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Review Article

Otolaryngological requirements for recreational self-contained underwater breathing apparatus (SCUBA) diving

R J Sim, R P Youngs*

Abstract

Recreational self-contained underwater breathing apparatus (SCUBA) diving continues to grow in popularity. Medical requirements to be 'fit to dive' vary throughout the world, from self-certification to a full medical examination prior to training. This review discusses the relative merits of the most commonly used guidelines for recreational SCUBA diving, with reference to common diving-related otorhinolaryngological conditions. Areas of controversy, such as fitness to dive after rhinological and otological surgery, are discussed. The authors suggest that a unified approach from the various recreational SCUBA diving organizations involved would aid in clarification for divers and physicians alike. The difficulties in achieving such a unified approach, however, should not be underestimated.

Key words: Diving; Otolaryngology; Decompression Sickness; Barotraumas; Standards

Introduction

Recent years have seen a large increase in the popularity of recreational self-contained underwater breathing apparatus (SCUBA) diving, and it is now common for otorhinolaryngologists to be confronted with patients enquiring as to their fitness to dive. When considering fitness to dive, two potential viewpoints are possible: firstly, that recreational diving is a sport with inherent risk and that individuals with any predisposing medical factor that increases this risk should be discouraged from diving; and, secondly, that recreational diving is a sport with inherent risk and that individuals with medical problems, who are able to fully evaluate the risks involved, should be encouraged to dive within their limitations. With either point of view, consideration should be given to any condition that is likely to be worsened by diving or that may threaten the safety of the diver concerned or of other divers. Thus, some countries have a mandatory diving medical examination, consisting of a detailed history, physical examination and investigations, undertaken by a physician with an interest in underwater medicine. Other countries have self-certification methods in which the diver assumes most of the risk but does not have the opportunity to discuss potential problem areas with a physician. Complicating these issues is the fact that diving is a worldwide sport facilitated by the ready availability of long distance air travel and often takes place in remote environments where access to high quality diagnostic and therapeutic medical expertise is difficult.

The underwater environment is potentially hazardous for both the fully fit and those with ENT pathology. For the clinician, determining which investigations should be undertaken in a given individual and identifying those who should be advised against recreational diving can be difficult, with medical guidelines varying throughout the world. In general terms, with regard to the ENT system as well as to specific pathologies that may cause morbidity, there are two major considerations: firstly, the exposure of the body to a hyperbaric environment and the problems this may cause regarding air-containing spaces that are unable to equilibrate with the environment; and, secondly, involvement of the vestibular system.

Exposure to a hyperbaric environment

Boyle's law states that, at a constant temperature, the volume of a gas varies inversely with the pressure and the pressure varies inversely with the volume. For gas-containing structures with rigid walls, such as the sinuses or middle ear, this means that if air is unable to enter or escape a pressure differential will occur, with congestion, oedema, haemorrhage or structural damage. This phenomenon is known

From the Department of Otolaryngology, and the *Gloucester Royal Hospital, Gloucester, UK.
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as barotrauma. Barotrauma can be caused by descent or ascent, with a decrease or increase in the volume of the trapped gas, respectively.

Structures at risk from barotrauma

The ear is the commonest structure to suffer with barotrauma, with the external, middle and inner ear all being potentially at risk.

In the external ear canal, air is normally replaced by water, thus avoiding problems. If this is prevented, by obstruction from wax, atresia, earplugs or a tight-fitting hood, then barotrauma may result as the diver descends. This results in the tympanic membrane bulging outwards, with haemorrhage and possible rupture.

The middle ear is the most common site for barotrauma to occur following failure to equalize via the Eustachian tube. This may be due to any condition causing Eustachian tube dysfunction, but is more commonly due to poor equalization technique on descent. As pressure increases and volume within the middle ear decreases, failure to equalize may cause the Eustachian tube to 'lock' as the mucosa is drawn inwards and becomes congested. The tympanic membrane is drawn in and may rupture if the pressure differential becomes great enough. Alternatively, haemorrhage within the middle-ear space may occur, with a haemotympanum balancing the pressure changes. Barotrauma during ascent is less common and is thought to be secondary to Eustachian tube oedema following barotrauma of descent.

Inner-ear barotrauma is most commonly seen following middle-ear barotrauma but can also follow difficulty in equalizing, particularly if excessive force is used. There are two main suggested mechanisms of damage. Firstly, as the tympanic membrane moves in during descent, the stapes footplate is displaced medially. This results in a displacement of the perilymph such that the round window bulges outwards. A forceful Valsalva manoeuvre at this stage rapidly returns the tympanic membrane to a neutral position, the stapes moves out and the round window is pushed back in. At this stage, the reverse flow of perilymph may not be sufficient to prevent round window rupture. Alternatively, it is suggested that the pressure rise in the cerebrospinal fluid due to a forceful Valsalva manoeuvre is transmitted through the cochlear aqueduct, causing a 'blowout' of the round window. Other potential mechanisms that can be neither diagnosed nor treated include haemorrhage into the cochlea or vestibule, rupture of Reissner's membrane, and traumatic transgression of air into the inner ear.

Of all the above events, the morbidity associated with inner-ear problems is potentially greatest, with sensorineural hearing loss, tinnitus and vertigo all being potential outcomes. Palsy is possible following barotrauma to the middle-ear facial nerve in the presence of a dehiscent fallopian canal; the possibility of otitis media and all its sequelae also exists.

Obstruction to the paranasal sinuses may occur due to nasal congestion, nasal polyps or other pathology. As in the middle ear, obstruction during descent will result in oedema and haemorrhage, whereas obstruction during ascent will result in blowout of the ostium. If this is not possible then the walls of the sinuses may be fractured, with surgical emphysema and possibly pneumocephalus.

The vestibular system

The underwater environment may be associated with loss of visual and proprioceptive input, placing increased emphasis on the vestibular system for spatial orientation. If for any reason the vestibular system is abnormally stimulated, either by pre-existing disease (e.g. Ménière's disease, benign paroxysmal positional vertigo or vestibular neuronitis), damage (e.g. barotraumas or decompression sickness) or unequal stimulation (e.g. caloric stimulation secondary to external ear canal obstruction or tympanic membrane perforation) then vertigo may result. If the vertigo is severe enough to cause vomiting, visual disturbance or unconsciousness then the situation can rapidly become potentially fatal.

Decompression sickness

In addition to the risks described above, the ENT system and, in particular, the inner ear are at risk from decompression sickness. Henry's law states that, at a given temperature, the amount of gas dissolved in a liquid is directly proportional to the partial pressure of that gas. During descent, pressure increases with depth and the amount of gas that can be held in solution increases. During ascent, as pressure drops, a supersaturated solution occurs, with the subsequent formation of gas bubbles. Decompression tables allow for asymptomatic excretion of absorbed gases, but it is still possible to detect venous gas bubbles by ultrasound in divers who have followed a safe dive profile.[1]

Otolaryngological guidelines for recreational SCUBA diving

Having considered the structures at risk and the potential mechanisms of injury, we will review the current medical guidelines available to ascertain fitness to dive. This review will consider the current guidelines of three of the most prominent recreational SCUBA diving organizations, the Professional Association of Diving Instructors (PADI), the British Sub Aqua Club (BSAC) and the South Pacific Underwater Medicine Society (SPUMS).

The Professional Association of Dive Instructors, although operating throughout the world, is based in the United States. It requires no mandatory medical examination but relies on a self-completed questionnaire filled in prior to diving, following a written statement of the potential risks of diving. If any of the medical questions are answered in the positive, a diving medical opinion must be sought, with the selected physician assuming responsibility for a decision regarding fitness to dive. If the responses are all negative, no further examination is necessary and fitness to dive is assumed. The potential danger of this approach is that divers may

falsify responses in the knowledge that a positive response may entail a medical examination (with its associated monetary cost), with possible subsequent disqualification from diving. This process may take place in an exotic tropical location, travel to which may have entailed considerable time and expense. The current PADI guidelines are reproduced in Appendix 1.[2]

The British Sub Aqua Club, in the United Kingdom, issues guidelines in collaboration with the UK Sport Diving Medical Committee (UKSDMC), which also advises the Sub Aqua Association and the Scottish Sub Aqua Club. The BSAC now operates a certification system similar to PADI, using a self-completed questionnaire. A change in policy, from a mandatory medical examination to a self-declaration medical form, was undertaken following a study casting doubt on the usefulness of routine diver medical examination undertaken by general medical practitioners.[3] The current UKSDMC questionnaire is reproduced in Appendix 2,[4] along with the medical standards from the BSAC website as Appendix 3.[5] Answering any of the questions in the positive requires the applicant to contact a UKSDMC-appointed medical referee, who will advise the diver regarding fitness to dive. Of significant concern in the UKSDMC questionnaire, from an otolaryngological standpoint, is the absence of any enquiry regarding paranasal sinus disease or surgery.

The South Pacific Underwater Medicine Society operates in Australia. Medical criteria for recreational SCUBA diving are produced as an Australian standard (AS4005.1) and are by far the most rigorous of those considered in this review. The SPUMS ear, nose and throat guidelines specify examination by a physician specifically trained in conducting recreational SCUBA diving medical examinations. The assessment includes pure tone audiometry and the recommendation to obtain specialist otorhinological advice if necessary. The SPUMS guidelines are reproduced in Appendix 4.[6]

The requirements discussed above vary greatly, and there is little clinical evidence to suggest which patients should be allowed to dive and which should be advised not to. Given the physiological changes described earlier, exclusion of those who are unable to equalize middle-ear pressure for any reason and of those with complete obstruction of the external ear canal may be advisable.

A number of mechanisms for establishing which divers are at risk of barotrauma have been investigated. Recent studies by Uzun *et al.*[7,8] have cast doubt on the validity of the Valsalva manoeuvre in predicting otitic barotraumas in recreational divers. Uzun *et al.* investigated the predictive value of the Valsalva, Toynbee and nine-step inflation/deflation tympanometric tests for middle-ear barotrauma in 22 healthy divers. The Valsalva manoeuvre involves exhaling with the mouth and nose closed to increase nasopharyngeal pressure and to force air up the eustachian tube. The Toynbee manoeuvre involves swallowing with the mouth and nose closed. The ability to perform these tests was measured using an impedance audiometer and recorded as a tympanogram. In the nine-step inflation/deflation test, the middle-ear pressure was recorded and then the external ear canal pressure increased to +200 daPa. The subject equalized by swallowing three times and a second tympanogram was recorded. The external ear canal pressure was returned to atmospheric pressure and equilibration of the middle ear performed and recorded on a tympanogram. These steps were then repeated with a negative external canal pressure of −200 daPA. Failure to alter middle-ear pressure by at least 10 daPA in any of the above tests was recorded as poor eustachian tube function. In addition, the direction of pressure shift, compared with that expected, was recorded for the nine-step test. All symptomatic ears were reviewed by the same clinician and all divers were interviewed about any otological symptoms at the end of the study. The ability of the tests to discriminate between ears prone to barotrauma or not was analysed. This analysis showed that the Valsalva manoeuvre was not a sensitive test – it identified none of the symptomatic ears and 84 per cent of the asymptomatic ears. The Toynbee test identified 18 per cent of the symptomatic ears and 85 per cent of the asymptomatic ears. The nine-step test identified 83 per cent (five of six) of the symptomatic ears and 95 per cent (36 of 38) of the asymptomatic ears. Combining the tests did not significantly increase the sensitivity of the results in this study. From these results, which are consistent with those of previous reports, the Valsalva manoeuvre cannot be recommended for the evaluation of fitness to dive. The nine-step test is a better predictor of the potential for middle-ear barotraumas.[7]

Additionally, work has been undertaken assessing mastoid pneumatization and the correlation with barotrauma risk. The area of the mastoid air cells was calculated by measuring the maximum length of air cells on the infraorbital line and the maximum length of air cells on a line perpendicular to this on an X-ray of the temporal bone taken in Schuller's view (the patient was positioned in the ventral decubitus position with the head turned laterally on the side to be examined). The X-ray tube was angled craniocaudally (about 25°); the central X-ray exited the external auditory canal to be examined. This method gave a result that did not represent the actual mastoid size but had a strong correlation with the mastoid volume as assessed by a planimeter. An inverse correlation was found between the degree of mastoid pneumatization and the risk of symptomatic barotrauma in a study involving 24 divers.[8]

As mentioned above, the inner ear is at risk from decompression illness (DCI). There are a number of theories regarding the mechanism of damage, including:

(1) Rupture of bone lining the otic spaces by bubbles forming within osteoclasts.
(2) Supersaturation and bubble formation within the perilymph/endolymph.
(3) Vascular emboli.

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(4) Impaired perfusion secondary to the haematological effects of DCI.
(5) Tissue damage secondary to bubble formation within an enclosed space.

Although the mechanism is unclear (and there could potentially be more than one), there is growing evidence to suggest that there is a greater risk of DCI in the presence of a right-to-left shunt, as occurs with a patent foramen ovale. As stated above, the formation of gas bubbles in the venous circulation during ascent is a relatively common and asymptomatic phenomenon. This occurs either directly or following formation in tissues. These bubbles are usually trapped in the lung and no clinical signs of DCI occur. One potential mechanism for the transfer of bubbles to the arterial system is via a patent foramen ovale, creating a transient right-to-left shunt during a forceful Valsalva manoeuvre.[9] This can be demonstrated using transcranial ultrasound to detect sonographic intravenous contrast medium consisting of air microbubbles.[10] The degree of shunt is classified according to the number of ultrasound signals detected following Valsalva.[7] Cantais *et al.* studied 101 divers presenting with decompression sickness and found a right-to-left shunt in 58.4 per cent, compared with 24.8 per cent in a group of control divers.[12] This shunt was described as major in 12 of 25 patients in the control group and 49 of 59 in the symptomatic group. The increased association seen in those with cochleovestibular disorders and cerebral symptoms suggests a correlation between major right-to-left shunt and decompression illness in these groups.[12] In practice, differentiating patients with inner-ear DCI from those with inner-ear barotrauma can be difficult. A recent article proposed hyperbaric oxygen therapy for all divers in whom inner-ear DCI was a possibility.[13] Worsening of inner-ear barotrauma is prevented by bilateral myringotomy prior to recompression.

With regard to other common ENT problems, experienced divers with tympanic membrane perforations are sometimes able to continue diving with little ill effect, but those about to start are correctly advised against taking up the sport due to the possibility of vertigo following asymmetric labyrinthine stimulation and exacerbation of chronic middle-ear infection. The same reasoning would presumably apply to those who suffer from Ménière's disease or other causes of acute vertigo, although it may be argued that the guidelines issued by the UK Driver and Vehicle Licensing Agency may be suitably applied to those wishing to dive.

One area of controversy often raised by otologists is that of previous ear surgery and in particular surgery for otosclerosis. Patients undergoing stapes surgery are normally advised not to undertake SCUBA diving due to the risk of barotrauma. However, there is some evidence that this advice is overcautious. Animal studies with hyperbaric exposure after stapedectomy have not shown an increased risk of inner-ear barotraumas.[10] Additionally, review of post-stapedectomy patients who had undertaken sky or SCUBA diving did not demonstrate an increased risk of inner-ear barotraumas.[15]

In cases of previous tympanoplasty surgery, the integrity of the tympanic membrane is clearly the important issue. Repaired tympanic membranes can have reduced, normal or increased mobility. Sclerotic, immobile tympanic membranes may prevent middle-ear equalization. Atrophic, hypermobile tympanic membranes may allow equalization but be in danger of spontaneous rupture when submitted to the large pressure changes that can occur in diving. Also relevant is the fact that the need for previous otological surgery may reflect relative dysfunction of the Eustachian tube. In considering these difficult cases, the otologist is often faced with a dilemma, as many divers can return to trouble-free diving after successful middle-ear surgery. A prudent approach, with a recommendation to undertake diving after middle-ear surgery initially in the controlled environment of a swimming pool rather than in open water, is usually sensible.

The risk to divers who have previously undergone sinus surgery is somewhat unclear. Undoubtedly, sinus barotrauma can cause rare but significant neurological sequelae, and this risk may be increased if there is a potential communication between the sinuses and the cranial cavity or orbits following sinus surgery.[16] However, in patients who remain symptom free having undergone successful and uncomplicated sinus surgery, there seems no reason to suspect an increased risk, particularly if the bony margins can be demonstrated to be intact radiologically. Indeed, most paranasal sinus surgery involves enlarging the ostia of the sinuses, which could in theory make sinus barotrauma less likely than in the un-operated individual. Other considerations, such as the presence of underlying sinus mucosal disease (including polypoid rhinosinusitis), would need to be taken into account.

There are, therefore, a number of concerns for the otolaryngologist certifying fitness to dive, many of which concern pressure changes and subsequent physiological changes. Identifying at-risk individuals requires a full history and, in some cases, a specialist examination of the ears and nasal cavity. However, since the greatest pressure changes occur in the first few metres underwater and since preliminary training is universally carried out in a pool or safe environment, it would seem reasonable to let these individuals attempt training if they wish to do so. It should also be remembered that many divers will develop temporary symptoms that may make diving unsafe for a period of time in an otherwise fit diver.

Since the above guidelines vary widely in their screening methods, intervals of examination and the specialist advice available to medical referees, we suggest a more unified approach. In particular, we feel that there is more guidance needed with regard to the required ENT examination and the potential risks posed to ENT structures from recreational SCUBA diving. Unfortunately, the large number of agencies involved in the regulation of recreational SCUBA diving, and the substantial commercial considerations involved, may well make such a unified approach unobtainable in practice.

References

1 Edmonds CL, Pennefather J, Walker R. *Diving and Subaquatic Medicine*, 4th edn. London: Arnold, 2002
2 Professional Association of Dive Instructors. (2001) version 2.0. URL: www.padi.com/english/common/courses/forms/pdf/10063-Ver2-0.pdf, viewed 22 May 2006
3 Glen S, White S, Douglas J. Medical supervision of sport diving in Scotland: reassessing the need for routine medical examinations. *Br J Sports Med* 2000;**34**:375–8
4 UK Sport Diving Medical Committee. 2005, URL: www.uksdmc.co.uk/main/medicalform.pdf, viewed 22 May 2006
5 British Sub Aqua Club. 1999, URL: www.bsac.org/medical/medform2.htm, viewed 22 May 2006
6 South Pacific Underwater Medicine Society. 1999, URL: www.spums.org.au/_data/page/16/SPUMS_Diving_Meidcal.pdf
7 Uzun C, Adali MK, Tas A, Koten M, Karasalihoglu AR, Devren M. Use of the nine-step inflation/deflation test as a predictor of middle ear barotrauma in sports scuba divers. *Br J Audiol* 2000;**34**:153–63
8 Uzun C, Adali MK, Koten M, Yagiz R, Aydin S, Cakir B *et al*. Relationship between mastoid pneumatization and middle ear barotrauma in divers. *Laryngoscope* 2002;**112**:287–91
9 Schminke URS, Daffertshofer M, Staedt U, Hennerici M. Patent foramen ovale: a potential source of cerebral embolism? *Cerebrovasc Dis* 1995;**5**:133–8
10 Teague SM, Sharma MK. Detection of paradoxical cerebral echo contrast embolization by transcranial Doppler ultrasound. *Stroke* 1991;**22**:740–5
11 Knauth M, Ries S, Pohimann S, Kerby T, Forsting M, Daffertshofer M *et al*. Cohort study of multiple brain lesions in sport divers: role of a patent foramen ovale. *BMJ* 1997;**314**:701–5
12 Cantais E, Louge P, Suppini A, Foster PP, Palmier B. Right-to-left shunt and risk of decompression illness with cochleovestibular and cerebral symptoms in divers: case control study in 101 consecutive dive accidents. *Crit Care Med* 2003;**31**:84–8
13 Klingmann C, Benton P, Schellinger P, Knauth M. A safe treatment concept for divers with acute inner ear disorders. *Laryngoscope* 2004;**114**:2048–50
14 Antonelli PJ, Adamczyk M, Appleton CM, Parell GJ. Inner ear barotrauma after stapedectomy in the guinea pig. *Laryngoscope* 1999;**109**:1991–5
15 House JW, Toh EH, Perez A. Diving after stapedectomy: clinical experience and recommendations. *Otolaryngol Head Neck Surg* 2001;**125**:356–60
16 Parell GJ, Becker GD. Neurological consequences of scuba diving with chronic sinusitis. *Laryngoscope* 2000;**110**:1358–60

Appendix 1. Professional Association of Diving Instructors guidelines[2]

Equalization of pressure must take place during ascent and descent between ambient water pressure and the external auditory canal, middle ear and paranasal sinuses. Failure of this to occur results at least in pain and, in the worst case, rupture of the occluded space, with disabling and possible lethal consequences. The inner ear is fluid-filled and therefore noncompressible. The flexible interfaces between the middle and inner ear, the round and oval windows, are however subject to pressure changes. Previously ruptured but healed round or oval window membranes are at increased risk of rupture due to failure to equalize pressure or due to marked overpressurization during vigorous or explosive Valsalva manoeuvres. The larynx and pharynx must be free of an obstruction to airflow. The laryngeal and epiglottic structure must function normally to prevent aspiration. Mandibular and maxillary function must be capable of allowing the patient to hold a scuba mouthpiece. Individuals who have had mid-face fractures may be prone to barotrauma and rupture of the air-filled cavities involved.

Relative risk conditions

Recurrent otitis externa
Significant obstruction of external auditory canal
History of significant cold injury to pinna
Eustachian tube dysfunction
Recurrent otitis media or sinusitis
History of tympanic membrane perforation
History of tympanoplasty
History of mastoidectomy
Significant conductive or sensorineural hearing impairment
Facial nerve paralysis not associated with barotrauma
Full prosthedontic devices
History of mid-face fracture
Unhealed oral surgery sites
History of head and/or neck therapeutic radiation
History of temporomandibular joint dysfunction
History of round window rupture

Severe risk conditions

Monomeric tympanic membrane
Open tympanic membrane perforation
Tube myringotomy
History of stapedectomy
History of ossicular chain surgery
History of inner-ear surgery
Facial nerve paralysis secondary to barotrauma
Inner-ear disease other than presbycusis
Uncorrected upper airway obstruction
Laryngectomy or status post partial laryngectomy
Tracheostomy
Uncorrected laryngocele
History of vestibular decompression sickness

Appendix 2. Diver medical health questionnaire, UK Sport Diving Medical Committee[4]

(1) Have you suffered at any time from diseases of the heart and circulation, including high blood pressure, angina, chest pains and palpitations?
(2) Have you at any time had chest or heart surgery?
(3) Have you suffered from or had to take medication for asthma?
(4) Have you ever had collapsed lung or pneumothorax?
(5) Have you ever had any other chest or lung disease?
(6) Have you suffered at any time from blackouts, fainting or recurrent dizziness?
(7) Have you had regular ear problems in the past 10 years?
(8) Do you have an ileostomy, colostomy or ever had repair of a hiatus hernia?
(9) Have you ever had epilepsy or fits?
(10) Have you had recurrent migraines?

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(11) Have you ever had any other disease of the brain or nervous system (including strokes or multiple sclerosis)?
(12) Have you ever had any back or spinal surgery?
(13) Have you any history of mental or psychological illness of any kind, fear of small spaces, crowds or panic attacks?
(14) Have you any history of alcohol or drug abuse in the past five years?
(15) Do you have diabetes?
(16) Are you currently taking any prescribed medication (except the contraceptive pill)?
(17) Are you currently receiving medical care or have you consulted the doctor in the last year other than for trivial infection or minor injury?
(18) Have you ever been refused a diving medical certificate or life insurance or been offered special terms?
(19) Have you ever had, or been treated for, decompression illness?

Appendix 3. ENT medical standards, British Sub Aqua Club Medical Section[5]

Disqualifying factors

Perforated eardrum in new entrants
Chronic vestibular disease in new entrants

Allowable factors

Perforated eardrum known to have been present during several years of diving
Healed perforation, including 'paper thin' scars
Unilateral nasal block
Sinusitis if not adversely affected by diving

Other points

Valsalva test of drum mobility should be carried out and, if doubtful, a practical diving test in a pool should be advised. For this purpose, any wax obscuring a good view of the drum should be removed.

Deafness: At the discretion of the medical referee, the candidate may be restricted to diving with a fit companion.

Sinusitis may benefit from diving!

Appendix 4. Ear, nose and throat guidelines, South Pacific Underwater Medicine Society[6]

(1) Both tympanic membranes should be seen to be intact and mobile. The eustachian tubes must be patent.
(2) Any evidence of chronic outer- or middle-ear discharge may be cause for rejection.
(3) Any evidence of chronic or recurrent sinusitis, catarrh or severe allergic conditions of the respiratory tract may be cause for rejection.
(4) Any history of middle-ear surgery (including tympanoplasty) should be referred for diving specialist opinion before any decision is made.
(5) Audiometry: Baseline audiometric examinations should be done. The audiogram shall be conducted at 500, 1000, 2000, 4000, 6000 and 8000 Hz. An abnormal audiogram should be noted in the diver's logbook. If there are any significant abnormalities in either audiometry or labyrinthine function, the patient should be referred to a diving specialist. Hearing loss is not necessarily a contraindication to diving.

Note: The middle ears and sinuses will develop problems on descent unless the pressure in these spaces equals ambient. There is no way of establishing the patency of sinus ostia by clinical examination. However, patency of the eustachian tubes, and so the ability to equalize the middle-ear pressures, can be established. Observation of the tympanic membranes while the patient holds his (or her) nose, shuts the mouth and blows (Valsalva manoeuvre) will show entry of air to the middle ear by movement of the drum.

Address for correspondence:
Robin Youngs,
Consultant Otolaryngologist,
Gloucestershire Royal Hospital,
Great Western Road,
Gloucester GL1 3NN, UK.

E-mail: robin.youngs@glos.nhs.uk

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