

# Discoid lateral meniscus of the knee-joint (questions of classification and diagnostics)

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In this article is analysed MRI of knee-joints of 409 patients and results of 15 knee-joint arthroscopic revisions of patients with a discoid lateral meniscus. Considered a few classifications of discoid lateral meniscus types. Based on the possibilities of MRI and arthroscopy in detecting of discoid lateral meniscus abnormalities, taking into account the correlation these researches' results there was highlighted Watanabe classification as the main for discoid lateral meniscus description as at MRI so at during arthroscopy. The third type of discoid lateral meniscus in Watanabe classification is selected as most clinically significant, while it is most hardness differentiated on MRI, that requires further scientific research.

**Key words:** knee-joint, discoid meniscus, lateral meniscus, MRI, arthroscopy.

The discoid lateral meniscus is an anomaly of the development of the knee joint, which occurs frequently and is characterized by a discoid configuration or configuration that is close to that, and also a possible violation of the fixation of the horn to the tibial condyle, which causes hypermobility of posterior horn. The above determines the clinical significance of the anomaly. Discoid meniscus, on the one hand can manifest itself with such symptoms as local pain, clicks during movements and restriction of movement in the knee joint up to the block. On the other hand, the discoid meniscus is stronger than normal that is susceptible to damage during the knee traumas. Own material and literature data characterize MRI as a highly informative method of medical imaging to identify those varieties of discoid menisci that manifest themselves by changing the configuration, as well as their damage. The confirmation of the established diagnosis is the data obtained during arthroscopic revision, which is also the «gold standard» in the treatment of intraarticular pathology of the knee joint.

## PATIENTS AND METHODS

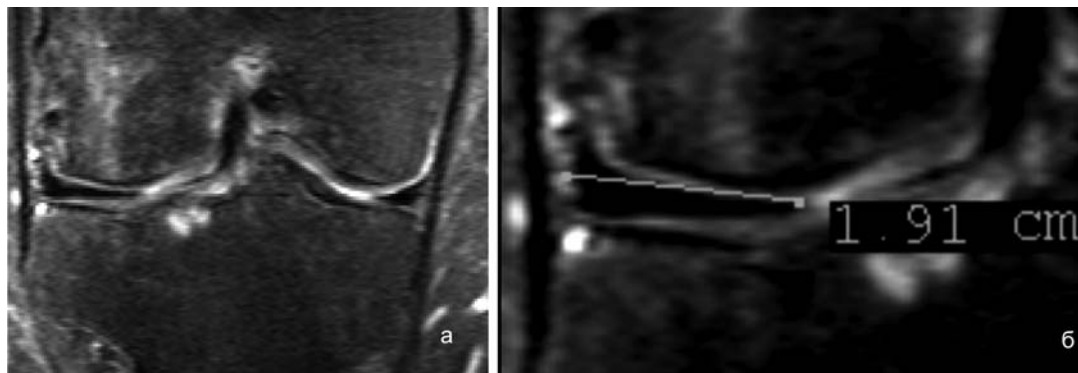
During April 2006 to January 2009 in the Scientific and Practical Center of Radiation Diagnostics of the Academy of

Medical Sciences of Ukraine performed studies of knee joints for 409 patients in connection with suspected traumatic, degenerative-dystrophic, inflammatory diseases, as well as local manifestations of systemic diseases. The studies were carried out on a magnetic resonance tomograph with a magnetic field strength of 1,5 Tesla (Magnetom Vision Plus, Siemens, Germany). There was used a standard knee joint examination protocol, which includes a series of images weighted by proton density with suppression of the MP signal from fat (fsPP-VI) in the axial, coronal and sagittal projections (a sequence of radio-frequency impulses (SRFI) fast spin echo (FSE), TR=, TE=, cut thickness 3–4 mm), T1 in the sagittal and coronal projections (SRFI FSE TR=, TE=, cut thickness 3–4 mm), T2\* in the axial projections (modification SRFI gradient echo DESS; TR=, TE=, cut thickness 0,7 mm). Visual analysis of images was carried out on a workstation SieNet (Siemens, Germany). In this case T2\* were analyzed in the regime of multiplanar reconstruction (MPR).

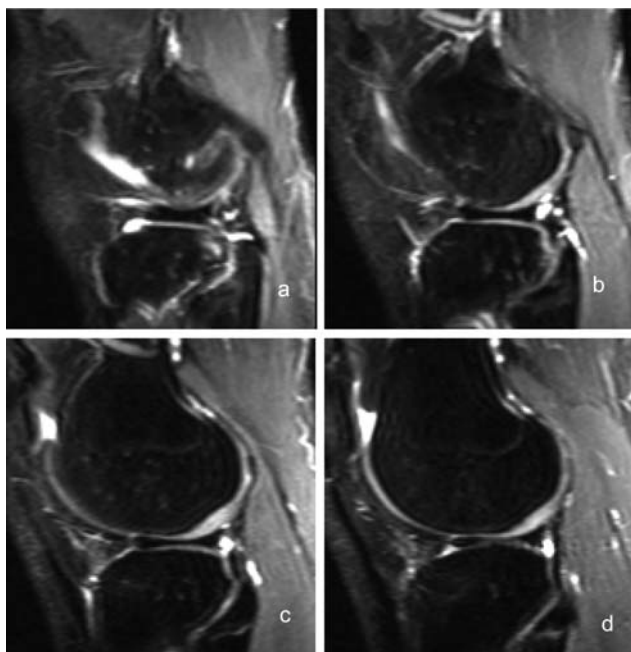
The following criteria were used to identify discoid menisci. In images in the coronal projection, the minimum transverse size of the meniscus should exceed 13 mm (Figure 1).

Accordingly, in images in the sagittal projection with a slice thickness of 4 mm, the meniscus body should be visualized on more than three slices going one after the other (Figure 2).

From these 409 patients, 115 people were operated. All had arthroscopic revision of the knee joint under spinal anesthesia. For arthroscopic interventions, we used the arthroscopic complex of Karl Storz GmbH u. Co. KG (Germany). The procedure was standard and included two stages: diagnostic and treatment. Arthroscopic signs of the discoid meniscus, we considered an increase transverse size of lateral meniscus at the level of the middle of the free edge more than 13 mm. A sign of the discoid meniscus type II by



**Figure 1.** Patient Yu., 42 years old. T2 right knee joint with suppression of MR signal from fat in the coronal projection. Discoid lateral meniscus type I by Watanabe: the minimum transverse size of the meniscus body is 1,9 cm.



**Figure 2.** Patient S., 18 years old. T2 Right knee joint with suppression of MR signal from fat in the sagittal projection; Slice thickness is 4 mm. Discoid lateral meniscus type I by Watanabe: the meniscus body is visualized on 4 slices, going one after another.

Watanabe was a thickening of the free edge of the lateral meniscus and its location in close proximity to the lateral tubercle of the intercondylar elevation of the tibia. Arthroscopic signs of the discoid lateral meniscus of the III type by Watanabe was its hypermobility and the absence of the meniscotibial ligament. Such a meniscus when palpated with an arthroscopic crochet is displaced toward the middle of the joint, while the free edge of the meniscus can reach the lateral tubercle of the intercondylar elevation of the tibia (Figure 4).

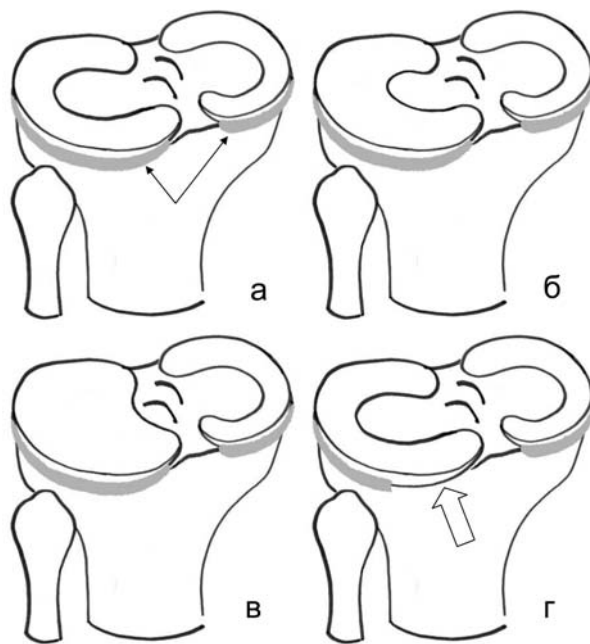
To characterize the discoid menisci, we used the Watanabe classification [1], according to which there are three types of discoid menisci: incompletely discoid meniscus (type I), completely discoid meniscus (type II) and the discoid meniscus like Wrisberg ligament (posterior meniscus ligament) (type III) (Figure 3).

The arthroscopic analogy to the Watanabe classification is shown in Figure 4. the absence of the meniscus-tibial ligament at the level of its posterior horn.

### RESULTS AND DISCUSSION

From the 409 patients who had MRI of the knee joint, 115 patients underwent arthroscopic intervention. At the same time, according to the results of arthroscopy, the discoid meniscus was diagnosed in 15 patients. Patients were divided into 2 groups: 1 group with true positive result – 12 patients (MRI result was confirmed on arthroscopy) and 2 group with false negative result – 3 patients (the diagnosis of the discoid meniscus on MRI was not set and was diagnosed only after arthroscopy).

From the 409 patients in 12 (2,7%), we found the presence of discoid meniscus by MRI. All 12 patients underwent arthroscopic intervention, and in each of them the presence of a discoid meniscus was confirmed, these patients was



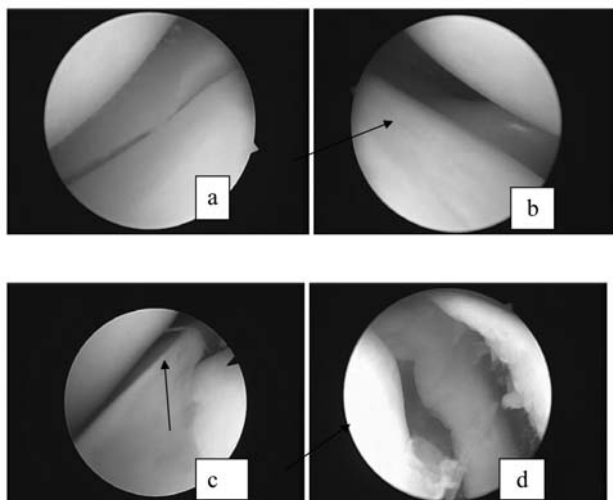
**Figure 3.** Types of discoid menisci (according to Watanabe): (a) - normal menisci (thin arrows show the usual arrangement of meniscus-tibial (coronal) ligaments); (б) incompletely discoid meniscus (type I); (B) - completely discoid meniscus (type II); (Г) - a discoid meniscus like Wrisberg ligament: the normal configuration of the lateral meniscus and the absence of the meniscus-tibial ligament at the level of its posterior horn (thick arrow).

entered to the first group. In this group of patients there were 7 men, 5 women. The age of the patients was from 8 to 59 years (mean age  $38 \pm 16,1$  years). In 1 case, we observed a discoid lateral meniscus of type II by Watanabe (Fig. 5), in 11 cases – a discoid lateral meniscus of the 1st type by Watanabe. One patient underwent MR examination of both knee joints and discoid lateral menisci were detected on both sides. In 11 cases, patients were referred for MRI due to a knee injury, in 1 case - due to complaints of discomfort in the knee area and a click sensation during flexing and extension.

Discoid meniscus damage have been identified by us in 4 patients: while in one case we observed a transverse tearing of the discoid lateral meniscus (Figure 6), in two cases – longitudinal tears, and in one case longitudinal and transverse tears.

In one case, we noted degenerative changes in the discoid lateral meniscus. In 7 patients, data for the presence of lesions of discoid lateral menisci on MRI was not obtained. Arthroscopically in a patient with a discoid meniscus of type II by Watanabe and in 6 patients with a discoid meniscus of type I without its damage – the articular cartilage was intact. In the remaining 5 patients were visualized cartilage damage of 2–3 stage by Outerbridge with the damaged area of 1–1,5 cm<sup>2</sup>. The damaged parts of the meniscus were resected. In the presence of a full discoid meniscus, a marginal resection was performed to reduce its transverse size (Fig. 7).

The second group included 3 patients who had an unmodified visualization of the lateral meniscus on MRI; however, during the arthroscopy revealed the absence of meniscotibial ligament in the region of the posterior horn of the lateral meniscus and its hypermobility, which is regarded as a discoid meniscus of the third type by Watanabe. All these patients were male, the mean age was  $21 \pm 4,2$  years. In all patients arthroscopic results revealed articular cartilage



**Figure 4. Types of discoid menisci (according to Watanabe) during the arthroscopy: (a) - normal lateral meniscus; (b) incompletely discoid meniscus (type I); (c) - completely discoid meniscus (type II); (d) - a discoid meniscus like Wrisberg ligament: the normal configuration of the lateral meniscus and the absence of the meniscus-tibial ligament at the level of its posterior horn.**



**Figure 5. Patient T., 52 years old, Images of the right knee joint and arthroscopy. Discoid lateral meniscus type II by Watanabe. Thickening of the free edge and its location near the lateral tubercle.**

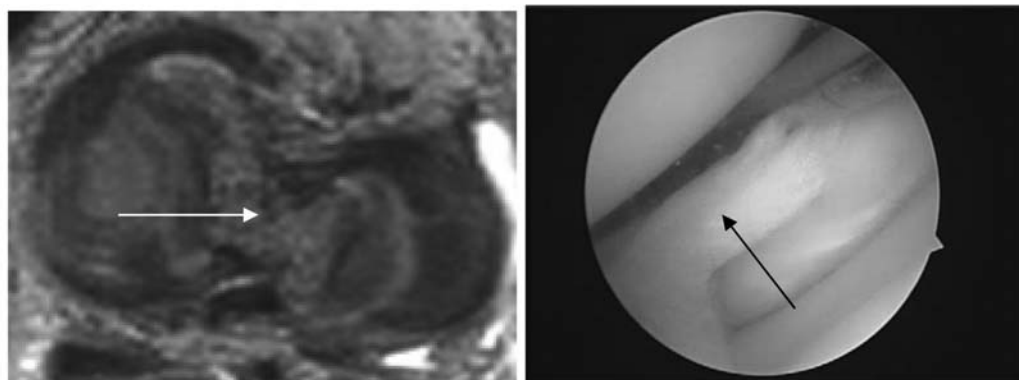
damage of the lateral femoral condyle 2–3 stage by Outerbridge with the damage area of 1–2 cm<sup>2</sup>. Clinically, all patients complained on painful clicks when performing deep sit-ups at the moment of the knee joint extension. Retrospective evaluation of MR tomograms of these patients revealed excessive accumulation of articular fluid between the tibial surface of the paracapsular part of the lateral meniscus' posterior horn and the edge of the tibia. Arthroscopically, these patients underwent marginal resection of lateral meniscus' posterior horn (Figure 7).

Discoid is considered to be a dysplastic meniscus, which has a disk configuration or is close to that, unlike a normal that has semilunar configuration. This anomaly was first described by Young et al. in 1889 on the section material [2]. According to Aichroth, the minimum transverse meniscus body size varies between 5 and 13 mm; therefore, the quantitative criterion of the meniscus discoidness is the value of the minimum transverse size of its body, which exceeds 13 mm [3].

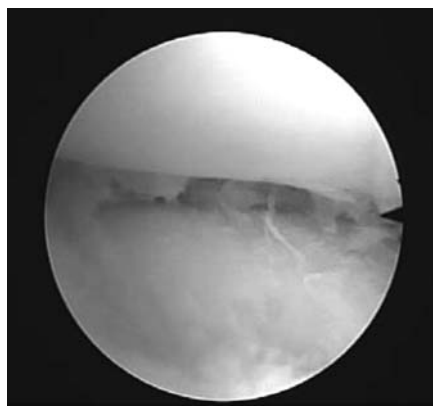
Discoid meniscus occurs in 1,4–15,5% of people [4–7]. Ikeuchi gives a figure of 16,6% for the people of Japan [8].

Discoid lateral meniscus occurs much more often than the medial; thus, Crues and Stoller found discoid medial menisci in only 0.3% of patients undergoing meniscectomy [9].

The first classification of discoid menisci was proposed in 1948 by Smillie [7]. Smillie distinguished three types of discoid menisci – primitive, intermediate and infantile. He believed that the menisci initially had a discoid configuration in the early stages of embryogenesis, and saving of such meniscus configuration in the postnatal period is evidence of their development disruption (delaying). This hypothesis has not been confirmed in subsequent studies. Thus, Kaplan [10] and later, Clark and Ogden [11], studying the structure of the knee joint at various stages of intrauterine development, did not find the presence of discoid menisci on any of them. According to Kaplan [10], the appearance of the discoid meniscus is promoted by the adhesion disruption of the posterior coronal (meniscotibial) ligament with the meniscus posterior horn. As a consequence, the meniscus experiences an increased load, which stimulates its hypertrophy and the formation of a discoid configuration. Discoid meniscus is less resistant to displacements and, thus, more suscep-



**Figure 6. Patient B., 53 years old, Multiplanar reconstruction of images of the right knee joint, obtained with the help of the SRFI GRE DESS in axial projection and arthroscopy. Discoid lateral meniscus type I by Watanabe; on the medial meniscus visualized transverse slit-shaped defect.**



**Figure 7. Patient K., 33 years old, arthroscopy of the right knee joint, resection of the discoid lateral meniscus.**

tible to damage (tears or ruptures). The discoid meniscus is not the cause of the pain by itself, but its high susceptibility to damage and degenerative changes often leads to the appearance of appropriate complaints in children and young adults.

In 1977, Hall proposed the classification of discoid menisci according to X-ray arthrography. Hall identified 6 types of discoid menisci: plate-shaped (meniscus, which has a relatively regular discoid configuration), biconcave (discoid meniscus, thinned in the middle, ie at the level of the greatest weight load), wedge shaped (discoid meniscus, which configuration on the arthrogram in a direct projection remembers the shape of the disc), asymmetric anterior (meniscus with asymmetrically enlarged anterior horn), so-called forme fruste (discoid meniscus has intermediate sizes between the normal meniscus and the above types of discoid menisci) and severely damaged (discoid meniscus with pronounced lesions (tears or ruptures) that make difficult his exact classification by the five types listed above on the arthrogram) [12]. Nowadays, this classification has more historical interest and deserves to be mentioned insofar as it is based on the medical imaging data.

Currently, the most commonly used, both by orthopedists and radiologists, is the classification of discoid menisci by Watanabe. In 1977, Watanabe analyzing the data obtained during the arthroscopy, identified 3 types of discoid menisci: an incompletely discoid meniscus (type I), a completely discoid meniscus (type II), and a discoid meniscus like Wrisberg ligament type (posterior, or lateral, meniscocofemoral ligament).

The incomplete discoid meniscus (type I) has a configuration which is closer to the discoid. It has anterior and posterior horns. Its body doesn't reach the intercondylar elevation of the tibia. A completely discoid meniscus (type II) according to Watanabe classification has a disk configuration; the anterior and posterior horns do not differentiate in it. The medial margin of the completely discoid meniscus reaches the intercondylar elevation of the tibia. Discoid menisci I and II types in children are not accompanied by clinical symptoms and are most often an accidental finding during the arthroscopy or MRI. Complaints of patients associated directly with discoid menisci are characteristic for older age [13]. As shown above, there are clear signs that

allow to identify the discoid meniscus I and II types in MR images [9, 14]. It should also be noted that already at the stage of X-ray study, which in our opinion should not be neglected, it is possible to identify bone changes that allow to suspect in the patient a discoid meniscus. These changes include: an isolated extension of the lateral or medial sections of the knee joint's x-ray joint slit, hypoplasia and / or the square configuration of the femoral condyle (usually lateral), strengthened in comparison with the usual concavity of the tibial condyle's articular surface (usually lateral) [15].

The discoid meniscus like Wrisberg ligament type (type III) is a special kind of discoid meniscus. This type of anomaly occurs only in the lateral meniscus [16]. In this case, the meniscus has a normal semilunar configuration and characterized by the absence of posterior section of the meniscotibial ligament. The meniscotibial, or coronal ligament ensures fixation of the meniscus to the tibial condyle, thus, the absence of its posterior section leads to the hypermobility of the meniscus horn. While movements in the knee joint (usually during the extension), the posterior or lateral, meniscocofemoral ligament (Wrisberg's ligament) displaces the posterior horn of the lateral meniscus toward the intercondylar elevation, which can be accompanied by pain sensations, clicks that are felt by ear or palpation and, sometimes, restriction of the movements volume in the joint. In addition to these symptoms, the hypermobility posterior horn of the lateral meniscus can be the cause of articular cartilage damage of the femoral and tibial bones. Clinically, this type of discoid meniscus has the greatest importance, since more often than other types it manifests itself as symptoms of hypermobility and serves as a direct indication to total meniscectomy [17]. At the same time, the detection of type III of the discoid meniscus by the methods of medical imaging, in particular –MRI, is problematic. This is due to the fact that the meniscotibial, or coronary ligament, together with the meniscocofemoral ligament forms a common meniscocapsular ligament and represents the deepest layer of the knee joint capsule; in this case, it is often difficult to differentiate the meniscotibial ligament in MR images [18].

## CONCLUSIONS

The data of the literature and our own data indicate that magnetic resonance tomography is a highly informative non-invasive method for detecting the discoid lateral meniscus I and II types by Watanabe, as well as evaluating their integrity. At the same time, it is still problematic to identify type III of the discoid lateral meniscus (discoid meniscus like Wrisberg's ligament type) at the stage of radiodiagnosis. This problem is aggravated by the fact that, from the clinic point of view, the third type of discoid meniscus is the most significant, since it often manifests itself in children and adolescents with a number of hypermobility symptoms of the lateral meniscus posterior horn, is a risk factor for early development of osteoarthritis and, therefore, absolutely indication for surgical treatment. The development of criteria for the timely non-invasive diagnosis of this anomaly, which would include a carefully executed clinical study on the one side and the integrated use of medical imaging techniques (radiography, MRI and ultrasound) on the other, seems to be a promising and actual task for orthopedists, traumatologists and radiologists specializing in the diagnosis of musculoskeletal system diseases.

**Дискоїдний латеральний меніск колінного суглоба (питання класифікації та діагностики)****О.А. Бур'янов, Ю.Л. Соболевський, О.В. Рябкін, Л.А. Міроняк, Ф. Хасанзаде Гасабех**

У статті проаналізовані МРТ колінних суглобів 409 пацієнтів та результати 15 артроскопічних ревізій колінних суглобів пацієнтів з дискоїдним латеральним меніском. Розглянуто декілька класифікацій видів дискоїдного латерального меніску. На підставі можливостей МРТ та артроскопії з виявлення аномалії латерального меніску з урахуванням кореляції результатів цих досліджень була виділена класифікація Watanabe як основна для описання дискоїдного латерального меніску при МРТ і артроскопії. Третій тип дискоїдного латерального меніску за Watanabe виділений як найбільш клінічно значущий, водночас він найбільш важко візуалізується за допомогою МРТ, що потребує проведення подальшого наукового пошуку.

**Ключові слова:** колінний суглоб, дискоїдний меніск, латеральний меніск, магнітно-резонансна томографія, артроскопія.

**Дискоидная латеральный мениск коленного сустава (вопросы классификации и диагностики)****А.А. Бур'янов, Ю.Л. Соболевський, О.В. Рябкін, Л.А. Міроняк, Ф. Хасанзаде Гасабех**

В статье проанализированы МРТ коленных суставов 409 пациентов и результаты 15 артроскопических ревизий коленных суставов пациентов с дискоидным латеральным мениском. Рассмотрены несколько классификаций видов дискоидного латерального мениска. На основании возможностей МРТ и артроскопии по выявлению дискоидного латерального мениска при учете корреляции результатов этих исследований выделена классификация Watanabe как основная для описания дискоидного латерального мениска при МРТ и артроскопии. Третий тип дискоидного латерального мениска по Watanabe выделен как наиболее клинически значимый, при этом он наиболее трудно дифференцируемый на МРТ, что требует проведения дальнейшего научного поиска.

**Ключевые слова:** коленный сустав, дискоидный мениск, латеральный мениск, магнитно-резонансная томография, артроскопия.

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