Evaluation of correction loss after open wedge distal tibial tuberosity osteotomy

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INTRODUCTION:
The incidence of medial compartment knee osteoarthritis (OA) treated with OWDTO has increased in recent years. OWDTO is a technique that leaves the tibial tuberosity attached to the proximal bone fragment, with the advantage of preventing increased contact pressure on the patellofemoral joint, which is a concern in conventional OWHTO[1,2]. Only few studies have evaluated the loss of correction after OWDTO. Therefore, the purpose of this study was to determine whether correction loss occurs within one year after OWDTO and to identify the factors associated with it.

METHODS:
Surgical procedure
OWDTO is performed by making a medial incision over the distal tibia, creating an oblique osteotomy, and gradually opening the wedge to correct the deformity. The osteotomy site is then stabilized using a locking plate **(Figure 1A)**.

Study Design and Patient Selection
This retrospective study included 171 knees of 171 patients who underwent OWDTO for medial-compartment knee OA at our institution between May 2021 and April 2024 and were followed for at least one year. Patients were excluded if they had incomplete radiographic data or follow-up of less than one year. The study cohort consisted of 105 males and 66 females, with a mean age of 55.3 years and an average Body mass index (BMI) of 25.2. All patients provided informed consent, and ethical approval was obtained from the institutional review board (IRB #2306).

Radiographic Evaluation
Standing full-length lower limb radiographs were obtained at one month and one year postoperatively. The following parameters were measured: the percentage of the mechanical axis (%MA), the medial proximal tibial angle (MPTA), and the joint line convergence angle (JLCA) **(Figure 1B)**. The occurrence of hinge fractures was assessed using computed tomography performed within one month after surgery.

Statistical Analysis
The loss of correction in %MA, MPTA, and JLCA was calculated as the difference between the values at one month and one year postoperatively. Multiple linear regression analysis was employed to identify risk factors associated with correction loss, with the presence of hinge fracture, BMI ≥ 30, sex, age ≥ 65 years, and smoking history as independent variables. All statistical analyses were conducted using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan). Paired and unpaired t-tests were also used where appropriate. A p-value of < 0.05 was considered statistically significant.

RESULTS:
A significant difference was observed in the %MA and MPTA between postoperative one month (60.2 ± 8.37%) and postoperative one year (57.1 ± 7.98%) ($p < 0.01$) and between postoperative one month (90.5 ± 1.98°) and postoperative one year (90.0 ± 2.05°) ($p = 0.01$). The postoperative JLCA was decreased from 1.23 ± 1.28° to 1.21 ± 1.32°, but there was no significant difference **(Table 1)**. Multiple regression analysis showed that the occurrence of hinge fractures was a risk factor affecting the change in %MA ($p = 0.03$), while age, sex, BMI, and smoking habit were not significant. No significant risk factors were identified for the change in MPTA **(Table 2)**.

DISCUSSION:
Our results showed that postoperative %MA and MPTA significantly decreased from one month to one year, with mean correction losses of %MA and MPTA was 3.1% and 0.5°, respectively. This study did not perform a formal a priori sample size calculation. However, the post-hoc statistical power for detecting the observed change in %MA (3.1%) with our sample size (n=171) was greater than 99%, indicating that the study was sufficiently powered. Another study reported a correction loss of 0.4° in MPTA after HTO [3]. In the short-term, there was no significant difference in MTPA correction loss between OWDTO and HTO. The JLCA was considered to remain unchanged, as no intra-articular procedures were performed on the knee during OWDTO. Multiple regression analysis revealed that hinge fracture was a risk factor for %MA reduction after OWDTO. Single plating in OWDTO has sufficient resistance against axial compression, but is vulnerable to rotational stress. When a hinge fracture occurs, this weakness becomes more pronounced, and weight-bearing can lead to rotational and translational displacement, resulting in a significant change in %MA. In contrast, MPTA reflects the bony coronal angle itself, and therefore is less affected by such rotation or translation, showing no significant difference. Another study also demonstrated that hinge fracture affected the accuracy of coronal alignment correction in OWHTO [4]. These findings support our results, suggesting that hinge fracture may contribute to correction loss after OWDTO within one year.

SIGNIFICANCE/CLINICAL RELEVANCE:
Although OWDTO is an effective procedure for medial-compartment knee OA, surgeons should be aware of hinge fractures, as they may contribute to correction loss after OWDTO.

REFERENCES:
1. Tanaka A, et al., ***J Exp Orthop***, 2025. 2. Akiyama T, et al., ***Arthrosc Tech***, 2019. 3. Pornrattanamaneewong C, et al., ***J Med Assoc Thai***, 2012. 4. Song JH, et al., ***Arthroscopy***, 2021.

IMAGES AND TABLES:

Table 1. Postoperative one month and one year %MA, MPTA and JLCA score

	postope one month	postope one year	*p* value
%MA	60.2±8.37%	57.1±7.98%	< 0.01
MPTA	90.5±1.98°	90.0±2.05°	0.01
JLCA	1.23±1.28°	1.21±1.32°	0.784

Statistical significance was set at $p < 0.05$.

Table 2. Multiple regression analysis for factors affecting changes in postoperative %MA and MPTA

	age: over 65	sex	BMI: over 30	smoking habits	hinge fracture
%MA	0.49	0.07	0.38	0.47	0.03
MPTA	0.88	0.93	0.72	0.06	0.87

Statistical significance was set at $p < 0.05$.

Figure 1:
A: Postoperative 3D computed tomography of OWDTO. The tibial tuberosity is retained on the proximal fragment via a distal arc cut, preventing increased patellofemoral pressure. Fixation is completed with a locking plate and an anteroposterior screw. **B:** %MA: The ratio from the medial edge of the medial tibial condyle to the point where the mechanical axis intersects the knee joint line of the proximal tibia. **C:** MPTA: The medial angle formed between the mechanical tibial axis and the knee joint line of the proximal tibia. **D:** JLCA: The angle between the tangent through the two most convex distal points of the femoral condyles and a line along the flat portion of the subchondral bone of the tibial plateau.