum and swelling and bruising of the skin lining the ear canal.

Obstruction of the canal can be caused by a tight fitting **hood**, **wax** in the ears, **bony growths** (**exostoses**) in the ear or the wearing of **ear plugs**. As this condition can be encountered at depths as little as 2 metres, **ear plugs should not be worn during any type of diving.**

The symptoms include discomfort and pain on descent, bleeding from the external ear and the other pressure effects of barotrauma on the middle ear, including difficult equalisation.

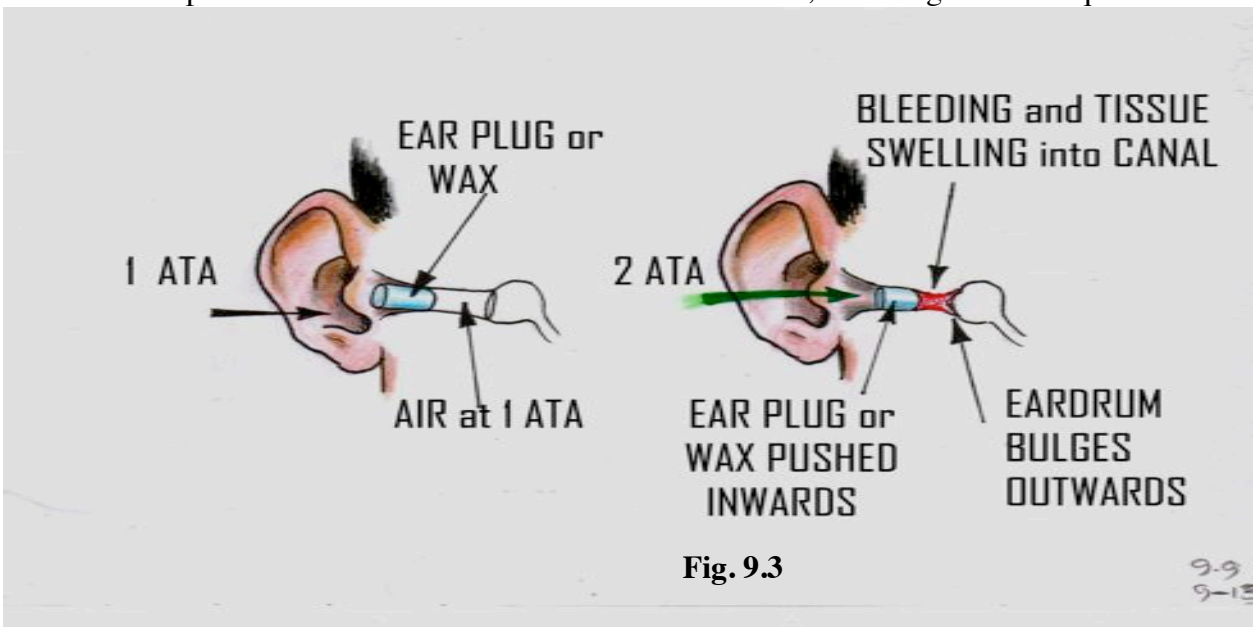

Fig. 9.3

MIDDLE EAR BAROTRAUMA OF DESCENT

(MIDDLE EAR SQUEEZE, AEROTITIS MEDIA)

The main risk of barotrauma to the ears is encountered on descent and the commonest site is the middle ear. About one quarter of diving trainees experience this, to a variable degree.

Water pressure around the diver increases as he descends. This pressure is transmitted to the body fluids and tissues surrounding the middle ear space causing compression of the gas space in the middle ear (Boyle's Law). The diver is aware of this sensation of pressure and voluntarily compensates for the reduction in middle ear gas volume by "**equalising the ear**" "auto-inflation" or "**clearing**". In this manoeuvre, air is blown up the Eustachian tube to replace the volume of gas compressed in the middle ear space. The ways of doing this are described later.

If the diver fails to equalise, water pressure will force the ear drum inwards, stretching it and escalating the sensation of pressure into one of pain. At the same time, reduced gas volume in the middle ear is compensated by blood and tissue fluid, swelling of the lining (mucosa) of the middle ear space. Ultimately, the blood vessels become over distended and rupture, bleeding into the ear drum and the middle ear space. This tissue damage takes days or weeks to resolve. Sometimes the ear drum itself will tear or rupture.

The depth at which this damage occurs depends on the size of the middle ear space and the flexibility of the ear drum. It is normally reached at 1–2 metres and if the diver does not equalise by the time he has reached this depth, barotrauma of the ear is likely.

The commonest diving problem!

If the diver can equalise his ears on the surface, the problem is due to incorrect diving technique

Fig. 9.4

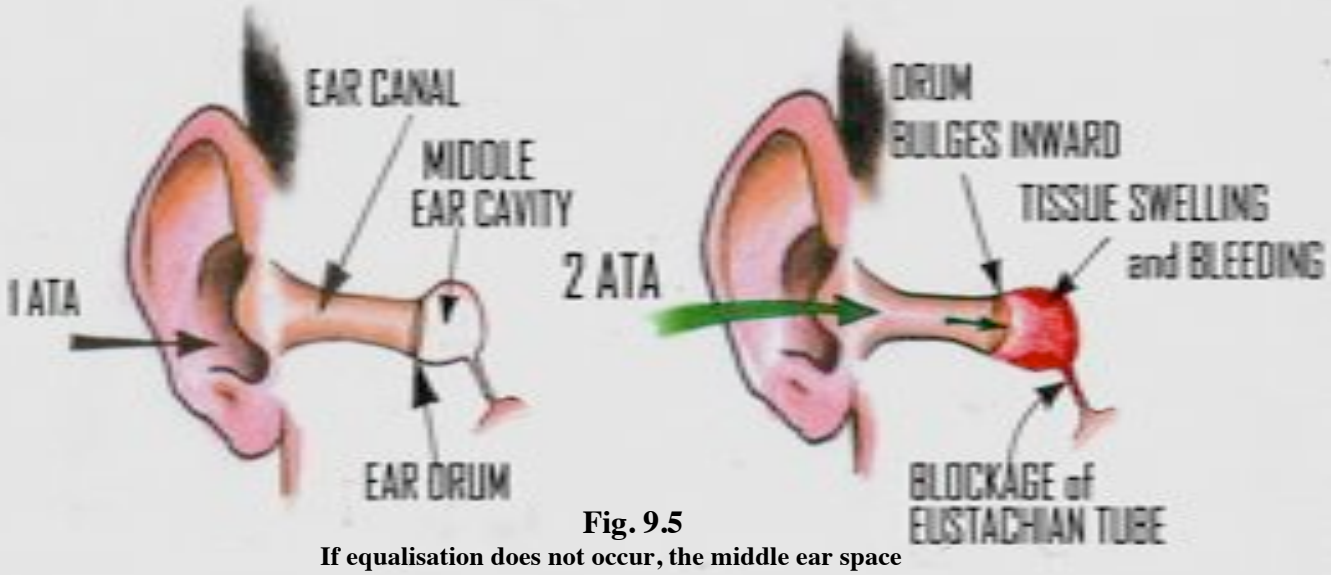

Fig. 9.5
If equalisation does not occur, the middle ear space is partly filled with blood, tissue fluid and swollen mucosa.

Clinical Features

A sensation of **pressure** is the first symptom of damage to the ear. This pressure sensation may develop into **pain**, which is usually severe, sharp and localised to the affected side. It increases as the diver descends, unless he equalises the middle ear spaces.

If the diver continues descending until the **ear drum ruptures**, he will experience relief of the pressure or pain, followed by a **cold feeling** in the ear. This is due to the sea-water which enters the middle ear space, cooling the bone and tissues near the balance organ. Thermal currents may be produced within the balance organ, causing stimulation and dizziness. Fluid may also be felt trickling down the throat, after running down the Eustachian tube from the middle ear space.

Fig. 9.6
Large perforation of the ear drum from a single dive to 8 metres without adequate equalisation.

Middle ear barotrauma, especially when associated with rupture of the ear drum, may be accompanied by **dizziness.** This sensation is termed **vertigo**. It may also be accompanied by **nausea** and **vomiting**. Vomiting underwater is a skill not frequently practiced and it can block the air supply and lead to aspiration of sea water (and vomitus) and drowning.

With lesser degrees of barotrauma, pain or discomfort in the ear may also be felt after the dive. There is often a **feeling of fullness** (or "water") in the ear and sounds may appear muffled. Crackling noises may also be heard (especially with chewing, swallowing or with jaw movements), caused by bubbles of air in the blood/body fluid mixtures within the middle ear.

Occasionally blood from the middle ear is forced down the Eustachian tube when the middle ear gas expands on ascent (Boyles Law). After surfacing the diver may notice **small amounts of blood** coming from the nose, on the same side as the barotrauma, or running down the throat.

Other symptoms due to the ear barotrauma include; a "**squeaking**" sound during equalisation (due to a Eustachian tube narrowed by mucosal swelling, or scarring from repeated episodes of barotrauma), or an **echo** sensation and/or a mild **ache** and **tenderness** over the ear/mastoid area following the dive.

Occasionally a diver has a naturally reduced pain appreciation, so that considerable barotrauma damage can be done despite the absence of much discomfort. These divers are vulnerable to permanent damage, as the usual warnings of middle ear barotrauma are absent. Others can suffer significant damage after exposure to even small pressures, e.g. in a swimming pool – especially if the submersion and pressure exposure is for many minutes duration.

The really serious problem from middle ear barotrauma in extension of the pathology to the inner ear with haemorrhage, or rupture of the round window and permanent hearing loss.

Treatment

A diver who has experienced middle ear barotrauma needs an examination by a diving **physician** to diagnose the condition, and check for complications such as a perforated eardrum or inner ear damage. Assessment of the cause, and advice on prevention of future difficulties is important (see later). **Audiograms** (hearing tests) are essential to test for damage to, and function of, the middle and inner ears.

Occasionally, the doctor may prescribe an oral **decongestant (or nasal spray)** to help open the Eustachian tube, while **antibiotics** may be prescribed if **infection** is present in the nose or throat area, or develops in the blood pooled in the middle ear cavity. This usually presents as a recurrence of pain hours or days after the barotrauma. **Ear drops** do not reach the middle ear and are of no value. They may be harmful if the ear drum has ruptured.

Once serious complications have been excluded, active treatment is usually unnecessary. In order to rest the ear and allow healing, diving, flying and middle ear equalisation should be avoided until the barotrauma has resolved. This commonly takes from 1–2 days up to 1–2 weeks.

The length of time away from diving depends on the severity of the barotrauma. The diver should not return to diving or flying until the physician has confirmed resolution of the barotrauma and the ability to equalise the ears. **Understanding why the barotrauma developed is necessary in order to prevent it happening again.**

If the ear drum was **perforated**, complete cure may take 1–3 months, even though it may appear to have sealed over within days. Early return to diving predisposes to recurrent perforation. Occasionally the drum fails to heal and requires surgical "patching" or "grafting" by a specialist. Later, diving may be permitted if repair is complete and easy voluntary equalisation of the ear is demonstrated.

It is necessary with the recurrence of symptoms, to perform repeat audiograms to confirm that no inner ear damage has occurred. About half of these divers may have ENT pathology, which may be treated by an otologist, and half will be recurring because of marginal Eustachian tube narrowing and failure to perform the equalisation techniques correctly. Both groups will gain from learning the correct “equalisation ahead of the dive” techniques.

PREVENTION OF BAROTRAUMA

Equalisation

Adequate equalisation of pressures in the middle ear space will prevent middle and inner ear barotrauma. This equalisation is necessary whenever increasing depth in the water. It should be performed frequently and before any ear discomfort is felt. It is necessary to equalise more frequently near the surface since the volume changes are greatest there (as explained by Boyle's Law). Equalisation should always be gentle to avoid damage. The technique of ear equalisation is a skill which improves with practice. Some divers can equalise without any apparent effort or action.

Upper respiratory tract infections (URTIs) cause congestion of the throat and Eustachian tube openings, making equalisation difficult or impossible. **Hay fever, allergies, snorting drugs** or **cigarette smoking** have a similar effect. Diving with these conditions is risky. A deviated nasal septum may also predispose to aural barotrauma as well as sinus barotrauma (see Chapter 10).

There are several ways of active and voluntary middle ear equalising before and during descent:

- **Valsalva manoeuvre.**

This technique is most frequently used because it is easy and effective. The diver **holds his nose, closes his mouth and blows gently against the closed nose and mouth.** This raises the pressure in the pharynx, forcing air up the Eustachian tubes into the middle ear. He hears the ear drums “pop”. If they produce a longer squeak, the tube is partially obstructed.

If there is infected material in the throat this can also be blown up the Eustachian tube into the middle ear, leading to **infection**. This is another reason why divers are advised against diving with an upper respiratory tract infection.

Fig.9.7

To supplement this manoeuvre, **opening of the Eustachian tubes** can be facilitated by wriggling the jaw from side to side or thrusting the lower jaw forward as the manoeuvre is performed (**Edmonds Number 1 technique**).

A drawback of the Valsalva technique is that if it employed too forcefully, it is theoretically possible that the inner ear may be damaged. Another drawback is that the nose must be held closed with the fingers, which is not always easy with some professional diving helmets or full-face masks.

- ## The Toynbee manoeuvre.

This involves **holding the nose and swallowing simultaneously**. This usually causes the Eustachian tubes to open momentarily, allowing air to enter or leave the middle ear.

The Eustachian tubes open only briefly with this manoeuvre and it causes a negative pressure in the pharynx, so only smaller amounts of air are able to pass into the middle ear space. Consequently, this manoeuvre is not as effective as the Valsalva manoeuvre, but it is used successfully by many divers.

- ## Others.

Voluntary Opening of the Eustachian tubes (BTV technique) can be performed at will by many experienced divers, by contracting certain muscles in their throat. This technique can be performed by holding the nose, closing the mouth, and then trying to lift up the larynx (Adams Apple), which can be viewed in a mirror. A clicking can be heard in both ears if the procedure is successful. This technique is difficult to describe but if it can be mastered it is convenient and effective, there is little force involved and the manoeuvre can be performed repeatedly.

If any difficulty is encountered, the **Lowry technique** ("swallow and then blow at the same time" – a Toynbee + Valsalva combination) or the **Edmonds Number 2 technique** ("sniff and blow" – suck the cheeks in with a sniff against the closed nostrils, immediately followed by a Valsalva), may be used.

Diving Technique

Anyone who has problems with middle ear equalisation should gently practice this procedure a few times each day, on land. Practice improves performance and makes perfect. Voluntary controlled equalisation becomes easier with repetition. Some may even need to use nasal decongestants to assist this, at first, but they should not be used when diving. Any diver who has difficulty with middle ear barotrauma should practice using the Valsalva, Lowry or Edmonds techniques, as they cause a positive pressure in the middle ears. They should not rely on swallowing, Toynbee or BTV techniques or any others that result in negative middle ear pressures, even though they may open the Eustachian tubes.

Many divers suffer hearing loss because they do not equalise their ears correctly.

Ideally on the day of a proposed dive, the diver should confirm that he is able to equalise easily before setting out on a diving expedition.

All divers should equalise on the surface immediately before descending. This confirms that equalisation is possible and the ear drums balloon slightly outwards, causing a slight positive pressure in the middle ear and allowing some margin for error if the diver becomes distracted and forgets to equalise during the first metre of descent.

The diver should then **equalise every metre or less as the descent proceeds**, so that no sensation of pressure is felt. This is called "**equalising ahead of the dive**" and is much safer than waiting until the pressure sensation (or actual pain) is felt. By that stage the middle ear mucosa is already swollen and obstructing the Eustachian tube, making equalisation more difficult.

If any difficulty is encountered, it is unnecessarily dangerous to descend further as equalisation will become more difficult - until the middle ear becomes congested with tissue fluid and blood. Instead the diver should either abort the dive or, if the dive is an important one, immediately ascend a little and repeat the equalisation manoeuvre. The diver should not persist with this "yo-yo" technique, or remain at a depth at which a "pressure sensation" is present. The middle ear is filling ("equalising") with blood. This is not a sensible situation. If the ears do not equalise easily, abort the dive. That way, he will be back diving much more quickly, having not damaged the middle ear.

If descent is continued, a '**locking effect' on the Eustachian tube** may develop**.** This is caused by the pressure difference between the middle ear and the throat. Equalisation is then impossible.

Descending 'feet first' makes equalisation considerably easier, and is best done on an anchor or shot line. This allows accurate control of the descent rate and depth while allowing the diver to concentrate on equalisation without the distractions of swimming and depth control. At least keep the head vertical when equalising, assisting the passage of air up the Eustachian tubes.

The novice diver and the diver who has difficulty with his ears should use a face mask which allows easy access to the nose to facilitate the various manoeuvres. If one ear causes more problems, then cock this ear to the surface when equalising (this brings that Eustachian tube even more vertical, and air travels upwards, under water.

Surgical correction of nasal septal deviations, cessation of smoking and adequate treatment of URTIs and allergies may be needed by those who have these predisposing causes.

Medication

Medication has been used to facilitate equalisation when there is some disorder of the ear, nose or throat. Topical nasal decongestant sprays and drops such as **phenylephrine and oxymetazoline** shrink the lining of the nose and Eustachian tube, reducing congestion and opening the air passages. Some oral medications such as **pseudoephedrine** have a similar effect.

While these drugs can make diving possible when it otherwise would not be, **they assist the diver to dive with conditions which should preclude diving**, such as upper respiratory tract infections. There is an added risk of the drug predisposing to barotrauma during the ascent - which is far more dangerous than ear barotrauma of descent. These drugs often relieve obstruction of the throat end of the Eustachian tube, improving equalisation during descent. Unfortunately they do not influence the middle ear end of the Eustachian tube, thus they do not assist release of gas from the middle ear during ascent. Decongestants may also permit diving despite minor descent barotrauma but can wear off during the dive, resulting in congestion of the pharyngeal end of the Eustachian tube and further obstruction to the outflow of gas from the middle ear (see below, "middle ear barotrauma of ascent").

Because these drugs mask the symptoms of conditions which would otherwise preclude diving, divers are advised that it is **better to avoid diving than to continue while taking these drugs.** See Chapter 37, last page, for more on the problems of drug treatment. They make other diving disorders more likely e.g. Sudden Death Syndrome.

•Middle Ear Equalisation (ME=) Client's Problem Check List

- **I descend a bit slower than my buddies.**
- **If there is any pressure, I halt my descent and wait a bit. Or,**
- **I may ascend until the ear clears. (Yo-Yo)**

Why do these procedures? If you are not ME= promptly or sufficiently, then these procedures merely allow the ME to fill with blood or tissue fluids, and thus allow further descent with less pain or discomfort. This is not a sensible way to ME=. It results in middle ear congestion, Eustachian tube obstruction and other pathology which may be temporary or permanent.

- **I am trying to use swallowing to ME=**

If you have any difficulty with ME=, employing techniques that result in a relatively negative ME pressure causes ME congestion and Eustachian tube blockage. Use the positive pressure Valsalva technique (or Lowry, or Edmonds) , prior to and during descents.

- **I dive down the shot line.**

This requires greater force to inflate the ME, as you are trying to force air down the Eustachian tube. Descend feet first and you can blow air up the Eustachian tube. Air travels easier up than down, in the water. Remember bubbles? They rise.

- **If there is any water in my ears (fullness, crackling) after the dive, I use alcohol ear drops to dry them out.**

It is likely that the "water" in your ear is really fluid in your ME!

- **I sometimes have a bit of blood from my nostril (or in my throat).**

Although it may be from your sinus, following expansion of air with ascent, it is more likely from the middle ear on that side. In either case, ME= correctly ("ahead of the dive") may well fix both. See previous pages.

- **When I dive and ME=, I hear a squeeking sound in my ear.**

This suggests a narrowed Eustachian Tube, possibly from inadequate ME=. The sound you should hear when you equalise, and the ear drum moves outward, is a click or pop. It takes a split second to achieve. Not a long drawn out sound.

- **I can often dive once, without problems, but cannot ME= on other dives.**

You have probably produced some middle ear congestion in the first dive, but continued the dive. By the second dive, you start off with significant middle ear congestion, and so ME= is more difficult.

- **One ear equalises before the other**

Not a problem. It is normal. You may wish to assist the slow ear by pointing it towards the surface as you ME=.

If reasonable, avoid the use of hoods which cover the external ear. If it is necessary to use these hoods, then it is preferable to have holes inserted over the ear, which will allow air and water movement and pressurisation. This is not, of course, necessary or possible with diving helmets or certain dry suits. Special ear plugs and masks used for prevention of ear barotrauma probably only work by delaying damage and therefore inducing fewer symptoms - not by preventing damage.

MIDDLE EAR BAROTRAUMA OF ASCENT

(ALTERNOBARIC VERTIGO, REVERSE SQUEEZE)

This condition is relatively uncommon by itself, but it is often a complication of a middle ear barotrauma of descent and/or the use of nasal decongestants. During ascent, air in the middle ear space expands and must escape. The air normally escapes down the Eustachian tube to the throat without any conscious effort by the diver. If very observant, he may actually hear or feel it escape from his ear.

Occasionally the Eustachian tube may obstruct this flow of air, with subsequent air distension and increased pressure sensation in the middle ear cavity during ascent. This causes bulging and possible rupture of the ear drum. There may also be damage to the inner ear, leading to hearing loss (see below, and Chapter 30). The increased pressure in the middle ear may also stimulate the nearby balance organ producing vertigo and its associated symptoms.

Clinical Features

Increasing pressure and pain is sometimes felt in the affected ear as the diver ascends. Often there may be **vertigo** as well as **nausea** and **vomiting**. After surfacing the diver may feel fullness or dullness in the ear. **Tinnitus** or **hearing loss** may indicate serious damage (inner ear barotrauma).

Vertigo may develop after only a metre or so of ascent (see Chapter 31, Case History 31.2). Many of these symptoms can be hazardous, especially as ascent may be prevented by the symptoms.

First–Aid

If a diver encounters ear pain or vertigo during ascent, he should **descend a little** to minimise the pressure imbalance and attempt to open the Eustachian tube by holding the nose and swallowing (Toynbee, or other equalisation manoeuvre). If successful, this equalises the middle ear by opening it up to the throat and relieves the distension in the affected middle ear.

Occluding the external ear by pressing in the tragus (the small fold of cartilage in front of the ear canal) and suddenly pressing the enclosed water inwards, may occasionally force open the Eustachian tube. If this fails then try any of the other techniques of equalisation described previously, and attempt a slow ascent.

Treatment

Uncomplicated cases resolve quickly but eardrum rupture or inner ear damage may need **specialised care. All cases need expert diving medical assessment, for diagnosis and advice.** Unless it can be understood and prevented, diving should be avoided.

INNER EAR BAROTRAUMA

A serious consequence of ear barotrauma is inner ear (hearing and balance organ) damage. The inner ear can be damaged in several ways.

- **Round window fistula (or "leak").**

If the diver fails to equalise the middle ear adequately, water pressure will bulge the eardrum inwards. Since the eardrum is connected to the oval window by the bony chain, this window is forced inwards and the round window bulges outwards. If these movements are excessive, the small end-bone can be pushed through the oval window or, more commonly, the round window may tear. After these injuries, the window may then leak the inner ear fluid (perilymph) into the middle ear.

Round window fistula may also be associated with an excessively **forceful middle ear equalisation manoeuvre**. Increased intravascular pressures in the head associated with this manoeuvre may be transmitted to the cochlea fluid, causing bulging and then rupture of the round window. Alternatively, the sudden displacement of the eardrum after an equalisation manoeuvre may set up a pressure wave in the inner ear fluid which tears the round window. The fluid which leaks out is crucial to the healthy function of the **cochlea** and its loss leads to damage to the hearing organ. Permanent severe **hearing loss** may follow if the fluid loss is not interrupted by healing of the round window or surgical repair,.

The same fluid also bathes the balance organ, and damage to this organ may also result in **dizziness (vertigo), nausea and vomiting.**

- **Other pathology.**

Permanent hearing loss or balance disturbance, unrelated to round window fistula, can be caused by direct cochlea damage from inner ear barotrauma. The cause may be haemorrhage (or bleeding), inner ear membrane rupture, or air entering the inner ear (from a stretched round window). This hearing loss may be temporary or permanent depending on the degree of damage and its management.

Clinical Features

The cardinal features of inner ear barotrauma are :

- **tinnitus** (ringing or buzzing noises in the ears)
- **hearing loss**
- **vertigo** (a feeling of being pulled, rotation, rocking or unsteadiness)
- nausea or vomiting
- rarely, **dysacusis** (painful hearing)

One or more of these must be present to make the diagnosis. Fluid may be noted in the middle ear.

Tinnitus is a ringing, buzzing or musical sound in the ear, usually high pitched, due to damage or irritation of the nerve cells of the cochlea.

Hearing loss is due to damage of the cochlea. It may improve, stay the same or deteriorate. Audiograms may differentiate this type of hearing loss (sensori-neural) from that due to middle ear barotrauma (conductive). See Chapter 30.

Vertigo is the spinning or pulling sensation due to balance organ damage (see Chapter 31).

Treatment

A diver presenting with any of these symptoms needs **immediate assessment** by a diving physician. In the interim, he should avoid any exertion, middle ear equalisation, altitude or diving exposure, sneezing or nose blowing.

The physician will examine the ear and perform **serial audiograms** to detect any hearing loss, which may not be obvious to the diver. **Tests** of **balance organ function (ENGs)** may be necessary.

Aspirin, nicotinic acid (vitamins), other vasodilators or anti-coagulants should not be taken.

An expert diving medical opinion concerning **future diving** should be sought if the diver has sustained permanent hearing loss, tinnitus or balance disturbance, as it is probable that further episodes of inner ear barotrauma will cause additional and possibly permanent disastrous effects. Training in correct middle ear equalisation techniques is essential if a return to diving is contemplated.

- ### Round window fistula.

This condition can usually be managed conservatively with **absolute bed rest in the sitting position.** Straining, sneezing, nose blowing, sexual activity, loud noise and middle ear equalising should be avoided, to prevent pressure waves in the inner ear.

The round window fistula often heals spontaneously within a week or two with this regimen but if hearing loss progresses or the other features persist, it may be necessary to resort to **surgery** to patch the round window leak.

Once an oval or round window fistula or cochlea injury has healed, the diver's future in this sport is bleak. Flying should be completely avoided for some months to allow complete healing of the injury or the surgical repair.

- ### Cochlea damage.

In the absence of a round window fistula, no specific treatment is available for this type of injury. Rest in a head elevated position, repeated pure tone audiograms, and avoidance of exertion, equalisation attempts and further exposures to barotrauma (flying or diving), is necessary until the condition has stabilised.