

# Cold sodium chloride solution 0.9% and infrared thermography can be an alternative to radiopaque contrast agents in phlebography

Sir,

Nowadays methods of X-ray diagnostics together with medical drugs or devices with contrasting properties may be used for imaging of humans and animals body parts. Intravascular and intracavitary injection of the X-ray contrast agent solutions is a common practice in clinical settings. However, it is known that the use of radiological methods of X-ray diagnostics together with contrast agents may carry an iatrogenic threat for human health.<sup>[1]</sup> Recent studies showed that infrared thermography is one of the safest methods for X-ray diagnostics.<sup>[2]</sup> The method provides a continuous and noncontact monitoring of the infrared images temperature and spectrum for all the parts of the human body.<sup>[3-5]</sup> However, the traditional methods for infrared monitoring have significant drawbacks, since they allow to obtain a thermogram only for the body surface which often have color images on the thermal imager screen, and this essentially limits the capability of subcutaneous formations imaging and in particular saphenous veins.

Therefore, the objective of the study was to improve the quality of infrared imaging of human saphenous veins through the use of thermal contrast agents.

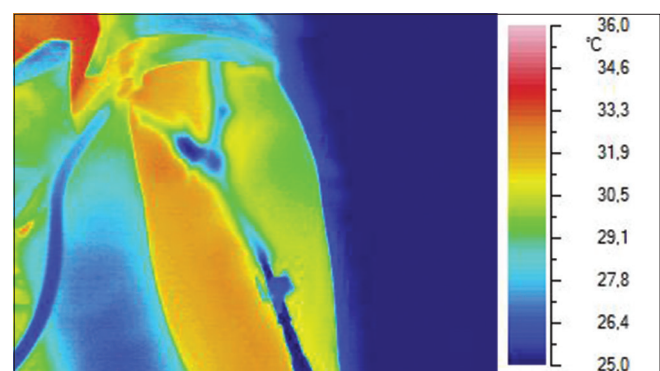
Previously, the changes in skin temperature of the anterior abdominal wall in ten awake pigs in the area of simultaneous hypodermic injections of 1 ml of 15°C, 25°C, and 35°C 0.9% sodium chloride at 5 cm distance apart from each other were observed. Infrared thermography was performed using ThermoTracer TH9100XX (NEC, USA) imager in a temperature range of 25–36°C.

Our results obtained in experiments with pigs showed that all medications infiltrate caused by hypodermic injections of 1 ml of 0.9% sodium chloride are being imaged in the infrared radiation spectrum, but their contrasting properties are different. For

example, when the vivarium room temperature was 25.0°C, the average temperature of the pigs' anterior abdominal wall skin was  $33.6 \pm 2.7^\circ\text{C}$ , at the same time the infrared spectrum of the image of piglets anterior abdominal wall skin was in the yellow-orange-red spectrum. In these circumstances, the infiltrates that demonstrated the best thermal contrast properties were formed by the 15°C solution injection, providing blue color for the infrared image of the skin above and reducing the average temperature to  $26.5 \pm 1.4^\circ\text{C}$  ( $n = 10$ ,  $P < 0.05$ ). The infiltrates which appeared invisible in the infrared spectrum were formed by the injection of 1 ml of 35°C 0.9% sodium chloride because they did not cause a change in infrared radiation color of the skin above. Results obtained in healthy pigs showed that the infiltrates with the best contrasting properties were formed by “cold” solutions which differed from the tissue temperature not less than by 5°C.

Clinical observation of the arm surface infrared radiation in thirty patients after catheter insertion into their saphenous veins showed that intravenous injection of 200 ml of 0.9% sodium chloride at a temperature of 25°C and at a rate of 3–4 ml/min reduces the skin temperature above the vein from  $34.8 \pm 1.1^\circ\text{C}$  to  $29.3 \pm 1.7^\circ\text{C}$  ( $P \leq 0.05$ ,  $n = 30$ ) and changes the color of its infrared image from orange-red to blue [Figure 1]. At the same time, the venous bed image is contrasted on the screen. Based on the dependencies obtained, the method for saphenous veins imaging in the infrared radiation spectrum was developed.<sup>[6]</sup> This method allows to obtain the venogram of the cooled surface after the warm blood influx in a safe and noncontact way.

Thus, veins thermal contrasting allows us to improve the quality of thermal imaging examinations. Liquid medications and blood may be used as thermal contrast agents. Noncontact method of veins imaging can be used in the operating room during a surgical restoration of intravascular patency.



**Figure 1:** Infrared image of the left forearm of patient P, made 2 min after intravenous injection 0.9% sodium chloride at a temperature of 25°C and at a rate of 4 ml/min

## Research Letters

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

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**Received:** 25-04-2016

**Revised:** 16-06-2016

**Accepted:** 28-07-2016

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Quick Response Code:	Website: <a href="http://www.jpharmacol.com">www.jpharmacol.com</a>
	DOI: 10.4103/0976-500X.189675

**How to cite this article:** Urakov AL, Kasatkin AA, Urakova NA, Urakova TV. Cold sodium chloride solution 0.9% and infrared thermography can be an alternative to radiopaque contrast agents in phlebography. *J Pharmacol Pharmacother* 2016;7:138-9.