

O2C (oxygen to see)



A short overview of the working method

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Preface: This short introduction into the working method and application of the O2C (oxygen to see) is intended to be an initial introduction and stimulus for possible clinical fields. Instructions are given to show how examinations can be carried out more efficiently with examples of typical measurement reports. Scientific references and references to literature have been omitted in order to keep these instructions short. We would like to draw attention, at this point, to our comprehensive collection of all publications on the O2C on the LEA information CD. Critical values and reference values are of great importance in everyday clinical life. Some of the critical values stated in these instructions still come from values gained through experience from the "first O2C users" and cannot be found, up to present date in all the publicly accessible publications.

This short introduction is also a working document and is subject to continuous addition and reworking. Under these circumstances, you will therefore find unfinished chapters and language inconsistencies: we ask you, in advance, to take this into account.

1 The O2C appliance (oxygen to see) – a short overview of the working method

The O2C is a new device where the following parameters can be measured simultaneously in tissue:

- the oxygen saturation of haemoglobin (SO₂) at the venous end of the capillaries (the so-called. "last meadow, post-capillary"); this shows the lowest oxygen saturation of the tissue and therefore also the critical values;
- the quantity of haemoglobin (rHb) in the micro-blood vessels is a measurement for filling of the blood vessels with haemoglobin (blood volume, in other words) and for the density of the blood vessels;
- the velocity of the blood in microcirculation;
- the flow of blood in the microcirculation

The technology of the O2C is based on two physical principles. White light spectroscopy, on one hand (sometimes called spectrophotometry, or reflection spectroscopy) and the laser Doppler technique, on the other hand are used. A probe is used to introduce white light (wavelengths of 500 to 800 nm) and laser light (wavelengths NIR) into the tissue at the same time. The light spreads out in a diffuse pattern through the tissue. The photons are scattered through the tissue in all directions. A few of these photons find their way back to the surface of the tissue and are recorded by the measurement probe. A part of the light spectrum is absorbed when the white light interacts with the erythrocytes. The light assumes the colour of the haemoglobin. This colour is a measurement for the oxygen saturation of the erythrocytes.

The light experiences a frequency displacement if the laser light falls on moving erythrocytes (the so-called Doppler Shift or Doppler Displacement). The Doppler displacement is a measurement for the velocity of the erythrocytes. The total of all erythrocytes and their velocity is a measurement of blood flow (volume flow) in the complex network of capillaries. In ultrasonic examination, the blood vessel has to be found and its cross-section has to be determined. Compared to ultrasonic measurement, the vessel does not need to be found and its cross section does not have to be determined.

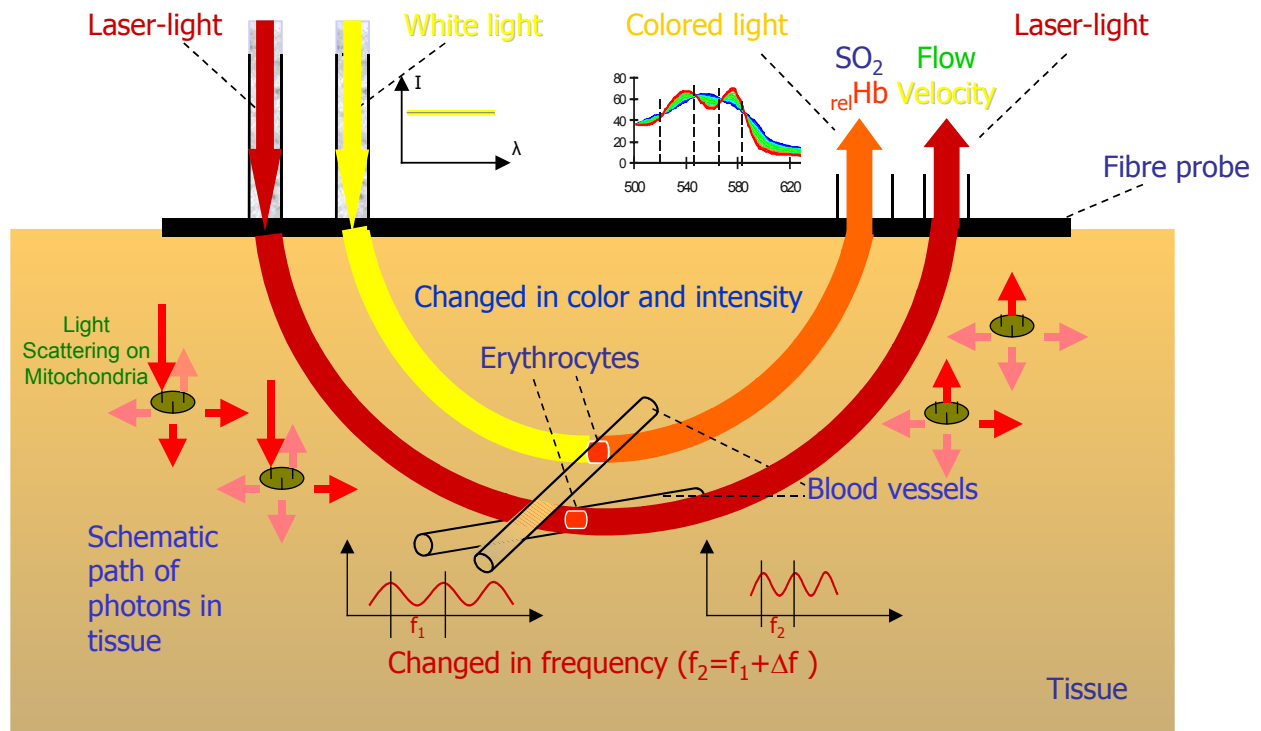


Illustration 1-1: The O2C (oxygen to see) works simultaneously with white light and laser light. The light does not propagate through the tissue linearly as in air, but is scattered instead. This is similar to the way in which light is diffused through fog. You are suddenly seriously blinded in fog since the light is immediately reflected and scattered back by the water droplets. The light in tissue is scattered at the mitochondria and makes its way back through the tissue to the surface via a "light arc". It is picked up there and analysed by the detectors of the O2C (oxygen to see) probe. The white light enables the colour of the blood to be determined here. The blood clearly changes its colour when it is charged or discharged with oxygen – this method enables the oxygen saturation of the haemoglobin to be determined with absolute precision. If there is a large quantity of colour in the tissue, the light will become more "coloured" and will become "redder" so that the amount of blood in the tissue can be determined by using this effect. The laser light is scattered in the same way at the mitochondria as the white light, but carries information, however, on the movement of the erythrocytes (the flow of blood) and therefore enables the blood flow to be determined in this tissue. The fact has to be added that there are no mitochondria in the erythrocytes so that they absorb light quite considerably but scatter the light very weak. The light is lost in whole blood for this reason – it is completely absorbed, in other words. It can be concluded from this that the O2C (oxygen to see) only determines all the parameters in the micro-vascular vessels.

The measurement depth of the O2C is principally determined by the type of probe used and by the optical characteristics of the tissue. The distance between the illuminated glass fibre and the detecting glass fibre (the so-called separation) determine the possible measurement depth of the probes. The path of the light from illumination to detection can be thought of as being banana-shaped. The path of the photons, which are scattered back the most lies within this banana shape here. The greater the separation now becomes, the larger this shape will be and also the original depth of the photons, which have been scattered back (the detection depth, in other words).

1.1 Measurement parameters of the O2C

SO₂ (white light spectrometry): Venous oxygen saturation is an excellent indicator of venous hypoxias, since the saturation reflects oxygen extraction processes along the capillaries. The tissue is not hypoxic and is not in acute danger of a hypoxia or an anoxia as long as there is oxygen saturation of more than 10% in the measured tissue. The doctors are able to react in the usual way, under these conditions, be either trying out another method of treatment or of continuing to observe the tissue. If the values fall below 10%, however, the doctor should know how long this tissue could tolerate a hypoxia when it is not receiving a sufficient supply. The O2C (oxygen to see) determines venous

erythrocytes of a certain velocity] x [velocity]) for all relevant, measured velocities. A particle volume flow is determined in this way.

Velocity (Laser Doppler): The measurement of the average velocity of the blood in the microcirculation is a parameter of no clinical relevance, since it delivers no information whatsoever on the quantity of blood transported in this way.

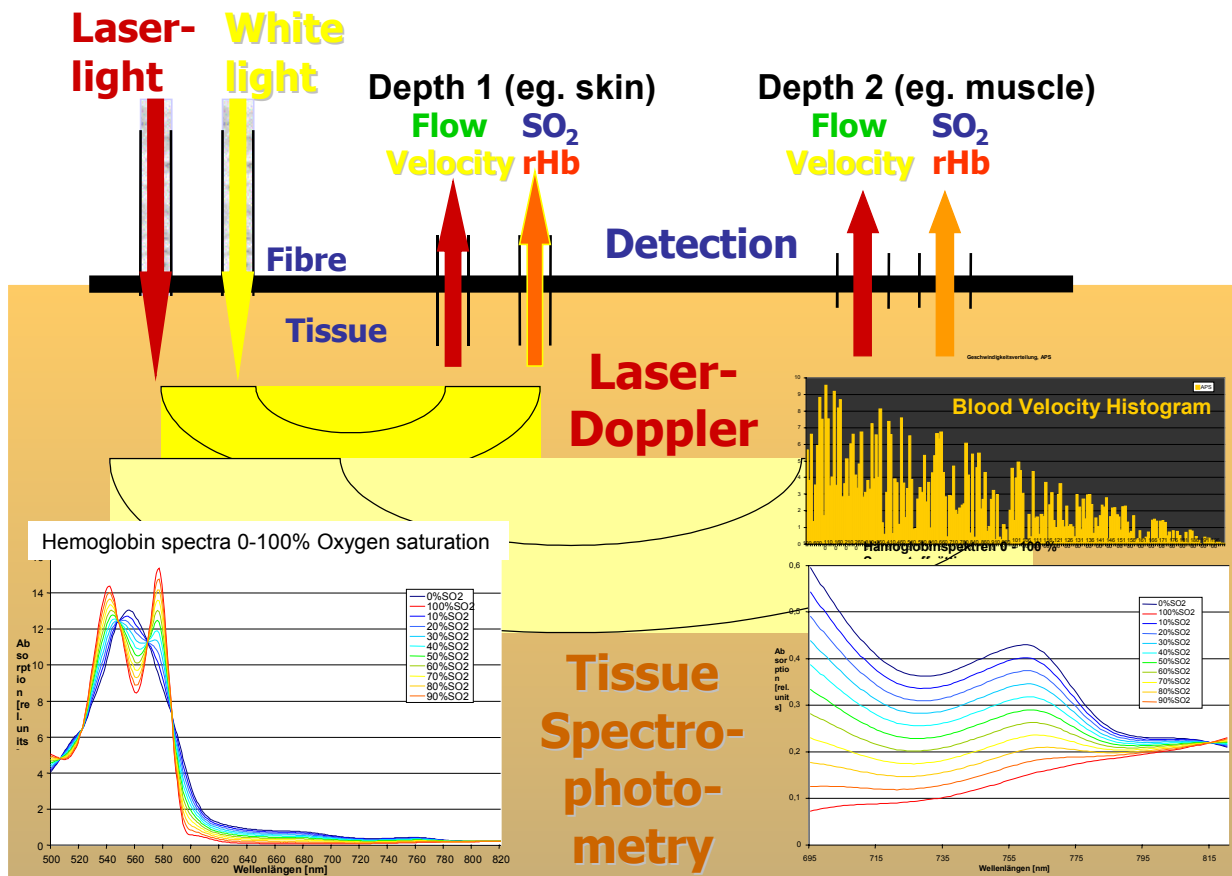


Illustration 1-3: The O2C (oxygen to see) works with white light and laser light at the same time and in the same place via a probe, which is placed on the tissue. The colour of the blood is determined mainly by the venous blood. The O2C (oxygen to see) therefore determines a so-called venous oxygen saturation and venous amount of haemoglobin (filled status of the vessels): The colour spectrum here is in the wavelength range of 500 up to 810 nm where approximately 300 wavelengths are analysed simultaneously. The Doppler effect is analysed via the laser light to determine the blood flow and its velocity.

Several detectors have been fitted into many of our probes, which capture light from various depths of the tissue so that all the measurement parameters of the O2C (oxygen to see) can be detected simultaneously from various depths.

The current variety of probes already offers detection depths in the range of approximately 100 µm (mucosa) up to 16 mm (transcutaneous skeletal muscle).