MISCELLANEOUS DISORDERS

CONTACT LENSES

Contact lenses are a convenient alternative to spectacles but can be a source of problems to the diver. The most common of these is **loss** of the expensive lens during removal of the face mask. The eyes should be shut while removing the mask underwater or on the surface.

In certain circumstances, especially during long or deep dives or in compression chambers, it is possible for **gas bubbles** to form behind the contact lens (particularly with hard, non gas-permeable lenses) causing pressure and damage to the cornea of the eye. If this happens, the diver may experience discomfort in the eye, blurred vision and the appearance of halos around bright lights. Long term effects could include scarring of the cornea.

Gas bubble damage can be overcome in the hard contact lens by an optician drilling a small hole in the centre of the lens (a **fenestrated** lens) which allows gas bubbles to escape. This has no effect on the visual performance of the lens. Soft contact lenses are usually not a problem because of their gas permeability and flexibility.

It is now relatively easy to have corrective lens ground into or attached to the diver's face mask, as an alternative to contact lenses (see Chapter 5).

CRAMPS

Cramp is a painful spasm of a muscle group. It is common in divers and can cause a dangerous diversion or incapacity. The muscles most commonly affected are those in the sole of the foot, the calf and the thigh, but other muscles can also be involved.

Unusual exertion of the muscles, due to changes in fins or equipment, makes cramp more likely, especially if the diver is generally unfit. Cold water is another predisposing factor.

Cramp is managed by slowly stretching and maintaining tension on the muscle involved. Sometimes this may require the diver to actually stand and push down with his toes onto some firm underwater surface in order to stretch the muscle. Ditching of weights underwater or inflation of the buoyancy vest on the surface may be helpful in an emergency, avoiding the need to continue swimming.

This condition can be inconvenient or even dangerous if the diver is simultaneously coping with environmental problems such as white water, strong currents or tidal flows.

It is best **prevented** by maintaining a high level of physical fitness, using familiar and comfortable fins and having adequate insulation from cold water.

EAR PROBLEMS

Wax (Cerumen)

Ear wax (cerumen) is a protective substance which coats and waterproofs the external ear canal. Occasionally the ear produces excessive wax which accumulates and obstructs the ear canal, or contributes to water retention with subsequent otitis externa (see Chapter 28). It may produce curable hearing loss, or caloric induced vertigo if water is able to enter only one ear (see Chapter 31). Divers may try to remove this wax with cotton-tipped "buds", but unfortunately this often results in infection or the wax being compacted even tighter in the canal, precipitating total obstruction.

The excessive wax is easily removed by a diving physician using an instrument or syringe. This leaves the ear canal somewhat open to infection however (otitis externa – see Chapter 28), and therefore should not be done unless the wax totally occludes the canal. Ear drops are readily available (Cerumol, Waxsol, olive oil etc.) which help to soften wax so that the normal self cleaning function of the canal can proceed more easily. Diving itself aids in wax removal.

Exostoses

The inner part of the external ear canal passes through bone. People who swim or dive regularly, especially in cold water, sometimes develop outgrowths of this bone, known as exostoses, bulging into the ear canal. These can cause partial obstruction which may lead to the accumulation of wax and the retention of water causing infection or hearing loss.

Large troublesome exostoses can be removed surgically, however this is not usually necessary.

Others

Infections (otitis externa, otitis media) are discussed in Chapter 28, hearing loss in Chapter 30, vertigo and disorientation in Chapter 31, barotrauma in Chapter 9 and decompression sickness in Chapter 15.

HEADACHE

Headache during or after a dive is a frequent complaint and can be caused by conditions ranging from trivial to life threatening. It always requires careful assessment.

The most likely cause of the headache can usually be deduced from the past medical history, location of the pain, dive history, mode of onset and progression.

Details of clinical and diagnostic features can be found in the relevant chapters elsewhere. Although most headaches are not serious, the more serious causes will be discussed first.

Decompression Sickness and Pulmonary Barotrauma

Air emboli and bubble development in the brain can cause brain injury and swelling which often presents as headache. This may start within a short time after surfacing, or may be delayed for several hours. Headache followed by confusion or loss of consciousness is very suggestive of this dangerous disorder. The dive profile is helpful in diagnosing headaches of this type (see Chapters 11 and 15).

Sinus Barotrauma

This condition usually affects the various sinuses located around the eyes, or the maxillary sinuses in the cheek bones. Sharp pain in the affected sinus may be experienced during descent or ascent, or a more dull pain in the region of the sinus may be felt after the dive (see Chapter 10). A more serious and difficult-to-diagnose sinus headache can develop in the sphenoidal sinuses, a deep and central headache. The barotrauma headache is not usually long lasting.

Pain may be referred from the sinus to the upper teeth or behind the eyes. After minor barotrauma, an infection (**sinusitis**) can develop hours or days after the dive, causing a headache in similar sites to those mentioned (see Chapter 28).

Migraine

This condition can be a worrisome problem in divers. It is common in the general population.

Clinical features.

These may include an "aura" before the onset of the headache, with visual effects ranging from flashes of light, shimmering lines, partial loss of a visual field to mild blurring of vision. A severe headache aggravated by bright lights, usually accompanied by nausea and vomiting, and sometimes numbness, tingling, weakness or paralysis of the limbs, most often follows the visual aura.

Migraine headaches can be trivial or can be associated with vomiting, severe incapacity and neurological symptoms (visual disorders, numbness or 'tingling sensations' in arms or legs etc.). These more severe symptoms lead to diagnostic confusion with air embolism and decompression sickness and may result in an emergency evacuation and inappropriate treatment.

A severe migraine developing during a dive can incapacitate the diver or induce vomiting underwater with subsequent drowning.

For reasons which are not well understood, mild migraine sufferers can sometimes have very severe and unusual migraine attacks precipitated by

diving. It may be that this is a response to bubbles within the cranial extravascular system. Migraine may also result from excessive exercise and carbon dioxide/oxygen pressure variations. Cold and exertion are also possible aggravating causes.

For these reasons migraine sufferers are not encouraged to dive. Nevertheless, some have no "neurological" features and are very infrequent and mild. Then if they do dive, they are usually **restricted to non-decompression dives** and to **less than 18 metres** and long surface intervals (i.e. dives that do not typically produce intra-arterial bubbles or cerebral decompression sickness).

Tension Headache

Diving and training for diving can be a stressful experience which can cause headaches in susceptible individuals from excessive muscular tension. These individuals will often recognise the headache as similar to those associated with other stressful experiences. Most are frontal or involve the neck and back of the head.

Mask Strap Tension

Inexperienced divers often tighten their mask strap excessively in the hope that the alarming prospect of loss of the mask underwater, can be avoided. Excessive tension of this strap interferes with the blood supply to muscles around the skull, causing a headache similar to tension headache. The pain is prevented by slackening the strap. As the diver gains confidence in his ability to deal with a flooded or displaced face mask, the need to keep the strap excessively tight disappears. Some headaches are related to the design of the strap (ie. wide single straps verses narrow split straps.) Trial and error may sort out this type of problem.

Carbon Dioxide Toxicity

This is a frequent problem with re-breathing equipment, but is sometimes observed with scuba. It can develop as a consequence of a breathing resistance from faulty regulators, possibly from excessive depth (when the air is more dense) or, more likely, from a voluntary inhibition of breathing (slowed or shallow breathing, “skip breathing”) in an attempt by the diver to reduce his air consumption. This popular explanation still awaits experimental or clinical proof.

The headache is often severe, throbbing and unresponsive to analgesics. It may last for an hour or more. See Chapter 22.

Other Types of Headache

Cold water entering an ear canal can cause headache (or earache) when it comes into contact with the ear drum (see Chapter 27). This is easily prevented in swimmers with normal ear plugs. These cannot be used safely by divers. Special ear plugs designed for divers, with perforations, may work The best prevention is a neoprene hood, which allows the trapped water to warm to body temperature. Some masks are designed to include the ears.

There are many **other causes** of headache, including neurological, barotraumatic, thermal, orthopaedic and vascular mechanisms, that are too complex to be assessed here. Any headache associated with diving deserves investigation, before its consequences during future diving become more serious than those occurring while on land. Exertional headaches cause particularly difficult diagnostic problems.

(Scuba Divers') Pulmonary Oedema (SDPE)

Scuba Divers Pulmonary Oedema (SDPE) was previously thought to be an uncommon disorder. It can occur in apparently healthy individuals, but is sometimes based on cardio-vascular pathology. In a survey of scuba divers about 1% described it. An individual predisposition is a likely factor since recurrences are common with diving, snorkeling or swimming.

Symptoms

It presents clinically with difficulty in breathing - with fast shallow respirations and a sensation of tightness, wheezing or crackling sounds in the chest. Symptoms are often aggravated during ascent or if the diver/swimmer remains immersed, but are relieved if the victim is removed from the water before the condition becomes too severe.

It may be associated with fatigue, cough, whitish or sometimes blood-stained expectoration, and possibly a bluish tinge to the lips, tongue and face (cyanosis).
Symptoms usually resolve rapidly (some hours) after the immersion, but deaths have been reported and it may be indistinguishable from drowning, at autopsy.

Clinical Signs

Hypoxia may be demonstrated by the cyanosis. Weakness, confusion or impaired consciousness may occur. Paramedics may detect signs of pulmonary oedema by listening to the chest. Later a mild temperature may develop.

Clinicians may demonstrate reduced spirometry and compliance, hypoxaemia and characteristic radiological (plain x-ray or CT scan) abnormalities. These usually resolve rapidly (hours) in most cases.

General

SDPE is more frequently seen in older divers, probably more common in females and tends to recur, either whilst diving or snorkeling. Most are in the 30-60 year age group and there may be an association with hypertension, ischaemic or other heart diseases or impaired respiratory function.

The actual incidence is unknown, but very likely it is under diagnosed. Both clinically and pathologically, the appearances are similar to salt water aspiration, near-drowning and drowning (Chapters 25 and 26).

Extreme exertion may be observed in some cases, but it is often specifically denied.

Predisposition

An individual predisposition for pulmonary oedema is likely since a diver, snorkeler or swimmer with pulmonary oedema may have other episodes of SDPE, previously or subsequently (in at least 30% of cases). Whether the recurrences relate to the individual diver's medical status, the dive profile, environmental conditions or the dive equipment, is conjectural. We do not know why most cases occur or recur.

Causes

Many causes have been incriminated. The common factor is a damage to the pulmonary capillaries, with leakage of fluid from the pulmonary capillaries into the lung alveoli ("drowning from within"). This may be more likely if more than one "stress" is put on these capillaries.

The stresses may include;
Pre-existing cardiac disease (possibly not known to the diver)
High blood pressure,
Cold exposure, inducing hypertension,
Salt water aspiration. See Chapter 26.
Intrathoracic blood pooling induced when the body is submerged.
Negative pressure during inspiration, which could occur from:

- Immersion per se, especially with a head-up/vertical or head-out position
- Inspiratory breathing resistance from diving equipment (regulator, snorkel)
- Reduced gas supply/pressure (low on air)
- Excessive gas density with depth
- Increased ventilation, as occurs with exertion, anxiety and hyperventilation
- In rebreathing equipment, when the counter-lung is positioned above the lung
- Tight chest clothing (wet suits)

Drugs, such as beta-blockers

Treatment

Rescue the patient from the water. Administer oxygen and rest. Positive pressure respiration may be needed in severe cases. Although improvement is relatively rapid after leaving the water, cases of

unconsciousness have been well recorded, as have deaths. Deaths are likely to be attributed to drowning, like so many other deaths in the underwater environment.

Medical assessment is required to verify the diagnosis and exclude any predisposing features. Although SDPE may develop in divers with no medical problem, often it is based on other diseases, such as cardiac or respiratory diseases. Thus, once it has happened, it tends to recur. Investigations to exclude such predisposing factors need to be undertaken. Sometimes the cardiac diseases are structural (ischaemia), sometimes mainly physiological (arrhythmias) and often due to transitory abnormalities (reversible myocardial dysfunction, takotsubo etc.). Thus SDPE, especially in older divers, should be an indication for comprehensive cardiac investigation, not only for possible therapy but also to avoid further SDPE episodes.

It seems reasonable that unless the cause can be identified, verified and corrected, divers with SDPE should be advised of the possible risks of continuing with the activity which provoked it, and should be advised against further diving, snorkeling or energetic swimming.

Differential Diagnosis

Other diseases that can produce pulmonary oedema and cause diagnostic confusion are the salt water aspiration syndrome, drowning, respiratory oxygen toxicity, gas contaminations, cold urticaria, the Irukandji syndrome (jellyfish envenomation) and diving induced asthma. Pulmonary decompression sickness, pulmonary barotrauma and the so-called 'deep diving dyspnoea' are diving disorders that may cause diagnostic confusion with SDPE. Anxiety produced hyperventilation may also cause some diagnostic confusion, but this has none of the other respiratory manifestations.

Immersion Pulmonary Oedema (IPE)

There are three forms of acute pulmonary oedema associated with immersion. It may be induced by swimming/snorkeling, free diving ("lung squeeze" at end of Chapter 11) or scuba diving. They have some features in common, but there are significant differences in their demographics, causation and therapeutic implications.

The swimming induced cases tend to be young and fit, but exposed to excessive exertion. Most of the swimmers affected were otherwise healthy. In special forces combat swimmers, extreme exertion was incriminated. It was observed in both cold and warm waters, sometimes over 20^0C. Over-hydration may have contributed to some of these
Explanations for IPE include; increased cardiac output due to physical exertion, pulmonary vascular blood pooling due to immersion, increase in pulmonary vascular resistance due to cold exposure, hydrostatic pressure effects and increased perfusion in the dependent lung with side-stroke swimming.

See Edmonds C. The evolution of SDPE, *UBR research j.* 2016

SUNBURN

Sunburn, especially in tropical areas, is a common problem for divers. It is caused by ultraviolet radiation from the sun. This radiation is scattered by the atmosphere and reflected from water so that even sheltering in shade does not provide complete protection.

The **clinical features** of sunburn have been experienced by almost all divers and do not require elaboration.

Treatment.

This is essentially symptomatic. Further exposure to sunlight (even indirectly) should be avoided. A soothing or cooling lotion is often of value in relieving the pain, and steroid (cortisone) creams may be beneficial in severe cases. Blisters should not be ruptured as this invites secondary infection.

Prevention.

Protection can be afforded by covering the skin by clothing, by wearing a hat and by the use of a broad spectrum UV screening cream or lotion. Snorkel divers are advised to wear one of the lightweight protective Lycra suits, which also give protection against marine stingers and coral cuts.

Ultraviolet screening agents are now coded by a SP number which gives an approximate indication of the degree of protection compared with unprotected skin e.g. SP 10 cream will protect the skin from burning for at period 10 times longer than unprotected skin. Unprotected skin can begin to burn in 15 minutes in strong sunlight so that a sun screen with this level of protection can be expected to protect for 2.5 hours if an adequate thickness is maintained and the screen is not washed off. SP 15+ creams are even more effective and are advised.

Prolonged exposure to sunlight is associated with an increased incidence of skin cancer and premature skin ageing.

SEASICKNESS

This is a distressing and potentially hazardous problem for divers. It usually develops in susceptible individuals in the dive boat but can also develop underwater, during decompression on a shot line, in rough conditions or with underwater surge. On the boat, less attention is paid by the sea sick diver to dive planning and equipment preparation.

The associated vomiting causes dehydration on the boat and requires considerable skill to cope with underwater, if the diver is to continue breathing through his demand valve. It does have the advantage of attracting all sorts of fish homing in for a free feed.

Another potential problem relates to the sedating effect which is produced to some degree by most of the available anti-seasickness medications. This will affect judgment and aggravate nitrogen narcosis.

Prevention.

General measures to be taken include:

- remain in the centre line of the boat, but not near the bow (reduce spatial movements),
- positioning in the boat so that head movement is minimised, remain still (lie down),
- either keeping eyes closed or focusing on the distant horizon (avoid reading),
- if in an enclosed cabin, ensure air circulation with a fan if possible.

If mildly seasick, swimming or snorkeling around on the surface of a sheltered area for a short while will often settle symptoms. The diver can then reboard the boat to don gear and start the dive.

Short acting anti-seasickness tablets such as cyclizine are effective if taken 1 or 2 hours before boarding the boat. These last about 4 hours.

Another effective preventative measure is to take promethazine tabs (a well known oral antihistamine), 25 mg. at bed time the night before. It will cause sedation during the night but this corresponds to the normal sleep time. One dose at night will provide some resistance to sea sickness for the early part of the following day, with minimum sedation. The **depth** of diving should be **limited to less than 30 metres** (100 ft.), maximum, and preferably less than 18 metres (60 ft.) if drugs are used. A cup of coffee (caffeine) beforehand reduces seasickness and counters sedation in some.

In all cases, medication should have been tried previously (a "dry run") to ensure adverse side effects are not produced. It should not be taken if alcohol has been consumed because of additive effects.

Transdermal ("Scop") skin patches are not recommended for diving due to side effects and variable absorption, but may be effective for sailors.

Acupuncture (via acupressure pads) and ginger, although currently fashionable, are really only of psychological value.

TEMPORO-MANDIBULAR (JAW JOINT) ARTHRITIS

Novice divers tend to be apprehensive underwater, especially about the reliability of their air supply. They therefore clamp their jaws tightly on the mouth piece, causing excessive stress on the joint between the upper and lower jaw. This can cause minor injury to the joint, manifested by spasm of the jaw muscles, pain, tenderness over the joint (in front of the ear), and inability to fully open the jaw.

In recreational divers this condition is usually temporary and is reversible by correcting the cause. The diver is encouraged to grip the demand valve less tightly with the jaws. Some older demand valves are heavy and bulky, placing undue stress on the jaw, while other types may be positioned so that the air hose pulls the jaw to one side, causing uneven and excessive strain.

In some older divers, permanent arthritic changes to the joint can occur, from this cause. Individually mouldable lugs on the mouthpieces of snorkels and regulators may help minimize these effects in some cases.

EXPLOSIONS – UNDERWATER BLAST

Fig. 32.1

This topic is included only as a warning for recreational divers not to use explosives underwater. Military divers are particularly at risk from these hazards, even in training – because of the use of "scare charges" which are designed to discourage underwater saboteurs and are sometimes used in the vicinity of trainee divers to toughen them up.

When an underwater explosion is observed from the surface, a sudden explosive projection of water and foam into the air can be seen immediately after the explosion. This is the effect of the pressure wave emanating from the blast when it meets an air–water interface.

A similar effect is produced at air–tissue interfaces in the body as the shock wave travels through the diver. This can shred tissues such as lungs, intestines, sinus cavities and the middle ear spaces, which are in contact with air – all gas containing spaces within the body can be affected.

Clinical features.

The organs worst affected are the lungs and intestines. Rupture and bleeding of the tissues in the lungs and bowel cause:

- chest pain
- shortness of breath
- vomiting or coughing up of blood
- passage of bloody or black bowel motions.

Damage to the ears and sinuses causes features similar to barotrauma. Ruptured ear drums and deafness are particularly common.

If a diver is caught in the water where an explosion is inevitable, some protection can be afforded by attempting to float on his back, on the surface – this will remove some of the air containing tissues from contact with the water.