

Features of the Dynamics of Infected and Septic Wounds Microcirculation in Children

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ABSTRACT

Treatment of infected and septic wounds remains one of the most important problems of pediatric surgery. According to the authors, the wound process monitoring affects the treatment outcome not less than operative technique.

The objective of the research was to examine the dynamics of microcirculation of the infected and septic wounds in children.

Materials and methods. The analysis of the study of infected and septic wounds microcirculation in 178 children was performed. Blood flow laser analyzer ("LAKK-02" RPE "Lazma", Russia) was used to study the blood flow in the wound area. Monitoring of wound healing process dynamics was conducted by studying the wound healing cytogram.

Results. On the first day the average parameter of microcirculation was markedly increased in the area of wound edges in comparison with the contralateral area. The subsequent study of a blood flow during 5 days showed that average value of microcirculation parameter in the wound area decreased by more than 2 times in comparison with the figures on the first day. Microcirculation parameters of in the wound area further decreased.

Conclusions. Dynamics of microcirculation changes in wound healing process significantly corresponds to cytogram of impression smears obtained from infected and septic wounds in children. Laser Doppler flowmetry is an effective method microcirculation control and minimally invasive diagnostic method of wound healing process.

PROBLEM STATEMENT AND ANALYSIS OF THE RECENT RESEARCH

Treatment of infected and septic wounds remains one of the most important problems of pediatric surgery. According to the literature on infected and septic wounds constitute 35% of cases [2, 7, 9]. This is due to the high frequency of this pathology in the structure of primary referring and increase in the number of surgical site infections [3, 5, 8, 11]. According to the modern principles, the management of patients with soft tissue surgical infection is based on the integrated effect [10].

According to the authors [7, 9], monitoring of the wound healing process and timely application of tactical decisions affects the treatment outcome not less than operative technique. Therefore, a lot of important questions of wound healing process monitoring acquire primary importance in the treatment of infected and septic wounds [7].

The study of wound process dynamics is primarily based on clinical signs [11]. Currently, a variety of modern informative study methods of wound healing process is developed. However, all of them are subjective. Therefore, it is advisable to use a number of methods for objective assessment of wound healing process. Planimetric methods, cytological examinations of wound prints, pH determination of wound, the amount of protein in it, the qualitative and quantitative bacteriological control are widely used In pediatric surgery.

Microcirculation violations play the significant role in the pathogenesis of various diseases. They reflect the dynamics of the disease process, as well as a significant effect on the treatment effectiveness. Therefore, the microcirculation parameters determination is currently widely used in different fields of the surgery.

Study method of microcirculation parameters of tissues of various localization, using laser Doppler flowmetry has become widely used in the practice of surgeons over the last decade [1, 2, 5, 7, 12]. This method provides an opportunity to assess the state of blood flow at the capillary level, during different inflammatory and reparative processes, thereby allowing simultaneous or dynamic non-invasive determination of capillary blood flow [5, 12, 13, 14].

However, the use of laser Doppler flowmetry for assessment of wound healing process of septic wounds in children is not sufficiently investigated [1, 4, 5, 9].

The objective of the research was to study microcirculation dynamics in infected and septic wounds in children.

MATERIALS AND METHODS

178 children with infected and septic wounds were under observation. They were treated at the Department of Purulent Surgery of the Regional Hospital of Zaporozhye in the period from 2013-2015. The children age ranged between 3 months and 17 years. There were 94 (52.8%) boys and 84 girls (47.2%).

The clinical observation included septic wounds after lancing of abscess, phlegmons, lymphadenitis and infected wounds of different localization.

Treatment of infected and purulent wounds was conducted on generally accepted principles of acute purulent surgical infection therapy and was aimed at haemostatic disorders correction, pathogen elimination and stimulation of reparative regeneration processes.

Our developed method of wound process microcirculation study was used to study blood flow in the wound area [3].

For this purpose the average microcirculation parameter in perfusion units (pf. un.) and bypass indicator in relative units (rel. un.) were determined on a daily basis during dressing in the area of the wound edges with the help of a laser blood flow analyzer ("LAKK-02" RPE "Lazma", Russia) with wave source of 0.63 micrometers and compared it with the index in the area of the contralateral wound site location, which was considered as the norm. Increase in microcirculation parameter was calculated.

Monitoring of wound process dynamics was conducted by studying the cytogram of wound process using the impression smears according to the method of M.V. Pokrovskiy, M.K. Makarova in modification of D.M. Steinberg. It was conducted on the 1st, 3rd, 7th and 10th day from the disease onset. Thus, such parameters as the number of neutrophils, the nature of phagocytosis ratio with cells and connective tissue (eosinophils, plasma cells, monocytes, macrophages, fibroblasts) were investigated.

Classification by M.I. Cusin (1977) was used during the study of the wound process. According to the classification, three phases are distinguished:

- inflammation with a division into two periods (vascular changes and abrasion);
- regeneration, formation of granulation tissue;
- scar reorganization and epithelialization.

Evaluation of the statistical probability of absolute values difference was performed according to the formula determining the Student's t-test using its standard values. Statistical processing of the results was conducted with the use of the application package for "Statistica Windows". The significance of differences was considered determined at $p < 0.05$.

RESULTS AND DISCUSSION

The analysis of the obtained data detected that the average microcirculation parameter of the wound edges was significantly increased in comparison with the contralateral region in all children on the first day and constituted 14.28 ± 2.4 pf. un. 2.4 ± 0.7 pf. un., respectively ($p < 0.05$), the index of bypass in the area of the wound edges constituted 0.9 ± 0.05 rel. un. and contralateral area of 0.65 ± 0.03 rel. un. ($p < 0.05$). Increase in these parameters indicated the attenuation of arterial vascular tone leading to an increase in blood volume in the arterioles and blood stagnation in venular component. Increase in microcirculation parameter constituted 83%. Thus, this indicated an increase in blood flow to the wound area and the course of exudative phase. It should be noted that the corresponding pattern was typical for impression smears. Blood cells, namely red blood cells and neutrophils were presented in them in overwhelming numbers as cellular elements on the first day in the wound.

The subsequent study of a blood flow during 5 days showed that average value of microcirculation parameter in the wound area to 39%. The average value of a microcirculation parameter in the wound area decreased by more than 3 times in comparison with the figures on the first day and constituted 3.87 ± 0.8 pf. un., and 2.36 ± 0.6 pf un ($p < 0.05$) in the area of the contralateral. The bypass indicator increased in the wound area (0.97 ± 0.06 rel. un.) being significantly different from intact skin index ($p < 0.05$). This indicated a decrease in congestion in the venous bed, and increase in arterioles muscle tone. Decrease in neutrophils, increase in macrophages and active fibroblasts, isolated epithelial cells occurrence was observed in impression smears of the wounds. This is typical for the beginning of the second phase.

Microcirculation parameters in the wound area further decreased. On the 7th day, microcirculation parameter growth increased by more than 50% in comparison with the contralateral region indices. The average parameter of microcirculation in the wound area constituted 2.8 ± 0.6 pf. un. and 2.27 ± 0.5 pf. un. ($p < 0.05$) in the contralateral region. Bypass index increased every day and reached its maximum on the 7th day (1.07 ± 0.04 rel. un.). Thus, this reflected increased microcirculation at the wound site. Cytogram reflected the following changes during these terms: decrease in the number of neutrophils, increase in fibroblasts and epithelial cells. Marginal epithelialization process was also observed in impression smears. It was represented in the form of cells layers.

A comprehensive comparison of the results of microcirculation and the cytogram of infected and septic wounds showed a statistically significant change of wound process phases.

CONCLUSIONS

1. Changes in microcirculation of wound process significantly corresponded to the cytogram of impression smears obtained from infected and septic wounds in children.
2. Laser Doppler flowmetry is an effective method of microcirculation control and minimally invasive diagnostic method of wound process course.
3. Determination of microcirculation in the area of the wound can be used as criteria for evaluation of the wound process course for the control over treatment efficacy.

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