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BLOOD CIRCULATION TEMPERATURE INDEX AS AN INDICATOR OF WOUND PROCESS FLOW STATE

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Keywords: *circulatory temperature index, inflammation, white blood cells, pain, body temperature, infiltration, exudation, edema.*

Summary: *the application of the circulatory temperature index is possible in surgical practice to diagnose and evaluate the local inflammatory process. The aim of the study was to identify the dependence of the circulatory temperature index on the level of pain, blood leukocytes, the degree of swelling, infiltration, exudation, hyperemia of the operating wound area and body temperature. The materials of the present study are presented by the results of indicators on the first, third and fifth days of the postoperative period of 258 patients who underwent emergency or planned treatment in a surgical hospital. The assessment of the level of indices was calculated on a point scale, the circulatory temperature index by the formula considering body temperature, the temperature of the studied skin area and the temperature of the environment. The study showed that circulatory temperature index is directly related to white blood cell levels. Also, CTI is associated with the level of hyperemia of the postoperative wound area. All these data could spur subsequent studies to compile a more accurate dependence of CTIs and inflammatory process indicators of the postoperative wound area.*

Relevance. Body temperature is a basic criterion for assessing a patient's health. Increase of body's temperature indicates the presence of inflammation, in which there is an expansion of the vessels of the microcirculatory system and an increase in metabolic processes. Temperature decrease consists of reduced microcirculation due to impaired arterial blood supply, decreased level of metabolism, degenerative processes with replacement of functionally active tissue with connective one. The reason for these changes in the process of surgical treatment may be the fusion of tissues around the area of operative access, the period of anesthesia, the restructuring of the functional activity of the organ when removing part of its tissue, etc. [1].

The circulatory temperature index is a criterion for assessing the local state of tissue. According to the index, it is possible to determine the severity of the inflammatory reaction at a certain area of the body. Compared to the body temperature index, the circulatory temperature index is a more accurate characteristic showing the tissue response of the wound surface region [2].

Postoperative wound status indicators are a symptom complex that can be assessed using the pain scale, exudate availability and quantity, infiltration, hyperemia and postoperative wound edema. These indicators are characteristics of inflammation. The presence of these phenomena and the degree of their severity indicate the state of the patient in the postoperative period [3, 4].

In surgical practice, it is necessary to pay attention not only to the general values of the indicators of the state of the body, but also to local changes in the area of operation. System and local metrics are interconnected. The identification of the dependence of these criteria is relevant for optimizing the treatment plan, as well as conducting diagnostic measures.

Purpose: determine dependence of circulatory temperature index on indices of wound surface state in postoperative period.

Tasks: 1. Comparison of CTI scores and postoperative inflammatory process criteria among different patient groups; 2. Detection of the presence or absence of a relationship between CTI values and other wound surface condition criteria.

Material and methods. An analysis of the wound surface condition in 258 patients was carried out, which included emergency and planned surgical intervention in the Tver's surgical hospital No. 7, the Central District Hospital, Solnechnogorsk and the Clinical Hospital, Tver, Russian Railways. The age range of the patients was between 18 to 86 years, male - 130, female - 128 people. Of these patients, with emergency surgical treatment, there were 78 people, with planned - 130 people.

The circulatory temperature index (CTI) was compared with the white blood cell level, body temperature and wound surface state.

When collecting material, the CTI was calculated by the formula, CTI = (st-at)/(ct-st) where "st" is the skin temperature of the studied area, "at" is the ambient air temperature, 'ct" is the temperature in the axillary cavity [1].

Wound indicators were characterized by scales with subsequent explanations. Hyperemia was assessed on a four-point scale, 0 - "hyperemia absent," 1- "non-intense local hyperemia," 2 - "intense local hyperemia," 3 - "intense hyperemia spreading far beyond the wound." Swelling indicators were also characterized on a four-point scale: 0 - "no swelling," 1- "non-intense local swelling," 2 - "intense local swelling," 3 - "intense swelling, spreading far beyond the wound." Infiltration was assessed on a four-point scale with the following explanations: 0 - "no infiltration," 1- "non-intense surface infiltration," 2 - "intense surface infiltration," 3 - "intense deep infiltration." The exudation indicator was determined on a four-point scale: 0 - "exudation absent," 1 - "serous exudate is separated in a small amount," 2 - "purulent exudate is separated in a small amount," 3 - "purulent exudate is separated in a significant amount." When assessing pain syndrome, the Behavioral Pain Scale was used with values from 0 to 4, where 0 is "no pain," 1 is "insignificant pain," 2 is "moderate pain," 3 is "severe pain," 4 is "severe pain, spreading beyond the wound."

White blood cell levels were assessed through a general blood test. The body temperature was measured with a mercury thermometer in the axillary cavity.

All indicators were evaluated on the first, third and fifth days of the postoperative period. The results were compared according to the values depending on the day of the postoperative period and the type of operation (emergency or planned). During the study, individual characteristics of patients were not considered.

Results and discussion. When comparing the performance of two groups of patients - with emergency and planned operational interventions, it was revealed that a greater percentage of emergency operations (58%) were performed for acute appendicitis. In the category of planned operations, 70 patients (54%) were with inguinal and umbilical hernias, 44 (34%) were operated on for bile disease.

CTI scores among the studied groups ranged in values from 5.18 to 6.23. During the comparison of the CTI value in the group after a planned and emergency surgical intervention with white blood cells level, body temperature, pain syndrome, exudation severity, hyperemia, edema and infiltration of the postoperative wound area, no obvious differences were revealed. Gender and age differences also did not affect the outcome.

In a separate analysis of the CTI indicator, it was observed that clear differences arise depending on the level of the index in the previously mentioned terms. Thus, the level of the white blood cells' level among six patients with a minimum available CTI of 5.18 on the first day after surgery was 10.73, and in nine patients with a maximum CTI of 6.23 in the same time range, the white blood cells' level was around 9.7. It was decided to compare the groups, depending on the value of the CTI, and not by categories of surgery. Note that the operation type also did not affect statistics. Age and sex were also not taken into account, since no clear dependence was detected according to these criteria.

During the comparison, the main emphasis was placed on the first and third days of the postoperative period. The values presented on the fifth day did not give a clear scene of the process and almost all the indicators approached the physiological norm.

All patients were divided into groups depending on the CTI value. In the first day after the operation, 5 groups were formed. Group 1 included patients with CTI indicators 5.18 - 5.31, 2nd - 5.4 - 5.55, 3rd - from 5.64 - 5.78, 4th - 5.8 - 6.01, 5th - 6.1 - 6.23. The values of the scores of the patients included in these groups were used in the analysis on the third and fifth day of the postoperative period. In each group, the number of patients was 35-50.

Note that the indicators of the first day after the patient's surgery were controlled to detect the dependence of the CTI level on the remaining indicators of the wound process.

Changes in indicators in 1 group of patients on day 3 of the postoperative period occurred an increase in CTI levels by 4.4 units (84%), hyperemia by 1.2 units, edema by 0.7 units, infiltration by 0.7 unit and a decrease in white blood cells' level by 0.6 unit (6%), body temperature by 0.3 degrees Celsius (0.8%), exudation by 0.7-unit, pain syndrome by 1 unit (40%).

In the 2 group, in comparison of 3 and 1 day, the results are: an increase in CTI by 3 units (53%), edema by 0.8-unit, hyperemia by 1 unit, infiltration by 0.5 unit and a decrease in body temperature by 0.2 degrees Celsius (0.5%), white blood cells' level by 1.1 units (12%), pain syndrome by 1 unit (40%), exudation by 0.6 unit.

The following changes occurred in group 3: an increase in CTI by 3 units (52%), hyperemia by 1 unit, edema by 0.6-unit, infiltration by 1 unit and a decrease in white blood cells' level by 1.2 units (13%), body temperature by 0.4 degrees Celsius (1%), pain syndrome by 0.9 unit (36%), exudation by 0.5 unit.

In group 4, CTI increased by 2.6 units (44%), edema by 0.8-unit, hyperemia by 0.9 unit. Infiltration by 0.5 and white blood cells' level decreased by 0.6 (7%), pain syndrome by 1.2 units (44%), exudation by 0.8 units, body temperature by 0.3 degrees (0.8%). In group 4, there was a decline in the total percentage of white blood cells, although the level of CTI increased.

In group 5, there was an increase in CTI by 2.6 units (42%), edema by 0.7-unit, hyperemia by 0.9-unit, infiltration by 0.7 and a decrease in white blood cells' level by 0.7 units (7%), pain syndrome by 1.2 units (46%), exudation by 0.6 unit, body temperature by 0.3 degrees (0.8%).

According to the results of the third day of the postoperative period, in comparison with the control indicators, it was revealed that an increase in CTI level is directly proportional to an increase in edema, hyperemia and infiltration and to decrease in white blood cells' level, body temperature, exudation and pain. It was also found that the higher

the CTI on the 1st day of the postoperative period, the smaller the interval of increase in its level in percentage increase by day 3. The percentage changes of white blood cells' level is wave-like, where the maximum percentage decrease at day 3 was observed in the mid-range CTI group (group 3) and the minimum was observed in groups 1 and 5, where the CTI level was lowest and highest. Body temperature almost always decreased in all groups by 0.2-0.3 degrees (0.8-1%) compared to the 1st day. Hyperemia increased significantly on day 3 of the postoperative period, characterized as intense local. The indicator of pain syndrome decreased, moving from the level of severe pain to moderate pain. The level of infiltration and exudation was in the range of 1.

Consider the indicators of the inflammatory process on day 5 of the postoperative period. In group 1, the level of pain syndrome on the fifth day decreased by 0.7, thereby making the difference between 5th and 3d days in the decrease by 0.7 (53%) and between 5 and 1 day - by 73%. The level of edema, exudation and infiltration approached 0. The level of hyperemia on day 5 decreased by 1.2 units, making up the difference from day 3 in 1.2 units. Body temperature decreased to normal at 36.6 degrees Celsius, in percentage terms there was a decrease of 1% compared to 3 days and 2% - with 1 day. White blood cells' level decreased by 1.9 units after 3 days (20%) and made up the difference with the 1st by 26%. The average CTI value at day 5 after surgery was 6.2, indicating a 35% decrease in the level after day 3 and 19% increase after day 1. There is an inverse relationship between white blood cells' level and CTI values. After the third day of surgery, there is a direct proportional decrease in CTI and white blood cells' level, but in percentage terms these indicators are different. Pain indicators also declined, and body temperature, swelling, infiltration and exudation equated to the norm by the day 5.

In group 2, pain syndrome rates decreased by another 0.7 units after 3 days, making a total change of 1.6 units from the baseline. The level of swelling decreased to 0.4 units. The level of hyperemia decreased by 0.5 units, reaching an intermediate value of 1, 3 and 5 days after surgery. Infiltration and exudation decreased by 0.2 units, closely approaching the mark 0 5 days after the operation. The body temperature reached normal (decreased by 2% from 1 day and by 1% from 3). White blood cells' level fell by another 1.2 units (16% of 3 days), total change was 2.3 units, representing a 24% decrease in white blood cells' level from the first day of the postoperative period. The average CTI was 5.8 for the group, down on 2.6 units (31%) after day 3. There is a direct proportional relationship between the decrease in CTI and white blood cells' level after 3 days, the percentage of these indicators is different.

In group 3, the level of pain syndrome decreased in 2 times compared to the indicator of 3d day and changed in total on 1.7 units. Swelling on day 5 fell to the level of the 1st day, amounting to 0.2 units. Hyperemia decreased by 0.8 units, approaching a value close to the 1st day after surgery. Infiltration and exudation almost completely disappeared, dropping to values of 0.2 and 0.1 units. The body temperature equalized to 36.6 degrees Celsius. White blood cells' level decreased by another 1 unit (12% of 3 days), with a total decrease in 2.2 units from the 1st day of the postoperative period (24%). The average CTI value on day 5 decreased to 5.8 units, practically reaching the initial value of the group.

In group 4, the level of pain syndrome decreased by 0.9 units after the third day (60%), reaching a minimum mark of 0.5. The difference with the 1st day was 2 units (fell by 80%). Swelling, infiltration and exudation dropped to an average of 0. Hyperemia was 1.1,

decreased by 0.7 units after 3 days and had a difference between the 1st and 5th days of 0.3 units. Body temperature similarly to other groups equalized to 36.6. After 3 days, white blood cells' level decreased by another 1.4 units (16%). The total difference between day 1 and day 5 was a decrease of 2 units (21%). The CTI level reached an average of 5.9 on the fifth day (decreased by 31% after 3 days) than approached the initial of the 1st day after surgery.

In group 5, swelling, infiltration and exudation decreased to 0, body temperature was 36.6 degrees Celsius, the level of pain decreased by another 0.8 units after 3 days (57%), making up the total difference with the 1st day in 2 units (a decrease of 71%). White blood cells' level dropped to 7.6 units, a 21% decrease from day 1 and 17.5% from day 3. The CTI on day 5 after surgery was 6.1 (decreased by 42%), thereby reaching exactly the same value as on the first.

Based on the comparison of the indicators of the 5th day with the 1st and 3rd day of the postoperative period, it was revealed that pain syndrome, exudation, infiltration and edema decreased to 0. The body temperature on the fifth day reached a physiological norm of 36.6 degrees Celsius. CTI almost returned to the initial indicators of the first day. White blood cells' level reached minimum values, dropping by an average of 2 units. However, it is worth noting that the reduction of white blood cells on the fifth day of the postoperative period was minimal in group 3 with a CTI level of 5.6-5.78, which is the opposite to the result of the third day in the group.

Conclusions. 1. The circulation temperature index is directly related to white blood cells' level. The optimal CTI value, at which the decrease in blood leukocytes was maximum, is in the range from 5.18 to 5.31 units; 2. CTIs are associated with postoperative wound area hyperemia levels (no direct correlation with the rest of the inflammatory process with CTIs has been established). On day 3, hyperemia reached its maximum, while inversely proportional dependence was noted, on the fifth day the dependence between hyperemia and CTI became directly proportional. However, abrupt changes in CTIs can also be associated with a difference in body temperature of even 0.2 degrees.

All these data could spur subsequent studies to compile a more accurate dependence of CTIs and inflammatory process indicators of the postoperative wound area.

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