Editorials

The lymphatic pathway for microbubbles

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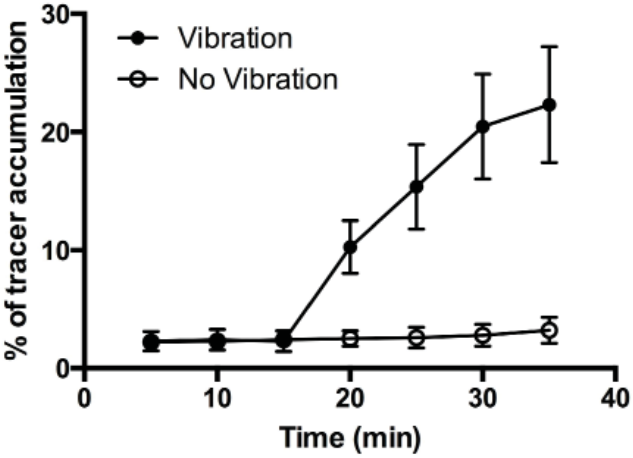
The sites for formation of microbubbles that are routinely detected precordially by Doppler after a decompression are still a matter of debate. Firstly, microbubbles could form on the endothelial wall of capillaries, at specific nanometric sites, but the release mechanism of such small emerging entities remains puzzling. They might also be formed from pre-existing gas nuclei present in the blood when favorable local hydrodynamic/supersaturation conditions generate microcavitation and tribonucleation phenomena. Finally, tissues could represent large pools for microbubble formation and amplification. Nevertheless, it remains unexplained as to what the potential driving pathways might be.[1]

Knowing that the permeability of most of the blood capillary network is quite low, an alternative is proposed for such transport. The lymphatic system, which drains the interstitial fluid to guarantee the fluid balance of tissues, could allow the transfer of micrometric elements, like stabilized microbubbles formed in tissues, over long distances. These might then be reinjected into the bloodstream via the right lymphatic and thoracic ducts. The characteristics of this slow transport, activated by the muscular pump, could explain the detection of vascular gas emboli (VGE) over long periods.

This hypothesis may give credence to a relatively old empirical finding of combat and commercial divers: that one should drive the boat fast to the dive site, but not on the way back, to reduce the risk of decompression sickness. These stories finally interested researchers enough to take a scientific look at why this happens. It was confirmed that 30 minutes of whole-body vibration before a dive (30 min, 30 msw) had preventive effects on post-dive bubble formation.[2] As there was no observed change in flow-mediated dilatation after vibration, the authors concluded that a nitrogen monoxide-mediated mechanism was not involved; rather, a mechanical dislodgement or enhanced lymphatic elimination of gas nuclei was hypothesized.

There are several possible explanations for this effect. Firstly, the vibrational force transmission to the whole-body should interact with the blood flow as well as the endothelium in order to eliminate the gas nuclei. In addition, vibrations may increase the blood friction forces on the endothelium favoring the detachment of gas micronuclei from the vascular wall. Vibrations should induce, by force transmission, a modification of endothelial spatial conformation. This modification should be responsible for a higher exposition of gas nuclei to the blood flow drag forces. Finally, the increase of lymphatic circulation, induced by vibration, would allow the elimination of a part of intercellular tissue micronuclei (Figure1).[3]

Figure 1
Accelerated peripheral elimination of radioactive tracer during vibration (n = 5); Tc99-labelled albumin was injected subcutaneously into the first dorsal interosseous space; the gamma camera was positioned over the axilla and the arm vibrated at 30Hz using a physiotherapeutic vibrator.



In conclusion, the effectiveness of vibration on VGE elimination might be explained by the mechanical action of vibration on the endovascular and tissue localization of micronuclei. Other preconditioning situations showing positive effects on the number of post-dive vascular gas emboli also can be explained by increased lymphatic activity.

References

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