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CLINICAL STUDIES

Disorientation with middle ear barotrauma of descent

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Edmonds, C., and F. A. Blackwood. 1975. Disorientation with middle ear barotrauma of descent. Undersea Biomed. Res. 2(4):311-314.—Disorientation and vertigo, which develops in divers during descent, is objectively demonstrated with dysbaric electronystagmographic tracings. Middle ear barotrauma of descent is verified as a valid etiology in the classification of vertigo associated with diving and may present as either a transitory or a more persistent disorder.

middle ear barotrauma
vertigo

The occurrence of vertigo and disorientation is particularly hazardous to divers in the aquatic environment, especially when there is no physical contact with a companion diver or a communication line. It is aggravated when there is inadequate visibility, resulting in exceptional reliance being placed upon vestibular responses.

Sir Leonard Hill (1912) made reference to vertigo in two large series of studies of occupational disease of caisson workers. Heller et al. (1900) gave an incidence of 1.3% and described two different presentations: one included temporary deafness with vertigo lasting for some days, which was caused by middle ear barotrauma of descent; the other was a Ménière-like complex of vertigo, vomiting, and deafness which could persist indefinitely and was caused by decompression sickness. The clinical differentiation of these two groups was clear. Barotrauma was experienced during compression and could result in vertigo; decompression sickness developed during or subsequent to decompression. Many other causes of vertigo have subsequently been proposed and verified before inclusion in the current etiological classification from Edmonds et al. (1973).

The vertigo associated with ascent, and related to pressure changes and barotrauma, has been adequately described by Lundgren (1965), Fields (1968), and Edmonds et al. (1973). It has been demonstrated experimentally by Tjernström (1973) and verified clinically and electronystagmographically by Edmonds et al. (1973). Lundgren used the term *alternobaric vertigo* for the production of vertigo and disorientation during ascent, which was related to a difference in pressure between the middle ear cavities. Lundgren also noted that less than one-half of the divers complained of vertigo during descent. Terry and Dennison (1966) stated that vertigo was as frequent with descent as with ascent. Vorosmarti and Bradley

(1970) reported a small series of vertiginous divers, again from questionnaire data. These investigators supported the observations of Lundgren that alternobaric vertigo resulted from an overpressure of middle ear spaces during ascent, or from the Valsalva manoeuvre.

No experimental or electronystagmographical verification of the vertigo with descent has been available, although it was included in the Edmonds et al. (1973) classification.

VERTIGO IN DIVING—ETIOLOGICAL CLASSIFICATION

(from Edmonds et al. 1973)

Due to Unequal Vestibular Stimulation

1. Caloric
   a. Unilateral external auditory canal obstruction
      i. Cerumen
      ii. Otitis externa
      iii. Miscellaneous
   b. Tympanic membrane perforation
      i. Shock wave
      ii. Middle ear barotrauma of descent
      iii. Forceful autoinflation
2. Barotrauma
   a. External ear barotrauma of descent
   b. Middle ear barotrauma of descent
   c. Middle ear barotrauma of ascent
   d. Forceful autoinflation
3. Inner Ear Barotrauma
   a. Fistula of the round window
4. Decompression Sickness
5. Miscellaneous

Due to Unequal Vestibular Responses

1. Caloric
2. Barotrauma
3. Abnormal gas pressures
4. Sensory deprivation

In this classification, vertigo in diving was claimed to be possible from the middle ear barotrauma of descent. Such objective evidence is now reported in two case reports.

CASE REPORT NO. 1

This patient was a certified diver who frequently developed dizziness on descent. She commonly experienced difficulty in equalizing the middle ear spaces and frequently resorted to nasal decongestants. There was no symptomatology suggestive of disorientation during ascent, and usually the sensation of dizziness reduced as she remained at a constant depth.

On examination, there was no conventional evidence of any abnormality in inner ear function; she had normal pure tone audiograms and normal electronystagmograms to positional and bithermal caloric stimuli, all performed immediately prior to dysbaric electronystagmograms.

Dysbaric electronystagmograms (as described by Edmonds et al., 1973) were performed with the diver in the sitting upright position and with the eyes closed and positioned centrally. Electronystagmographic monitoring was controlled while the patient was subject to changes in atmospheric pressure. The compression was at the rate of 9 m/min to a depth of 18 m. The patient was then kept at the depth of 18 m for 2 min and ascended at the same rate. Minor problems were encountered with middle ear equalization during descent, but did not require cessation or delay of this descent.

The electronystagmographic results verified the subject's observation of vertigo associated with compression, which was relieved by maintenance of pressure and absent during decompression.

CASE REPORT NO. 2

This subject also had demonstrable normal hearing and vestibular function before having difficulty in equalizing both middle ear pressures during a recompression chamber descent. Because of the inability to achieve this middle ear equalization, the compression was terminated at 4.5 m. At that time the ongoing electronystagmographic monitoring (performed in conjunction with another experimental aim) demonstrated severe nystagmus associated with the subjective complaint of vertigo. The diver was in the supine position. Vertigo was stated to persist for many minutes after the initial middle ear injury, and nystagmus was demonstrated to persist in a progressively decreasing degree, for approximately 12 min.

CONCLUSIONS

Case Report No. 1 demonstrated in an objective manner that vertigo and nystagmus can be precipitated with the middle ear pressure changes during descent.

Case Report No. 2 demonstrated that middle ear barotrauma of descent can initiate vertigo and nystagmus, that this manifestation may continue, and that the condition need not be merely transitory.

Because there is no evidence of either abnormal cochlear or vestibular function prior to the dives referred to above, there is no reason to believe that the vestibular response is due to an underlying vestibular inequality. In both cases there is a history of inability in equalizing the middle ear spaces, and it is presumed that the inequality of middle ear pressure is the cause for both the transitory and the persistent abnormal vestibular response. The transitory response could be the result of the unequal physiological stimuli, i.e. unequal middle ear

pressures; the persistent nystagmus may be related to more persistent barotraumatic pathology in the vestibule. These descriptions are thus similar in concept, although opposite in direction, to the *alternobaric vertigo* described by Lundgren and confirmed independently by Edmonds and Tjernoström. The nystagmus responses described in this and previous reports are abolished or inhibited by eye opening, supporting the peripheral nature of the disorder.

The value of the dysbaric electronystagmogram to supplement routine vestibule function tests in aviators and divers is again verified.

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Edmonds, C., and F. A. Blackwood. 1975. La désorientation associée au barotrauma de déscente de l'oreille moyenne. Undersea Biomed. Res. 2(4):311-314.—La désorientation et les vertiges qui apparaissent chez les plongeurs au cours de la déscente sont objectivés par des tracés électronystagmographiques dysbariques. Le barotrauma auriculaire de déscente a donc sa place dans la classification étiologique des vertiges associés à la plongée, et peut présenter comme un trouble transitoire ou quasi-permanent.

barotrauma de l'oreille moyenne
vertiges

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