Infrared Energy Synchronized with the Heartbeat

H.E. Roman and M. Santucci*

Dipartimento di Fisica, Università di Milano, Italy
**Createk, s.r.l., Milano, Italy*

Summary

A bio-feedback technique based on the use of infrared radiation (IR) is suggested as a new therapy in the field of physical and rehabilitation medicine. The IR source is constituted by filament lamps of common clinical use. The bio-feedback mechanism consists in switching on and off the infrared lamps in synchrony with the heart rate of the patient. To quantify some of the main features of this technique, preliminar studies of its effects on the body have been performed by measuring the blood velocity in arteries using standard Doppler techniques. For the common carotid artery, considered as a typical example, the blood velocity is found to increase significantly with respect to the value reached using constant emission intensity. The practical application of this bio-feedback method is illustrated in the treatment of typical pathologies such as cervicalgia and several types of arthrosis.

Introduction

The application of infrared energy is a physical therapy based on the beneficial effects of heat on the dermis and underlying tissues [1]. Traditional therapy utilizes filament lamps in which the emission intensity is kept constant throughout the whole period of treatment, causing local heating responsible of vasodilatation and increased blood flow to the target tissues. Maximum benefit from the IR can not be obtained, however, since the application time is limited to few minutes to avoid cutaneous overheating. To overcome these limitations, a new technique is introduced (see section Materials and Methods) that keeps heating to a much lower level and is aimed at increasing the rate of blood flow further to improve joint mobility and the elimination of toxic products.

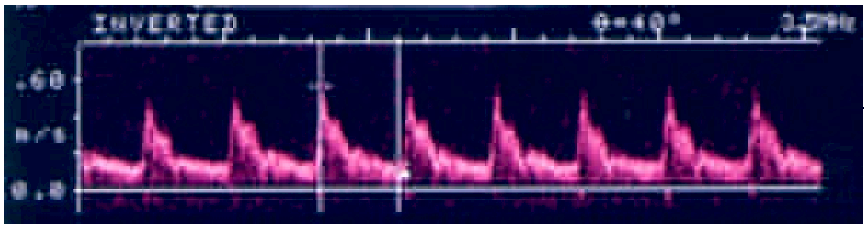

Fig.1 Reference Doppler waveform for the common carotid artery. One can note the systolic peak, which in this case corresponds to a (systolic) velocity of about 0.56 m/s. The minimum value of the blood velocity occurs during diastole, and its value (diastolic velocity) is about 0.14 m/s.

Materials and Methods

To quantify the effects of the IR on the body we resort to standard Doppler techniques [2] to determine the velocity of blood in an artery. The arterial velocity is pulsatile having a diastolic and systolic components (see e.g. [3]). An example of such pulsatile velocity is illustrated in Fig.1 for the common carotid artery.

Traditionally, infrared radiation is applied at constant emission intensity during the whole period of treatment. The IR energy absorbed by the skin causes the heating of the tissue which calls for vasodilatation and the increase of the blood flow to the zone under exposition. While the systolic velocity remains unaltered in the presence of IR, the diastolic velocity increases with respect to its reference value (cf. Fig. 1), reflecting the increased blood flow through the vessel, as indicated by the Doppler measurement in Fig. 2.

The new method we consider here consists in switching on and off the IR lamps, thus allowing for a partial cooling of the tissue, while the on/off frequency is regulated by the patient's heartbeat [4]. In this way, the absorption of energy is most efficient since it occurs in synchrony with the pulsed blood flow. This feedback is essential since the cardiovascular system responses to the external stimulus by modifying the heartbeat rate.

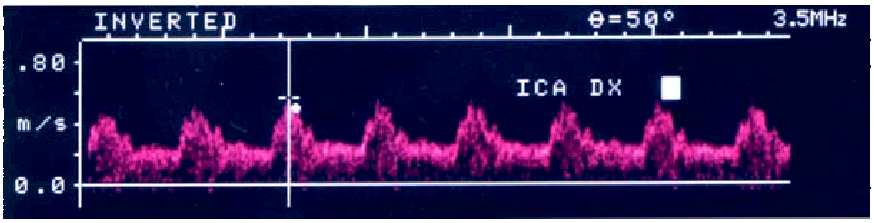

Fig.2 Doppler waveform of the common carotid in the presence of constant IR emission applied for 5 min. Note that the systolic velocity remains unaltered with respect to the reference state (cf. Fig.1), while the diastolic one increases to about 0.19 m/s from its reference value of 0.14 m/s.

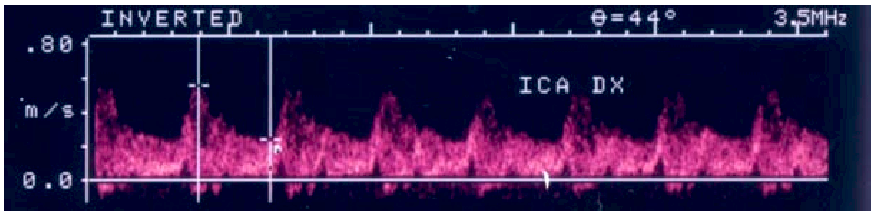

Fig.3 Doppler waveform of the common carotid in the presence of IR emission self-regulated by the patient's heartbeat applied for 5 min. Again here, the systolic velocity remains at its intrinsic level, while the diastolic velocity has increased up to about 0.24 m/s.

Results

The results using pulsed IR emission, self-regulated by the patient's heartbeat, is shown in Fig. 3. The diastolic velocity is found to increase further up to about 0.24 m/s, yielding an enhanced blood flow with respect to the constant emission case.

In addition to these findings it is important to assess the usefulness of the method in practical situations. Preliminar clinical applications suggest that indeed the present bio-feedback mechanism may become a useful physical therapy. The method has been applied with success to the following pathologies: cervicalgia, coxarthrosis, gonarthrosis and metatarsal and phalange arthrosis. The group of patients under treatment was composed of 20 subjects, of age ranging from 30 to 80 years old. In the 90% of the cases, objective improvements have been obtained already after three to four applications, of 30 to 40 minutes each.

Here we report three typical cases in more detail:

(1) Gonarthrosis (bilateral): female, 62 years old. Therapy: 15 sessions (over three weeks) of 30 min each (250 W) to each knee. Results: complete suppression of pain since end of treatment (July 2002).

(2) Extended osteolisis of the right shoulder (advanced joint destruction): female, 82 years old. Therapy: 35 daily sessions of 30 min each (250 W). Results: Considerable pian reduction and good acquired joint mobility.

(3) Cervicalgia: male, 48 years old. Therapy: 10 sessions (over three weeks) of 40 min each (250 W). Results: complete elimination of pain and total suppression of giddiness present before treatment.

Conclusions

The enhanced blood flow resulting from the bio-feedback of the IR source with the patient heartbeat is expected to improve the efficiency of the IR heat therapy with respect to the traditional use of fixed emission intensity. Furthermore, the possibility to prolong the application of heat at a rate controlled by the cardiovascular system of the patient may

open the way to unexplored healing mechanisms which had not been attained so far by means of the standard technique. This method therefore opens a new era in the analgesic therapy based on the use of infrared radiation.

References

[1] J. R. CAMERON and J. G. SKOFRONICK, Medical Physics, New York, John-Wiley & Sons, 1978

[2] C. OATES, Cardiovascular Haemodynamics and Doppler Waveforms, London, Greenwich Medical Media Ltd, 2001

[3] A. MACDONALD, Blood flow in arteries, London, Edward Arnold, 1974

[4] Patent no. 0819017 (European Patent Office)