New effects of oxygen unveiled by DAN Europe Research

DAN Europe's Physicians and diving experts are focused on enhancing dive medicine and they have performed numerous research studies to the benefit of the entire diving community. One of the recurring themes in DAN's studies is the use of normobaric oxygen breathing and the beneficial effects it has on our health. The breathing of 100% oxygen at atmospheric pressure, known as normobaric oxygen (NBO), is proven to be beneficial for several problems, it is used for example in cases of decompression Sickness (DCS), because it contributes to a faster elimination of nitrogen bubbles from the body. This is one of the reasons why DAN Europe considers that the administration of NBO should be used as a first aid tool in DCS. In addittion to the already known usages of NBO breathing, does the breathing of normobaric oxygen have other beneficial implications? This was the question that DAN researchers analysed in some of their studies and how they discovered new health impacts of breathing oxygen, investigating further how these effects can be translated in practical diving safety advice.

In case of decompression Sickness, the body responds immediately to it by causing a chain of inflammatory reactions within minutes of the onset of DCS, in a protective attempt to cope with harmful elements. During this reactive process, proteins attach themselves to the surface of the nitrogen gas bubbles that are formed. These gas bubbles, being covered by proteins, are not only more stable but they are also smaller than the obstructive bubbles and it allows them to pass through the circulation. When white blood cells are sent into the inflamed tissues, the protein-coated bubbles can easily slip through with them and go into the body tissues. On top of that, it is also known that the proteins can denaturate. This can cause an accumulation of free fat globules, that is often found in cases of decompression sickness and it can form fat emboli that can damage the nervous system. However, the human body has provided a mechanism to eliminate these proteins in the body tissues. Proteins are captured by the lymphatic system, a part of the circulatory system that is made up of a network of the lymphatic vessels, carrying lymph to the venous system. DAN's research study on the use of normobaric oxygen is to analyse whether NBO breathing enhances lymphatic activity and therefore also causes a more effective elimination of proteins. A research study was organised by the DAN Europe Research Division in collaboration with the Université Libre de Bruxelles, Haute Ecole Paul Henri Spaak and the Centre for Hyperbaric Oxygen Therapy of the Military Hospital Queen Astrid in Brussels, to analyse the beneficial effects of breathing oxygen on protein captation. The research is based on the supposition that oxygen has positive effects on the metabolism of the lymphatic vessels and also on the reduction of the fluid accumulation in body tissues (edema).

In this research, 7 healthy volunteers, with an age range from 19 to 27 years old, participated in the examinations. Persons suffering from diabetes, vascular disease and upper limb traumatic injuries were excluded from participating in the examinations and neither pregnant women nor practitioners of sports that could result in abnormalities in the lymphatic system, such as volleyball players and martial arts practitioners, were accepted as volunteers in the tests. The subjects were examined, right after they received an injection of a saline preparation containing marked proteins using an isotopic method. The injected proteins had different sizes, ranging from 50 to 100 nm so that they could be absorbed by the lymphatic circulation. The injection caused a slight accumulation of fluid right underneath the skin on the back of the hand. The proteins injected were first absorbed by the cells and then taken into the lymphatic system. During the experimental sessions, the subjects were lying down or leaning. The first experiment consisted of analysing the absorption of proteins in the lymphatic nodes while the seven volunteers were

breathing normal environmental air. During a second test, the subjects were asked to breathe normobaric oxygen from a mouth mask, covering both nose and mouth. Right after the protein injection and the continued breathing of oxygen for thirty minutes, the isotopic activity in the lymph nodes of the armpit was measured by means of a gamma camera as to establish the speed of protein captation and the quantity of proteins that were eliminated by the lymphatic system. At the same time, the level of oxygen pressure in the area beneath the skin, where the fluid was accumulated, was also measured.

In all seven subjects, after they had breathed normobaric oxygen for thirty minutes, an increase in isotopic activity was measured in the cells in the area of the armpit. Additionally, during the first ten minutes of the oxygen breathing, there was also an increase in oxygen tension in the area of the fluid accumulation (edema). After the first increase, the oxygen pressure level remained even at the increased level, creating a plateau phase. Finally, when the oxygen breathing time was over, the values fell rapidly back to the oxygen pressure levels that were measured before breathing NBO. The speed and quantity of the elimination of proteins by the lymphatic system when breathing oxygen, were compared to protein elimination when breathing normally. The result of this comparison was that the amount of proteins that were captured and the speed of the protein absorption was significantly higher after 30 minutes of breathing 100% normobaric oxygen. In all the volunteers, breathing oxygen for thirty minutes, significantly enhanced the metabolism of the lymphatic system and the captation of proteins in the lymphatic vessels *(see picture, with comparison between blood system and lymphatic system, before and after the treatment*). On top of its beneficial impacts on the removal of proteins, the experiment showed that breathing oxygen can also be used for treating edema. The conclusion that DAN Europe draws from this study and the advice to all divers is to immediately administer oxygen for at least thirty minutes during on-site first aid after a diving accident. Administering first aid is essential to a proper treatment after an accident and it is DAN's research division's mission to analyse all the elements necessary to provide the medical care you need and deserve.

What the expert says

The results of this innovative study do have an importance for us divers too. The increased protein captation through the lymphatic system is also accompanied by evidence of increased lymphatic flow and this represents a parallel pathway for the washout of inert gas from circulating and tissue bubbles, improves the delivery of oxygen to tissues and offers another very strong evidence for the need and usefulness of Oxygen First Aid for Decompressions Sickness

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