Alternobaric vertigo in professional divers

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Alternobaric vertigo of any cause may be hazardous. In the terrestrial environment our sense of balance is redundant, comprised of vestibular function, vision, proprioception, and the tactile sense. Nevertheless, acute, spinning vertigo in a person driving a car for instance, might cause a serious accident. A free-swimming, neutrally buoyant diver in darkness or murky water receives little or no useful information regarding balance from vision, proprioception, or tactile sense, and has to rely more on vestibular function for orientation. Any disturbance of vestibular function in this situation may be critical, and a multitude of mechanisms causing such disturbance during diving have been described (1–3). However, experienced divers may use additional information regarding their position and movement in the water, such as changing pressure in gas spaces, movement of exhaust bubbles, and the effect of gravity on heavy equipment. Severe vertigo is frequently combined with nausea, and vomiting underwater when wearing a helmet with an oronasal inner mask may prove fatal. Vertigo and disorientation during diving could also cause other dangerous
situations, but whether vertigo caused by increased, asymmetric middle ear pressure,
alternobaric vertigo (AV) has actually caused death in diving is an unknown possi-
bility. Diving safety might improve if divers did not dive during respiratory tract
infections.

MATERIALS AND METHODS

The present investigation was part of the research program "Long-term effect of
diving on man." All professional divers who came to the Norwegian Underwater
Technology Centre (NUTEC) for different reasons were invited to participate. The
principal author also traveled to the worksite of a major dive project where many
divers were gathered. The first 164 divers who were collected have been described
in more detail previously (4). Since that time, 30 more have been added in the same
way. Many would combine scuba, hard hat, and deep heliox diving, so it is difficult
to divide them into fixed categories. The age distribution in the present sample of 194
civilian and Navy divers is shown in Fig. 1. More than half of them (52%) were in
the age group 20–29 yr and the vast majority (88%) were below 40 yr of age.

Their diving experience, defined as total number of years of diving, is illustrated
in Fig. 2. The modal experience level was 5 yr; this group contained 20 divers. The
age span in that group was 21–30 yr with a mean and median of approximately 25.5
yr. The age span of the divers in the mean experience group (10–11 yr) was 26–36
yr, with a mean and median of approximately 30.5 yr of age, which is close to the
mean age of the total sample.

A detailed history was taken from each diver regarding ear disease or injury,
especially during diving, head injury affecting the ears, and noise exposure at work
and during spare-time activities, such as the use of firearms. Age, diving experience,
the incidence of vertigo, particularly AV, and tobacco habits were also noted, as well as possible hearing problems in close relatives. In 111 subjects eye color was recorded.

Our criteria for defining a case as AV were that acute vertigo, usually a sensation of rotation, could occur in direct relation to even small changes in ambient pressure or asymmetric middle ear equalization, and would be relieved by either a similar pressure change in the opposite direction or by symmetric pressure equalization to the middle ears. Other causes of vertigo should not be present simultaneously.

Each diver had an otologic examination performed by an otolaryngologist. For the majority this included otomicroscopy and pneumo-otomicroscopy, while in a minority a field examination using an otoscope and pneumo-otoscope was done. Pure tone audiometry was performed according to internationally accepted standards. Details about the audiologic aspects can be found in a paper on the hearing acuity in 164 of the divers (4). The group has since expanded to the present 194.

Bithermal caloric vestibular tests were performed in 48 divers. Each diver was tested from 1 to 6 times, and altogether 94 tests were performed. During testing, the subjects were lying supine in a lighted room with the head elevated to an angle of 30° above horizontal. The right and left ear were irrigated consecutively for 30 s with water at 30° and 44°C, i.e., 7°C below and above normal body temperature. After the nystagmic reaction had stopped there was a 10-min break before the next irrigation started. Sequence of stimulation was cold right, cold left, warm right, warm left.

Twenty of the divers (24 tests) were examined with their eyes open, but gaze fixation was prevented by the use of Bartel’s glasses. The nystagmus was observed visually and timed by using a stopwatch. In these cases the duration of the nystagmus was used as a measure of the cristo-ocular reaction.

In 28 cases (70 tests) the reaction was recorded by electronystagmography (ENG), using a Hewlett-Packard Bioelectric amplifier and recorder. A calibration procedure was performed at the beginning and end of each test, and the subjects kept their eyes closed during testing. They also performed mental arithmetic to stay alert.
The vestibu-lo-ocular response to caloric stimulation, the nystagmus, can be evaluated according to duration, frequency, or amplitude, and all these parameters were measured on the ENG. The most widely used criterion is the angular velocity of the slow nystagmus phase measured in degrees per second. Consequently, the results in this investigation refer to that criterion. A symmetric, slow-phase response of 5–80°/s was considered normal, whereas a side difference exceeding 15% of the total reaction and a directional preponderance exceeding 45% were considered abnormal (5–8).

Statistical tests for independence in bivariate tables were performed by the X-square test (age and diving experience grouped in 10-yr intervals). Further, a stepwise logistic regression analysis was performed to detect possible variables influencing the presence of AV. The stepwise selections of the independent variables were based on the maximum likelihood ratio (MLR). t-Tests were performed to detect a possible significant difference in mean age between divers with and without AV, and whether there was a significant difference regarding mean diving experience between divers with and without AV. Computations were performed by means of the Biomedical Computer Programs (BMDP) and the Statistical Package for the Social Sciences (SPSSX), installed in a Sperry 1100 computer.

RESULTS

Distribution of the variables used in the statistical analysis are shown in Table 1. Ear disease had been encountered at some time in more than one-third of the cases (36%). The majority had been exposed to high noise levels both during spare-time activities (58%) and during diving (82%). Susceptibility to noise-induced hearing loss is race and gender dependent (9, 10). An association with eye color has also been suggested. All the divers in this sample were male, all but 1 were Caucasians, and the majority (71% of the 111 with available information) had blue eyes. Consequently, they should belong to the most noise-sensitive fraction. Nevertheless, hearing loss was present in less than half of the sample (44%), in spite of the liberal criterion for hearing loss used (see footnote to Table 1).

Barotrauma of the ear is the most commonly occurring injury in diving. However, in the majority of cases it is so mild that it only causes minimal discomfort, and is thus not reported. "Ear barotrauma" in Table 1 refers to a degree of severity causing transient or permanent cochleo-vestibular damage. This has been encountered by approximately one-fifth of the divers (20%) in the present sample. Tobacco in any form was being used by less than half of the divers (43%).

Useful information about vertigo was obtained from 193 of the divers (Table 2). Of these, 117 (61%) denied having experienced vertigo during diving. Of the 76 (39%) who admitted to vertigo from any cause, 44 had mainly recognized such problems during ascent, 24 during descent, and 8 at stable depth. In 11, the condition was recognized in more than one of the described situations. In 1 of them, one reason was caloric stimulation caused by hot water suddenly entering one external ear canal from the hot-water supply to the suit. A slight upper respiratory tract infection was common in AV cases, especially when AV was experienced during descent, necessitating forceful Valsalva maneuvers. In such cases, asymmetric ear clearing cannot be excluded.
## Table 1

### Distribution of the Variables Used in the Statistical Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Response</th>
<th>No.</th>
<th>Percent of 194</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertigo</td>
<td>No</td>
<td>117</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>76</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Ear disease</td>
<td>No</td>
<td>118</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>70</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>6</td>
<td>3.1</td>
</tr>
<tr>
<td>Noise exposure spare time</td>
<td>No</td>
<td>80</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>113</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Noise exposure diving</td>
<td>No</td>
<td>34</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>159</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Hearing loss*</td>
<td>No</td>
<td>154</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>86</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Ear barotrauma</td>
<td>No</td>
<td>103</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>38</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>Use of tobacco</td>
<td>No</td>
<td>83</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>8</td>
<td>4.1</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>83</td>
<td>43</td>
</tr>
<tr>
<td>Eye color</td>
<td>Brown</td>
<td>19</td>
<td>9.8</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>13</td>
<td>6.7</td>
</tr>
<tr>
<td></td>
<td>Missing</td>
<td>83</td>
<td>43</td>
</tr>
<tr>
<td>Age</td>
<td>Fig. 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diving experience</td>
<td>Fig. 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Elevation of the hearing threshold in excess of 20 dB (re ISO 389) for a minimum of two frequencies.

In 4 of the vertigo cases the cause was cold caloric stimulation. Two of them suffered a ruptured tympanic membrane during descent, and the other 2, wearing dry suits, accidentally got cold water into one external ear canal. In 2 different vertigo cases the reason was believed to be high pressure neurologic syndrome (HPNS). In 6 other divers it was felt that nitrogen or CO₂ toxicity, darkness, inner ear barotrauma, or decompression sickness could have contributed to or caused the reported episodes of vertigo. After these 12 cases were excluded, we were left with 64 (33.2%) who had experienced AV according to our defined criteria.

Of the 48 divers who were subjected to vestibular tests, 20 (42%) had experienced vertigo of some kind during diving (Table 3), and 13 of those (13 out of 48, 27%; 13 out of 20, 65%) had reported AV. (The number of AV cases here is 13, although the
TABLE 2
INCIDENCE AND CAUSES OF VERTIGO

<table>
<thead>
<tr>
<th></th>
<th>No</th>
<th>Percent of All</th>
<th>Percent of Those with Vertigo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Useful sample</td>
<td>193</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Vertigo</td>
<td>76</td>
<td>39</td>
<td>100</td>
</tr>
<tr>
<td>AV</td>
<td>64</td>
<td>33</td>
<td>84</td>
</tr>
<tr>
<td>Caloric</td>
<td>4</td>
<td>2.1</td>
<td>5.3</td>
</tr>
<tr>
<td>HPNS</td>
<td>2</td>
<td>1.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Other*</td>
<td>6</td>
<td>3.1</td>
<td>7.9</td>
</tr>
<tr>
<td>Descent</td>
<td>24</td>
<td>12</td>
<td>32</td>
</tr>
<tr>
<td>Stable depth</td>
<td>8</td>
<td>4.1</td>
<td>11</td>
</tr>
<tr>
<td>Ascent</td>
<td>44</td>
<td>23</td>
<td>58</td>
</tr>
<tr>
<td>Comb.</td>
<td>11</td>
<td>5.7</td>
<td>15</td>
</tr>
</tbody>
</table>

*Darkness, barotrauma, N₂ "narcosis," CO₂ intox., DCS.

TABLE 3
RESULTS OF CALORIC VESTIBULAR TESTING IN 48 DIVERS

<table>
<thead>
<tr>
<th>Test Results</th>
<th>Vertigo Cases</th>
<th></th>
<th></th>
<th>No Vertigo</th>
<th>Sum (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AV (%)</td>
<td>Other (%)</td>
<td>Both (%)</td>
<td>Vertigo (%)</td>
<td>(%)</td>
</tr>
<tr>
<td>Normal only</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>7</td>
<td>23</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(21)</td>
<td>(15)</td>
<td>(48)</td>
<td>(83)</td>
<td></td>
</tr>
<tr>
<td>Abnormal only</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.1)</td>
<td>(0)</td>
<td>(2.1)</td>
<td>(4.2)</td>
<td></td>
</tr>
<tr>
<td>Normal and abnormal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.1)</td>
<td>(2.1)</td>
<td>(8.3)</td>
<td>(13)</td>
<td></td>
</tr>
<tr>
<td>Sum</td>
<td>12</td>
<td>7</td>
<td>1</td>
<td>28</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>(25)</td>
<td>(15)</td>
<td>(2.1)</td>
<td>(58)</td>
<td>(100)</td>
</tr>
</tbody>
</table>

number in Table 3 is 12, because we have included here the diver who had experienced both AV and other types of vertigo.) The incidence of vertigo from any cause, as well as the incidence of AV in this subsample, is close to the corresponding level in the total sample.

In this subgroup of 48 divers, 17 vertigo cases (35%) and 23 nonvertigo cases (48%) had only normal caloric vestibular test results. Among those who had more than one caloric test, 1 diver in each group (2%) had only abnormal test results, whereas both normal and abnormal results were found in 2 of the vertigo cases (4%) and in 4 (8%) of the nonvertigo cases.

Of the 94 caloric vestibular tests performed at different times in the described 48 divers, 80 (85%) were normal and 14 (15%), abnormal. Three of the cases in the abnormal category had borderline results, but since they were not strictly normal
they were classified as abnormal. One of the abnormal results was caused by the consumption of alcohol before testing. That diver had two normal test results, one before and one after the abnormal test.

The skew distribution of cases with normal-abnormal vestibular test results in this sample did not allow statistical analysis of whether there was a significant association between normal-abnormal caloric vestibular response and AV-not AV. In the bivariate analyses, the only variable having a statistically significant association with AV was barotrauma of the ear ($\chi^2 = 5.26, P = 0.022$).

Variables selected in the multiple regression analysis were barotrauma of the ear ($P = 0.015$) and noise exposure during diving ($P = 0.042$). Final computations were based on 179 cases. The odds for AV being present in cases experiencing aural barotrauma was 2.63 times the odds for AV in cases without aural barotrauma in their diving history. The odds for AV in cases with noise exposure during diving was 2.57 times the odds for AV in the group without noise exposure during diving. This strongly indicates an association between AV and aural barotrauma, and between AV and noise exposure during diving. No interaction terms were found to have significant effect on the presence or absence of AV.

Diving experience had a significant association with AV in the first step of the stepwise logistic regression analysis (corresponding to a univariate test). However, after adjusting for barotrauma in the stepwise logistic regression analysis, diving experience was no longer significant. (This is discussed in the following section.) However, the $t$ test showed a significant difference in mean diving experience (years of diving) between divers with (12 yr) and without (10 yr) AV ($t = -2.01, P < 0.05$). There was no significant difference in mean age between divers with (33 yr) and without (30 yr) AV.

Although no univariate effect could be demonstrated on AV from the use of tobacco, there was a significant association between tobacco use and aural barotrauma in a bivariate analysis. The odds ratio for aural barotrauma in present tobacco users was 3.3 times higher than in those who had never used tobacco. Not unexpectedly, we also found significant association between noise exposure during diving and diving experience.

DISCUSSION

Of the 64 divers in our AV group, 38 (59%) attributed their vertigo to middle ear pressure equilibration problems. The reasons for such problems were common cold or sinusitis in 29, or equalization trouble from other reasons and fast descent in the sea or in surface decompression chambers in 8. In 1 diver, no reason was given.

Several causes of vertigo during diving have been reported (11, 12). More than 25 yr ago Lundgren (13) focused on the mechanism behind a type of vertigo sporadically mentioned in the diving medical literature, and coined the term "alternobaric vertigo." The condition has also been called "le syndrome de Lundgren" (14). In a few of Lundgren’s 92 cases who had experienced this condition regularly or occasionally during diving, he had the opportunity to observe the condition being self-induced by the Valsalva maneuver in his laboratory. These subjects experienced severe vertigo combined with horizontal nystagmus, nausea, and loss of balance. In one person the reaction was severe enough to throw him headlong to the floor. This subject reported...
that, when diving, he would experience rapid relief from his vertigo when descending
in the water. Vertigo was often associated with reduced ability to equalize middle
ear pressure, and would last from a few seconds to 15 min.

The majority (95%) of Lundgren’s cases experienced AV only occasionally, most
frequently during ascent (73%), and the symptoms were rather mild (75%). A similar
pattern was present in our sample. However, in some of Lundgren’s cases (13) the
disorientation was severe enough to cause them to swim toward the bottom when
they intended to ascend. Fortunately, descending relieves the symptoms, but they
will relapse on ascent again, which may be hazardous, especially in breath-hold
divers.

In one of our cases vertigo was severe enough to force the diver to hold on to the
bottom line until the attack subsided, after he had managed to equalize the middle
ear pressure. One diver had recognized that a descent of 0.5 m was sufficient to
clear the vertigo. In 1 diver the vertigo lasted for 1 h after surfacing. One
of the standard hard-hat divers in this sample would experience AV during ascent,
severe enough to force him to hold on to the bottom line every time he dived during
a common cold. Sometimes he would become so nauseated that his helmet had to be
removed immediately on surfacing to allow him to vomit. During common colds, AV
and ear pain on ascent would force him to descend repeatedly, and once he needed
2 h to reach the surface from 10 msw.

Altemobaric vertigo has also been observed in aviation (15, 16), but less frequently
(17%) than in diving (up to more than 33%). Asymmetric ability in pressure equili-
bration to the middle ears was experienced significantly more frequently in the vertigo
group than in the nonvertigo group, both in diving and in aviation (13, 15), and was
specifically mentioned in 1 of our cases who would regularly experience AV during
ascent.

Experimental studies have demonstrated that the vestibular labyrinth, although
developed to detect linear and angular accelerations, is also sensitive to pressure
changes (17). Further, pressure changes in the middle ear are transferred to the
labyrinth (18). During diving, slow or insufficient pressure equalization to the middle
ears is a frequent problem, influenced by several factors (19–23). AV is caused by
increased and asymmetric middle ear pressure exceeding a threshold level of approx-
imately 60 cmH2O (24–27). During AV, nystagmus is present (28), and the direction
is toward the side that requires the highest forcing pressure for middle ear equalization
(26). Accordingly, during erect ascent the sensation of spinning is toward the ear with
the highest middle ear pressure (29).

In his original work in 1965, Lundgren (13) found AV in 26% of his sample of
Swedish sport divers (Table 4), which corresponds well with the 23% in our sample
who had experienced AV during ascent. In a more comprehensive survey 8 yr later
Lundgren and coworkers (30, 31) found an incidence of 17–19% among sport and
Navy divers. In 1966, Terry and Dennison (32) found an incidence of 32% in a small
sample of U.S. Navy divers. That was the highest incidence reported among Nor-
wegian professional (military and civilian) divers, before the present investigation. An
incidence of 12% was found in a substantial sample of U.S. Navy divers in 1970 (33).
Before Lundgren’s work in 1965 (13) the presence of vertigo related to pressure
changes was not systematically investigated. It is thus not possible to know how
many of Taylor’s sport divers (11) who felt dizzy during or after dives were AV cases.
The one who felt dizzy when ascending faster than 25 ft/min probably had the
alternobaric type of vertigo. Some of Coles and Knight’s British Navy divers (34) who felt giddiness during diving were probably AV cases. That might have been the case for at least the 4.8% who experienced giddiness from Valsalva’s maneuver. The incidence of vertigo reported in Australian Navy trainees in 1968 (35) was exceptionally low, probably because these trainees had not been exposed to alternobaric conditions often enough to encounter the condition. Furthermore, that investigation on aural barotrauma seems to have been more focused on cochlear effects.

The quoted literature (13, 30, 31, 33) indicates that the risk of experiencing AV at some time increases with increasing diving experience. In the present sample we also found that the AV cases had longer diving experience than the no-AV cases. The association between underwater noise exposure and AV is not easy to explain, although high noise levels per se may cause vertigo (36, 37). It may have to do with the association between noise exposure during diving and diving experience, and further between diving experience and AV.

It is interesting that the regression analysis indicated an association between previous aural barotrauma and AV, since impaired eustachian tube function may cause both these conditions. Aural barotrauma may also damage the vestibular labyrinth (1), and after some time of adaptation the diver will become symptom-free even if the healing of the damage is incomplete. Whether divers with asymmetric vestibular function are more susceptible to AV than divers with symmetric vestibular function is unknown.

We cannot explain why AV was so frequent in the present sample, but since all the divers were interviewed and examined by an otologist experienced in diving and diving medicine, who explained the AV phenomenon to each diver, we think our numbers are accurate. A possible source of error may be the divers’ memories. Incidents of AV that were remembered and reported were most likely real. However, divers who did not report such incidents may still have experienced AV occasionally but forgotten about it. Underreporting can thus not be excluded. Some divers want

### Table 4

A Survey of Vertigo During Diving

<table>
<thead>
<tr>
<th>Authors, yr</th>
<th>Country</th>
<th>Category</th>
<th>No. of Divers</th>
<th>Vertigo No, %</th>
<th>AV No, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taylor (1959)</td>
<td>USA</td>
<td>Sport</td>
<td>38</td>
<td>13 (34)</td>
<td>?</td>
</tr>
<tr>
<td>Coles &amp; Knight (1961)</td>
<td>UK</td>
<td>Mil.</td>
<td>62</td>
<td>14 (23)</td>
<td>?</td>
</tr>
<tr>
<td>Lundgren (1965)</td>
<td>Sweden</td>
<td>Sport</td>
<td>354</td>
<td>118 (33)</td>
<td>92 (26)</td>
</tr>
<tr>
<td>Terry &amp; Dennison (1966)</td>
<td>USA</td>
<td>Mil.</td>
<td>37</td>
<td>15 (41)</td>
<td>12 (32)</td>
</tr>
<tr>
<td>Bayliss (1966)</td>
<td>Australia</td>
<td>Mil.</td>
<td>526</td>
<td>2 (0.4)</td>
<td>?</td>
</tr>
<tr>
<td>Varosmarti &amp; Bradley (1970)</td>
<td>USA</td>
<td>Mil.</td>
<td>143</td>
<td>?</td>
<td>17 (12)</td>
</tr>
<tr>
<td>Lundgren et al. (1974)</td>
<td>Mil.</td>
<td></td>
<td></td>
<td>(22–23)</td>
<td>(17–19)</td>
</tr>
<tr>
<td>Molvær &amp; Albrektsen (1988)</td>
<td>Norway</td>
<td>Prof.</td>
<td>193</td>
<td>76 (39)</td>
<td>64 (33)</td>
</tr>
</tbody>
</table>
to be perfect and may selectively forget any minor incident disturbing their self-image. We are not insinuating that divers deliberately conceal relevant information from the physician, but this mechanism may possibly have caused underreporting. The frequency of AV in this study would therefore be low if reporting bias is considered. It has been suggested that AV may be a diving hazard (13). Vertigo and disorientation severe enough to force experienced, professional divers to cling to the bottom line and descend, as well as nausea and vomiting as described above, support that suggestion. On the other hand, none of the present divers seemed to think of AV as dangerous, and some of them deliberately and repeatedly exposed themselves to situations they knew would cause AV. Still, none of them suffered any lasting untoward effects from the condition. However, we do not know whether AV may have started a series of events that eventually led to a fatal accident in any of the many cases of divers’ death where no obvious cause has been found.

Now, 7 yr after the start of this investigation, 6 (3.1%) of the divers are reported dead. Four of them did not admit AV during diving when interviewed in connection with the present project, and 2 reported experiencing AV. Deaths of 2 of these divers were related to diving, but could not be attributed to vertigo.

All divers are taught not to dive during respiratory tract infections. Compliance with this rule would probably reduce the incidence of AV. The AV problem should be addressed specifically during diver training. Divers should at that stage be instructed to stop the ascent whenever AV occurs, hold on to the bottom line, try to obtain symmetric pressure equalization to the middle ears by moving the jaw or performing Toynbee’s maneuver, or descend approximately 1 msw. The occasional and intermittent nature of this phenomenon prevents any selection test or procedure to screen out susceptible individuals.

CONCLUSION

Alternobaric vertigo was associated with reduced eustachian tube function, and was experienced by one-third of the divers in the present sample. The majority experienced AV only occasionally, and usually the symptoms were not severe. However, as the symptoms sometimes were severe, AV cannot be excluded as a diving hazard.

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ANTERIOR VERTIGO IN PROFESSIONAL DIVERS

antérieur à l'oreille ($P < 0.05$) et l'exposition au bruit durant la plongée ($P < 0.05$). Le VA survint le plus souvent au cours des plongées avec un rhume ordinaire. Dans cet échantillon de plongeurs, le VA n'entraîna aucunes situations critiques ou sérieuses.

Molver O, Albrektsen G. Vertigo alternobarico en buceadores profesionales. Undersea Biomed Res 1988; 15(4):271–282.—Esta investigación forma parte de un proyecto realizado para detectar posibles efectos del buceo en el sistema cocleoverstibular. Se entrevistó, examinó otológicamente y estudio audiometricamente la audición de 194 buceadores profesionales. Se realizó pruebas vestibulares calóricas a 48 individuos. En la entrevista se investigo edad, experiencia en el buceo, enfermedad o lesión otológica previa, traumatismo craneoecefálico, exposición a ruido durante el buceo o durante actividades en el tiempo libre, color de ojos, habitu de tabaquismo y presentacion de vertigo durante las inmersiones. Se obtuvo informacion significativa en relacion al vertigo de 193. De los 76 (39%) que lo presentaron, 64 (33%) fueron clasificados como vertigo alternobarico (VA); que es un tipo de vertigo ocasionado por una presion asimetrica en el oído medio. Se realizo un analisis de regresion logistic de escalonamiento multiple para detectar las variables que contribuyen a la presentacion de VA. Las variables que presentaron una asociacion estadisticamente significativa con VA fueron el barotrauma del oído previo ($P < 0.05$) y la exposicion a ruido durante el buceo ($P < 0.05$). El VA que se presento con mayor frecuencia fue al bucear con resfrío comun. En este grupo de buceadores, el VA no llevo a ninguna situacion seria o critica.

REFERENCES