



Assessing Fitness to Dive in Children and Adolescents. Relevance to Otolaryngologists

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Abstract

Diving as a leisure sport has become increasingly popular. Most health problems in sports divers occur in the otolaryngological field. Assessing fitness to dive is thus a major issue to Ear, Nose and Throat (ENT) physicians. About 10% of all sports scuba divers are children and adolescents. They underlie differences in the anatomy of the upper respiratory tract. Little is known about the particular risks and consequences of scuba diving on a child's health. Due to the differences of childhood anatomy and physiology to adults, certain restrictions apply to the diving fitness of children and adolescents, let alone carrying the heavy equipment as well as the mental stress of encountering an unforeseen dangerous animal.

Before starting scuba training, the presence of particular cognitive abilities must be demonstrated and Eustachian tube dysfunction must be examined by a specialist. Medical contra-indications to scuba diving for adults apply to children too, but must be adapted to the paediatric circumstances. Relative risks for adults may translate to absolute contra-indications in children and adolescents.

When planning dives, there should be rigorous limitations as to depth and time. Experienced adult divers must always assist with dive planning and accompany children and adolescents when scuba diving.

In this present chapter, anatomical bases and requirements for fitness to dive will be described, with special emphasis on children and adolescents. A review of the current literature adds to the discussion who should dive, and when.

Introduction

In line with the rising number of recreational divers, otorhinolaryngologists are facing growing numbers of diving-associated disorders of the ear, nose and throat (ENT) ¹. Also children want to participate in this popular sport. Additionally, the majority of divers present to their otolaryngologist for assessment of their fitness to dive, making this a section with growing importance in our field. Compared to times when only professional divers were allowed under water, the requirements to be fulfilled are being lowered and a wider population is granted access to this sport now ². On the basis of long-term follow-up examinations and increasing experience in diving medicine, even divers with a history of ENT problems can be considered fit to dive ³⁻⁵. The guidelines for fitness to dive in such patients are being constantly revised. Assessing fitness to dive in children is yet another topic ⁶. Not only the physical health plays a major role, also the ability of active pressure equalization or the technical capability of handling the equipment must

be considered. Additionally, children tend to be less aware of the potentially life threatening situation under water, or be scared of expected and unexpected situations, like a big fish, losing the mask or reduced visibility.

Prior to training, all scuba diving candidates must successfully complete a medical examination to determine their medical, physical, and psychological fitness for survival in a subaquatic environment. For example, in the United States, diving of individuals who have insulin-dependent diabetes or severe asthma is not approved of ⁷.

Physiology

Immersion under water accounts for different physiological circumstances by the environmental pressure changes. Additionally, saturation of inert gases in the tissues increases and can cause decompression illness.

Anatomy / Special attention to be paid when assessing fitness to dive

EAR: Eustachian tube dysfunction is most common in children since their Eustachian tube is shorter. Additionally, adenoids are larger than in adults and may impair middle ear ventilation. A careful otolaryngologic exam thus needs to be performed, including otomicroscopy to assure movement of the tympanic membrane during Valsalva manoeuvre as well as epipharyngoscopy to exclude adenoid vegetations.

AIRWAYS: Asthma and Allergy are the most common chronic diseases in children and thus occur often in pediatric patients wanting to dive. A lung function test / spirometry and pletysmography is recommended before admitting children under water. Until a few years ago, asthma was an absolute contraindication for diving, this threshold is now being lowered ^{2, 8, 9}.

SKELETON: The spine needs to be stable enough to carry the heavy equipment and withstand the physical strains of diving. Fractures are transient contraindications, as well as diseases with minor expression such as scoliosis or arthritis, which are relative contraindications and should be referred to a diving medical officer specialized in orthopaedic surgery. The oromaxillofacial anatomy is also not fully developed, and an impaired occlusion may severe the grip of the mouthpiece in children. Additionally, problems can occur with the temporomandibular joint, which is quite common in adults ¹⁰.

HEART: The incidence of a patent foramen ovale is much higher in children, and thus children are more prone to a shunt allowing bubbles of inert gases into the left circulation. Parents must be informed about the higher risk of a decompression sickness^{11, 12}. Also, the heart is smaller, and the pulse higher, leading to quicker exhaustion. Pulmonary hypertension is also a contraindication. Chronic arrhythmias as in Wolf Parkinson White syndrome are absolute contraindications.

NERVOUS SYSTEM/ PSYCHE: Epilepsy – except for non- recurrent fever fits in early childhood- is an absolute contraindication for diving. Attention deficit has to be carefully evaluated, since absolute concentration is needed under water to handle the equipment and follow the group. Adolescent who are reluctant to following instructions and who find a thrill in risk- searching, should not dive until they are completely aware of the dangerous situation under water, as well as confident in calm behaviour in emergencies

METABOLISM Insulin dependent diabetes mellitus is an absolute contraindication in children¹³. Extremely adipose children should not dive. The body fat with its insulating function has to be taken into account, since children suffer faster from hypothermia and are less aware of cold¹⁴. They should always wear neoprene suits.

Requirements for fitness to dive

Current recommendations for diving of children and adolescents include

- age older than 16 year old
- intact tympanic membrane
- ability for spontaneous pressure equalization (Valsalva manoeuvre)
- good swimmer
- stable psyche / no fright or panic/ good concentration/ following instructions and not searching risks
- stable spine / ability to carry heavy equipment
- No more than one dive per day and no decompression- time requirements
- Presence of experienced adult divers and instructors

Generally, most of the risks and requirements apply as for adults, but must be handled stricter! A careful, individual evaluation of fitness to dive is extremely crucial. Only experienced instructors and physicians should clear children for fitness to dive and set their individual margins for depth and diving time.

Review of the literature

In 2007, Gonnermann et al. published an investigation on diving related health problems of 429 active divers. They found that a substantial number of scuba divers suffered diving-related ENT disorders. They found that otitis externa was the most frequent disorder (43.6%). Barotrauma of the sinuses (10.9%), alternobaric vertigo (9.0%) and barotrauma of the middle ear (8.7%) played an important role as well. In contrast, inner ear barotrauma and decompression illness of the inner ear were less frequent but not rare (1.7 % each).

Another study from the Heidelberg ENT diving clinic presents the distribution of ENT related diseases in divers as follows: 24 divers (8%) with external ear disorders, 140 divers (46%) with middle ear disorders, 56 divers (18%) with inner ear disorders, 53 divers (17%) with disorders of the nose and sinuses, 24 divers (8%) with decompression illness (DCI) and nine divers (3%) who complained of various symptoms. Only 18% of the divers presented with acute disorders. The most common disorder (24%) in those adult divers was Eustachian tube dysfunction. This underlines the importance of good middle ear ventilation in children wanting to dive! The middle ear is the main problem area for divers. Middle ear ventilation problems due to Eustachian tube dysfunction can be treated conservatively (training of pressure equalization every hour) with excellent results whereas pathology of the tympanic membrane and ossicular chain often require surgery.

Conclusion

Although diving is a beautiful sport, it should be pointed out that it is potentially dangerous. Being under water is a life threatening situation to humans, which is only made possible by breathing compressed air. Diving is not just like going to the zoo or aquarium to watch the animals and plants! There are many other great things children can experience in a vacation or under water. Snorkelling is one of them, and until a child is absolutely safe and confident swimming and snorkelling, it should not be admitted under water! The desires of a parent should never be projected onto the child, and the initiative and motivation should come from the diver himself. Otherwise the children will have more pressure than leisure under water.

Consent on a special diving certification for instructors and SCUBA bases for children is desirable, but far from reality.

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