



Magnetic Resonance Tomography for Damage to the Ligamentous Structures of the Knee Joint

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Abstract: The aim of the study was to study the possibilities of magnetic resonance imaging in assessing post-traumatic changes in the knee joint. Examined 150 patients with post-traumatic processes in the knee joint, all victims underwent magnetic resonance imaging on various classes of tomographs with a magnetic field strength from 0.5 to 1.5 T. Based on the principles of evidence-based medicine, the values of the effectiveness of magnetic resonance imaging of the knee joint in post-traumatic changes are presented. The accuracy of MRI is 95% in diagnosing meniscus injuries, 91% in diagnosing ligament injuries, 73% in cases of changes in the synovial membrane, 34% in cases of changes in articular cartilage.

Keywords: ligamentous apparatus, knee joint, magnetic resonance imaging .

Knee injuries are a serious problem in clinical medicine, as they are a fairly common cause of disability and disability. Knee injuries occupy one of the first places among all cases of pathology of the musculoskeletal system, and from 41% to 82% of cases are caused by injuries of its ligamentous apparatus.

One of the most significant factors affecting the outcome of an injury is the accuracy and timeliness of diagnosing damage to the ligamentous structures of the knee joint, especially in the early stages, when adequate therapeutic or surgical treatment can significantly affect the nature of the cure.

In recent years, there has been a significant improvement in the methods of radiological diagnosis of the musculoskeletal system, however, early diagnosis of injuries to the ligamentous structures of the knee joint is still difficult. Despite significant advances in the development and improvement of clinical and diagnostic methods of examination of the knee joint with the aim of possibly early detection of changes in the ligamentous apparatus, a high percentage of untimely or inadequate diagnosis remains.

The introduction of magnetic resonance imaging methods into wide clinical practice has opened up new perspectives in the diagnosis of injuries to the ligamentous structures of the knee joint. At the same time, magnetic resonance imaging is constantly being improved and requires systematization in visualization of varying degrees of severity of damage to the anatomical structures of the knee joint. MRI-tomographic symptoms of traumatic changes in the ligamentous structures of the knee joint and

posttraumatic complications are presented only by separate MR-signs of processes. The possibilities of MRI in the differential diagnosis of traumatic changes and post-traumatic complications have not been fully studied.

Based on the urgency of the problem, the present study was undertaken, which is based on many years of experience in magnetic resonance imaging and arthroscopic examination of the knee joints.

Materials and methods

A total of 310 MR studies of the knee joint structures were performed (taking into account damage to both knee joints in 150 patients).

Three groups of patients were identified depending on the localization of traumatic changes in the knee joint.

The first group included 96 patients with traumatic changes in the menisci (isolated injuries of the medial or lateral meniscus or both menisci together): 54 men (56.25%), 42 women (43.75%).

The second group consisted of 5 patients with traumatic changes in the ligaments (isolated injuries of the cruciate or collateral ligaments, or both together in different variants); 3 men (2.4%), 2 women (2.9%).

The third group included 49 patients with traumatic changes in the menisci and ligaments (combined injuries of the medial meniscus with cruciate or collateral ligaments, or both together; combined injuries of the lateral meniscus with cruciate or collateral ligaments or with both together; combined injuries of both menisci with cruciate or collateral ligaments, or with both, together in various versions); 30 men (40.8%), 19 women (36.8%).

According to the nature of damage to the capsular-ligamentous structures of the knee joint, revealed by MRI, the patients were conditionally divided into two large groups (A and B).

Group A included 25 patients with uncomplicated traumatic changes in the capsular-ligamentous structures of the knee joint (menisci, ligaments, cartilage) without degenerative and inflammatory changes. Of these, there were 9 men (14.2%), women - 16 (18.4%).

Group B included 125 patients with traumatic changes in the capsular-ligamentous structures of the knee joint and post-traumatic complications of an inflammatory, degenerative nature, with the presence of cysts. Of these, there were 98 men (85.8%), women - 27 (81.6%).

The main research methods were diagnostic arthroscopy (25 studies) performed by the Akuflex hardware complex (USA) and magnetic resonance imaging (150 patients) performed on Philips devices (Germany, Holland) with a magnetic field strength of 0.5 and 1.5 TL.

Results

Injuries to both knee joints simultaneously were detected in 13.33% of cases in patients with traumatic changes in the capsular-ligamentous structures; in 6.67% - in patients with traumatic changes and post-traumatic complications of an inflammatory nature; in 35.33% - in patients with complications of a degenerative nature; in 43% - in patients with complications of inflammatory and degenerative nature; in 1.33% - in patients with cysts.

As a result of the analysis of the nature of damage to the capsular-ligamentous structures of the knee joint, depending on the age of the patients, it was found that all of these changes are most common in patients aged 31-50 years. Thus, the share of traumatic changes in the capsular-ligamentous structures of the knee joint accounted for 49.9% of cases; the share of traumatic changes with post-traumatic complications of an inflammatory nature - 52.7%; the share of traumatic changes with post-traumatic complications of a degenerative nature - 45.8%; the share of traumatic changes with post-traumatic

complications of an inflammatory and degenerative nature - 51.7%; the share of traumatic changes with the presence of cysts - 35.7%.

A subgroup of patients with traumatic changes in the ligamentous structures of the knee joint and post-traumatic inflammatory complications

MR symptoms, represented by tears, were detected in 129 (97.7%) patients, meniscus inflammation - in 30.5%, tears - in 64 (48.2%), ligament inflammation - in 29 (22.1%).

Inflammation of the articular cartilage was diagnosed in 3 (2%) patients, its hypertrophy - in 25 (16.67%). In 125 (83.99%) patients, edema of the synovial membrane was determined, in 11.4% - soft tissue edema. In 111 (74%) patients, an excess amount of fluid in the joint was revealed, in 8 (5.33%) patients, an excess amount of blood in the joint.

A dynamic MRI study was performed in 3 (2%) patients, including 2 after surgery and 1 during conservative treatment.

Arthroscopy was performed in 18 (12%) patients of this group. After analyzing the results of arthroscopic and magnetic resonance imaging, it was found that not all changes in the capsular-ligamentous structures of the knee joint were visualized by both methods to the same extent.

During intraoperative examination, it was difficult to identify partial damage to the menisci, partial intracapsular changes in the fibers of the ligaments. Arthroscopic visualization of the medial and lateral collateral ligaments was hampered by their anatomical features.

At the same time, with arthroscopy, it was possible to assess the condition of the synovial membrane (color, condition of the villi, presence of deposits), the condition of the articular cartilage of the knee joint better than with MRI.

In this group of patients, MR symptoms were revealed, represented by meniscus ruptures (101 (67.3%) cases) and their degenerative changes (75 (75.5%) cases), ligament ruptures (12 (35.8%) cases) and their degenerative changes (13 (30.1%) cases), damage to the articular cartilage (2 (1.7%) cases) and its degenerative changes (53 (52.8%) cases), soft tissue atrophy (13 (12, 5%) cases), bone damage (3 (2.2%) cases) and their degenerative changes (92 (61.9%) cases).

In 64 (64.2%) patients of this group, traumatic changes were visualized only in the menisci, in 2 (1.1%) - only in the ligaments, in 31 (34.2%) - both in the menisci and in the ligaments. Changes in menisci in 24 cases (24.2% of all cases of meniscus damage in this group) were detected in the medial, in 6 (3.3%) in the lateral, in 126 (72.5%) in both menisci. In 60.6% of cases, injuries were localized in one of the meniscus horns, in 39.4%, both horns were damaged. At the same time, with isolated damage to the menisci, changes in the medial were revealed in 30 (26.5%) cases, in the lateral - in 6 (5.3%), in both together - in 77 (68.2%). With combined injuries of the menisci and ligaments, changes in the medial meniscus were detected in 12 (19.6%) cases, in both cases together - in 49 (80.4%). No changes in the lateral meniscus were detected.

With combined injuries of the menisci and ligaments, changes in the posterior cruciate ligament were most often observed, in 13 cases (21.4% of all combined injuries in this group) they were combined with injuries of both menisci and the lateral collateral ligament, in 11 (17.9%) with damage to both menisci. Damage to three ligaments at once was visualized somewhat less often: anterior and posterior cruciate and lateral lateral in combination with damage to both menisci (6 (9.9%) cases).

In 4 people (2.2% of the total number of patients in this group), along with damage to the menisci and ligaments, damage to bone structures was visualized, which in 3 (1.7%) cases were accompanied by damage to cartilage with the presence of a zone of change in its structure and shape, which was

displayed on MR tomograms in the form of an increase in the intensity of the MR signal on T2 images.

Degenerative changes in the menisci were manifested on MRI scans in the form of a decrease in height and changes in the contours of menisci, the presence of zones of altered structure of various sizes and shapes. The intensity of the MR signal on T1 and T2 images in sagittal and frontal projections increased. Degenerative changes in the form of one, less often - two zones, not reaching the articular surfaces of the menisci, were visualized in 66.2% of cases; in the form of one or more extensive areas that do not reach the articular surface of the menisci - in 30.3%; in the form of extensive areas reaching the articular surfaces - in 3.5% of cases. The degree of degenerative changes in one joint was more often different.

Degenerative changes in the ligaments on MRI tomograms were manifested by an unevenness of the contour and thinning of the ligaments, the presence of zones of altered structure, of various sizes and shapes, were displayed by areas of an increased MR signal on T1- and T2-weighted images.

Degenerative changes in the articular cartilage on MRI scans were manifested in the form of unevenness and jaggedness of the contour, an uneven decrease in height. In the early stages of the disease, changes were reflected in the form of an increase in the intensity of the MR signal on T2 images in sagittal and frontal projections. In the late stage, the intensity of the MR signal approached the average intensity on T1 and T2 images.

Soft tissue atrophy on MRI scans was manifested by a decrease in the volume of soft tissues of the knee joint with areas of muscle structure changes. In the operated patients, postoperative cicatricial changes were determined, which were reflected by a decrease in the intensity of the MR signal on T1- and T2-weighted images.

Degenerative changes in the bones on MRI scans were manifested by bone growths, zones of rarefaction of the bone structure with destruction of the articular endplates. This pathology was displayed as a non-uniform low-intensity MR signal on T1 and T2 weighted images.

Dynamic MRI studies were carried out in 15 (8.5%) patients, including 6 patients after surgery, 9 after conservative treatment. Arthroscopy was performed in 21 (11.9%) patients of this group.

A subgroup of patients with traumatic changes in the ligamentous structures of the knee joint and post-traumatic complications of an inflammatory and degenerative nature

In this group of patients, MR-symptoms were revealed, represented by meniscus ruptures (117 (94.5%) cases), inflammatory (45 (19.6%) cases) and degenerative (85 (85.1%) cases) their changes; ligament ruptures (51 (51.1%) cases), inflammatory (38 (16.6%) cases) and degenerative (54 (58.5%) cases) changes in them; damage to the articular cartilage (2 (0.9%) cases), inflammatory (40 (17.4%) cases) and degenerative (34 (32.7%) cases) changes in it; synovial hypertrophy (64 (62.9%) cases) and its edema (79 (78.1%) cases); edema of soft tissues (50 (21.8%) cases) and their atrophy (32 (13.9%) cases); damage to bones (1 (0.4%) cases), inflammatory (4 (1.7%) cases) and degenerative (94 (41.0%) cases) changes in them; excessive amount of fluid in the joint (29 (100%) cases).

In 91 (48.4%) patients of this group, traumatic changes were visualized only in the menisci, in 12 (5.2%) - only in the ligaments, in 106 (46.4%) - both in the menisci and in the ligaments. Changes in menisci in 39 cases (17.9% of all meniscus injuries in this group) were detected in the medial, in 20 (9.3%) - in the lateral, in 78 (72.8%) - in both menisci. In 36.8% of the lesions were localized in one of the meniscus horns, in 63.2% both horns were damaged. At the same time, with isolated damage to the menisci, changes in the medial were revealed in 27 (24.4%) cases, in the lateral - in 14 (12.6%), in both together - in 70 (63.0%). In the case of meniscus injuries combined with ligaments, changes in

the medial were revealed in 12 (11.4%) cases, in the lateral - in 6 (5.6%), in both menisci - in 88 (83.0%).

With combined injuries of the menisci and ligaments, changes in the posterior cruciate ligament were most often observed; in 19 cases (18.0% of all combined injuries in this group), they were combined with injuries of both menisci.

MRI studies in dynamics were performed in 18 (7.8%) patients, including 7 after surgery, 11 during conservative treatment. Arthroscopy was performed in 41 (17.9%) patients of this group.

In this group of patients, MR symptoms were revealed, represented by meniscus ruptures (82 (97.6 %) cases), their inflammatory (12 (14.2%) cases) and degenerative (42 (50.0%) their changes; ligament ruptures (26 (30.9%) cases), their inflammatory (7 (8, 3%) cases) and degenerative (31 (36.8%) cases) changes in them; inflammatory (5 (5.9%) cases) and degenerative (11 (13.0%) cases) changes in articular cartilage; synovial hypertrophy shell (25 (29.7%) cases) and its edema (51 (60.7%) cases); soft tissue edema (7 (8.3%) cases) and their atrophy (2 (2.3%) cases); the presence of cysts (84 (100%) cases); inflammatory (2 (2.3%) cases) and degenerative (24 (28.5%) cases) bone changes; excess fluid in the joint (10 (11, 9%) of cases).

In 58 (69.0%) patients of this group, traumatic changes were visualized only in the menisci, in 2 (2.4%) - only in the ligaments, in 24 (28.6%) - both in the menisci and in the ligaments. Changes in the menisci in 18 cases (21.9% of all meniscus injuries in this group) were detected only in the medial, in 6 (7.3%) - only in the lateral, in 58 (7.8%) - in both menisci. In 21.6% of cases, injuries were localized in one of the meniscus horns, in 79.1% of cases, both horns were damaged. At the same time, with isolated damage to the menisci, changes in the medial were revealed in 17 (29.3%) cases, in the lateral - in 6 (10.3%), in both together - in 35 (60.4%). In combined with ligamentous injuries of the menisci, changes in the medial were revealed in 1 (4.2%) case, in both cases together - in 23 (95.8%). No changes were found in the lateral meniscus.

With combined injuries of the menisci and ligaments, changes in the posterior cruciate ligament were most often observed, in 6 cases (25.0% of all combined injuries in this group) they were combined with injuries of both menisci, in 3 (12.5%) cases - with injuries of both menisci and anterior cruciate ligament; In 3 (12.5%) cases, there were injuries of the lateral collateral ligament in combination with injuries of both menisci.

In 64 (76.2%) patients of this group, a cyst of the popliteal fossa was visualized in the form of a pathological volumetric formation with clear even contours and fluid contents, without signs of edema of the surrounding tissues, more often between the heads of the bicomperitoneal and semimembranous muscles. On MRI tomograms, the popliteal fossa cyst was displayed with an increased intensity of the MR signal on T2 and a reduced intensity of the MR signal on T1-weighted images.

In 67 (51.3%) patients of this group, traumatic changes were visualized only in the menisci, in 2 (1.5%) - only in the ligaments, in 62 (47.2%) - both in the menisci and in the ligaments. Changes in menisci in 54 cases (41.9% of all meniscus injuries in this group) were found in the medial meniscus, in 1 (0.8%) - in the lateral, and in 74 (57.3%) - in both menisci. In 77.3% of cases, injuries were localized in one of the meniscus horns, in 22.7% of cases, both horns were damaged. At the same time, with isolated damage to the menisci, changes in the medial were detected in 29 (43.2%) cases, in the lateral - in 1 (1.6%), in both - in 37 (55.2%). In the case of meniscus injuries combined with ligaments, changes in the medial were revealed in 25 (40.3%) cases, in both menisci together - in 37 (59.7%). No changes were found in the lateral meniscus.

With combined injuries of the menisci and ligaments, changes in the lateral collateral ligament were most often observed, in 11 cases (17.8% of all combined injuries in this group) - in combination with

injuries of the medial meniscus, in 10 (16.2%) - with both menisci together. Changes in the anterior cruciate ligament in 6 (9.7%) patients were combined with injuries of the medial meniscus and lateral collateral ligament (the so-called "ill-fated triad"), in 6 (9.7%) - with injuries of both menisci together. In 6 (9.7%) cases, injuries to the posterior cruciate ligament with both menisci were visualized.

Inflammation of the lateral meniscus was detected more often than the medial. On MRI tomograms, inflammatory changes in the meniscus were displayed by an increase in its size, a change in the cone-like shape, indistinct contours, and "blurred" structure. An increase in the intensity of the MR signal was noted on the T2 image in the frontal projection.

Inflammatory changes in the ligaments during MRI were manifested by the presence of thickening areas, "blurring" of the contours, structural disturbances, and were displayed as changes in the structure, the average intensity of the MR signal on T1 and T2 images.

Hypertrophy of the synovial membrane on MRI scans was visualized as areas from low to medium intensity MRI signal on T1- and T2-weighted images covering the surface of volvulus, fatty fossae and fibrous capsule of the joint.

Edema of the synovial membrane was visualized as areas of high-intensity MR-signal on T2- and low-intensity MR-signal on T1-images.

Edema of soft tissues on MRI tomograms was manifested by an increase in the intensity of the MR signal on T2 images from the structure of muscles, tendons, and adipose tissue. The size of the zone of increased MR signal depended on the extent of the process in soft tissues, end tours had no clear boundaries.

Joint effusion was displayed by low MR signal intensity on T1 and increased MR signal intensity on T2-weighted images.

Hemarthrosis on MR imaging differed from inflammatory exudate: in acute and subacute hemarthrosis, the average intensity of the MR signal was visualized on T1- and high - on T2-weighted images. In chronic hemarthrosis in the central part of the hematoma, a high intensity of the MR signal was visualized on T1 and T2-weighted images, and along the outer contour the MR signal was low on T1 and T2 images.

The group of post-traumatic complications of an inflammatory nature included pigment-vile synovitis, which was detected in 7 (5.3% of the number of patients in this group) patients. Most often, it developed as a result of repeated trauma with the presence of hematrosis. At the same time, hemosiderin deposits were visualized in the hyperplastic synovial bursa. In the MR image, masses of irregular shape, inhomogeneous structure, with a reduced MR signal on T1 and T2 weighted images were determined. They clearly differentiated against the background of an excessive amount of synovial fluid. Dynamic MRI studies were performed in 4 (3.1%) patients: in 1 - after surgery, in 3 - during conservative treatment. Arthroscopy was performed in 18 (13.7%) patients of this group.

Conclusions

1. The magnetic resonance tomographic picture of injuries to the ligamentous structures of the knee joint corresponds to the arthroscopic classification and makes it possible to almost accurately detect even minor injuries of all its elements. Isolated damage to the menisci was diagnosed by MRI in 57.7% of cases, with arthroscopy - in 64.2%; isolated ligament injuries - in 2.7 and 0.9% of cases; combined injuries of the menisci and ligaments - in 39.6% and 31.2% of cases; changes in the synovium - in 72.4% and 96.3% of cases, respectively; changes in articular cartilage - in 31.6% and 92.7% of cases, respectively; operated on 19.8% of patients.

2. Magnetic resonance imaging of the knee joint is a highly effective method of radiological diagnosis, which, due to the high tissue specificity and multi-projection of the study, allows to study in detail the structure and simultaneously assess the condition of all elements of the knee joint: bones, menisci, ligaments, articular cartilage, synovial membrane, muscles, vascular - nerve bundle. The accuracy of MRI is 96% in diagnosing meniscus injuries, 90.5% in diagnosing ligament injuries, 71% in cases of changes in the synovium, 37% in articular cartilage.

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