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Optimizing Modern Treatment of Knee Osteoarthritis in the Context of Type 2 Diabetes Mellitus

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Annotation: Deforming osteoarthritis (OA) of the knee joint in the context of type 2 diabetes mellitus (T2DM) not only worsens the condition of patients but also requires improved treatment efficacy. This pathology affects a significant portion of the global population and is one of the leading causes of disability. In particular, OA in patients with diabetes tends to be clinically more severe, with pronounced morphological and immunological changes.

Within the study, a group of patients was examined using clinical, instrumental (X-ray and MRI), morphological, and immunohistochemical methods. They were divided into three groups:

1. Control group – patients diagnosed with deforming osteoarthritis of the knee joint without diabetes, treated with conventional methods;

2. Control group – patients diagnosed with knee DOA against the background of type 2 diabetes mellitus, treated with conventional methods;

3. Experimental group – patients with knee DOA on the background of type 2 diabetes mellitus, who underwent the proposed minimally invasive surgical techniques (arthroscopy and neuroablation).

The results showed a high severity of diabetic DOA, with a significant decrease in CD3, CD20 lymphocytes, and the Ki-67 proliferation index. Minimally invasive surgical methods were more effective than conventional treatments in reducing pain syndrome, improving function, and decreasing the frequency of complications.

Conclusion: Modern minimally invasive technologies are an effective approach to optimizing the treatment of deforming osteoarthritis of the knee joint in patients with type 2 diabetes.

Keywords: knee joint, deforming osteoarthritis, type 2 diabetes mellitus, arthroscopic debridement, genicular denervation, minimally invasive surgical techniques, treatment optimization.

Relevance of the Topic:

Among musculoskeletal diseases, deforming osteoarthritis (DOA) of the knee joint is one of the most prevalent pathologies and is recognized as one of the leading factors contributing to disability and decreased quality of life in the population. According to the World Health Organization, 80–90% of individuals over the age of 60 exhibit various degrees of osteoarthritis manifestations.

Diabetes mellitus, particularly type 2 diabetes, is closely associated with a more severe course and faster progression of osteoarthritis. Due to metabolic disorders, hyperglycemia, and the accumulation of advanced glycation end products (AGEs) in joint tissues, the metabolism of collagen and proteoglycans becomes impaired, inflammatory processes intensify, and tissue regeneration is significantly slowed. Clinically, this leads to increased pain syndrome, restriction of motor function, and pronounced morphological changes.

Conventional conservative or surgical methods often provide limited efficacy. Therefore, in recent years, minimally invasive technologies—such as arthroscopic debridement and genicular denervation—have been widely applied in practice. These approaches are recognized as effective

methods for reducing pain syndrome, improving functional outcomes, and lowering complication rates.

From this perspective, assessing the effectiveness of modern minimally invasive surgical techniques in the treatment of knee joint deforming osteoarthritis associated with type 2 diabetes mellitus, as well as optimizing treatment processes, represents an urgent scientific and practical task.

Research Objective:

The main objective of the study is to investigate knee joint deforming osteoarthritis (DOA) associated with type 2 diabetes mellitus from clinical, morphological, and immunohistochemical perspectives and to optimize the treatment process by applying modern minimally invasive surgical methods (arthroscopic debridement and genicular denervation).

Materials and Methods:

This scientific research is based on the clinical data analysis of 125 patients treated at the Bukhara State Medical Institute and the private clinic "Star Ortomed" during 2024–2025.

The patients were divided into three groups:

- **Comparison Group 1:** 35 patients diagnosed with knee joint DOA without diabetes, treated with conventional methods;
- **Comparison Group 2:** 40 patients diagnosed with knee joint DOA associated with type 2 diabetes mellitus, treated with conventional methods;
- **Main Group:** 50 patients diagnosed with knee joint DOA associated with type 2 diabetes mellitus, treated with the proposed minimally invasive surgical methods (arthroscopy and neuroablation).

The study material included:

- ✓ patients' medical histories and treatment protocols;
- ✓ results of clinical examinations;
- ✓ instrumental diagnostics (radiography, magnetic resonance imaging [MRI]);
- ✓ laboratory findings and morphological examinations.

Methods:

- ✓ Clinical assessment (anamnesis, general examination, evaluation of pain and functional changes);
- ✓ Radiological examinations (assessed according to Kellgren and Lawrence classification);
- ✓ MRI studies;
- ✓ Morphological and histochemical examinations, immunohistochemical markers (CD3, CD20, Ki-67);
- ✓ Laboratory tests (general and biochemical blood analyses, glucose levels);
- ✓ Statistical methods (Student's t-test, Fisher's exact test, Mann–Whitney test, regression and correlation analysis). The reliability of the results was evaluated at a significance level of $p<0.05$.

Research Results:

A total of 125 patients were studied clinically, morphologically, in laboratory terms, and instrumentally. Results were analyzed across the three groups.

Clinical and Functional Findings:

- ✓ Patients with DOA associated with diabetes mellitus demonstrated more pronounced pain and restricted mobility.

- ✓ According to the Lequesne index: in Comparison Group 1, the results corresponded to the "severe" category, while in Comparison Group 2 and the Main Group they corresponded to the "very severe" category.
- ✓ Movement restriction: in the Main Group, significant flexion and extension dysfunction was observed in 48–52% of cases.

Radiological and MRI Findings:

- ✓ Kellgren classification: Grades II–III changes were mainly observed in Comparison Groups 1 and 2, while Grade I–II changes were more frequently detected in the Main Group.
- ✓ MRI findings: Grade I DOA was most common in the Main Group (22 patients), while severe Grade III cases were less frequent (12 patients). Additionally, synovitis, meniscopathy, chondromalacia foci, Baker's cysts, and subchondral cysts were identified.

Morphological and Immunohistochemical Results:

- ➢ Cartilage tissue showed swelling, increased proteoglycan content, and a reduction in cellular components.
- ➢ Immunohistochemical analysis revealed:
- ✓ CD3 (T-lymphocytes) expression was 1.23 times lower in diabetic DOA patients;
- ✓ CD20 (B-lymphocytes) expression was reduced 1.86 times;
- ✓ Ki-67 proliferation marker decreased 1.53 times.

Final Treatment Outcomes:

In the Main Group, where minimally invasive surgical methods (arthroscopic debridement + genicular denervation) were applied:

- ✓ "Good" outcomes were achieved in 88% of patients;
- ✓ "Satisfactory" outcomes in 12%;
- ✓ No "unsatisfactory" results were observed.

In groups treated with conventional methods, "good" outcomes were achieved in 71% and 57% of patients, respectively, while the remainder showed satisfactory or unsatisfactory results.

Distribution of Patients by Sex and Age

Гуруҳлар	**Age** / **Sex**	**35-44 y.o**		**45-59 y.o**		**60-80 y.o**	
		Abs	%	Abs	%	Abs	%
Comparison group n= 35	Male n=11	2	1,6	6	4,8	3	2,4
	Female n=24	3	2,4	12	9,6	9	7,2
Comparison group n=40	Male n=12	3	2,4	5	4	4	3,2
	Female n=28	4	3,2	14	11,2	10	8
Comparison group n= 50	Male n=17	2	1,6	10	8	5	4
	Female n=33	6	4,8	18	14,4	9	7,2
Total= 125		20	16	65	52	40	32

Analysis of Patient Distribution by Sex:

This pathology is generally more prevalent among women, with a female-to-male ratio of approximately 2:1 to 3:1.

All patients with knee joint deforming osteoarthritis were characterized according to etiological factors, as presented in Figure 2.1..

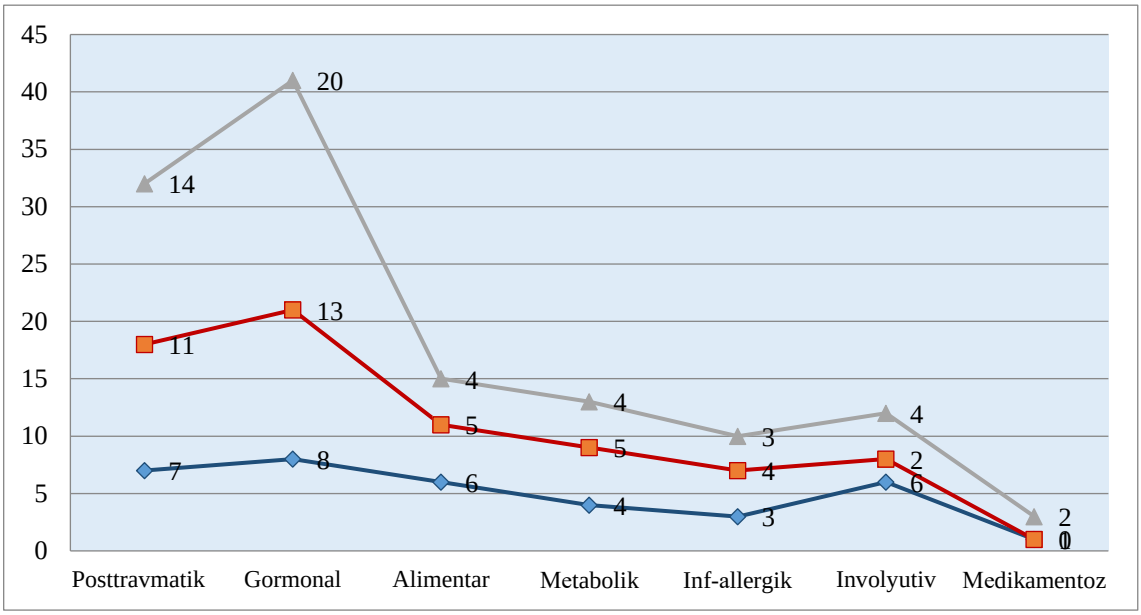

Figure 2.1. Distribution of patients according to etiological factors

Among the 125 patients with knee joint deforming osteoarthritis (DOA), the majority were associated with hormonal factors, accounting for 41 clinical cases (32.8%). Within the comparison groups, the Main Group included 20 patients (16%), followed by the First Comparison Group, i.e., patients with knee joint DOA associated with type 2 diabetes mellitus who were treated using conventional methods. The second most common etiological factor was trauma, identified in 32 cases (25.6%). This was followed by alimentary and metabolic disorders, infectious-allergic factors, and involutive changes. Medication-related causes were the least frequent, observed in 3 patients (2.4%).

In all 125 patients with knee joint deforming osteoarthritis, clinical and functional changes—collectively referred to as the *joint syndrome*—were evaluated. This syndrome included pain (based on the Lequesne index results), limitation of flexion and extension movements in the knee joint, and the degree of periarticular swelling.

One of the main symptoms of joint syndrome is pain. In our clinical cases, the intensity of pain and its correlation with the functional capacity of the knee joint (algo-functional index) were assessed according to the results of the Lequesne Index (1991) (Table 2.2).

Table 2.2. Evaluation of pain and functional changes in knee joint osteoarthritis

	Description	Scores
1	• **Night pain or discomfort**	
	○ None	0
	○ During movements or certain static positions	1
	○ At rest	2
2	• **Duration of morning stiffness and pain**	
	○ None	0
	○ Less than 15 minutes	1
	○ 15 minutes or more	2
3	• **Pain increasing after standing for 30 minutes**	
	○ None	0
	○ Present	1
4	• **Pain during movement**	
	○ None	0
	○ After walking a certain distance	1
	○ At the onset of movement	2
5	• **Pain after sitting for 2 hours**	

	Description	Scores
	○ None	0
	○ Present	1
6	• **Restriction of walking distance**	
	○ None	0
	○ With difficulty after more than 1 km	1
	○ After 1 km (after 15 minutes)	2
	○ After 500–900 meters (8–15 minutes)	3
	○ After 300–500 meters	4
	○ After 100–300 meters	5
	○ Less than 100 meters	6
7	• **Need for walking aids**	
	○ None	0
	○ Walking with 1 crutch or 1 cane	1
	○ Walking with 2 crutches or 2 canes	2
8	• **Ability to climb up and down stairs**	
	○ Can perform freely	0
	○ With mild difficulty	+0,5
	○ With moderate difficulty	1
	○ With severe difficulty	+1,5
	○ Cannot perform	2
9	• **Ability to descend one stair step**	
	○ Can perform	0
	○ With mild difficulty	+0,5
	○ With moderate difficulty	1
	○ With severe difficulty	+1,5
	○ Cannot perform	2
10	• **Ability to squat (bend knees fully)**	
	○ Can perform	0
	○ With mild difficulty	+0,5
	○ With moderate difficulty	1
	○ With severe difficulty	+1,5
	○ Cannot perform	2
11	• **Ability to walk in cross (crossover) gait**	
	○ Can perform	0
	○ With mild difficulty	+0,5
	○ With moderate difficulty	1
	○ With severe difficulty	+1,5
	○ Cannot perform	2

Олинган натижалар таҳлил қилинганда минимал “0” ва максимал 22 баллни ташкил этади. Натижалар қуйидагича баҳоланади (2.3-Schedule).

23-Schedule

Total score	Severity level
0	• Healthy
1-4	• Mild
5-7	• Moderate
8-10	• Severe
11-13	• Very severe
> = 14	• Extremely severe

Discussion:

The results obtained indicate that in patients with knee joint deforming osteoarthritis (DOA) associated with type 2 diabetes mellitus, the clinical course of the disease is significantly more severe, with higher levels of pain syndrome and functional limitations. This condition can be explained by chronic hyperglycemia observed in diabetes, disturbances in collagen and proteoglycan metabolism, as well as the accumulation of advanced glycation end products (AGEs) in joint tissues. As a result, degenerative changes in the joint progress more rapidly and morphological damage deepens.

Immunohistochemical examinations revealed a decrease in the number of T- and B-lymphocytes and a reduction in the proliferation marker Ki-67, which indicates slowed regenerative processes in the joints of diabetic patients. This explains the more severe clinical manifestations of osteoarthritis in this category of patients.

When minimally invasive surgical techniques—arthroscopic debridement and genicular denervation—were applied, a significant reduction in pain, restoration of joint function, and decrease in complication rates were achieved. These findings are consistent with data reported in modern international literature, confirming that in recent years minimally invasive technologies have become a preferable approach in the treatment of DOA.

However, the study has certain limitations: the relatively small sample size and the short follow-up period restrict the possibility of generalizing the results. Nevertheless, the findings demonstrate that minimally invasive surgical methods are effective in optimizing the treatment of DOA associated with type 2 diabetes mellitus.

Conclusions:

- The results of the study show that in patients with knee joint deforming osteoarthritis (DOA) associated with type 2 diabetes mellitus, the severity of clinical manifestations, functional impairments, and morphological changes are more pronounced.
- Immunohistochemical analyses revealed a marked decrease in T- and B-lymphocytes as well as proliferative activity, confirming the negative impact of diabetes-related metabolic and inflammatory processes on joint structures.
- Radiological and MRI studies demonstrated a faster progression of DOA in diabetic patients, with complications such as synovitis, meniscopathy, and subchondral cysts occurring more frequently.
- Optimized minimally invasive surgical approaches—arthroscopic debridement combined with selective/total genicular denervation—produced more effective outcomes compared to conservative and conventional surgical methods. This approach contributed to pain reduction, improvement of functional parameters, and a decrease in complication rates.

Thus, in the treatment of knee joint DOA associated with type 2 diabetes mellitus, the comprehensive application of modern minimally invasive technologies optimizes the therapeutic process and significantly improves patients' quality of life.

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