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Radiological Aspects of Temporo-Mandibular Joint Osteoarthritis

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Abstract: This article is about applications of computed tomography (CT) in diagnosis of inflammatory and degenerative disease of temporomandibular joint (TMJ). CT is highly informative method forvisualization of disease of temporomandibular joint. Finally, sections on other aspects of CT research related to the TMJ, clinical decision-making and concluding remarks are added. However, it should be emphasized that the diagnostic information obtained is limited to the morphology of the osseous joint components, cortical bone integrity and subcortical bonedestruction/production. Author of this research studied the frequency of radiological signs in different age group. In addition, there were studied frequency of isolated, combination types, and more and less localization sitesof radiological patterns of inflammatory and degenerative changes of temporo-mandibular joint.
Keywords: Degenerative joint disease, temporomandibular joint osteoarthritis; diagnostic imaging; temporomandibular disorders; joint pain; masticatory muscle pain.

Introduction.

Osteoarthritis (OA) of the temporomandibular joint (TMJ) is defined as a degenerative joint condition, characterized by involvement of the jointtissue and concomitant remodeling of the main subchondral bone [1]. 15% ofthe world's population suffers from osteoarthritis of the TMJ; clinical signs ofosteoarthritis of the TMJ are manifested in 8-16% of the general population [4]. Osteoarthritis of the TMJ can be unilateral, bilateral, and more common inwomen.

Osteoarthritis is associated more with the inflammatory process. Risk factors include age, heredity, traumas, disorders of joint structures and muscles, systemic lesions (systemic osteoarthritis, infections, idiopathic degenerative processes, congenital and acquired pathologies)[8]. Mechanical and metabolic factors lead to early destruction of cartilage. Inflammatory mediators, such as cytokines and chemokines, activate the degrading factor of the cartilage and produce matrix-metalloproteinases and prostaglandin E. This process extends to the deeper layer of cartilage, forming marginal bone erosion [3].

Cardinal signs of OA of the TMJ are revealed by clinical and radiographic methods [4]. Clinical features include joint stiffness, joint pain during mouth opening and lateral excursions, often accompanied by a hard sound or crepitus [4,5].

X-ray signs of the disease are erosion of the cortical bone, flattening of joint surfaces with productive changes in bones, such as sclerosis and osteophytes [6]. These signs of the TMJ OA are present different stages of the disease process.

Erosive lesions, subchondral bone changes and narrowing of the articular space indicate acute or early changes, whereas sclerosis, flattening, subchondral cyst and osteophyte may indicate late changes in the TMJ [7]. CT is often used to determine the early changes of the articular disc and study the structure of the joint in different planes, including with 3D reconstruction. Despite patient irradiation, CT remains the method of choice, since it allowsto determine early and late signs of TMJ disease before and after treatment of the patient. CT is especially informative for determining bone changes, suchas erosion, trauma, post-surgical deformities, as well as changes in the

temporal bone, the condylo-coronoidal angle that changes in the pathology ofthe TMJ. The research was carried out with the opening and closing of the mouth to determine the condition of the joint disc (thickness of sections from1 to 2.5 mm).

In the present work, the frequency of occurrence and features of various CT signs were studied in patients with OA of the TMJ in various age groups.

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Material and methods

Studies were carry out in 56 patients aged 50 to 80 years, 36 womenand 20 men. All of them were examined for temporomandibular dysfunction.Tenderness in the TMJ and the mandible was assessed by bilateral palpation of the preauric region when the mouth was opened and closed.

Stiffness in the periarticular muscles was checked by palpation of each muscle.

The presence of a crack in the area of the TMJ was verified by palpationof the sides of the joint near the preauric region or auscultation of the preauric region, with the patient doing three openings and lateral movementsin the joint.

Clinical criteria were formulated using the standard Okeson questionnaire, which includes: (1) stiffness present in the preariculer region,

(2) stiffness in the masticatory muscles, (3) restriction or deflection in the range of motion of the mandible (restriction of mouth opening to 30 %) (4) click, or pop-up, or crepitus [8].

Multispiral computed tomography of the TMJ was performed on a 6 cutter (SIEMENS SOMATOM EMOTION, 125 kV, 500 mA), thin sections (thickness from 1 to 2.5 mm). Postprocessing analysis included obtaining coronal-oblique sections (parallel to the axis of the condyles of the mandible), sagittal-oblique sections in bone and soft tissue regimes. Also used 3 D reconstruction.

Magnetic resonance imaging (MRI) performed in 30 patients with TMJ OA using Magnetom Open (Siemens)-0.2 T and Ingenia-1.5 T (Philips) tomographs. Studies with the patient lying on his back, using a preliminary radiofrequency coil for the head, in the closed and open mouth position up to 25 mm. Study of the TMJ at the conference in oblique-sagittal flatfoot - perpendicular to the heads of the mandibles and axial projection, in T1 and T2 weighted sequences. The position of the articular disc, the presence and severity of dystrophy were assessed on MR images.

Results

CT scan of the control group showed that the normal cortical bone of the mandible condyle has smooth contours. The condyles look wider in the coronary planes. The anterior and posterior horns of the articular disc are of ahigher density than the surrounding soft tissues. Bilaminar and median zone of the disk on CT scans without contrast was not visualized.

The results of the study showed that of the 112 joints evaluated in 56 patients, bone changes were present in 88 (78%) joints, either in condylar or in the condylar fossa (Fig. 1) in the articulation. They could reveal their combination. Unilateral lesion was noted in 24 patients, bilateral lesion in 32patients.

Osteoarthritis of the TMJ was manifested by the following changes in CT imaging:

1. Narrowing of the joint space - reduction of the space between the condyles and the glenoid fossa in all directions (anterior, upper and posterior). A narrowing (Fig. 1A.) was considered a reduction in the width of the slit of less than 1.5 mm, normal from 1.5 mm to 4.0 mm, expanded more than 4.0 mm.
2. Erosion - interruption or absence of cortical bone (Fig. 2)
3. Osteophytis-marginal outgrowths of bones (Fig. 3.)
4. Sclerosis - increasing the density of the cortical or subchondral bone
5. Subchondral cyst - single or multiple rounded subchondral lesions up to 2 mm in size, having sclerotic margins (1B.)

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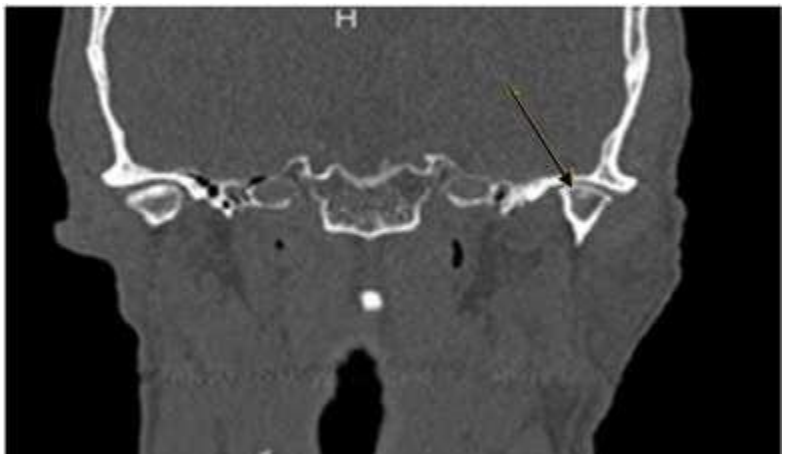

Fig-1A. CT of patient V., 60 years old. Coronal section of the TMJ. The arrow indicates the narrowing of the joint space and moderate mushroom deformation of the head of the condylar process of the mandible to the left.

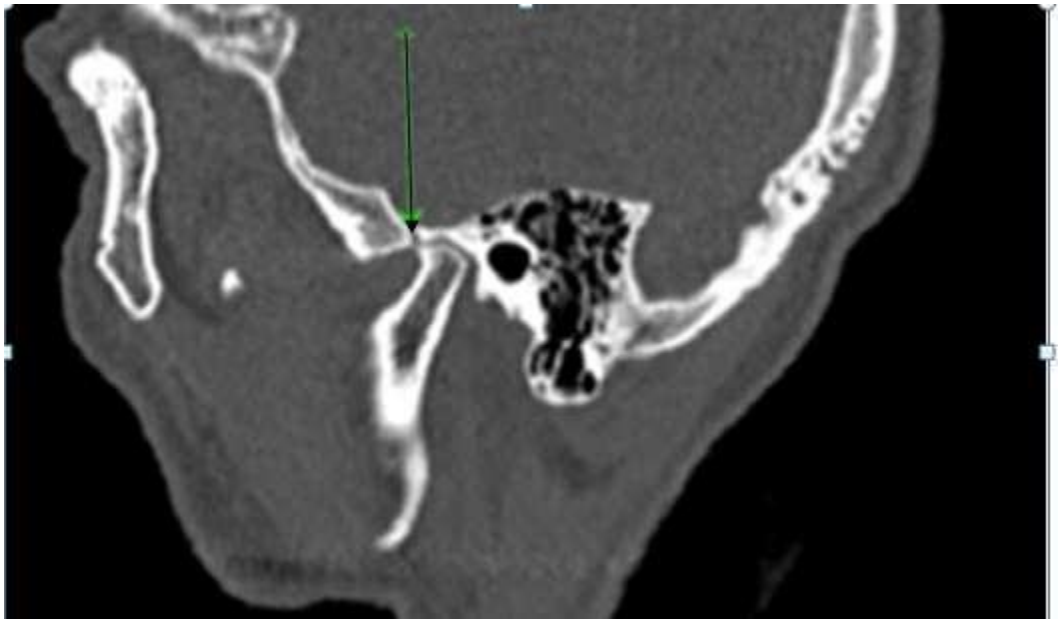

Fig-1B. CT of the same patient, sagittal section of the TMJ on the left. The arrow indicates a small subchondral cyst in the anterior part of the temporal fossa of the temporal bone.

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Fig-2. CT of patient A., 61 years old. (A-coronal section, B-sagittal section). Expressed erosive changes along the inner-anterior surface of the head of the condyle of the mandible and destructive changes in the joint fossa of the temporal bone on the left.

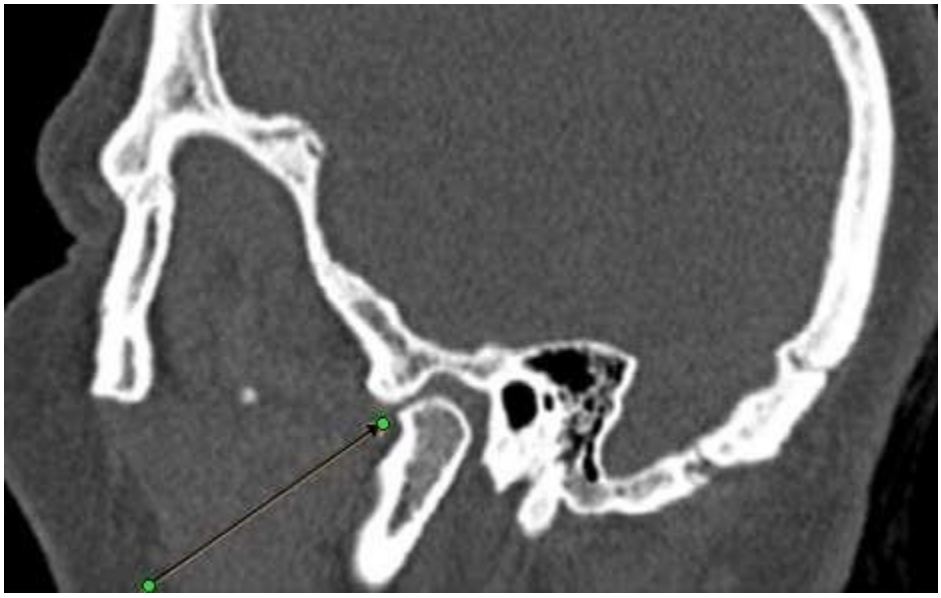
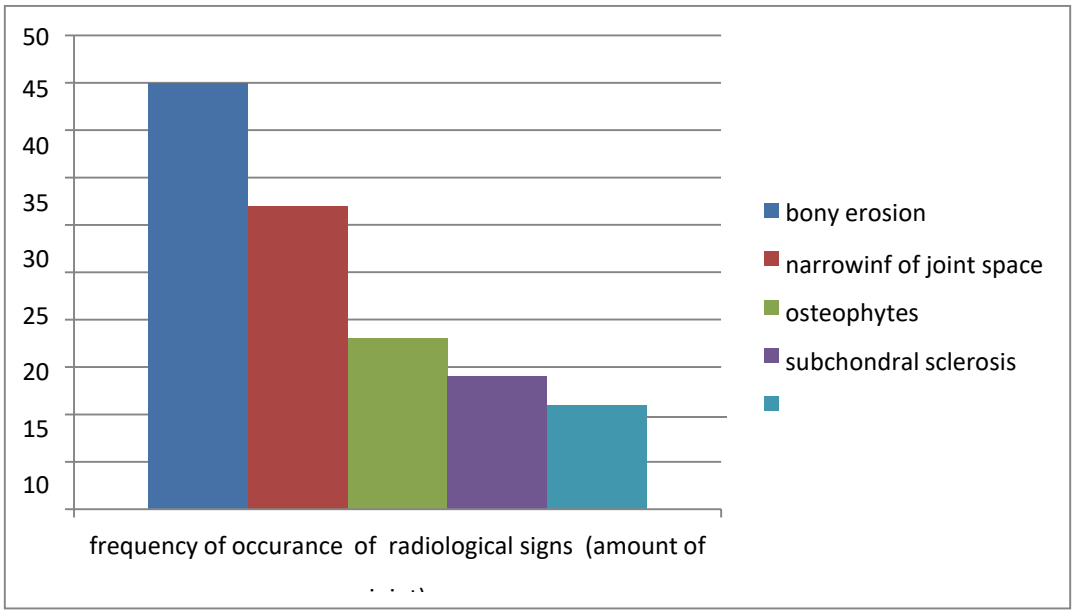


Fig-3. CT of the patient L. 65 years old. Sagittal section. A small marginal aggravation due to bone growth on the anterior contour of the headof the condyle of the mandible.

In most observations on CT scans, the OA of the TMJ was manifested by a combination of different characters, i.e. narrowing of the joint gap couldbe combined with marginal bone erosions, osteophytes, subchondral sclerosis, etc.

Osteoarthritis was considered obvious if even one of the five above- mentioned joint changes was detected. This occurred only in 8 of the 88 affected joints, the remaining joints visualized a combination of various signsof damage to the joint structures.

Figure- 1 graphically shows the frequency of occurrence of various CT signs of the OA of the TMJ.



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As can be seen from the diagram above, bone erosive changes were most often detected, which are noted in 45 joints. The narrowing of the joint space was revealed in 32, subchondral cysts in 11, osteophytes in 18, sclerosis in 14 joints.

Changes in the head of the condylar process were noted more often than in the joint fossa.

Table 1.

	Radiological signs	Frequency of occurance ofradiological signs	(%)	Age (M±m)
	Single sign	8	9	54±4
	The presence of 2 signs	36	41	61±4
	The presence of 3 signs	31	35	68±3
	The presence of 4 signs	13	15	73±3

According to the CT scan, the combination of various radiological signs of the disease predominated in patients with OA of the TMJ (Table 1). A combination of 2-3 different symptoms (narrowing of the joint space, erosionand osteophytes) was more common.

In the past stages, a combination of erosions and osteophytes with subchondral sclerosis, cysts and false widening of the joint space predominated due to the destruction of the condylar process and the glenoid fossa.

Only in 9% (8 joints) there was only one sign of OA in isolated form, in 41.1% there was a combination of two radiological signs, in 35.7% of the threesigns, and in 16.1% of the four characters. At the same time, was detected thatthere is a direct correlation between increase in the frequency and multiplicity of the combination of the OA radiological signs with age of patients. (Table -1).

Fig-4 . T1 weighted MRI image of the right TMJ of patient S., 34 years old in sagittal projection. An increase in the intensity of the articular disc signal is seen due to its degenerative changes.

These changes in the articular head, changes in the bilaminar zone. The displacement and change in the localization of the joint disc was clearly demonstrated when comparing MR images in the closed mouth state with MR images in the open mode.

Axial scans were obtained at baseline. To plan the operation in the oblique-sagittal planes, an image was selected in which both heads of the mandible were visualized. The smooth installation planes were

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attached to the heads of the condyle. The number of tomograms was selected individually to ensure visualization of the entire volume of the joint. The results of the study. Signs of bone and/or soft tissue changes were found on MR images in 50 out of 60 joints in 30 patients, or 83.3%. Unilateral lesion was noted in 10 patients (10 joints), bilateral lesion in 20 patients (40 joints). 10 joints showed no signs of arthrosis.

In magnetic resonance images, the structures of the cartilaginous disc, as well as the cortical bone, demonstrate the absence of a signal in all the imaging sequences used, and, therefore, are visible as a dark area. In contrast, the bone marrow shows high signal intensity in all imaging sequences due to its high fat content. There is a good contrast differentiation between the low disc signal in T1-weighted images and the high signal of the synovial parts of the joint, as well as the bony parts of the articular fossa.

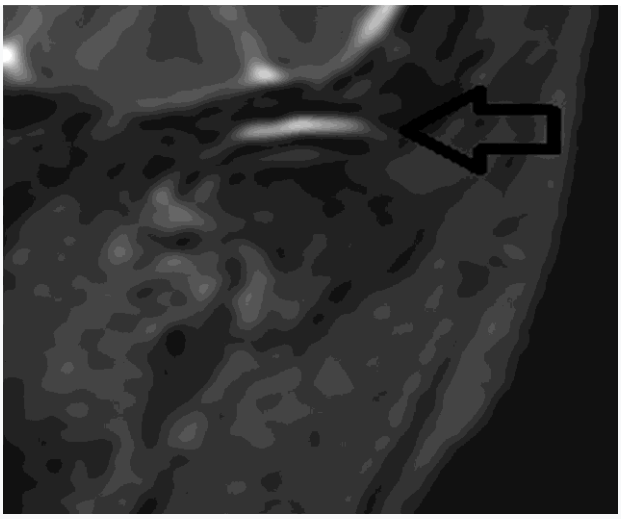

Fig-5. MRI of the left TMJ of patient N., 39 years old in coronal projection in PD mode. A small effusion is visible in the joint cavity (arrow).

The images obtained by MRI scanning were interpreted using criteria for the diagnosis of OA, such as in the presence or absence of signs of degenerative bone changes in the form of flattening and sclerosis of articular surfaces, formation of osteophytes and subchondral pseudocyst. However, MRI data on changes in the soft tissue structures of the joint were of particular value.

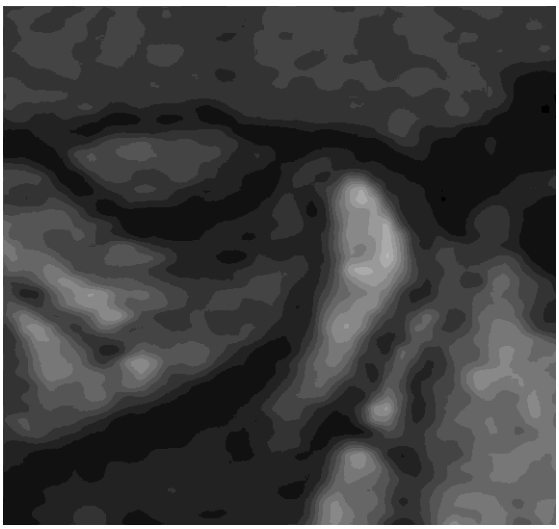

Fig-6. Sagittal MRI of patient K., 45 years old. T1 weighted MRI of the left TMJ of the same patient on which the condylar head is visible with a high signal intensity.

Discussion

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The prevalent CT signs of the TMJ were joint surface erosion (56.6%) and joint narrowing (40%), whereas osteophytes, sclerosis and subchondral cysts were less common and represented a more advanced stage of the disease. Consequently, most patients included in the CT scan demonstrated manifestations of the disease when early treatment, such as occlusal adjustments, physiotherapy, topical NSAIDs and intra-articular injection of corticosteroids, can help prevent the progression of the disease.

Changes in the head of the condylar process (70%) are observed more often than changes in the temporal bone, such as changes in the joint fossa (9.6%) and articular tuberosity (6.7%).

In our study, a combination of different radiologic features was observed more often than single radiological signs. With the age of patients, the combined signs were more frequent and became more plural, which was confirmed by the data of other authors (Wiberg and Wanman 1998) that OA TMJ is an age-related disease, observed mainly in the elderly. There is also a tendency of OA of the TMJ to the female sex where it is more pronounced in nature with the lesion of multiple joints. [5,7]. Low levels of estrogen during menopause have a detrimental effect on the property of the material property of articular cartilage, causing degeneration and erosion. [4,5]. In this study of 56 patients, 20 were men, 36 women, studies show that women are more involved in the lesion.

MRI has proven effective in detecting early soft tissue signs of TMJ dysfunction in osteoarthritis, such as thickening of the anterior or posterior band, rupture of retrodiscal tissue, disc-shaped changes, and effusion in the joint. Changes in the bone and soft tissue structures of the TMJ were visualized on MRI scans with varying frequency. The most frequent bone changes were flattening of the articular head and erosion, soft tissue changes were degeneration and disc displacement.

In identifying signs of subchondral cysts, T2 weighted images were more informative, on which cysts manifested as foci of high signal intensity. However, it was noted that often subchondral cysts on T1 and T2 weighted MR images had a hypointensive signal, which was explained by their filling with a granulomatous substrate rather than liquid.

The spread of the pathological process beyond the joint can lead to inflammatory and degenerative changes in the chewing muscles. On MRI, they are manifested by an increase in muscle volume due to edema and a decrease in the differentiation of the structure, and in the later stages their atrophy develops. In T1 weighted images, the intensity of the signal from the muscle decreased, in T2 weighted images it increased.

The most common MRI images revealed a flattening of the articular surfaces, which was noted in 37 out of 50 affected joints - 74%, erosion – in 24 (48%), disc degeneration – in 25 (50%), subchondral sclerosis – in 18 (36%), osteophytes - in 17 (34%),

disc displacement – in 15 (30%), bone marrow edema – in 20 (40%), masticatory muscle hypertrophy - in 7 (14%), masticatory muscle thickening – in 7 (14%), subchondral cyst – in 7 (14%), synovitis – in 4 joints (8%).

Fungal deformity of the head of the mandibular process of the mandible was revealed in 8 joints in the frontal projection on MRI, indicating a dislocation of the head of the condyle. On MRI in axial sections, asymmetry of the pterygoid muscles indirectly indicating displacement of the articular head was detected in 14 joints. The informative value of T1 and T2 modes increased significantly in the presence of inflammatory changes in the joint, because in these cases, the articular disc was clearly visible against the background of the surrounding effusion in both T2 and T1 modes.

Sagittal projection was the most obvious for detecting disc dislocations, degeneration and tears. Coronary and sagittal sections are more informative for detecting changes in the bone elements of the joint. MRI showed high sensitivity in detecting synovitis, and thus in diagnosing the early stages of arthritis, since synovitis was the earliest sign of inflammatory changes in the joint (Fig. 2).Exudate in the joint cavity was clearly visualized on T1, T2, PD-weighted images.

Thus, Figure 3 shows an MRI image of the TMJ in the sagittal plane in a T1 weighted sequence. On MRI, a distinct increase in signal intensity is visualized in the projection of the mandibular click, which indicates the presence of active inflammation in a patient with TMJ OA. To identify the features of disk displacement

A functional MRI examination was used in the lower jaw, in which a TMJ scan was performed sequentially at first with the jaws closed, then repeated with the patient's mouth possibly fully open. Changes

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in the location of the disc relative to the head of the condyle and articular tubercle when opening the mouth, normally and with OA of the TMJ are shown in Fig. 4.

Conclusion

CT is an effective method of diagnosis of OA of the TMJ, which allows to differentiate relatively early and more advanced stage of the disease.

Magnetic resonance imaging was more informative in the early stages of TMJ inflammatory processes in the form of increased signaling characteristics in PD mode. In subchondral sclerosis, there was a decrease in signaling characteristics in T1 and T2 modes. Axial projections were also informative for determining the bilateral and antero-posterior dimensions of the condyle head, subchondral sclerosis, subchondral cysts, erosive changes on both CT and MRI.

In the initial stage of osteoarthritis, MR images can show an increase in the signal of articular disc, as well as synovitis and edema of the bone marrow. X-ray imaging may not reveal changes at this stage. But CT scans show some flattening of the articular surfaces of bones and narrowing of the articular gap.

MRI is particularly effective in diagnosing the early stages of osteoarthritis, when the process is limited by degenerative changes in the cartilage of the joint, as well as in the appearance of concomitant inflammation, which can be observed not only in the initial stage of osteoarthritis, but may indicate an exacerbation of the disease.

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