Estimation Of Pathomorphological Peculiarities of Perivulnar Tissue After Ultrasonic Curettage Of Pilonidal Cysts Of Sacro-Coccygeal Region

DOI 10.52739/bio-up.2.2021.28-36

Dmytro Ye. Dubenko[1], Yuliia V. Dibrova[2], Ievhen V. Tsema[1], Sergiy G. Gychka[2], Mariia B. Khominska[2], Viacheslan A. Dibrova[2], Volodymyr T. Yurchenko[3], Yaroslav R. Musiiets[2], Benedict Adjatey Dadebo[4]

ABSTRACT

The results of morphological research of operative wound's tissue after ultrasonic curettage of acute pilonidal abscess are presented in the article. 13 patients were treated using the offered method, and of these, 11 patients underwent morphological research of the wound's walls. Areas of the mucoid degeneration of the fibrous connective tissue and fragments of coagulation necrosis were identified, as a result of low-frequency ultrasound. The morphological substrates of recurrence pilonidal sinus, such as stratified squamous epithelium and hair follicles, were not found in any preparation, The offered method of treatment allows for ambulatory primary radical treatment in the

[1] Department of Surgery with a Course of Emergency and Vascular Surgery, Bogomolets National Medical University, Kyiv, Ukraine
[2] Department of Pathological Anatomy, Bogomolets National Medical University, Kyiv, Ukraine
[3] Kyiv City Clinical Bureau of Forensic Medicine, Kyiv, Ukraine
[4] Department of Pathological Anatomy, Histology and Forensic Medicine, Kyiv Medical University, Kyiv, Ukraine

acute stage of pilonidal illness. The offered method of ultrasonic curettage of the pilonidal sinus requires more scientific research and monitoring.

Key worlds: pilonidal sinus, ultrasonic curettage, radical treatment, morphological substantiation.

INTRODUCTION

The incidence of pilonidal cysts of the sacro-coccygeal region is 7 cases per 1000 population of Ukraine. Patients with pilonidal cyst (PC) account for up to 15—25 % of all inpatient proctology patients and 1—2 % of all patients in a surgical hospital. The PC mainly affects young men (18—30 years), the ratio of men and women is 7: 3 [1, 8, 9]. Among hospitalized PC patients, in 65 % of cases, the disease manifests itself in the form of an acute pilonidal abscess. Among urgent proctological interventions, operations for this form of pilonidal disease take second place, second only to acute paraproctitis (Yurkiv & Tsema, 2018, Zakharash et al., 2010, Muller et al., 2011).

Methods of surgical treatment of acute PC abscess are traditionally divided into radical and palliative according to the volume of surgical intervention, and emergency, delayed and planned according to the terms of execution (Yurkiv & Tsema, 2018, Rusak, 2008, Bradley, 2010, Nesbakken, 2010). Palliative surgery is performed as a matter of urgency and involves the opening and drainage of an acute pilonidal abscess. These operations should be considered as a preparatory stage for radical surgery. Radical surgery involves the removal of all elements of the PC as a morphological substrate of the disease. Depending on the timing of execution radical surgery can be performed immediately after admission to the hospital (emergency primary radical surgery), after remediation of an acute abscess without discharge from the hospital (delayed radical surgery), and as planned after complete remediation of the wound cavity. In modern professional literature, there are several reports on the advantages and disadvantages of methods of treatment of acute pilonidal abscess, however, the only generally accepted approach to this issue has not been developed to date (Yurkiv & Tsema, 2018, Tsema, 2017, Zakharash et al., 2010, Muller et al., 2011). Recently, there has been a tendency to perform not only palliative, but also radical operations in an outpatient setting due to the introduction of novel surgical technologies (laser irradiation, ultrasound, electric welding, etc.), which significantly reduces the cost of treatment, time, and the trauma of surgical manipulations (Zakharash et al., 2010, Tsema, 2020). This area is promising for the treatment of patients with acute PC abscesses and requires further comprehensive scientific study.

The work aims to substantiate the possibility of radical treatment of complicated pilonidal cysts by the method of ultrasonic curettage by conducting a series of histological examinations of biopsies of the walls of the postoperative wound.

MATERIALS AND METHODS

The presented study included 13 patients with complicated pilonidal cysts undergoing minimally invasive surgical treatment according to the method of ultrasound curettage (US-curettage) PC developed by athours. The average age of patients was 24.3 ± 3.1 years. Among the patients, there were 11 (84.6 %) men and 2 (15.4 %) women.

We considered the method of PC ultrasound curettage developed by us was shown to the following patients:

1. patients with pilonidal disease complicated by primary acute abscess, in the absence of secondary fistula;

2. patients with fistulous form of pilonidal disease complicated by secondary acute abscess, provided that there are no more than two secondary fistulous courses at a distance of not more than 3 cm from the primary fistula and localization of secondary fistulas within inflammatory infiltration around the acute pilonidal abscess.

The technique of ultrasound curettage of the PC was as follows. Local infiltration anesthesia of the sacro-coccygeal region was performed. An incision 1.0—1.5 cm long was made over the area of maximum fluctuation, on the side and parallel to the sciatic fold. Ultrasound curet-

tage of the PC was performed using an ultrasound machine Sonoca 190 (Suring, Germany). With the help of a monopolar waveguide of the "hoof" type, the abscess cavity was sonicated (ultrasonic sanitation) with an oscillation frequency of 25 kHz and an amplitude of 40-80 μm until the wound was completely cleared of purulent-necrotic contents. A 0.25 % solution of novocaine was used as an intermediate medium. During performing ultrasound manipulations in the wound, it is necessary, if possible, to avoid touching the lateral parts of the waveguide to the edges of the wound to prevent thermal injury to tissues that do not carry the pathomorphological substrate of the disease. When sounding the wound, there is no need to create pressure on the working tool, which can prevent the solution of novocaine (as an intermediate medium) between the appliance and the wound wall. A grooved probe is passing through the sanitized abscess cavity to the primary fistula opening. An incision was made on the probe at a length of 1.0—2.0 cm strictly along the midline with the mandatory involvement of the primary fistula. If there are several primary fistula openings, the incision line was made through all apertures. Ultrasound curettage of the PC was performed directly through the formed incision. Sounding began with more superficial tissues, gradually moving deeper (as the wound cavity was being cleared of wound detritus and PC elements). The duration of exposure to ultrasound was determined based on the presence of visually visible elements of the PC in the wound and the appearance of diffuse petechial hemorrhage from the wound walls. Sounding began with more superficial tissues, gradually moving deeper (as the wound cavity was being cleared of wound detritus and PC elements). The duration of exposure to ultrasound was determined based on the presence of visually visible components of the PC in the wound and the appearance of diffuse petechial hemorrhage from the wound walls. Ultrasound with a frequency of 25 kHz and an amplitude of 60—120 μm was used to perform PC ultrasound curettage. PCs used ultrasound with a frequency of 25 kHz and an amplitude of 60—120 μm. In cases of localization of acute pilonidal abscess along with the midline (or close to it) with the involvement of the primary fistula hole (holes), only one incision is made in the sciatic fold, through which the rehabilitation of the abscess cavity and ultrasound curettage PC. In the postoperative period, the wound was being treated openly. The repeated sounding of wound surfaces with an interval of one or two days until complete remission of the perifocal inflammatory process, cleaning the wound from purulent-inflammatory detritus and PC elements. If necessary, with severe perifocal inflammatory infiltration, to prevent the spread of purulent-inflammatory process in the sacro-coccygeal region, some patients were prescribed antibacterial therapy with tablets.

To morphologically substantiate the method of ultrasound curettage of the PC after the last session of sounding the wound in 11 (84.6 %) patients from the wound, surfaces performed a multifocal tissue biopsy (6—12 pieces). The histological structure of biopsies of the walls of the surgical wound was examined on a Leica DM LS2 optical microscope (eyepiece x10, lens x10 or x20, optical magnification of the camera x4). Histological staining was performed with hematoxylin and eosin.

RESEARCH RESULTS AND THEIR DISCUSSION

In the studied patients, 2—6 sessions of PC ultrasound curettage were performed (on average 3.2 ± 0.4 sessions). The average time of temporary disability after ultrasound curettage was 9.4 ± 0.7 days. In 8 patients in the postoperative period, antibacterial therapy was performed (on average 5.7 ± 0.5 days), while in 5 patients antibiotics were not prescribed. The average course dose of the consumed tablet non-narcotic analgesic (ketorolac tromethamine) was 3.1 ± 0.4 doses.

During the follow-up period from 3 months to 1 year in 1 (7.7 %) patient, in whom treatment was carried out during the development of the technique, recurrence of PC was detected, a biopsy of the wound walls was not performed. Postoperative wound after ultrasound curettage PC was healed by secondary tension due to marginal epithelialization with the formation of a small postoperative scar. Purulent-septic complications from the postoperative wound in the operated patients were not observed. The patient with recurrence of PC re-performed ultrasound curettage of the fistula, in the immediate postoperative period (2 months) relapse of the disease was not detected.

During histological examination of tissue biopsies of the surgical wound, the following microscopic findings were found: structures of the pyogenic membrane of the pilonidal abscess: tortuous vessels of the capillary type (granulation tissue), tissue infiltration by polymorphonuclear leukocytes with a predominance of lymphoid cells (Fig. 1). Elements of coarse fibrous connective tissue with perivascular infiltration and formation of structures such as "lymphoid follicle" (Fig. 2, 3), angiomatosis, replacement of granulation tissue with "young" connective tissue (Fig. 4) were found in the taken tissues during biopsy of wound walls. The described changes reflect different phases of the chronic inflammatory process and, as a consequence, the formation of immature connective tissue in the site of inflammation.

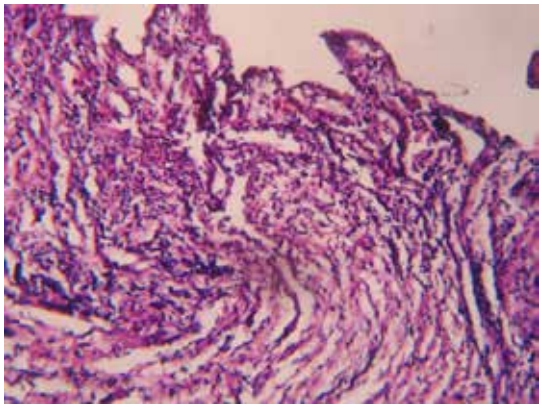

Figure 1. Structures of the pyogenic membrane of the pilonidal abscess: tortuous vessels of the capillary type (1) — granulation tissue, infiltration of tissues by polymorphonuclear leukocytes with a predominance of lymphoid cells (2). Hematoxylin and eosin. x 400.

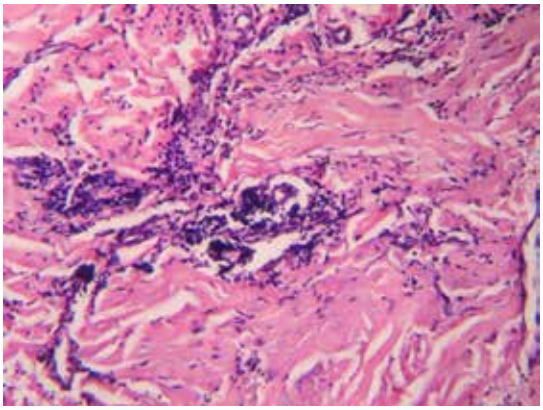

Figure 2. Coarse fibrous connective tissue (1) with perivascular infiltration by polymorphonuclear leukocytes (2). Hematoxylin and eosin. x 400.

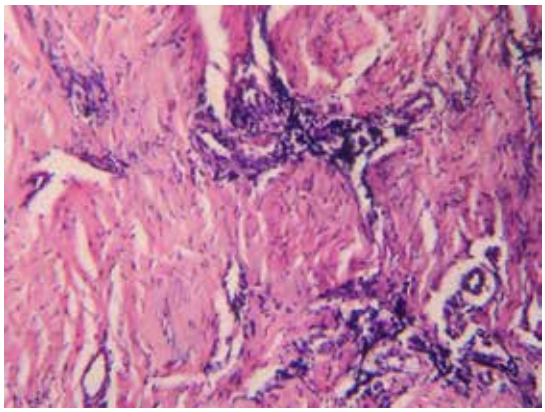

Figure 3. Coarse fibrous connective tissue (1) with perivascular infiltration with the formation of structures of the type «lymphoid follicle» (2). Hematoxylin and eosin. x 400.

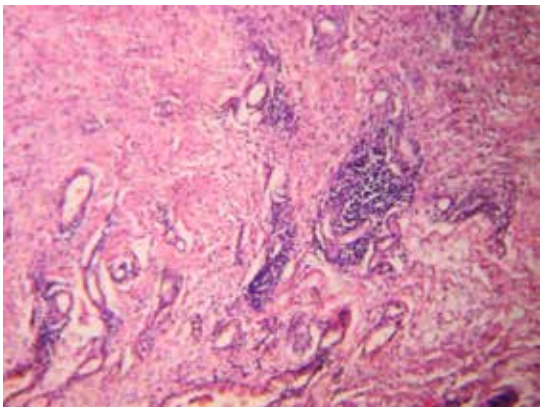

Figure 4. Angiomatosis (1), replacement of granulation tissue with «young» connective tissue (2). Hematoxylin and eosin. x 400.

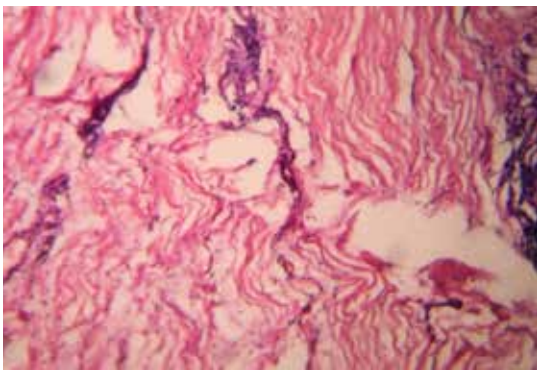

Figure 5. Irreversible destruction of connective tissue — edema and divergence of connective tissue fibers by type of mucoid swelling (1). Hematoxylin and eosin. x 400.

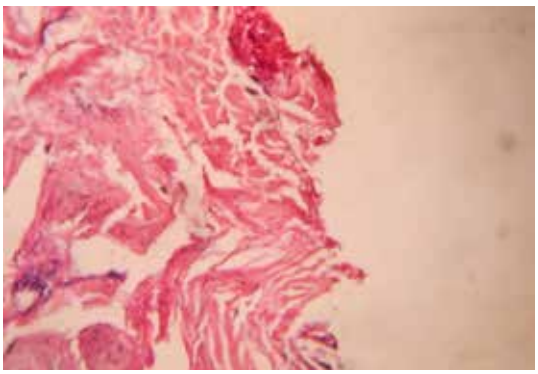

Figure 6. Foci of coagulation necrosis (1) on the background of inflammatory infiltration (2). Hematoxylin and eosin. x 400.

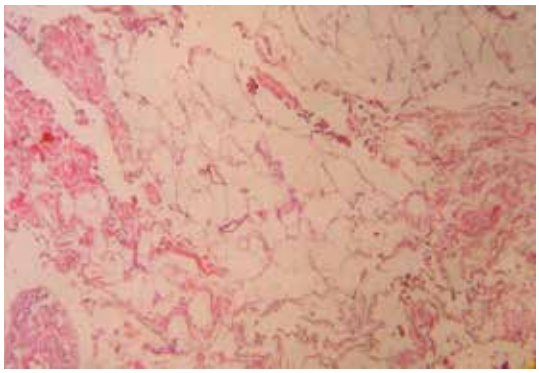

Figure 7. Foci of coagulation necrosis (1) on the background of unaltered adipose tissue (2). Hematoxylin and eosin. x 200.

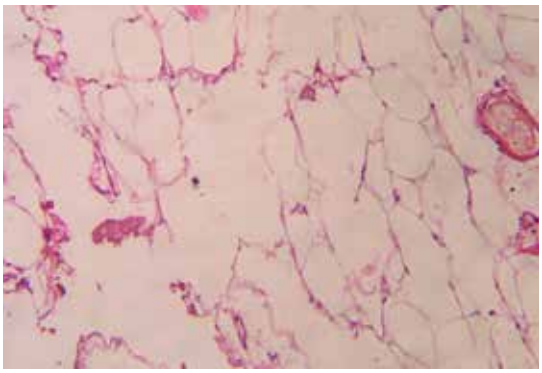

Figure 8. Thrombosis and coordination of erythrocytes in the lumen of blood vessels (1). Hematoxylin and eosin. x 400.

The studied histological specimens showed signs of irreversible destruction of connective tissue — edema and divergence of connective tissue fibers by type of mucoid swelling (Fig. 5), as well as islands of cell-free mass, i.e. areas of formed coagulation necrosis (Fig. 6, 7). Moreover, necrotized tissues were detected both on the background of inflammatory infiltration (Fig. 6) and on the background of unchanged adipose tissue (Fig. 7), which indicates the formation of irreversible changes in tissues under the influence of ultrasound and confirms the possibility of complete removal of the morphological substrate from wound surfaces. Detected irreversible changes in the tissues after sounding them with low-frequency ultrasound characterize the different stages of development of coagulation tissue necrosis. The described changes are a morphological confirmation of the possibility of carrying out a full-fledged "curettage" of the PC with the use of ultrasound. Accordingly, it can be assumed that the elimination of the morphological substrate of the disease from the wound, that is, the epithelial elements of the cyst and hair, occurs in two ways. First, due to mechanical excision and cavitation, these tissues are removed during ultrasound curettage. Second, due to the thermal effect of ultrasound, some of the tissues that remain in the wound and carry the morphological substrate of disease recurrence are subject to irreversible necrotic changes and are removed from the wound in the postoperative period with wound exudate. These mechanisms of elimination of the morphological substrate of pilonidal disease explain the possibility of using ultrasound curettage of the PC as an independent radical method of surgical treatment of complicated PCs.

Note, in the studied tissues, thrombosis and coordination of erythrocytes in the lumen of blood vessels (Fig. 8), which explains the absence of profuse intraoperative bleeding from wound surfaces during PC ultrasound curettage and confirms the sufficient hemostatic effect of low-frequency ultrasound.

DISCUSSION

Given the results of the study, proposed method of treatment can be used in an outpatient setting without the use of additional hemostatic measures. As a result of a series of histological examinations of wound wall biopsies after ultrasound curettage of PC in 11 patients, it can be concluded that the proposed method allows for both direct (mechanical excision) and indirect (through the formation of necrosis) complete removal of the morphological substrate of the disease (no multilayered squamous epithelium or hair were detected in any histological preparation) and treatment in one step.

The above-described morphological changes in PC tissues are due to the action of the following mechanisms of ultrasonic action: cavitation mechanism, mechanical excision, temperature, bactericidal and regenerative effects.

The mechanism of cavitation is due to the formation in a liquid medium under the influence of low-frequency ultrasonic vibrations of microbubbles, which are filled with gas. A rupture of these bubbles in intracellular liquid there is destruction (irreversible destruction) of intracellular structures and a cellular membrane. Mechanical tissue excision is realized due to the axial vibration of the working part of the tool (waveguide), which provides mechanical removal of the underlying tissues. The mechanism of temperature action is realized due to the conversion of mechanical friction energy of the working part of the tool against biological tissues into the thermal energy of heating adjacent tissues. By implementing the cavitation factor and mechanical excision of tissues, effective ultrasonic sanitation of the abscess cavity with the removal of necrotic and nonviable tissues, as well as ultrasound curettage of PC elements with the elimination of multilayered squamous epithelium and hair is achieved. Temperature exposure to abscess tissue leads to irreversible destruction (coagulation necrosis) of the epithelial elements of the coccygeal passages in the wound, which may remain visually invisible and become a morphological substrate of disease recurrence. The bactericidal effect is achieved due to the mechanical destruction of bacterial bodies under the influence of ultrasonic mechanical vibrations, which significantly reduces the microbial contamination of the wound. This makes it possible for some patients to undergo treatment without the use of antibiotics. The use of low-frequency ultrasound performs micro-massage of healthy tissues of the edges and bottom of the wound, which allows achieving a stimulating regenerative effect. Thus, the combination of these factors of therapeutic action of low-frequency ultrasound oscillations leads to the removal of non-viable tissues from the wound, wound detritus, epithelial elements of the coccygeal passages, as well as reducing microbial contamination of the wound and creates favorable conditions for primary tension healing.

By analyzing the results of morphological studies and the above mechanisms of ultrasound on PC tissues complicated by acute abscess, it is possible to identify the following techniques that justify the feasibility of using our proposed method of ultrasound curettage PC as a radical method of surgical treatment:

1. The traumatic effect (energy of ultrasound irradiation) required to remove the morphological substrate of the disease is distributed over time in two ways: between several sessions of ultrasound curettage and within one session. First, during ultrasound curettage, depending on certain factors (the patient's pain threshold, the patient's sensitivity to ultrasound vibrations, the thickness of the pyogenic abscess capsule, the number of fistulas, and the spatial configuration of the PC), the power of ultrasound is distributed (modeled) within one session of ultrasound curettage. In this case, the required total amount of energy of ultrasonic vibrations is transmitted to the tissues to achieve the expected effect. Thus, patients with a low threshold of pain sensitivity have to conduct a longer ultrasound treatment of wound surfaces with less ultrasound power.

So, in patients with a low threshold of pain sensitivity, it is necessary to carry out a longer ultrasound treatment of wound surfaces with a lower power of ultrasound irradiation. Similarly, the duration of ultrasound is modeled depending on the volume of the wound cavity, the thickness of the abscess walls, the number of primary and secondary fistulas, the thickness of the subcutaneous fat. Secondly, the required traumatic effect on PC tissues is distributed between several sessions of ultrasound irradiation, which allows you to transfer the required amount of energy of PC oscillations to PC tissues and evenly distribute it among all interested tissues. Therefore, the use of ultrasound with simulated power allows you to conduct repeated sessions of ultrasound curettage without additional analgesia in an outpatient setting.

2. Maximum preservation of tissues that do not carry the morphological substrate of the disease. The use of various factors affecting the ultrasonic vibrations on the tissues of the PC and the abscess wall allows for a complex effect on the underlying tissues, which is unevenly distributed between the tissues of the wound wall. Most of the energy of ultrasound oscillations is absorbed by necrotic tissues and non-vascularized elements of the PC, namely epithelium, hair, wound detritus, fibrinous layers (which do not have blood vessels). Acordingly, a somewhat controlled effect is achieved (at the microscopic level), which allows removing only the tissues that carry the morphological substrate of the disease. This allows the intervention to be performed precisely, considering the geometric configuration of the wound and minimal soft tissue damage.

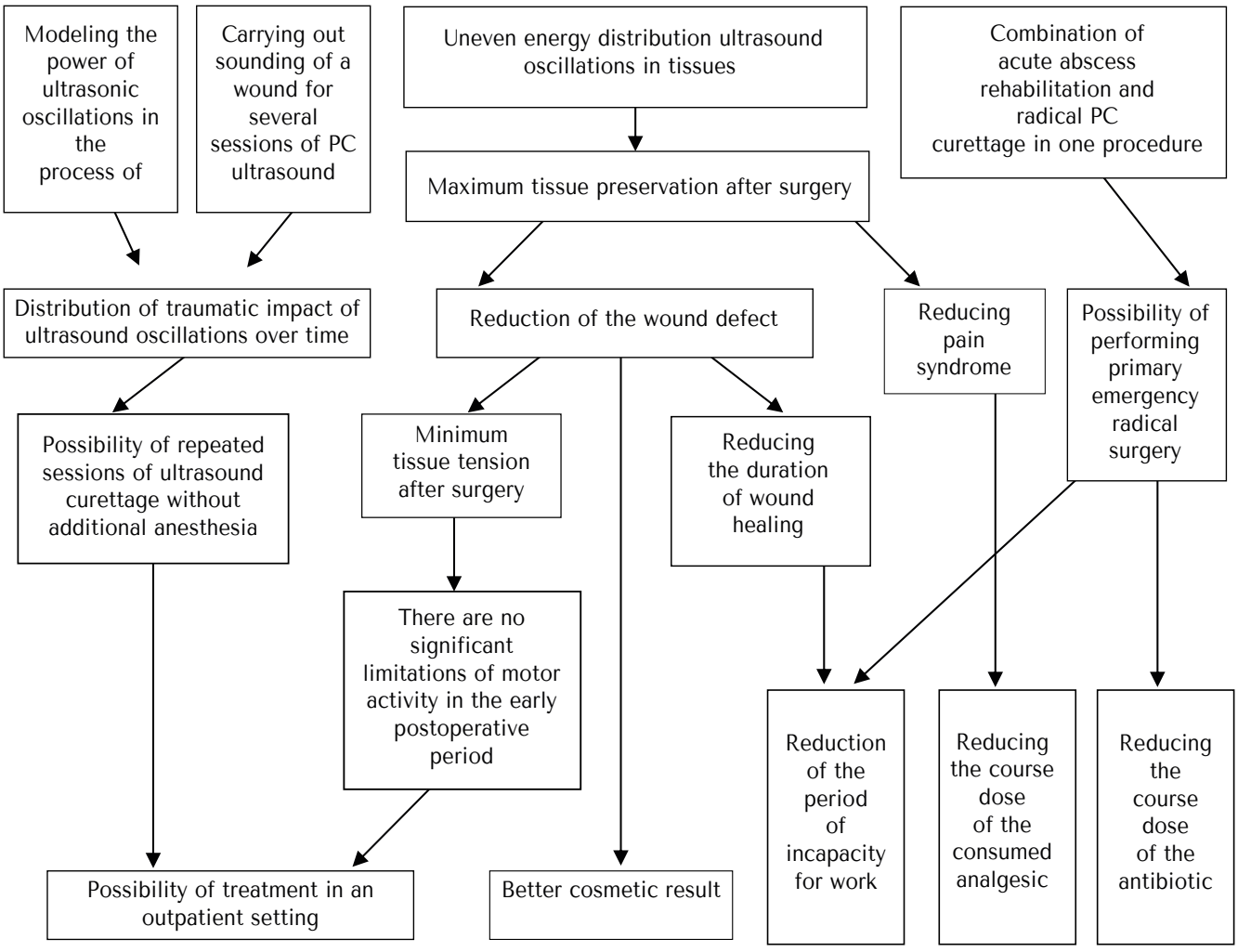

Figure 9. Schematic block diagram of the mechanisms of therapeutic effect of the method of ultrasound curettage PC.

Minimal trauma to the tissues of the sacro-coccygeal region allows to reduce postoperative pain, and accordingly reduces the course dose of tablet painkillers. Minimizing the wound tissue defect after ultrasound curettage of the PC can reduce the duration of wound healing, and thus reduce the duration of temporary disability of the patient. In addition, ensuring a minimal wound defect prevents the tension of postoperative wound tissues, which avoids the need to limit the patient's motor activity in the early postoperative period (bed or semi-bed rest) and makes it possible to conduct radical treatment in an outpatient setting. Carrying out ultrasound curettage of the PC through small (1,0—2,0 cm) incisions allows to reach the best, in comparison with a traditional technique, cosmetic result of treatment.

3. One method combines remediation of an acute abscess and radical removal of the PC. This allows for simultaneous treatment in two directions, without increasing the frequency of purulent-septic complications and without reducing the radicality of the method. The possibility of radical treatment in an emergency without increasing the frequency of postoperative complications and recurrences of the disease can reduce the duration of temporary disability of the patient.

Thus, the use of the above techniques in the proposed method of ultrasound curettage of the PC is more advantageous compared to traditional surgical treatment (see Fig. 9).

Table 1 shows the fundamental differences between the basic techniques used in the proposed and traditional methods of treatment of complicated forms of PC.

Table 1

Comparative characteristics of traditional methods and ultrasound curate in the treatment of pcs complicated with acute abscess

Technique	The traditional way	Ultrasound curettage
Mechanical removal of PC tissues is performed:	single-step, traumatic	multi-moment, low-traumatic
Tissue removal is performed within:	healthy tissues	morphological substrate of the disease
The intervention is carried out:	with the removal of a large array of tissues	precision - with minimal tissue removal within the geometric configuration of the PC
Control of tissue removal is performed:	only visually	visually and due to the redistribution of ultrasound energy (at the microscopic level)
The nature of the therapeutic effect:	mechanical removal	multifactorial influence
In the early postoperative period:	bed or semi-bed mode is required	there is no need to restrict physical activity

CONCLUSIONS

1. The method of ultrasonic curettage of a pilonidal cyst is a radical minimally invasive method of surgical treatment of complicated pilonidal cysts, which allows to completely eliminate the morphological substrate of the disease — multilayered squamous epithelium and hair.

2. The use of the proposed method of low-frequency ultrasound allows for primary radical treatment in the acute stage of the disease in an outpatient setting.

3. Morphological studies and the results of treatment of patients with pilonidal cyst complicated by acute abscess, using the method of ultrasound curettage showed the prospects of the proposed method to improve the treatment of this category of patients, but the final results should be based on more observations.

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Corresponding author: Dmytro Ye. Dubenko, dubenko.md@gmail.com

Manuscript was recieved on 16 September; accepted for publication on 2 November.