

Laser Doppler flow meter and the pulpal diagnosis

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Introduction:

The sophistication of the technology available to current practitioners upholds the soundness of the diagnostic procedures. However, this technology does not vary the essential nature of the diagnosis as a process of monitoring service, precise observation and genuine curiosity of the origin of the present signs and symptoms. A good diagnosis is the result of scientific knowledge synthesis, clinical experience, intuition and common sense.⁽¹⁾

There are some procedures to determine the existence or non- existence of pulpal vitality, which can be invasive or non-invasive. These procedures are tests such as medical history, dental history, pain history, percussion tests, palpation, mobility, cavity tests, X-ray tests, periodontal tests, diaphanoscopy tests, among others.

When making various tests, the age of the patient should be taken into account, since he may have immature apices, calcification or big restorations, which may alter the tests, or the patient may be overanxious or medicated.

There are some instruments capable of detecting the pulpal circulation within the new technology.

These instruments, known as *Laser Doppler Flow meter* (flow meters by means of laser Doppler) use the application of sensors on the enamel surface, either by the vestibular or lingual surface of the tooth, and the blood flow and the pulpal vitality are shown with light rays (spectrophotometry of the dual wave length). It is a non-invasive method.

The early research works on the use of *Laser Doppler Flow meter* were carried out in the early 80's, and they were put into practice on the microvasculature of various vital organs. Afterwards, studies on the use of the pulpal vitality in human teeth were carried out. Even several cases of traumatized teeth were reported⁽²⁾ thanks to the help of the *Laser Doppler Flow meter*.



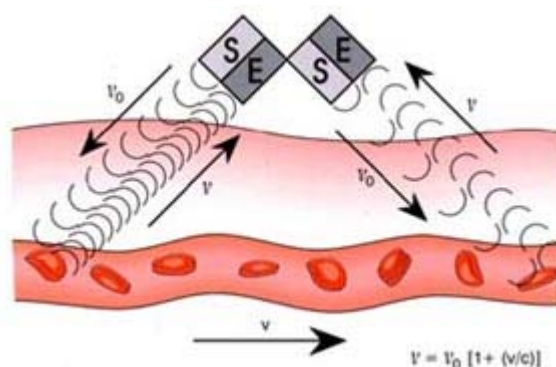
Laser Doppler Unit
Mod. DRT4" manufacturing company

MOOR INSTRUMENTS.

Operation

The *Laser Doppler Flow meter* measures and determines the blood flow of the dental pulp. This principle is based on variable reflection signals, which depend on the direction and the movement speed of the erythrocytes, when radiated with the laser light, which has an effect on the biconcave surface of red corpuscles, and these respond as birefringence elements ⁽³⁾⁽⁴⁾

The technique consists in directing the low power laser beam through an optical fiber on the tooth surface. The light follows the direction of the enamel prisms and of the dentinal tubules up to the dental pulp. As a result of the movement of the erythrocytes, some light is reflected in the inside of the pulpal capillaries.



Principle of measurement of blood flow
by means of a Laser Doppler instrument

S	E	Vo	V	v
Transmitter	Recipient	Frequency of the laser beam emitted	Frequency of the laser beam sent	erythrocytes' conduction speed

The light reflected goes back to the flow meter through the return segment of the fiber to the equipment, where the changes of frequency as regards the strength of the signal and the pulsatility are recorded.

The flow meter shows on the screen a signal by which the practitioner must interpret if the pulp is alive, healthy or dead.

The accuracy of the assessment of the pulpal vitality depends of the variables of the instrument and can be improved by the mathematical analysis of the signal. In traumatized teeth, measuring with the Laser Doppler has been used to determine vitality. ⁽⁵⁾

The instrument estimates the flow of blood cells, their concentration and speed.

The data are shown on a screen by means of a graph or digitally. These data are stored for subsequent analyses or for printing. There are also models that allow the direct connection with a printer. The data can be transferred to a personal computer while used or after been recorded with software of Moor (manufacturing company) for

Windows. The data can be stored, for compression into files, statistic examination or printing⁽⁶⁾

Applications:

The dentinal tubules act leading the light from the dental surface to the pulp. This pulp is a vascularized tissue and by its position within a rigid structure, the vessels are very limited.

The heart cycle of the blood flow is transmitted to the pulpal capillaries to the speed of beats. These beats in a vital tooth appear as signals on the screen of the Laser Doppler monitor and they are absent in non-vital teeth.

The average level of blood flow in healthy teeth is very high if compared with non-vital teeth. Yet, in vital teeth with diminished blood contribution, the level of flow can be lower and the presence of beats is the only sign of vitality. The measuring with *Laser Doppler Flow meter* widens the clinical observations aiming at improving the planning of the dental treatment.⁽⁷⁾

The Laser Doppler Flow meter assesses the flow in:

- ☞ Plastic Surgery (attachment of pedicles)
- ☞ Dermatology (skin measuring)
- ☞ Maxillofacial Surgery (intra – operation reconstructions and monitoring in the recovery). In a research carried out at the University of Hamburg, the pedicles measured with LDF, which gave high values, were successful, whereas those showing lower values reported problems.⁽⁸⁾
- ☞ Vascular surgery (in by pass procedures)
- ☞ ***Dentistry (pulpal vitality, gingival perfusion)***
- ☞ Transplant Surgery
- ☞ Heart Surgery
- ☞ Pharmacology (drug effects in various tissues).

Studies:

A scientific research compares two systems of laser Doppler of different makes to measure the blood flow in various pulpal conditions. The study was carried out in vivo with the following lasers: DRT4, Moor Instruments Ltd and Laserflo BMPZ, Vasamedics. This was done so as to differentiate between vital pulp and necrotic pulp in children's premolar teeth which were to be submitted to extraction for orthodontics reasons. Readings were conducted with both instruments before and after being submitted to adrenaline-free anesthetic.

Significant differences between vital teeth and teeth with necrotic pulps were found in the results. The DRT4 instrument detected a significant difference in the vital pulpal flow before and after the use of analgesia. No other further significant differences were found.⁽¹⁰⁾

Another study compares the Laser Doppler Flow meter with another diagnostic method (CO₂), assessing the vitality of previously traumatized teeth.

The Laser Doppler Flow meter proved to be a reliable method to assess the condition of the pulp of previously traumatized teeth, whereas the CO₂ yielded negative results. However, it is a sensitive technique and it requires certain amount of time to carry out measuring. ⁽¹¹⁾

The Laser Doppler flow meter is used in another study where a clinical test of pulpal vitality is carried out. The Laser Doppler flow meter proved reliable to measure the pulpal blood flow and to record the changes occurring in this flow when anesthetic is used. ⁽¹²⁾

In another case reported, an eight-year-old boy had two central incisor teeth luxated, which were reimplanted. Vitality was detected in only one tooth with a cold test, whereas with the Laser Doppler Flow meter, vitality was detected in both teeth. This means that revascularization was occurring in both teeth. Due to the readings conducted with the Laser Doppler, no endodontic treatment was started and the teeth evolved normally. ⁽¹³⁾

Another study measured the pulpal blood flow under the continuous intrusive forces exerted during the orthodontia treatments. The laser Doppler was used and the results showed that the measuring with this technique may detect changes in the pulpal blood flow by the application of continuous intrusive forces and that such changes stood for a significant lowering of the flow. ⁽¹⁴⁾

The use of LDF has been studied lately at the University of Beijing-China with satisfactory results. They hold that it is a system which has great possibilities in the study of pulpal flow, and which deserves further concern. ⁽¹⁵⁾

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