

Incidence of adductor tubercle tendinitis and its effect on clinical results in patients with genu varum undergoing high tibial osteotomy

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Abstract. – OBJECTIVE: This study aims to investigate the incidence of adductor tubercle tendinitis (ATT) and demonstrate the effects of intraoperative steroid injections on clinical outcomes in patients undergoing high tibial osteotomy (HTO) due to genu varum (GV).

PATIENTS AND METHODS: Of 738 patients who underwent HTO due to GV between 2014-2021, 454 patients had accompanying preoperative ATT. Of these patients, 324 patients who presented to follow-ups and had adequate medical records were evaluated. Mean patient age was 52.6 years. Patients who received steroid injections to the adductor tubercle during HTO (Group I, n=182) and patients who did not receive injections (Group II, n=142) were compared. Univariate and multivariate logistic regression analyses were performed by evaluating preoperative and postoperative VAS scores and presence of ATT.

RESULTS: Preoperative ATT sensitivity was present in 61% of the patients. ATT findings were significantly less in Group I compared to Group II in the early-term (1-3 months) ($p=0.0001$), while there was no significant difference in the late-term (6-12 months) ($p=0.880$). There was no statistically significant difference between the preoperative and postoperative VAS scores of the groups ($p=0.0001$).

CONCLUSIONS: Stress and tendinitis often develop in the adductor muscle groups due to increased adductor moment in GV. We believe that tendinitis contributes to increased knee pain. HTO reduces the symptoms of tendinitis in the long term by decreasing the adductor moment, while intra-operative steroid injections contribute to relieving complaints related to tendinitis in the early term.

Key Words:

Osteotomy, Tendinopathy, Osteoarthritis, Tendinitis, Methylprednisolone acetate.

Introduction

Tendons are dense regular connective tissue structures found throughout the body. They are

known for their anatomical placement, connecting muscles to the bone^{1,2}. Type I collagen constitutes 70-80% of their dry mass. They provide movement and stabilization in joints by transferring the mechanical load produced by the muscles to the bone^{1,3}. A clinical condition resulting in thickening of the tendons, loss of functional properties, and pain, referred to as tendinitis emerges due to changes in the composition of the tendons, overuse, degeneration, obesity and age-related factors. Aging tendons undergo structural and compositional changes, including decreased fluid content and collagen changes. These changes may cause a predisposition to tendinitis^{2,3}. The diagnosis of tendinopathy is made based on the patient's history and physical examination. Physical examination is performed while the patient is in supine position, with the knees extended, and the lower extremities in external rotation of 15 degrees from the hip; pain and tenderness that occurs after pressure is applied to the adductor tubercle with palpation and is evaluated as a sign of tendinitis (Figure 1).

Osteoarthritis is a chronic disease observed in elderly individuals, especially in load-bearing regions such as the knee and hip joints. Osteoarthritis in the knees usually develops with deviation in the mechanical axis, such as varus deformity, and results in narrowing in the medial joint. The lower extremity mechanical axis is the connecting line drawn from the mid-femoral head to the mid-ankle (Mikulicz line)^{2,4}. This line passes 2-5 mm medial to the center of the knee joint. If this axis passes more than 15 mm medially or more than 10 mm laterally, it is defined as mechanical axis deviation. Considering that there is normally 5-7 degrees of valgus in the knees, 60% of the loads on the knee are transmitted from the medial compartment and 40% from the lateral compartment. The shift of the mechanical axis towards the medial increases the load on the

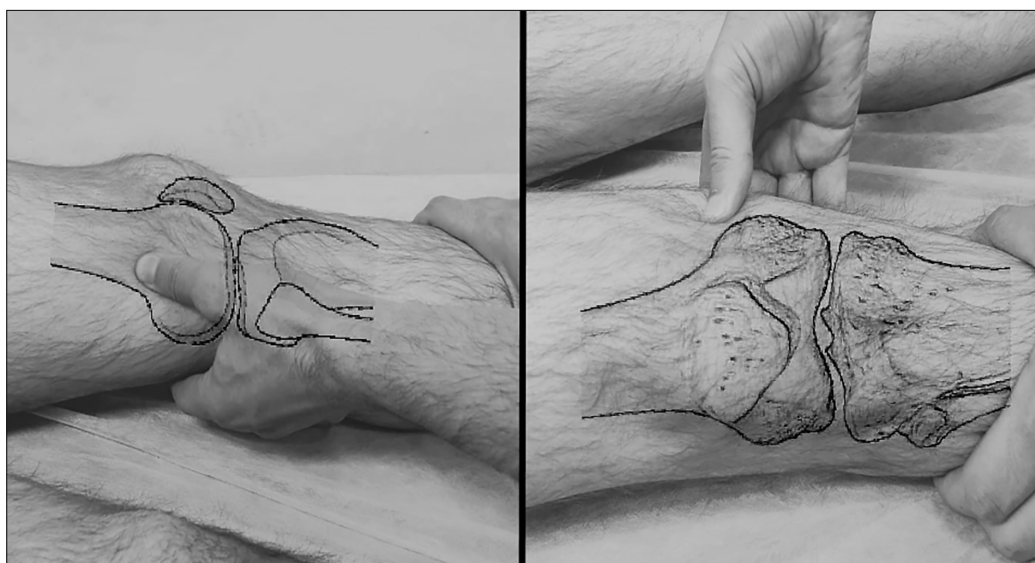


Figure 1. Adductor tubercle tendinitis examination.

unit area in the medial compartment of the knee, causing degeneration and damage to the cartilage and bone structures in that region, resulting in medial arthrosis. The varus alignment produces a constant, static adduction moment in the knee, causing increased loads on the medial compartment and tension on the lateral structures when standing. 3° varus angulation of the knee doubles the load on the medial compartment^{3,4}. Varus malalignment causes a 4-fold increase in the development of medial compartment arthrosis, and a 2-fold increase in valgus malalignment. Loads concentrated in the medial compartment causes tension in the ligaments and muscles in the lateral compartment, eventually leading to lateral stretching, causing the mechanical axis to shift more medially^{3,4}. Literature has demonstrated the relationship between pain and dynamic loading. In the presence of varus deformity, increased load in the medial compartment is directly proportional to increase in the adduction moment. Adduction moments in the knee joint are a reflection of the lower extremity varus alignment^{4,5}. The adductor muscles of the hip offer strong resistance to the abduction moment of the femur in knees with varus deformity. The hip adductors extend from the ischial tuberosity to the medial aspect of the femoral shaft⁵. The adductor tubercle is located at the distal end of this insertion and is affected by the load on the adductor. Most patients with knee osteoarthritis with varus deformity experience tenderness in the adductor tubercle of the medial femoral condyle. In addition to qua-

driceps and hamstrings, the adductor muscles of the hip are also effective in stabilizing knees with medial compartment osteoarthritis⁴⁻⁶.

Increase in the adduction moment increases the incidence of tendinitis and tendinopathy by causing certain degenerative and inflammatory changes, especially in the tendons and areas of attachment of the tendons to the bone. This type of tendon pathology is encountered as an increase in pain sensation. The incidence of adductor tubercle tendinitis (ATT) is quite high in genu varum knees presenting with complaints of tenderness and pain in the adductor tubercle region. In addition to complaints due to degeneration caused by medial arthrosis, complaints of tenderness and pain due to tendinitis should also be considered^{5,6}.

In our study, we aimed to reveal the incidence of concomitant ATT in patients with genu varum who were undergoing high tibial osteotomy (HTO), and to show the effect of HTO and steroid injection on clinical and functional outcomes in the postoperative period.

Patients and Methods

A total of 738 patients underwent HTO between March 2014 and November 2020 at a single center by a single surgeon. All patients had narrowing and arthrosis in the medial compartment due to genu varum deformity. In addition to the pain caused by preoperative medial arthrosis, concomitant ATT was investigated. ATT was

diagnosed with physical examination, presence of severe pain and tenderness with the application of pressure to the adductor tubercle with palpation was accepted as an ATT finding. ATT was identified in 454 of the 738 patients. After the HTO operation, 324 patients of the 454 who regularly came to follow-ups and with adequate medical records were included in the study. Mean age of the 324 patients (315 females, 9 males) was 52.6 (80-39) years. Of these patients, 182 patients were injected 40 mg of methyl prednisolone acetate to the adductor tubercle for tendinitis during the operation and were classified as Group I, while 142 patients who were not administered steroids were classified as Group II. Univariate and multivariate logistic regression analyses were performed by evaluating preoperative and postoperative VAS scores and ATT findings in both groups.

Surgical Technique

Medial open wedge osteotomy was performed under spinal anesthesia with tourniquet application. Incomplete open wedge osteotomy extending from the medial to the lateral head of the fibula was performed with an incision approximately 8-10 cm from the anteromedial of the tuberosity of the tibia to the knee. Metal wedged HTO plates were used for the patients. During the operation, an average valgus angle of 6-10 degrees was achieved by using a 6-8-10 mm metal wedge with the plate. After the tourniquet was released, bleeding was controlled, and the layers were closed anatomically with an aspirative drain. At this stage, intra-operative steroid injection was performed to the adductor tubercles of Group I patients. The knee was wrapped with an elastic bandage. Group I and Group II patients were evaluated in terms of ATT findings and VAS scores by physical examination in the early term between 1-3 months and in the late period between 6-12 months after the removal of the postoperative stitches. The patients were initiated prophylactic antibiotic (Cefazol 1 gr 3x1) and anticoagulant (Enoxyheparin 0.4 ml 1x1) treatment together with compression stockings one day before the operation. Physical examination and VAS scores were used to evaluate the severity of ATT in patients followed up for one year.

Statistical Analysis

Statistical analyses were performed with NCSS (Number Cruncher Statistical System) 2007 Statistical Software (Kaysville, UT, USA) package program. In addition to descriptive statistical

methods (mean, standard deviation), the distribution of the variables was assessed with the Shapiro-Wilk normality test, paired *t*-test was used for time comparisons of normally distributed variables, independent *t*-test was used for comparison of paired groups, and Chi-square test was used for comparison of qualitative data. The results were evaluated at a significance level of $p < 0.05$.

Results

Concomitant ATT findings were present in 454 (61.5%) of 738 patients who underwent HTO. ATT sensitivity was present at baseline in all 324 patients included in the study and was observed in the early term follow-up of 19 patients (10.4%) in Group I, and 86 patients (60.5%) in Group II. ATT findings were present in 41 patients (22.5%) in Group I, and 33 patients (23.5%) in Group II at late-term follow-up (6-12 months) (Figure 2). Mean preoperative VAS score was 7.1, while mean postoperative VAS score was 2.35 in both groups. ATT findings are frequently encountered in patients indicated for HTO. Presence of ATT

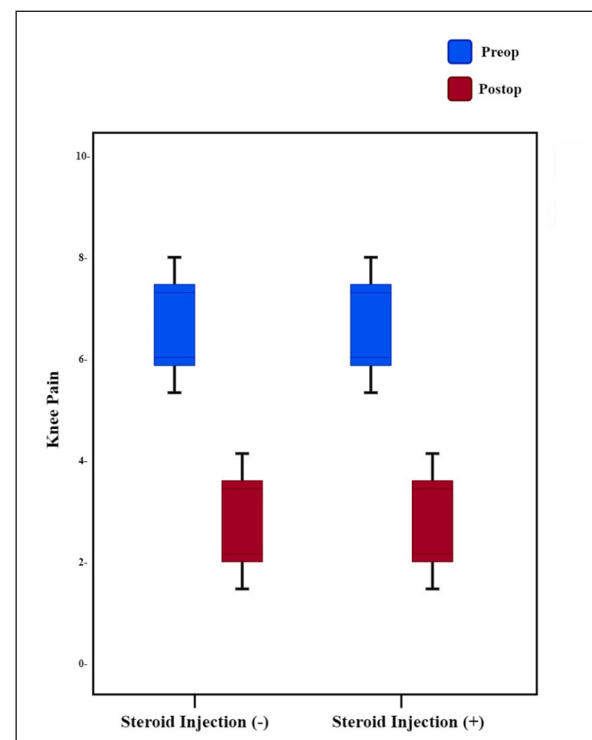


Figure 2. Correlation between steroid injections and preop-postop knee pain.

decreased significantly in the early term in patients who received steroid injections compared to the patients who did not, but no difference was observed in the long term. Therefore, we believe that ATT sensitivity decreases when varus is corrected with HTO (Figure 3).

No statistically significant difference was observed between the mean preoperative and postoperative VAS scores of Group I and Group II ($p=0.703$ $p=0.736$) (Table I).

There was no statistically significant difference between Group I and Group II in terms of mean preop-postop VAS score difference ($p=0.985$).

Rate of early-term ongoing tendinitis was found to be statistically significantly lower in Group I compared to Group II ($p=0.0001$). However, no statistically significant difference was observed between Group I and Group II in terms of ongoing tendinitis in the late term ($p=0.880$).

In order to determine the factors affected by steroid injection, logistic regression analysis was performed with the early tendinitis variable, which was found to be significant in univariate tests. Risk of early tendinitis was found to be 13.1 (7.36-19.21) times higher in those who did not receive intra-operative steroids compared to those who did (Table II).

Discussion

Knee osteoarthritis is a chronic disease that develops due to many factors. It is known that biomechanical factors such as varus deformity play a role in its etiology and cause narrowing of

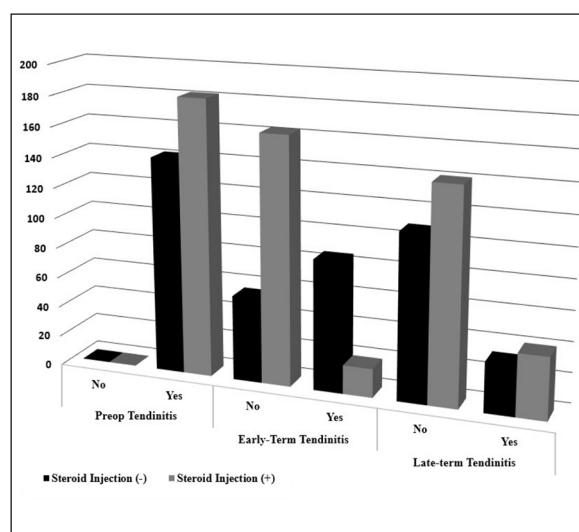


Figure 3. Early-term and late-term outcomes after steroid injections in ATT treatment.

the medial joint space of the knee^{6,7}. Studies⁷⁻¹⁰ have demonstrated its relationship with dynamic loading. It has been stated that the adduction moment is an effective factor in the presence of varus deformity, and this moment is directly related to narrowing in the medial joint space, pain, and varus deformity⁸⁻¹⁰. Shifting the load in the medial compartment to the lateral after HTO will reduce the stress in the medial compartment, decreasing the pressure and load strength on the medial joint space, cartilage structures, ligaments and muscles⁸⁻¹². High momentum and loading in the medial during the preoperative period cause degeneration of the adductor muscle and tendon

Table I. Statistical analysis.

Variable		Group I Steroid injection (+) n = 182	Group II Steroid injection (-) n = 142	p
Age		52.05 ± 6.71	53.25 ± 6.7	0.114*
Sex				
Male		7 (3.85%)	2 (1.41%)	0.185+
Female		175 (96.15%)	140 (98.59%)	
Preop VAS		6.94 ± 0.73	6.97 ± 0.79	0.703*
Postop VAS		2.47 ± 0.91	2.51 ± 0.91	0.736*
p*		0.0001	0.0001	
Preop-postop VAS score difference		4.47 ± 1.11	4.46 ± 1.05	0.985*
Preop tendinitis	Yes	182 (100.00%)	142 (100.00%)	
Early term ongoing tendinitis	No	163 (89.56%)	56 (39.44%)	0.0001+
	Yes	19 (10.44%)	86 (60.56%)	
Late-term ongoing tendinitis	No	141 (77.47%)	109 (76.76%)	0.880+
	Yes	41 (22.53%)	33 (23.24%)	

*Independent t-test; †Paired t-test; +Chi-square test.

Table II. Logistic regression analysis.

Variable	OR (95% CI)	p
Early-Term tendinitis	13.1 (7.36-19.58)	0.0001

groups in the medial with overload and tendinitis in the attachment sites of the tendon to the bone. In order to prevent preoperative tendinitis from adversely affecting postoperative clinical and functional results, intra-operative steroid injections have a positive effect on the functional results in the early and late terms. The most important reason for the significant improvement in VAS scores in the post-op period is the decrease in medial stress with HTO^{12,13}. In our study, we determined that ATT findings were present in the majority of patients (61.5%) who had genu varum deformity and were undergoing HTO. Most of the patients' complaints of pain were due to narrowing of the medial joint space and medial arthrosis due to genu varum, and we believe that adductor tubercle tendinitis contributes to another aspect of this pain. Therefore, we believe that the use of long-acting steroid injections will be beneficial in terms of clinical outcomes by performing ATT examination in the treatment principles of genu varum patients undergoing HTO. While steroid injections improve clinical and functional results in the early term (1-3 months), similar clinical and functional results were observed in the late term (6-12 months) in patients who did not receive steroid injections. Decreased medial adductor moment after HTO contributed to clinical and functional improvement in both groups by reducing the stress on soft tissues such as bone and tendon, providing similar results in terms of VAS scores and ATT findings in late clinical data.

Tan et al¹³ reported that adductor tubercle tenderness is frequently encountered in varus knees with osteoarthritis. Bokhari¹⁴ reported that adductor tubercle pain is an important component of pain in patients with genu varum, and steroid injection into the adductor tubercle caused a significant reduction in pain complaints.

Yamada et al¹⁵ stated that adductor muscles are one of the most important inhibitors of lateral shifting of the knee (forcing the knee to varus and increase in medial compartment pressure) caused by the increase in the adductor moment of the knee in genu varum. Wang et al¹⁶ reported that the adductor muscles should be strengthened

in order to balance the adductor moment of the knee, so that it can be corrected in the varus deformity.

Murray et al¹⁷ stated that HTO can provide a permanent solution for preserving joints in symptomatic medial compartment pathologies of the knee. Kang et al¹⁸ stated that factors such as ligament balance, patellar height, and posterior tibial slope play a role for an ideal correction, that there should be no over-correction or under-correction in obtaining a good outcome after HTO. Sethi et al¹⁹ stated that HTO is a successful application in medial knee osteoarthritis and the post-op valgus angle should be between 3-13 degrees to obtain the best results. They stated that this valgus angle leads to improvement in soft tissue pathologies such as tendinitis in structures such as adductor muscles and tendons, due to a decrease in medial compartment load. Sprenger and Doerzbacher²⁰ conducted a 10-year study on 76 knees and reported that a 3-11-degree valgus angle was ideal, while Valenti et al²¹ reported an ideal valgus angle of 3-8 degrees. Hernigou et al²² on the other hand, reported that a 3-6-degree valgus angle was ideal, and both under-correction and over-correction may lead to poor results in the long-term. In our study, we achieved a valgus angle of 6-10 degrees according to the scope of the deformity.

Evciik et al²³ stated that the increase in adductor moment in the knee caused by genu varum deformity triggered degeneration and pain in the medial muscle and tendon groups, causing chondral damage in the medial knee joint. Wright et al²⁴ reported that open medial wedge osteotomy is beneficial in young active patients with medial compartment osteoarthritis, and that this method not only relieves the medial compartment but also improves the accompanying muscle and tendon structures.

Lee and Byun²⁵ stated that HTO is an ideal choice in middle-aged patients with good range of motion and without ligamentous instability, and the ligament and tendon structure should be well analyzed when planning HTO.

According to the literature, it has been stated that HTO is nearly the gold standard in middle-aged patients with genu varum without medial compartment involvement. When the medial compartment is affected, the increase in adductor moment causes degeneration and soft tissue pathologies such as tendinitis due to excessive load and stress on the muscle and tendon structures in the medial region. Accompanying ATT patho-

logy, which can contribute to the pain and functional limitation caused by medial compartment osteoarthritis, should be considered and physical examination and adductor tubercle palpation should be performed when evaluating patients preoperatively.

Diagnosis of ATT is an easy and simple method, and it is significant in terms of its effect on early clinical and functional outcomes in patients scheduled for HTO. Intra-operative long-acting steroid injections may be preferred in the treatment of ATT.

Limitations

Our study had some limitations including its retrospective study design without randomization of patients before the operations. Furthermore, the fact that there were almost no studies in the literature regarding adductor tubercle tendinitis had a negative impact on the evaluation of the results.

Conclusions

The incidence of ATT is high in genu varum. We believe that intra-operative steroid injections will be beneficial in preventing this condition, which decreases patient comfort and increases knee pain, in the early postoperative period. Tendinitis complaints decrease with steroid injections in the early postoperative period and improve to a large extent in the late period with the decrease in adductor moment provided by HTO. We would like to emphasize that the presence of ATT should not be overlooked in genu varum patients who were undergoing HTO and that a physical examination for tendinitis should be performed in the preoperative period. We believe that further studies that include more patients and evaluate more parameters are needed, and we hope that this study will shed light on future studies.

Conflict of Interest

The Authors declare that they have no conflict of interests.

Funding

None.

Informed Consent

All patients provided written informed consent for their clinical records to be used for research purposes.

Ethics Approval

The study obtained approval from the Sakarya University Faculty of Medicine Ethics Committee (Date: 03.01.2022; No. 92634-547). The study was conducted in line with the Declaration of Helsinki.

Availability of Data and Materials

The dataset used during the current study is available from the corresponding author, however it is not allowed to be shared publicly.

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