

Ultrasound for diagnosing inner ear decompression sickness

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Abstract: A 26-year-old male presented at our hospital complaining of vertigo after scuba diving. He had directional nystagmus and was hard of hearing in his right ear. An ultrasound study revealed a snowstorm pattern in the inferior vena cava, corresponding to grade III by Spencer's classification without persistent foramen ovale. He was diagnosed with decompression sickness and hyperventilation and transferred to the medical facility for hyperbaric oxygen recompression therapy. The presence of gas bubbles in the vascular system is often considered a sign of decompression sickness, and a positive relationship has been reported between the amount of bubbles detected on ultrasonography and the incidence of decompression sickness. Ultrasound may therefore be useful for diagnosing decompression sickness.

Keywords: ultrasound; inner ear; decompression sickness.

INTRODUCTION

Vertigo is among the most common complaints in medicine, affecting approximately 20% to 30% of the general population [1]. A crucial aspect in managing emergency patients with vertigo is the differentiation of vertigo associated with acute stroke syndromes from that due to peripheral causes [2]. We herein present a case describing the usefulness of an ultrasound study for diagnosing inner ear decompression sickness after diving

CASE PRESENTATION

A 26-year-old male presented at our hospital complaining of vertigo, discomfort, and dysesthesia in his extremities 2 hours after going scuba diving. He had no remarkable medical or family history. On arrival, he had a clear consciousness with isochoric reactive pupils. His vital signs were as follows: blood pressure, 90/60 mmHg; heart rate, 72 rate/min; body temperature, 36.5 °C; and percutaneous oxygen saturation 98% breathing room air. He had directional nystagmus, dysesthesia, and cutis marmorata on the right side of his trunk and was hard of hearing in his right ear (**Figure 1**). The findings on chest roentgen and electrocardiogram were negative, and head CT revealed no remarkable lesions. However, truncal CT showed a bubble in the left femoral vein. (**Figure 2**) An ultrasound study revealed a snowstorm pattern in the inferior vena cava, corresponding to grade III by Spencer's classification without persistent foramen ovale (**Figure 3**, Table 1). [3] The biochemical analyses performed on his arrival revealed respiratory alkalosis and leukocytosis. His levels of fibrin degradation products were within normal limits (1.3 µg/ml). He was diagnosed with decompression sickness and hyperventilation and

transferred to the medical facility for hyperbaric oxygen recompression therapy.



Fig 1: The body surface on arrival

Cutis marmorata was observed on the chest and upper abdomen.



Fig 2: Truncal CT

The CT showed a bubble in the left femoral vein.

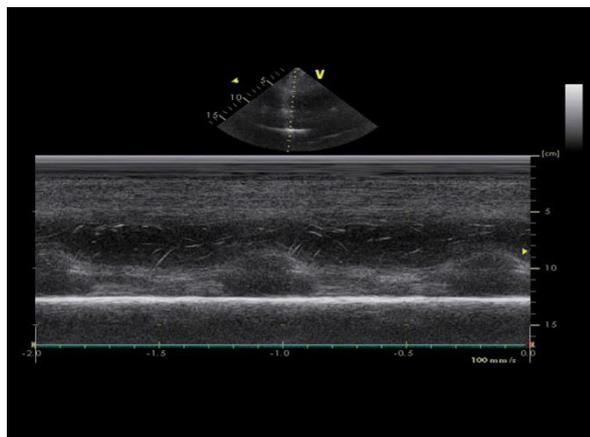


Fig 3: an ultrasound finding on arrival

The ultrasound revealed a snowstorm pattern in the inferior vena cava, corresponding to grade III by Spencer's classification

Spencer's scale of Doppler-detected bubbles Grade

0: No bubble signals

I: Occasional bubble signals; the majority of the cardiac cycles are signal-free

II: Many but less than half of the cardiac cycles contain bubble signals

III: All cardiac cycles contain bubble signals but do not obscure the cardiac motion

IV: Bubble signals evident throughout systole and diastole, obscuring the normal cardiac signals

DISCUSSION

The differential diagnoses of vertigo after diving include inner ear decompression, barotrauma, motion sickness, stroke, and psychogenic disease in addition to common diseases of the vestibular system, such as benign paroxysmal positional vertigo [4-7]. Urgent hyperbaric oxygen recompression therapy is required to treat inner ear decompression, but post-dive vestibular symptoms might also result from other causes which require only conservative treatment. Furthermore, hyperbaric oxygen recompression therapy is a contraindication for inner ear barotrauma. As such, physicians should familiarize themselves with the differential diagnoses and main diagnostic clues of these clinical entities.

Cutis marmorata is a distinct cutaneous manifestation of decompression sickness easily recognized by its typical mottled, marbled, violaceous appearance [8]. It may start as an intense multifocal itching, followed by generalized hyperaemia which in turn progresses to irregular dark-violet or purple patches. Cutis marmorata is thought to be caused by

vascular congestion triggered by vascular inflammation secondary to the development of intravascular gas bubbles. A combination of cutis marmorata and post-dive vestibular symptoms strongly suggests that the symptoms are induced by decompression sickness [5].

The presence of gas bubbles in the vascular system is often considered a sign of decompression sickness, and a positive relationship has been reported between the amount of bubbles detected on ultrasonography and the incidence of decompression sickness [9]. Efted *et al.*; reported that bubble detection by the ultrasonic scanning of the heart can be useful for assessing the severity of decompression sickness and is highly sensitive, although not very specific [9]. Ultrasonography may therefore be useful for ruling out decompression sickness, as in the present case.

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REFERENCES

1. Karatas M; Central vertigo and dizziness: epidemiology, differential diagnosis, and common causes. *Neurologist*. 2008; 14(6):355-64.
2. Delaney KA; Bedside diagnosis of vertigo: value of the history and neurological examination. *Acad Emerg Med*. 2003; 10(12):1388-95.
3. Spencer MP, Johanson DC; Investigation of new principles for human decompression schedules using the Doppler blood bubble detector. Washington: Office of Naval Research Tech Rep ONR Contract N00014-73-C-0094; 1974.
4. Gempp E, Louge P, Soulier B, Alla P; Cerebellar infarction presenting as inner ear decompression sickness following scuba diving: a case report. *Eur Ann Otorhinolaryngol Head Neck Dis*. 2014; 131(5):313-5.
5. Gempp E, Louge P; Inner ear decompression sickness in scuba divers: a review of 115 cases. *Eur Arch Otorhinolaryngol*. 2013; 270(6):1831-7.
6. Tal D, Domachevsky L, Bar R, Adir Y, Shupak A; Inner ear decompression sickness and mal de débarquement. *Otol Neurotol*. 2005; 26(6):1204-7.
7. Azizi MH; Ear disorders in scuba divers. *Int J Occup Environ Med*. 2011; 2(1):20-6.
8. Oode Y, Yanagawa Y, Inoue T, Oomori K, Osaka H, Okamoto K; Cutaneous manifestation of decompression sickness: cutis marmorata. *Intern Med*. 2013; 52(21):2479.
9. Eftedal OS, Lydersen S, Brubakk AO; The relationship between venous gas bubbles and adverse effects of decompression after air dives. *Undersea Hyperb Med*. 2007; 34(2):99-105.