Differences in Lower Limb Mechanical Axis Between Supine and Standing Positions Before and After Medial Closed-Wedge Distal Femoral Osteotomy

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INTRODUCTION: In open-wedge high tibial osteotomy (OWHTO), it has been reported that varus alignment tends to increase in the standing position compared with the supine position before surgery, whereas the difference in the % mechanical axis (%MA) between the two positions disappears after surgery.[1] On the other hand, it has been reported that %MA tends to shift laterally in the standing position compared with the supine position before and after medial closed wedge distal femoral osteotomy (MCWDFO).[2] Knowledge of the difference in %MA between the standing and supine positions before and after surgery is important to improve postoperative alignment accuracy. However, it remains unclear in which cases the postoperative %MA tends to shift laterally in the standing position. Thus, the purpose of this study was to investigate Δ%MA (Δ = standing position – supine position) before and after MCWDFO and to detect factors associated with large postoperative Δ%MA. It was hypothesized that Δ%MA would be smaller after surgery compared to before surgery, and that a large Δ%MA before surgery would tend to remain large after surgery.
METHODS: Patients who underwent MCWDFO for valgus knee at our hospital between June 2018 and May 2025 were examined. The exclusion criteria were as follows: patients with concomitant medial closed-wedge high tibial osteotomy or joint reconstruction; preoperative %MA < 50; multi-ligamentous knee injury; valgus deformity after ankle fracture; poor limb positioning on preoperative radiograph; revision surgery due to postoperative fracture and a case with preoperative Δ joint line convergency angle (JLCA) > 3°. Initially, 43 patients (47 knees) were identified and after applying criteria, 31 patients (34 knees) (18 males/16 females; mean age: 48.4 years) were included. It has been reported that the %MA changes by approximately 4% for each 1° of correction angle in MCWDFO.[2] In surgical procedure, a deviation within ±1° (±4%) is considered acceptable. Therefore, the acceptable range was defined as ±4% (equivalent to approximately 1°), and cases with postoperative Δ%MA within this range were classified as Group I (22 knees), and cases outside this range were classified as Group O (12 knees). Parameters such as %MA, Hip knee ankle (HKA) angle, JLCA, mechanical lateral distal femoral angle (mLDFA) and mechanical medial proximal tibial angle (mMPTA) were measured on preoperative and postoperative radiographs in both supine and standing positions. For comparison between the two groups, a t-test was performed. A regression analysis was conducted to identify factors associated with the postoperative Δ%MA. A receiver operating characteristic (ROC) analysis was performed to determine the cutoff value of preoperative Δ%MA. Statistical significance was set at $p < 0.05$.
RESULTS: There was a significant difference in Δ%MA (Pre-op: 5.1%, Post-op: 2.9%) before and after surgery (Table 1). When divided into two groups, 35% of cases were in Group O (Figure 1). No significant differences in patient characteristics were observed between Group I and Group O. Significant differences were observed in preoperative Δ%MA (Group I: 2.5%, Group O: 9.8%), preoperative ΔJLCA (Group I: –0.3°, Group O: –1.1°), postoperative Δ%MA (Group I: –0.5%, Group O: 8.9%) and postoperative ΔJLCA (Group I: 0.1°, Group O: –1.0°) (Table2A,2B). Δ%MA demonstrated a significant change from preoperative to postoperative in Group I (Pre-op: 2.5%, Post-op: −0.5%, $p < 0.01$), while no significant change was detected in Group O (Pre-op: 9.8%, Post-op: 8.9%, $p = 0.42$). Simple linear regression analysis demonstrated that postoperative Δ%MA was significantly correlated with preoperative Δ%MA ($\beta = 0.72$, $R^2 = 0.53$, $p < 0.0001$) and preoperative ΔJLCA ($\beta = -4.17$, $R^2 = 0.32$, $p < 0.001$). ROC analysis indicated that preoperative Δ%MA ≧ 7% predicted postoperative Δ%MA outside the acceptable range (±4%) with area under the curve (AUC) of 0.87, sensitivity of 0.77, and specificity of 0.83.
DISCUSSION: Group O had significantly larger Δ%MA than Group I both preoperatively and postoperatively, and preoperative Δ%MA was strongly correlated with postoperative Δ%MA. Compared with OWHTO, MCWDFO showed smaller changes in soft tissue balance before and after surgery. Especially in cases with large preoperative Δ%MA, preoperative soft tissue imbalances may persist postoperatively. ROC analysis suggested that in cases where preoperative Δ%MA exceeded 7%, postoperative Δ%MA was likely to deviate from the clinically acceptable ±4% range. This finding emphasizes the importance of assessing Δ%MA in preoperative planning for MCWDFO.
SIGNIFICANCE/CLINICAL RELEVANCE: The difference in preoperative %MA between standing and supine positions was the most relevant predictor of the difference in postoperative %MA between two positions in MCWDFO. Surgeons should be aware that greater difference in preoperative %MA between two positions may indicate residual soft tissue effects that could reduce postoperative alignment accuracy.
REFERENCES: 1. Nagata N, et al. ***J Orthop Surg Res.*** 2025 Mar 28;20(1):321. 2. Shimozono R, et al.***The Japanese Knee Society*** 2025.
IMAGES AND TABLES:

Table 1. Parameters on radiographs

	Pre-op	Post-op	P value
%MA (supine)	59.6±12.0	38.1±9.3	<0.0001
%MA (standing)	64.7±11.3	40.9±9.2	<0.0001
Δ%MA (standing-supine)	5.1±5.5	2.9±5.4	<0.01
JLCA (supine)	-0.9±1.8	-1.0±1.9	0.32
JLCA (standing)	-1.5±1.9	-1.3±1.8	<0.05
ΔJLCA (standing-supine)	-0.6±0.7	-0.3±0.7	<0.001
HKA angle (supine)	3.0±2.8	-2.1±2.0	<0.0001
HKA angle (standing)	4.2±2.7	-1.4±2.1	<0.0001
ΔHKA (standing-supine)	1.2±1.3	0.7±1.2	<0.001
mLDFA	84.5±1.8	90.2±2.4	<0.0001
mMPTA	87.8±1.4	87.8±1.3	0.41

Figure 1. Histogram of postoperative Δ%MA

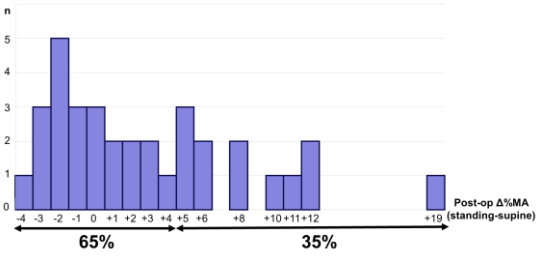

Table 2. Comparison of parameters on radiographs between two groups

A) Preoperative parameters

	Group I (within ±4%)	Group O (outside ±4%)	P value
%MA (supine)	60.3±11.4	58.4±13.5	0.67
%MA (standing)	62.8±10.6	68.2±12.1	0.19
Δ%MA (standing-supine)	2.5±4.2	9.8±4.5	<0.0001
JLCA (supine)	-1.1±2.0	-0.4±1.2	0.29
JLCA (standing)	-1.5±2.1	-1.6±1.3	0.85
ΔJLCA (standing-supine)	-0.3±0.7	-1.1±0.5	<0.001
HKA angle (supine)	3.1±2.8	2.9±3.1	0.88
HKA angle (standing)	3.7±2.6	5.1±2.8	0.17
ΔHKA (standing-supine)	0.8±1.0	2.2±1.5	<0.001
mLDFA	84.1±1.7	84.1±2.0	0.31
mMPTA	87.7±1.1	87.9±2.0	0.73

B) Postoperative parameters

	Group I (within ±4%)	Group O (outside ±4%)	P value
%MA (supine)	40.0±7.5	34.6±11.6	0.11
%MA (standing)	39.5±8.1	43.5±10.9	0.24
Δ%MA (standing-supine)	-0.5±2.2	8.9±4.2	<0.0001
JLCA (supine)	-1.2±2.3	-0.6±1.1	0.35
JLCA (standing)	-1.1±2.2	-1.6±1.0	0.51
ΔJLCA (standing-supine)	0.1±0.5	-1.0±0.5	<0.0001
HKA angle (supine)	-1.9±1.7	-2.6±2.6	0.32
HKA angle (standing)	-1.8±1.8	-0.8±2.5	0.19
ΔHKA (standing-supine)	0.0±0.6	1.8±1.3	<0.0001
mLDFA	90.5±2.3	89.8±2.5	0.46
mMPTA	87.8±1.0	87.8±1.8	0.93