

## CYTOLOGICAL METHOD OF STUDYING THE DYNAMICS OF WOUND HEALING

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**Ключевые слова:** цитологический препарат-отпечаток, клетка, раневой экссудат, симпласт, цитограмма.

**Резюме:** Статья посвящена аспектам изучения заживления ран посредством использования метода раневых отпечатков на основании динамики клеточного состава раневого экссудата. Рассмотрено применение метода раневых отпечатков для определения фазы заживления раны и оценки эффективности применяемой терапии.

**Keywords:** the cytological preparation-imprint, cell, wound exudate, symplast, cytogram.

**Resume:** The article is devoted to the aspects of studying wound healing by using the wound imprint method based on the dynamics of the cellular composition of the wound exudate. The application of the wound imprint method is addressed for determining the wound healing phase and evaluating the effectiveness of the applied therapy.

**Relevance:** The value of a cytological preparation-imprint from a wound or from a piece of rapidly growing tissue is that it can "select" the least mature cells of the regenerate, which have not yet firmly bounded together with the basic substance of the connective tissue, onto the glass. It enables a researcher to study the youngest cells of the upper layer of the wound, due to which the new tissue is grown at the site of its defect.

Besides, cytological analysis of a wound exudate provides to surgeons a number of objective data for judging the activity of reparative processes occurring in the wound, the immunobiological status of the patient and allows them to follow up the dynamics of the wound cleansing from microorganisms.

**Purpose:** To study the characteristic of using the wound imprint method, to evaluate and to compare the cellular composition of the wound exudate of various types of cytograms.

**Tasks:**

1. To perform a meta-analysis of literature.
2. To define the pattern of changes in the cellular composition of the wound exudate, respectively to the wound healing phase.
3. To distinguish individual types of cytograms of wound imprints.
4. To analyze the technique of wound prints.

**Materials and methods:** The study of the cytological method of studying of the dynamics of wound healing was carried out based on an analysis of data from literature.

**Results:** The method of "wound imprints" in the modification of D.M. Steinberg, M.P. Pokrovskaya and M.S. Makarov (1948) gave a detailed description of the cytology of preparation-imprints and showed a close connection between the dynamics of cellular elements of the wound exudate and the nature of wound healing.

For analysis of an imprint and objective conclusions, it is necessary to have a

distinct idea of the regular biological processes that develop because of tissue damage and the invasion of infection into the wound. Morphologically, these processes are expressed in regressive-destructive and proliferative changes in tissues and exudative reactions from the vessels. The wound exudate has a complex biochemical and cytological picture. The cellular composition of exudate vasogenic and histiogenic origin is of particular interest to a researcher.

The usage the cytological method to study the wound healing in clinical practice is based on the idea that the course of the wound process occurs in accordance with a universal pattern. This pattern is expressed in a strict sequence of changes in cellular elements in the wound during its healing.

There are almost no topographic relationships in a cytological preparation-imprint. The tissue elements are located separately and only sometimes in the form of a complex of the cell symplast in it.

The method to evaluate the morphology of the wound healing is carried out by preparing the cytological preparation-imprint from the edge of the wound according to the M.P. Pokrovskaya and M.S. Makarov's method and it is performed in the following sequence.

1. The quantitative determination of the cellular composition of the traumatic discharge.

2. The analysis of the dynamics of individual cellular forms and the ratio of different cells that form specific types of cytograms.

3. The calculating of the regenerative-degenerative index (RDI) according to the formulation:  $RDI = (SN + SGN) / DFN$ , where SN is the number of stab neutrophils; SGN - the number of segmented neutrophils; DFN is the number of degenerative forms of neutrophils. It is noteworthy that a long-lasting RDI less than one indicates the development of wound complications.

There are four types of cytological pattern corresponding to different stages of the wound process: necrotic, degenerative-inflammatory, inflammatory, inflammatory-regenerative.

I type is inflammatory type of cytogram. Regardless of the age of injury, cellular elements are represented in the imprint with only a large number of neutrophils and single histiocytes with a vacuolated cytoplasm. Simultaneously on the cytogram there are abundant flora, both coccuses and bacilli, and weakly expressed phagocytosis. Such a cytogram suggests a low resistance of the organism to infection, inhibitions of immunobiological resistance and regeneration processes.

II type is inflammatory-regenerative type of cytogram. On the cytogram a sparse microflora is observed in the phenomena of an extremely limited number of elements. Neutrophils are predominantly in a destruction stage. Phagocytic fragments of neutrophils in some macrophages are observed. The productive, proliferative processes are suppressed, there are no signs of the development of connective tissue components. This type suggests a good resistance of the organism to the infection, while reducing its regeneration capacity, which can be observed, for example, with hypo- or avitaminosis, and also if an overall resistance of the organism is expressed much better than the local reactivity of tissues in the wound area.

III type. In this type, the character of the cytogram is, to a certain extent, the opposite of the previous one. There are a large number of connective tissue elements at different stages of development and differentiation on the imprint. At the same time, there is abundant microflora. Clinically, such wounds are characterized by hypergranulation with delayed epithelialization. Obviously, in such cases the defenses of the body are not weakened, as evidenced by the well-flowing proliferative processes in the wound, however the infection, perhaps due to its great virulence, nests in the wound and inhibits epithelization processes. In particular, such phenomena are pointed out when the wound is damaged with diphtheroides bacilli.

IV type. In the secondary infection of wounds, most often with ulceration and suppuration scars, in the cytograms one can see many epithelial cells, both young and keratinizing, as well as differentiated connective tissue. Along with this, in the prints of such wounds, there are abundant coccuses and rod microbial flora, indicating a secondary origin of the infection due to mechanical or other damage of the young epithelium or scar. The quantitative expression of cellular elements on repeated cytograms is convenient for studying the dynamics of the wound process and the choice of rational treatment.

Comparing the content and relationships of the various elements of the cytograms of these four types with cytograms of normal healing of a planar wound, it is possible to determine the nature and extent of deviations from the normal direction of wound healing.

Depending on the cytological picture, wound healing could be divided into certain periods and phases (according to M.P. Kamaev):

1. Early period - duration 12 hours. - Data of the cytogram: cellular elements of normal blood, fibrin.

2. Degenerative-inflammatory period - duration 5-8 days. - Data of the cytogram: polymorphonuclear leukocytes cover the entire field of vision, detritus, single mononuclear cells.

3. Regenerative period - duration from 8-10 to 30 days. Data of the cytogram:

a. Phase 1 - the presence of little-modified polymorphonuclear leukocytes in a significant or moderate amount and polyblasts (3-5 in the field of vision),

b. Phase 2 - further decrease of the number of leukocytes, their fragmentation and the appearance of specialized cells such as fibroblasts and macrophages.

In addition to the abovementioned, it is worth to emphasize the advantages of the wound imprint method. One of the main advantages of the method is atraumaticity. Therefore, there is a possibility of repeated analyses throughout the day.

Cellular elements are entered on the imprint from the two upper layers of the wound (leukocyte and vascular ones), which reflect the dynamics of a reparative regeneration adequately.

In addition, the advantage of the method is the simplicity and safety of obtaining a material to study the wound process in any phase of it enabling detecting of deviations from the normal course of the process timely.

**Conclusions:** Overall, a dynamic control of the wound conditions by means of a cytological evaluation of preparation-imprints from the wound surface allows:

1. To determine objectively the phase of the course of the wound process and the effectiveness of the applied method of treatment.

2. To correct the treatment, if needed.

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