

Letters to the Editor

Commentary on Plogmark, et al. Agreement between ultrasonic bubble grades using a handheld self-positioning Doppler product and 2D cardiac ultrasound

We read with great interest the paper “*Agreement between ultrasonic bubble grades using a handheld self-positioning Doppler product and 2D cardiac ultrasound*”.¹ We agree with authors general conclusion regarding a lower sensitivity to microbubbles, especially to the small ones, of the subclavian Doppler sensor O’Dive when compared to 2D medical echocardiography with a premium level echograph. However, we found this conclusion incomplete, because it lacked the analysis of observed decompression sickness (DCS) in relationship to venous gas emboli (VGE) scores.²

The authors recorded VGE with the O’Dive for 152 controlled experimental air dives in a hyperbaric chamber in addition to medically diagnosed DCS (the study’s primary endpoint) and VGE measured using echocardiography (the study’s secondary endpoint). Courtesy of the authors we have accessed paired data of O’Dive VGE grades blindly scored by Azoth Systems and medically diagnosed DCS (of which Azoth Systems was not aware). The analysis of such medical data is of a great interest to divers and is rare because the O’Dive is designed for self-positioning and autonomous use by recreational or professional divers without any medical assistance.

For the purpose of analysis, we used a classical binary cut-off to convert each dive’s maximum O’Dive grade into ‘high bubble grade’ (HBG, grades 3 to 4, $n = 40$) versus ‘low bubble grade’ (LBG, grades 0 to 2, $n = 112$) and investigated the association between O’Dive’s HBG and DCS status. Firstly, we considered only oxygen-treated DCS cases ($n = 6$, including three cases necessitating hyperbaric treatment), then we enlarged the analysis to all possible DCS cases ($n = 13$, including untreated minor cutaneous stress and one doubtful case). The data used in both analyses are summarised in Table 1.

Fisher’s exact test confirmed a significant association between HBG and DCS for both treated DCS ($P < 0.001$)

and all DCS ($P < 0.001$). All treated DCS cases ($n = 6$) were associated with O’Dive HBG, with a 15% treated DCS rate for HBG ($n = 40$) and no treated DCS for LBG ($n = 112$). When including minor cutaneous stress DCS, nine were associated with O’Dive HBG (22.5% DCS for HBG) and four were associated with O’Dive LBG (3.6% DCS for LBG). These DCS rates are comparable with those found in the literature for conventional echocardiography HBG³ or Doppler HBG⁴.

O’Dive HBG had both high specificity (77% for treated and 78% for any cases) and sensitivity to DCS (100% for treated and 69% for any cases). The positive predictive values of HBG were low (15% for treated DCS and 23% for any DCS), which are typical for VGE which are considered an unsuitable parameter for DCS diagnosis, but an important risk indicator. In contrast, the negative predictive values of LBG were high (100% for treated DCS and 96% for any DCS).

We stress that VGE gives only partial information regarding DCS risk,⁵ which is why the O’Dive application computes a ‘dive quality index’ (QI, ranging from unsafe 0% to safe 100%) integrating information from both the dive profile and maximum VGE grade. Unfortunately, we could not analyse the association between QI and DCS in the present study because the authors did not communicate the dive profiles.

However, VGE can drive QI, as illustrated by the case of an O’Dive user diagnosed with cutaneous DCS after a 44 msw CCR dive, with QI = 59% and VGE grade 4 (described with permission of the user and his medical doctor P Germonpré).

These results, while beyond the original scope of the article,¹ are of interest for divers and they confirm that higher bubble grades (as measured by the O’Dive) seem associated with a higher risk of DCS.

Table 1

DCS cases versus high (HBG) or low bubble grades (LBG) from O’Dive (based on data provided by Dr O Plogmark, published with permission of the authors)

Parameter	Oxygen-treated DCS $n = 6$	Oxygen-treated DCS rate	Any DCS $n = 13$	Any DCS rate
O’Dive LBG $n = 112$	0	0%	4	3.6%
O’Dive HBG $n = 40$	6	15%	9	22.5%

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Asya Metelkina and Axel Barbaud work for Azoth Systems, the company who manufactures the O'Dive Doppler sensor and application.

Keywords

Decompression sickness; Doppler; Risk Factors; Risk Management; Scuba diving; Venous gas emboli

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