USE OF THERMAL IMAGING FOR DIAGNOSIS OF VASCULAR PATHOLOGIES

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Abstract

Qualitative comparative analysis of thermal infarction was carried out using thermograph in the spectral range of 8 - 14 microns. There was made the quantitative assessment of myocardial temperature measurement accuracy which depends upon the ambient temperature. Based on the proposed approach to the analysis of infarction thermal images, there was made the research of thermoabnormal zones on the surface of the myocardium, which gives a clear picture regarding the distribution of the internal temperature and the level of the microcirculation in the myocardium and vessels.

Keywords: thermogram; myocardium; temperature distribution; vascular pathology.

Introduction

Many pathological processes are changing the normal distribution of temperature on the surfaces of thermoabnormal zones, and the closer the pathological portion of body is to the surface the clearer those changes. In many cases, local temperature changes are ahead of other clinical features, which is very important for early diagnosis and early treatment [1]. The method of contactless control of heart temperature helps to reveal the interrelation between electromechanical characteristics of a myocardium (according to an electrocardiogram) and temperature fluctuations on a myocardium surface. Thermography allows specifying the location of the functional changes in the myocardium, the activity of the process and its distribution, the character of functional changes – inflammation or malignancy.

Feature of Use Method

When applying the non-contact method of heart temperature control there was used FLIR i7 thermograph to spectral range of 8-14 microns on the basis of not cooled matrix of 320 × 240 elements size and with temperature sensitivity of 0.1°C. The method of comparative analysis for thermograms of myocardium allows descripting of the thermal picture for open heart [2]. Also, the method allows us to control the functional condition of the body in vivo when studying the thermoabnormal zones on skin surface and gives a clear picture regarding the distribution of internal temperature and microcirculation in the myocardium and vessels.

The lowest temperature of an operational field is registered with infrared scanner in a point of focusing of Sp2 – 28.2°C, and rather high in the point of Sp1 – 32.6°C, i.e. on the exposed surface areas of the myocardium the temperature difference can reach 6 - 7°C.

Propagation of electrical excitation and mechanicals contraction of the heart muscle is cause of temperature fluctuations on the surface of the myocardium in researched areas, which have a certain periodic regularity of temperature change in the range of 28.1°C at the minimum to 32.1°C at maximum. The operative field with heat portrait of myocardium is shown in Figure 1.

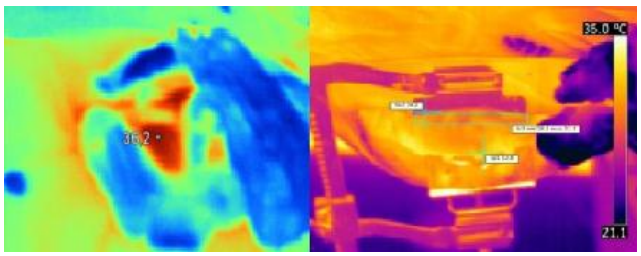

Figure 1. Heat portrait of operative field and myocardium.

Temperature variations on the surface of myocardium in the researched area are clearly defined during hypothermia and hyperthermia under extracorporeal circulation (EC). Graphical representation thermal portraits of myocardium along the area Ar1 - (28.1°C – 32.1°C) is shown in Figure 2.

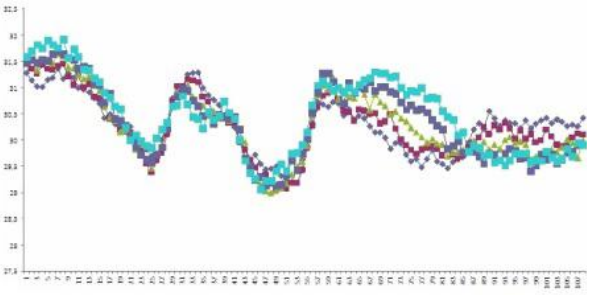

Figure 2. Graphic image of thermal portraits myocardium.

Temperature Control of the Heart and Brain

Electrical activity of brain was registered using "EkspertTM" – the 16-channel electroencephalograph which is part of medical diagnostic telemetry complex "Tredeks". Recording of electroencephalogram (EEG) was performed on background of anesthesia before the start of extracorporeal circulation at the stages of cooling and warming patients (Figure 3).

Figure 3. Recording EEG in the operating room on the background of anesthesia and extracorporeal circulation.

The temperature decrease of Heart and Brain from +36°C to +18°C is the main factor of protection from hypoxic damage of Brain under exclusion of those organs from circulation during open heart surgery.

Method of producing of graphic image thermal portraits of myocardium for open heart and brain allows controlling the temperature of operating area during operations on the brain and heart. The developed comprehensive approach with the remote control of temperature allowed us to define the uniformity of thermal protection, the level of cooling in different temperature zones, significantly improve the security of controlled cessation of circulation in vitally important organs.

Conclusions

It is shown that at every point of the myocardium the measured and own temperature (true temperature) of object are linearly related between the temperature on a surface of thermoabnormal zone (measuring zone) and the temperature in the volume of the given zone (temperature at depth) and temperature of the environment (an operational zone). At every point of myocardium there is a correlation between the measured and true temperature within the temperature coefficient which is a value of blood emissivity.

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