Coronary air embolism

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The case report of acute coronary episode caused by air embolism associated with the removal of central vascular access, published in “Anaesthesiology Intensive Therapy” 1/2012 aroused much interest [1]. Iatrogenic gas emboli are rare, albeit dramatic complications of therapeutic interventions, which result in persistent neurological symptoms in over 40% of cases [2].

Depending on the type of medical procedure, the incidence of gas embolism ranges from 1/750 to 1/3000 for lung central venous accesses, from 1/1000 to 2/1000 for laparoscopies and from 1/1000 to 3/1000 for cardiac surgical procedures with extracorporeal circulation [3]. The above data show that even in the best medical centres, which improve the quality of treatment by monitoring and notifying all iatrogenic complications, the absolute number of gas embolism cases depends, amongst other things, on the number of procedures carried out during which the air can physically enter the cardiovascular system.

The authors of the case report in question describe quick diagnosis of gas emboli based on echocardiography and effective treatment primarily involving the supply of oxygen (FIO₂=1.0) for lung ventilation, not to mention general post-resuscitation intensive therapy. While accepting that in the case discussed the clinical symptoms of coronary gas embolism subsided several hours after the episode and no cerebral gas embolism was observed, it should be emphasised for educational purposes that the basic therapy of gas embolism is hyperbaric oxygenation (HBO), i.e. respiration with 100% oxygen (FIO₂=1.0) under increased-pressure conditions (usually 2.5–2.8 atm).

The HBO mechanism of action is based on the following: an immediate physical decrease in the volume of gas bubbles according to the Boyle-Mariotte’s law, acceleration of gas elimination by increasing the gradient of nitrogen elimination (so-called oxygen window) [4], decrease in endothelial response, for instance by down-regulating the expression of ICAM-1 [5], VCAM-1 and E-selectin [6], anti-inflammatory action with reduction of multinuclear leukocyte adherence through inhibition of the β2-integrin-dependent mechanism [7] and anti-oedematous effects on CNS via vasoconstriction together with increased brain supply of oxygen physically dissolved in plasma.

Interestingly, contrary to popular opinions on HBO-related induction of oxidative stress, neither experimental studies [10] nor clinical observations [11] confirm such effects of HBO.

The effectiveness of this therapy in gas embolism cases is high and complete recovery exceeds 70% of cases with early institution of HBO (less than 6 h) [12]. Therefore, the European Committee for Hyperbaric Medicine (ECHM) strongly advocates the use of HBO for gas embolism [13]. In patients with partial recurrence of symptoms after HBO or with residual neurological symptoms despite the institution of HBO, encapsulation of gas bubbles with platelets and fibrosis with formation of permanent thrombus, impairment of the blood-brain barrier or reperfusion syndrome are suspected [4].

The onset of HBO is essential as the therapy outcome depends on the time of its institution [14]. Delayed institution (after more than 6 h) markedly reduces the efficacy [12], although there are literature cases describing effective HBO even after 48 h [15, 16].

In Poland, the National Centre for Hyperbaric Medicine has been working for years in Gdynia (www.hiperbaria.gdynia.pl). At present, it is a part of the Medical University in Gdańsk. The Centre is equipped with two-compartment multi-place hyperbaric chambers, which enable to conduct hyperbaric sessions according to all published therapeutic protocols for gas embolism. The chamber devices allows to continue intensive therapy under increased-pressure conditions, including artificial lung ventilation (also with 100% oxygen or respiratory mixtures containing any proportion of oxygen and helium), continuous supply of drugs using hyperbaric syringe pumps, continuous drainage of body cavities (passive and active), and complete monitoring of physiological parameters, including respiratory gases and cardiac output. Thanks to big sizes of chambers, the medical staff (at least one anaesthetic nurse and/or a specialist in anaesthesiology and intensive therapy) is continuously present with the patient, which is indispensable to continue
intensive therapy during the long-hour stay under high pressure. The severity of patient’s general condition, once considered a contraindication for hyperbaric sessions, at present is rather an additional indication to initiate HBO instantly when the circulatory system has been stabilised [17, 18]. The National Centre for Hyperbaric Medicine is also equipped with the ITU, which guarantees the continuation of therapy before and after the HBO session.

The only problem is the transport of patients with gas emboli to Gdynia. The longest distance from any place in the country to Gdynia is less than 700 km in a straight line, which is within the reach of air transport. However, it should be remembered that due to the Boyle-Marriott’s law mentioned earlier, increased altitude decreases the environmental pressure leading ultimately to an increase in gas embolism volume. This is likely to deteriorate transiently the patient’s conditions. The low-altitude flight (maximum to 150–200 m above the sea level) or the use of medical airplanes (e.g. Piaggio Aero P.180 Avanti, owned by the Air Emergency Services), which have a cabin with constant pressure of 1 atm, irrespective of altitude, seem to be the solution to this problem. Whatever method is chosen, the patient with air embolism has to be monitored during transport by a medical team, similar to the specialist ambulance team, and artificial lung ventilation with 100% oxygen should be provided.

In the last decade, the National Centre for Hyperbaric Medicine admitted 4315 patients who underwent 66481 HBO sessions. In this group of patients, there were only 14 (0.32%) cases of iatrogenic gas emboli. Consider- ing the fact that our population is almost 40 million, which translates to high numbers of medical procedures, it could be anticipated that a high proportion of iatrogenic gas emboli remains either undiagnosed or untreated with HBO. All the physicians carrying out procedures with the risk of emboli remains either undiagnosed or untreated with HBO. Nevertheless, the fact that our population is almost 40 million, which translates to high numbers of medical procedures, it could be anticipated that a high proportion of iatrogenic gas emboli remains either undiagnosed or untreated with HBO. All the physicians carrying out procedures with the risk of gas embolism should be aware that HBO is available in Poland for patients requiring air transportation and that their intensive therapy can be continued in hyperbaric chambers.

**REFERENCES**


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