

## *Short communications*

# The sticker-type skin-surface temperature indicator in anesthesia

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The sticker-type skin-surface temperature indicator ProChecker (Kyowa Medex Tokyo, Japan) is a skin-surface temperature monitor that enables continuous and long-duration measurement of body temperature by merely attaching it to the body surface [1]. ProChecker indicates temperature in increments of 2 °C, and body temperature can be read by changes in color at a precision of 0.5 °C (Fig. 1). We studied the usefulness of ProChecker as a surface temperature monitor during anesthesia by comparing the skin surface temperature measured by ProChecker with the rectal temperature measured by thermometer.

The present study included 18 patients (age 11–75 years, body weight 42–70 kg) who underwent laparotomy under general anesthesia. Informed consent was obtained from each patient. To measure the skin surface temperature, ProChecker and the PTP-50 sensor of the thermocouple thermometer PTW-100A (Unique Medical, Tokyo, Japan) were placed side by side on the center of the forehead and on the forearm. The rectal temperature was measured using an electronic thermometer ETC-21A (Top, Tokyo, Japan). During surgery, all temperatures were monitored continuously and recorded at any points where a change in temperature occurred. The differences between the temperatures measured with ProChecker and with the thermocouple thermometer were investigated. Correlations between temperatures were obtained by the least squares method. A value of less than 0.05 was considered significant.

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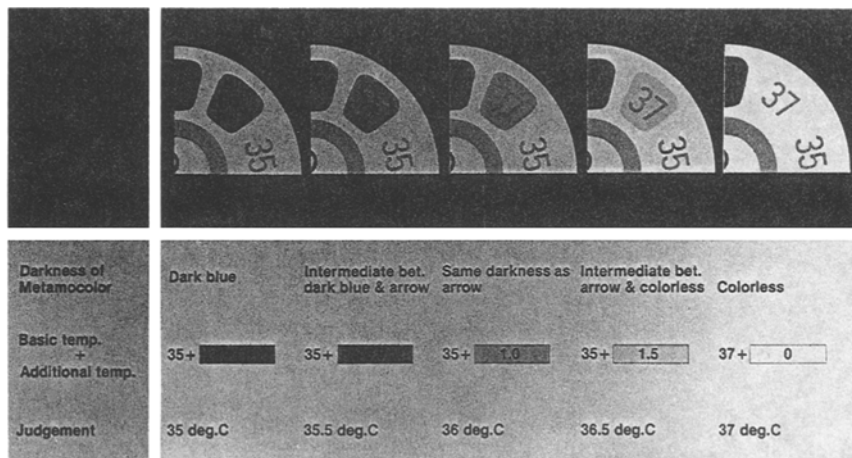
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Measurements were taken 115 times on the forehead and 124 times on the forearm with ProChecker, 41 times on the forehead and 54 times on the forearm with the thermocouple thermometer, and 126 times with the rectal thermometer.

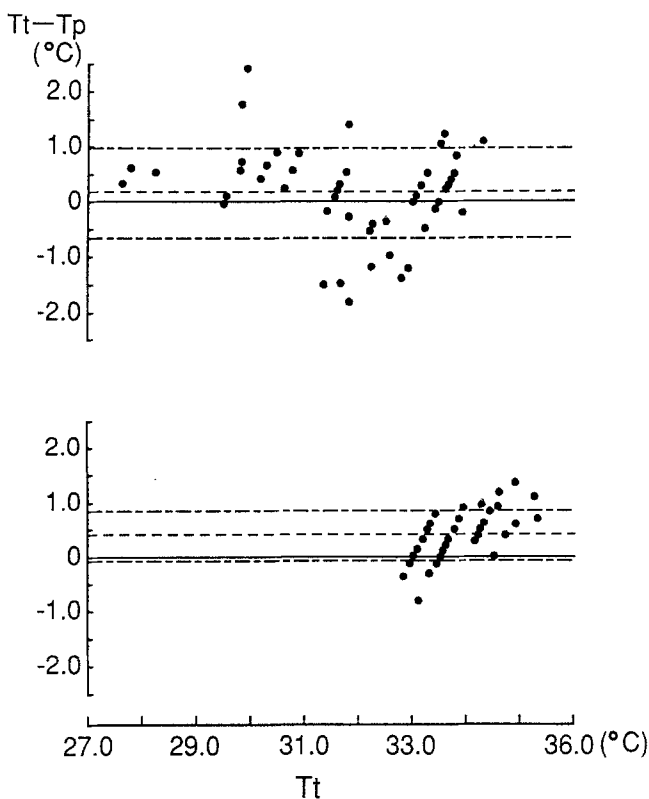
The temperatures measured with ProChecker were lower than those measured with the thermocouple thermometer (Fig. 2), but the differences were almost within the standard deviation. A highly positive correlation was found between the forearm surface temperature measured with the thermocouple thermometer (Y) and that with ProChecker (X),  $Y = 0.787X + 6.935$ ,  $r = 0.896$ ,  $P < 0.01$ . In the forehead surface temperature as well, a highly positive correlation was noted between the thermocouple thermometer (Y) and ProChecker (X),  $Y = 1.244X - 7.126$ ,  $r = 0.833$ ,  $P < 0.01$ . No correlation was found between the surface temperatures and the rectal temperature.

Body temperature is divided into two categories: core temperature and peripheral temperature. Core temperature includes blood, rectal, esophageal, pharyngeal [2], bladder [3], and tympanic membrane temperature [4]. To measure the peripheral temperature, axillary, skin surface, and deep peripheral temperature [5] are employed. The usefulness of the procedure may change with the measurement environment such as the sites of operation [6,7]. In this study, we used rectal temperature as a monitor for core temperature because this method is the most commonly used during laparotomy. Of the peripheral temperatures, skin surface temperature is the easiest to monitor continuously.

With the use of reversible thermal discoloring agents, ProChecker is designed to read the change in color and darkness caused by the exchange of electrons induced by temperature. ProChecker has a very quick and reversible response [1]. Another skin surface temperature monitoring device, a liquid crystal plastic disc, is usable but it has a slow reaction and is potentially unreliable [8].



**Fig. 1.** Method of measuring temperature with ProChecker (from KYOWA MEDEX Co. Ltd., catalog; with permission). The lower part of the chart indicates how to judge the temperature. For example, if the color at number 37 is the same darkness as the arrow (central ring), it is judged as 36 °C



**Fig. 2.** Differences in measured temperature between with ProChecker ( $T_p$ ) and with thermocouple thermometer ( $T_t$ ). Upper figure indicates the temperature measured in the upper arm and the lower figure indicates that measured in the forehead. Dashed line, average; chained line, standard deviation

Skin surface temperature monitoring by ProChecker is reported to be very useful in evaluating the results of finger reconstruction [9]. The temperature measured with ProChecker has been reported to be well correlated with deep peripheral temperature and skin surface temperature monitored with a thermometer [1]. The present study showed a good correlation between skin

surface temperature measured with ProChecker and that measured with the thermocouple thermometer; the differences between the two methods were small. All these findings indicate that ProChecker is useful for the measurement of skin surface temperature during anesthesia.

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