Regional cooling patch for pain reduction in the needle insertion

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Purpose

In order to reduce the pain of the needle insertion, we propose and fabricate a new disposable regional cooling patch using the heat absorption reaction of resolving urea into water and evaluated on a phantom.

Methods

The cooling patch was fabricated with a cotton sheet and urea particles of less than 1 mm in diameter. A polyethylene plate as substitute of skin and a silicone tube of 6 mm in inner diameter as a vessel model were employed as a phantom. Heated water at 38 degrees Celsius flowed into the silicone tube. Two milliliters water to dissolve the urea (0.9 grams or 0.015 mol) in a heat absorption reaction was added at constant rate of 0.5 mL/s using a linear actuator (Fig.1). The cooling patch was removed from the plate after five minutes. Time transient waveforms of temperature and heat flow through the prototype were measured with sampling frequency of 1 Hz. The time required to reach temperature of 25 degrees Celsius (t25) and the period during which the plate had a temperature under 25 degrees Celsius (T) after removal of the cooling patch were measured.

Results & Discussion

The t25 of the patch was 17 seconds in average. Relation between the maximum heat flow (average 1531 W/m^2) and the maximum temperature drop (average 9.96 degrees Celsius) show slightly negative correlation (Fig.2). T was 87 seconds in average. Minimum temperature of the phantom showed a negative correlation with T as shown in Fig.3.

Current phantom employed continuous flow of heated water, which heated the cooling patch. Further study is needed to check feasibility by a phantom with pulsatile flow of heated water, and to clarify the method of adding water on the cooling patch in a hospital.

Keywords: pain in needle insertion, cooling, heat absorption reaction, heat flow.

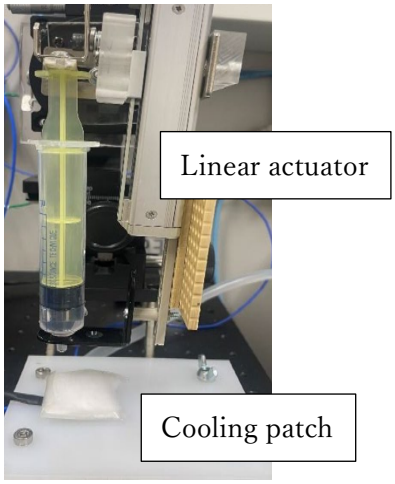

Fig.1 Experimental setup for the cooling patch with a phantom and a syringe for water

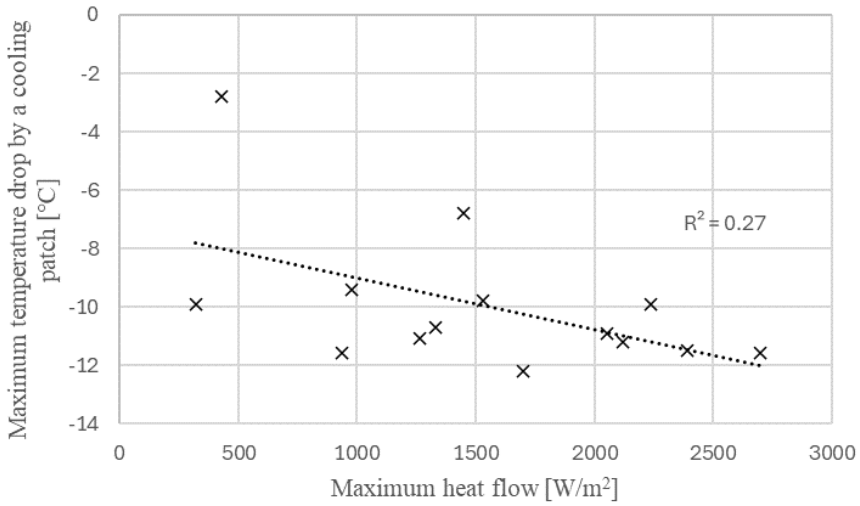

Fig.2 Relation between the maximum temperature drop by a cooling patch and the maximum heat flow.

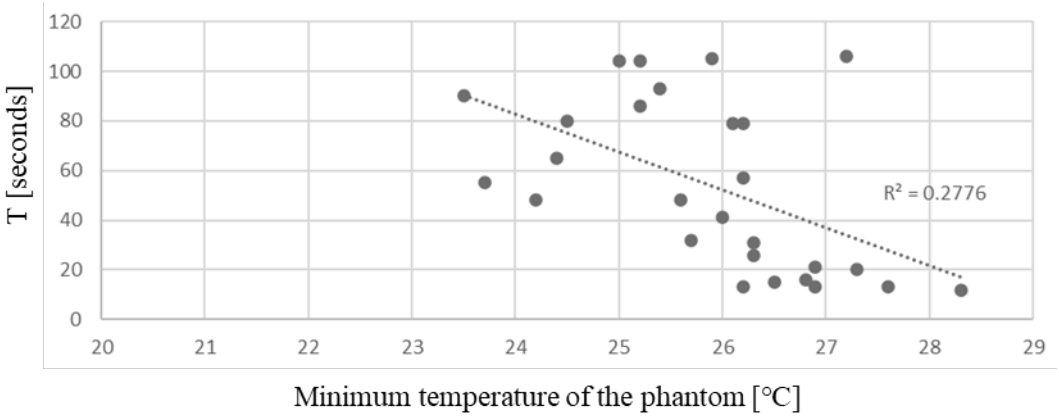

Fig.3 Relation between the period during which the plate had a temperature under 25 degrees Celsius (T) after removal of the cooling patch and the minimum temperature of the phantom.