

# Pathomorphological Characteristics of Knee Joint Structures Specific to The Stages of Gonatrosis

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## Abstract

*This article presents the concept of gonarthrosis pathogenesis based on analysis of pathomorphological data together with our clinical, angioscintigraphic and laboratory studies. A classification is proposed that considers three types (A, B, C) of structural changes in gonarthrosis, in which the dominant clinical sign is related to anatomical signs on radiographs.*

**Key words:** bone structures, ligaments, synovial membrane, inflammation

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## Introduction

Gonarthrosis (degenerative-dystrophic arthrosis of the knee joint) is one of the most common problems, and in general, its development takes place over the years and is caused by cumulative changes in the tissues of bones and joints. The basis of the gonarthrosis process is degradation, which begins with the cartilage tissue of the joint and then spreads to bone structures, ligaments, synovial sheath and other tissues. During the development stages of gonarthrosis, various pathomorphological changes are observed in the knee joint. In this article, the pathomorphological features characteristic of different stages of gonarthrosis are extensively analyzed.

Currently, researchers associate the development of degenerative-dystrophic processes in gonarthrosis with a disorder of microcirculation in the articular ends of the knee joint. In this case, the severity of the pathological process is proportional to the degree of circulatory disorder in the subchondral layer of the bone epiphyses [1, 2, 3].

### Normal morphology of knee joint structures

The structures of the knee joint mainly consist of the following components:

- The synovial space is a fluid-filled area inside a joint.
- Hyaline cartilage is an elastic tissue that covers the surface of bones.
- Menisci are fibrocartilaginous structures that soften joint movements and distribute the load.
- Synovial tissue is a membrane that provides movement within the joint and produces joint fluid.
- Subchondral bone is a bone structure located in the lower part of the cartilage tissue.

Together, these structures provide joint movement and participate in equal distribution of the load.

### Developmental stages of gonarthrosis and pathomorphological changes

The development of gonarthrosis occurs gradually, through several stages. Each of its stages is characterized by various pathomorphological changes in cartilage, subchondral bone and other structures of the knee joint.

#### 1. First stage: initial changes

*Changes in cartilage tissue:*

- Painless, imperceptible changes are observed in the superficial part of the cartilage. Microscopic weakness, loss of proteoglycans and reduced water content are observed in the collagen fibers of the cartilage.
- There is deposition of hyaline cartilage and small erosions on the surface, but they are still not very severe.

*Changes in synovial fluid:*

- The chemical composition of the synovial fluid begins to change. The concentration of hyaluronic acid decreases, which reduces the grinding and motion-smoothing properties of the synovial fluid.

*Menisci and ligaments:*

- There are no visible changes in the menisci, but microscopic cracks can appear in them.

**2. The second stage: developing changes***Changes in cartilage tissue:*

- On the surface of the cartilage, more noticeable erosions appear, deeper spreading cracks appear.
- The collagen fibers in the cartilage become disorganized, the elasticity of the tissue decreases, pain occurs when the joint moves.
- Proteoglycans almost disappear, which further reduces the cold and pressure resistance properties of cartilage.

*Subchondral bone tissue:*

- Along with the erosion of cartilage, the remodeling process in the subchondral bone increases. In this process, bone plates harden, in which subchondral osteosclerosis (bone densification) is observed.

*Changes in synovial tissue:*

- Synovial membranes are inflamed, which causes serious changes in the synovial space. Inflammatory cells are activated in this process, which further increase inflammation through cell products.

*Menisci:*

- Scattered cracks, small seams appear on the menisci, which disrupts their function of distributing the load.

**3. The third stage: evening changes***Changes in cartilage tissue:*

- The cartilage is almost completely eroded, the bone tissue becomes exposed, and the surface of the articular bone is separated from the tissue in many places. On the surface of this bone, a strong clicking sound occurs during movement.
- The number and activity of chondrocytes seriously decreases, the process of apoptosis increases, which reduces the possibility of tissue regeneration.

*Subchondral bone tissue:*

- Microcysts and osteophytes appear in the subchondral bone. Osteophytes are bony growths that occur at the edges of a bone that try to expand the bone's surface, but limit movement and cause pain in the joint.

*Synovial membrane and synovial fluid:*

- Congenital inflammation and fibrotic changes are observed in synovial membranes. The membranes thicken, which limits movement in the joint.
- The amount of synovial fluid decreases, which causes the joint to become thinner and stiffer.

*Menisci and ligaments:*

- Menisci are severely fragmented and eroded. They are completely eroded and lose the ability to distribute the load.

#### 4. The fourth stage: complete decay and deformation of the joint

##### *Changes in cartilage tissue:*

- The cartilage is completely gone, the bones are in direct contact with each other.
- There are almost no chondrocytes left, the matrix has no chance of recovery.

##### *Subchondral bone tissue:*

- Subchondral bone tissue undergoes serious changes. Osteosclerosis reaches a high level, bones thicken and deform.

##### *Synovial tissue and membrane:*

- Serious fibrotic changes are observed in the synovial tissue, inflammation has become permanent.
- The mobility of the joint is completely limited, the tissues are stiff, and severe pain occurs.

#### **Stages of knee joint gonarthrosis:**

The first stage of gonarthrosis - the patient rarely complains of pain, mainly after heavy physical exertion, sports. The pain can be described as aching, constricting. A symptom of "starting pain" occurs - pain at the beginning of movement, for example, if a person stands up abruptly. A slight swelling can be noticeable in the knee joint, which occurs and disappears on its own. Synovitis - an accumulation of synovial fluid in the area of the articular bag of the knee - can occur a little less often. With it, the knee area swells and becomes spherical, and the limb is limited in movement. However, at this stage, joint deformation is not yet observed.

The second stage of gonarthrosis - the patient is bothered by severe and prolonged pain both on the front side of the joint and on the inner lateral side. At this stage, even minimal loads can provoke pain, but after a long rest they disappear. When moving the joint, a person hears a characteristic crunch, and if he tries to bend the leg all the way, then a sharp, severe pain appears. The range of motion of the limb decreases, deformation appears. Synovitis, unlike the first stage of the disease, already appears frequently.

The third stage of gonarthrosis - the patient feels pain not only when moving, but also at rest, even in sleep. The pain is very strong and interferes with a normal, full-fledged lifestyle. The joint is greatly deformed, and the position of the limb is O-shaped or X-shaped. The person's gait also changes, since due to pain it is not possible to bend or straighten the leg entirely. Some patients begin to use a walking support (cane or crutches).

#### **Conclusion**

Gonarthrosis, especially its stages of development, causes serious pathomorphological changes in the structures of the knee joint. If the weightless changes in the first stage begin with small erosions and a decrease in the amount of water in the cartilage tissue, the later stages are characterized by the complete erosion of the cartilage, the densification of the bone tissue, and the appearance of osteophytes. Along with inflammatory processes, fibrotic changes of synovial membranes cause severe limitation of joint movements and pain.

In the late stages of gonarthrosis, almost complete loss of cartilage tissue, exposure of bone surfaces and development of osteosclerosis are observed, which is manifested in patients with constant pain, limitation of movements and deformation of the joint. Through these changes, ligaments and menisci are also damaged and their functions are lost. Therefore, it is important to diagnose and treat gonarthrosis in the early stages. Early treatment can slow down or stop the development of pathomorphological changes in cartilage tissue.

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