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MODERN SURGICAL TREATMENT OF GAS GANGRENE

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Abstract:

Presented article displays the work, containing review and analysis of modern literature and textbooks, which contains the most important information about the gas gangrene – a dangerous infection of the battlefield, which could sometimes occur in a peaceful time.

Keywords: gangrene, surgery, infection, Pirogov, clostridium

INTRODUCTION

Gas gangrene (ICD-10 code A48.0, Clostridium-induced cellulitis, muscle necrosis) is an infection caused by bacteria of the genus Clostridium: C. perfringens, C. novyi, C. septicum, C. histolyticum, and others. The most common pathogen is C. perfringens (70-80% of cases), which has more than 10 pathogenic factors—toxins and enzymes.

These include alpha, beta, epsilon, iota, delta, theta, kappa, lambda, mu, nitoxin, enterotoxin, and neuraminidase. Due to the epidemiological, pathogenetic, and microbiological characteristics of the disease, it often occurs during wartime, but also occurs outside of war. A physician of any specialty must have an understanding of anaerobic gangrene, and surgeons are simply obliged to master the most advanced techniques for treating this infection, the foundation for which was laid by the great Russian surgeon, N.I. Pirogov (1810–1881).

OBJECTIVE OF THE STUDY

To study the clinical, microbiological, and pathogenetic features of gas gangrene and modern surgical treatment methods for this disease.

MATERIALS AND METHODS

The study involved an analysis of the most accessible and up-to-date literature in the disciplines of "Microbiology, Virology," and "General Surgery," as well as scientific articles available for study on the electronic platforms "PubMed" and "Elibrary." Biographical and medical literature from the last century was also used.

RESULTS AND DISCUSSION

General characteristics of the disease, history of discovery, contribution of N.I. Pirogov. Gas gangrene (anaerobic myositis, clostridial anaerobic infection, gas infection, anaerobic gangrene, anaerobic wound infection, anaerobic wound gas infection) is a severe wound infection of humans and animals caused by bacteria of the Bacillaceae family, genus Clostridium, in association with each other and with other anaerobes (these anaerobes can also cause anaerobic infection independently [1], but due to the higher frequency of gas gangrene caused by clostridia, this name has been assigned to clostridial anaerobic infection [6]). It is characterized by an acute, severe course, necrosis, severe intoxication, the development of gas formation, and the absence of pronounced inflammatory reactions. The disease was first described by Ambroise Paré as hospital gangrene in 1562 [3], but the most complete and up-to-date description of gas edema was given by Nikolai Ivanovich Pirogov in 1864, based on Pirogov's experience as a physician during several previous military campaigns of the Russian Empire—the Caucasian War and the Crimean War of 1853-1856. Nikolai Ivanovich initially participated in these wars as a rank-and-file surgeon, and then as an organizer of the medical service.

Epidemiology, pathogenesis. The natural habitat of clostridia is the lower gastrointestinal tract of animals, particularly farm animals, and humans. C. perfringens colonizes the intestines of approximately 25-35% of healthy individuals. Microorganisms are excreted into the soil through excrement, where they transform into spores resistant to physical and chemical influences. When they enter a wound

by contact (for example, when particles of soil-contaminated clothing containing a bullet penetrate deep into the wound channel), within 3-5 days, clostridia germinate into vegetative forms (the incubation period), which requires specific conditions (as N.I. Pirogov noted). This is the presence of a deep wound channel (in the case of a shrapnel wound, for example), a wound cavity that poorly communicates with the external environment, and ischemia of the affected area due to damage to a major vessel or the application of a tourniquet for a long period. All these conditions make gas gangrene a pure infection of wartime, however, with the development of surgery and the increasing complexity of surgical procedures.

With the development of anaerobic infections as a postoperative complication, the possibility has arisen of anaerobic infection. For example, during abdominal surgery, most often the colon [2]. After transforming into vegetative forms, microorganisms begin to rapidly

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multiply and secrete pathogenic factors—exotoxins and enzymes. The most common cause of gas gangrene, C. perfringens, has more than 10 different toxins and enzymes, primarily targeting the membranes of various cells. Impairment of their selective permeability is the leading pathogenetic mechanism in the development of gas gangrene. Tissue edema develops, followed by increasing necrotic changes, which rapidly spread through the perivascular and intermuscular tissue. As a result of the action of toxins (in particular, delta and theta toxins), hemolysis occurs, which causes brown, bronze, or even bluish spots. Edema, in turn, contributes to the compression of nearby blood vessels, leading to ischemia of the affected area and, consequently, to an intensification of the pathological process. Such a powerful spread of gangrene is inevitably accompanied by the resorption of exotoxins and tissue breakdown products into the blood, leading to severe intoxication with fever, shock, and failure of vital body systems.

Clinical presentation, progression, diagnosis. The clinical presentation of gas gangrene has a number of specific features and symptoms. The earliest of these signs is restlessness of the patient; in some cases, the patient may be apathetic. Increased body temperature, increased pulse rate, bursting pain in the wound, tenderness along the vascular-nerve bundles, and a sensation of increasing pressure from the bandage, which the patient may describe as "a feeling of tightness," are observed. Local symptoms are observed upon examination of the wound. These include the characteristic appearance of the wound—lifeless and dry, the presence of scanty mucous exudate of a light yellow or dirty brown color with an unpleasant odor, and edematous tissue soaked with blood. The gas formed is a mixture of hydrogen and carbon dioxide [1]. The names of surgical symptoms useful for detecting gas formation are quite interesting: the razor blade sign (occurs when shaving the skin around a wound), the spatula sign (when tapping on a wound), which produces sharp metallic sounds, and the champagne cork sign (gas accumulations deep in the wound cause a typical sound when removing a tampon from the wound). Of these signs, clinicians identify several of the most significant, forming a triad: pain in the wound, increased body temperature, and an enlarged limb. These signs indicate the onset of gas gangrene, primarily. Of course, this is not the case when examining a patient with pronounced symptoms of the disease. Among the general symptoms, the most important are fever, general weakness, thirst, impaired consciousness (delirium), low blood pressure, and decreased urine output. Anemia and leukocytosis develop rapidly. Sometimes leukopenia occurs.

Gas gangrene can be clinically classified by a variety of characteristics, some of which (by location relative to the fascia) date back to the time of N.I. Pirogov. Others are more modern, such as the rate of clinical progression, prevalence, the nature of clinical and morphological changes, and the nature of pathological changes. There is a special classification of forms of gas gangrene for field work, used by the military medical service [6].

The second is clostridial necrotic myositis (subfascial according to Pirogov), also called the classic form of gas gangrene. It is characterized by rapidly increasing swelling, skin stretching, epidermal peeling in the form of blisters, and the skin acquiring bronze spots, sometimes with a greenish-blue tint. Intoxication develops rapidly, and the predominantly affected muscles are gray in color and bulge out from the wound defect. The third is mixed; in this type of gangrene, all tissues are equally involved. Diagnosis of gas gangrene has an important feature: the speed of diagnosis must be as rapid as possible, as the pathological process can develop very rapidly, and without timely assistance, death will be a natural consequence of the infection. In this regard, rapid diagnostic methods play a significant role in diagnosing the disease. If the patient is admitted late, the importance of rapid methods increases.

X-ray examination is used, which allows us to detect manifestations of Krause's sign - featheriness, lamination, and characteristic clearings, which arise mainly due to gas formation in the deep layers of the wound [1]. Of course, serodiagnosis is much more accurate: the use of methods such as immunofluorescence, passive hemagglutination assay, enzyme-linked immunosorbent assay, and latex agglutination assay [8] allows for a quick preliminary diagnosis.

The diagnosis can be confirmed using a microscopic method, and refined using a bacteriological or, less commonly, biological method. These methods are of no use for urgent diagnosis, but their results can be used to adjust treatment. The bacteriological method for diagnosing gas gangrene, as well as other diseases caused by obligate anaerobes, has some peculiarities. The materials for examination include wound exudate, tissue fragments around the suspected infection portal, and dressing material. Culture is performed on specialized media for obligate anaerobes [9], and anaerobic conditions are created using systems.

Modern surgical treatment and the contribution of N.I. Pirogov to its development. Today, treatment tactics for gas gangrene involve a combination of general and surgical methods. Surgical intervention is indicated immediately after diagnosis. Three types of surgical procedures are performed. The first type involves wide, so-called "lampas" incisions, used when a segment or even an entire limb is involved. The purpose of these procedures essentially reflects N.I. Pirogov's observations: to create unfavorable conditions

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for infection. This principle remains key in the surgical treatment of gas gangrene today, despite the seemingly long history of Nikolai Ivanovich's observations. Incisions are made deep into the wound toward the affected tissue, as if opening the wound defect. In this case, clostridia, as obligate anaerobes, receive a dose of oxygen, which is lethal to them. The resulting wounds are not sutured, but loosely packed with gauze soaked in hydrogen peroxide solution. The number of stripe incisions varies in different segments – on the shin, 3-4 incisions are required, while on the thigh, 5-6. Moreover, one of them should be made as deep as possible, opening the wound inward. This incision will also be important for the drainage of edema fluid containing toxins. The second type of surgery for gas gangrene is wide necrectomy, or excision of the affected surface. This is a more radical and specific operation than stripe incisions, as it is only feasible for limited processes. If a wide necrectomy is not possible, it is combined with "lampas" incisions.

Sometimes, due to the patient's severe condition, it is impossible to achieve the maximum radicality of the surgery. In such cases, a staged necrectomy is used. It is often necessary to perform multiple necrectomy procedures to finally stop the progression of the process.

The third type of surgery for gas gangrene is amputation and disarticulation of the limb. This is the most radical treatment method, used only for specific indications, that is, in cases where the spread of gangrene is difficult to stop with other surgical methods and the patient's life is at risk. In such cases, saving the life may come at the cost of losing the limb. Special indications include: injury to a major vessel, severe gunshot fracture with extensive bone destruction, total gangrene of an entire limb segment or the entire limb, and the risk of spreading to the torso.

A distinctive feature of amputations and disarticulations for gas gangrene is the use of simple methods without suturing the stump. This is necessary so that, if there is a suspicion of infection spreading above the surgical level, additional longitudinal incisions can be made in the stump tissue, extending to the torso. After the surgery, the wound is treated with antiseptics. If fractures are present, immobilization with plaster splints is indicated. As mentioned above, modern treatment for gas gangrene involves a combination of surgical and therapeutic methods. Specific therapeutic treatment is initiated as quickly as possible. For this purpose, during the surgery (under general anesthesia), a polyvalent antigangrenous serum containing antibodies that neutralize the toxins of the most common pathogens—C. perfringens, C. novyi, and C. septicum—is slowly administered (1 ml/min). The serum is diluted in 300-400 ml of isotonic sodium chloride solution. Five prophylactic doses of serum (10,000 IU for each pathogen) are simultaneously injected intramuscularly. Before administering the serum, a blood test is performed.

Often. Detoxification and transfusion therapy play an important role in complex treatment: patients are administered up to 4 liters of multicomponent solutions, including blood-substituting detoxifying drugs , as well as drugs that improve microcirculation, such as dextran. Dextrose solutions and protein-based blood substitutes are also used. In cases of progressive anemia, blood transfusions of 200-250 ml of preserved blood are indicated.

An emergency method, used only after the acute manifestations of infection have passed. Hyperbaric oxygenation, a treatment method in a pressure chamber at a pressure of 2.5-3 atmospheres, occupies a special place in the complex of treatment measures. This method allows for a significant reduction in the scope of surgical intervention and avoidance of amputation. In the postoperative period, antibiotic therapy is mandatory, the patient is provided with rest, careful care, and full.

CONCLUSION

Thus, modern surgical treatment of gas gangrene is a microbiologically, epidemiologically, and pathogenetically sound combination of both surgical and therapeutic measures. Despite the rarity of this "wartime disease" outside of war, civilian surgeons are always ready to fight for the lives and health of their patients, using principles established in the 19th century.

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