Gender Differences in Early Recovery After Minimally Invasive Distal Transverse Metatarsal Osteotomy - Akin Osteotomy (MITA) for Hallux Valgus: A Propensity-Matched Study of 300 Cases

Taebyeong Kang
SNU Seoul Hospital
Jeong Hwan Lee
SNU Seoul Hospital
Dongoh Lee
SNU Seoul Hospital
Kyung Jin Choi
Dr. Choi's Orthopedic clinic
Sang Gyo Seo
sanggyoseo@naver.com
SNU Seoul Hospital

Research Article

Keywords: hallux valgus, minimally invasive surgery, distal transverse osteotomy, sex differences

Posted Date: April 7th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9201426/v1

Additional Declarations: No competing interests reported.

Abstract

Background

Evidence regarding sex-based differences in outcomes after minimally invasive distal transverse metatarsal osteotomy - Akin osteotomy (MITA) for hallux valgus remains limited. This study compared clinical and radiographic outcomes and complication rates between male and female feet using a propensity score–matched cohort.

Methods

This retrospective study included 300 feet (150 male and 150 female) that underwent MITA. Male and female feet were matched using propensity scores based on age, preoperative hallux valgus angle (HVA), and preoperative intermetatarsal angle (IMA). Clinical outcomes were assessed using the visual analogue scale (VAS), American Orthopaedic Foot and Ankle Society (AOFAS) score, and Manchester–Oxford Foot Questionnaire (MOXFQ). Radiographic outcomes included HVA, IMA, and bony foot width. Assessments were performed preoperatively, at 3 months postoperatively, and at 1 year.

Results

After propensity matching, baseline age (53.6 vs 53.8 years), HVA (31.2° vs 31.1°), and IMA (14.2° vs 14.2°) were comparable between groups. Preoperatively, male feet showed worse clinical status, with lower AOFAS scores (66.6 ± 13.5 vs 69.7 ± 10.7; $p = 0.03$), despite similar radiographic deformity. At 3 months postoperatively, male feet showed better early clinical outcomes, including lower VAS pain scores (0.2 ± 0.4 vs 0.5 ± 0.8; $p < 0.001$), higher AOFAS scores (91.2 ± 2.0 vs 90.3 ± 3.0; $p = 0.002$), and lower MOXFQ pain scores (12.0 ± 6.0 vs 16.0 ± 10.1; $p < 0.001$). At 1 year, clinical outcomes were comparable between groups. Radiographic correction of HVA and IMA was similar between groups at both 3 months and 1 year. Complication rates were low and comparable between groups.

Conclusions

Male feet undergoing MITA present with worse baseline functional impairment but show greater early postoperative improvement, with clinical and radiographic outcomes comparable to those of female feet at 1 year. These findings suggest that sex influences early recovery trajectory but not 1-year effectiveness of MITA.

Trial registration

not applicable

Background

Hallux valgus is a common forefoot deformity characterized by lateral deviation of the hallux and medial deviation of the first metatarsal, often leading to pain, functional impairment, and difficulty with footwear. Epidemiologic studies have consistently demonstrated a higher prevalence of hallux valgus in women compared with men, with reported female-to-male ratios ranging from 2:1 to 4:1 depending on the population and diagnostic criteria used. Large population-based data further suggest that female sex is independently associated not only with higher prevalence but also with greater radiographic severity of deformity (1).

Despite this clear sex disparity in prevalence, the majority of surgical outcome studies for hallux valgus have focused predominantly on female patients, resulting in limited evidence regarding potential sex-based differences in clinical presentation, radiographic correction, and postoperative outcomes. Previous investigations assessing the effect of sex on hallux valgus surgery have reported inconsistent findings. Some studies have suggested inferior clinical outcomes or higher complication rates in male patients, whereas others have found no clinically meaningful differences after adjustment for baseline deformity severity and patient characteristics (2) (3).

Over the past three decades, minimally invasive surgery (MIS) for hallux valgus has evolved substantially, beginning with early percutaneous distal metatarsal osteotomies and progressing through successive generations with improved fixation and biomechanical stability (4). Contemporary third- and fourth-generation MIS techniques have demonstrated reliable deformity correction, early weight-bearing, and favorable patient-reported outcomes comparable to those of traditional open procedures (5) (6). Nevertheless, variability in surgical technique, fixation methods, and reporting standards persists across the MIS literature, and sex-specific outcome analyses have not been well characterized.

Minimally invasive distal transverse metatarsal osteotomy - Akin osteotomy (MITA) represents a fourth-generation MIS technique that emphasizes multiplanar correction through a distal transverse osteotomy stabilized with rigid screw fixation. Previous studies have demonstrated that MITA provides effective correction of hallux valgus deformity with satisfactory clinical outcomes and an acceptable complication profile, even in moderate to severe deformities (7). However, these reports primarily evaluated overall outcomes and did not specifically address whether patient sex influences postoperative results following MITA.

Given known differences in foot morphology, ligamentous laxity, and first-ray biomechanics between male and female patients(8), it remains unclear whether findings from conventional hallux valgus surgery can be directly extrapolated to minimally invasive techniques. Moreover, male patients are markedly underrepresented in most published MIS series, limiting the ability to adequately evaluate potential sex-based differences following minimally invasive hallux valgus correction. Consequently, sex-specific outcomes after MITA have not been sufficiently investigated.

Therefore, this study aimed to compare clinical outcomes, radiographic correction, and complication profiles between male and female feet following MITA using a propensity score–matched, foot-based cohort, with particular attention to changes over predefined postoperative time points. We hypothesized that when baseline deformity severity is adequately matched, postoperative outcomes after MITA would not differ significantly between male and female patients.

Methods

This retrospective cohort study included consecutive feet that underwent minimally invasive distal transverse metatarsal osteotomy - Akin osteotomy (MITA) for hallux valgus between March 23, 2020, and October 18, 2024. During the study period, a total of 2,710 feet underwent MITA, including 318 male and 2,392 female feet. For outcome analysis, feet with a minimum follow-up duration of at least 1 year were eligible. A total of 1,415 feet met this criterion, comprising 150 male and 1,265 female feet. Because of the marked imbalance in sex distribution, a matched cohort was created for comparative analysis. From the 1,265 eligible female feet, 150 female feet were selected to match the 150 male feet, resulting in a final study cohort of 300 feet. Propensity score matching was performed using a nearest-neighbor approach without replacement. Matching variables included preoperative hallux valgus angle, preoperative intermetatarsal angle, and age, with primary emphasis placed on radiographic parameters(Fig. 1).

All procedures were performed under C-arm fluoroscopic guidance using a minimally invasive distal transverse metatarsal osteotomy - Akin osteotomy (MITA), as previously described (9). Through a small medial stab incision, a distal transverse osteotomy of the neck of the first metatarsal was created using a Shannon burr after subperiosteal

dissection. The distal fragment was translated laterally and rotationally corrected under fluoroscopic control, followed by percutaneous fixation with two 3.5-mm cannulated screws. Resection of the medial eminence was then performed using a powered rasp system, and an Akin osteotomy of the proximal phalanx was subsequently performed through a separate medial stab incision and fixed with a single 3.0-mm screw to optimize hallux alignment.

Postoperatively, immediate weight-bearing as tolerated was permitted for all operated feet using a postoperative shoe with a rigid outsole for four weeks. After wound healing, typically at approximately two weeks postoperatively, a corrective soft orthosis was applied and maintained until six weeks after surgery, and routine implant removal was performed at approximately three months postoperatively. The same surgical technique and postoperative management protocol were applied to all cases regardless of sex.

Radiographic evaluations were performed preoperatively, at three months postoperatively, and at final follow-up of approximately one year(Fig. 2). Radiographic parameters included the hallux valgus angle and intermetatarsal angle measured on standardized weight-bearing anteroposterior foot radiographs. Bony foot width was defined as the linear distance from the medial cortex of the first metatarsal to the lateral cortex of the fifth metatarsal on weight-bearing anteroposterior radiographs and was measured in millimeters(Fig. 3).

Clinical outcomes were assessed using the visual analogue scale for pain(10), the American Orthopaedic Foot and Ankle Society hallux metatarsophalangeal–interphalangeal score(11), and the Manchester–Oxford Foot Questionnaire, including the pain, walking, and social interaction subscales(12). Clinical and radiographic assessments were performed at the same postoperative time points.

Underlying diseases, including hypertension, diabetes mellitus, dyslipidemia, and rheumatoid arthritis, were recorded. Postoperative complications were documented and analyzed on a foot-based basis, with each operated foot considered an independent observational unit. Underlying diseases were assessed on a patient-based basis and were therefore identical for bilateral feet in patients who underwent surgery on both sides.

Postoperative complications were identified through chart review and graded using a Clavien–Dindo–based framework adapted for orthopaedic and foot-and-ankle surgery. Complications were categorized into three grades according to the level of treatment required: Grade 1 events did not result in any deviation from routine postoperative follow-up, Grade 2 events required additional treatment but did not require further surgical intervention or unplanned hospital admission, and Grade 3 events required surgical intervention and/or unplanned hospital admission (13) (14) (15). To ensure transparent reporting and comparability, complication definitions and event lists were organized with reference to prior orthopaedic reliability work and the foot-and-ankle–specific reporting recommendations, and were harmonized with those used in our prior large-cohort MITA report(7).

Continuous variables were expressed as means with standard deviations and categorical variables as frequencies and percentages. Between-group comparisons were performed using the independent-samples t-test or the chi-square test (or Fisher’s exact test, as appropriate). Propensity score matching was performed using a nearest-neighbor algorithm without replacement based on preoperative hallux valgus angle, intermetatarsal angle, and age. All analyses were conducted using R software (R Foundation for Statistical Computing, Vienna, Austria), with statistical significance set at $p < 0.05$.

Results

A total of 300 feet (150 male and 150 female) were included in the final analysis. Baseline demographic characteristics and preoperative clinical and radiographic parameters are summarized in Table 1. There were no significant differences between male and female groups in age (53.6 ± 17.3 vs. 53.8 ± 14.6 years, $p = 0.937$) or follow-up duration (16.7 ± 7.8 vs.

17.6 ± 8.8 months, p = 0.322). Male patients were significantly taller and heavier and had a higher body mass index than female patients (all p < 0.001).

Table 1
Baseline demographic, clinical, and radiographic characteristics of the matched cohort.

Variable	Male (n = 150)	Female (n = 150)	p-value
Age (years)	53.6 ± 17.3	53.8 ± 14.6	0.937
Height (cm)	171.1 ± 6.3	157.7 ± 5.4	< 0.001
Weight (kg)	72.8 ± 10.0	56.9 ± 7.9	< 0.001
BMI (kg/m²)	24.8 ± 2.7	22.9 ± 3.0	< 0.001
Follow-up (months)	16.7 ± 7.8	17.6 ± 8.8	0.322
Pre_OP HVA (°)	31.2 ± 8.2	31.1 ± 8.6	0.905
Pre_OP IMA (°)	14.2 ± 2.7	14.2 ± 3.1	0.904
Pre_OP Bony foot width	108.3 ± 6.0	97.7 ± 6.0	< 0.001
Pre_OP VAS	3.2 ± 1.1	3.1 ± 1.0	0.366
Pre_OP AOFAS	66.6 ± 13.5	69.7 ± 10.7	0.03
Pre_OP MOXFQ pain	47.5 ± 14.0	45.1 ± 11.9	0.114
Pre_OP MOXFQ walking	40.0 ± 11.4	37.2 ± 9.4	0.021
Pre_OP MOXFQ social	45.7 ± 15.9	40.8 ± 14.8	0.006
HTN, n (%)	44 (29.3%)	22 (14.7%)	0.002
DM, n (%)	12 (8.0%)	5 (3.3%)	0.08
Dyslipidemia, n (%)	36 (24.0%)	33 (22.0%)	0.681
RA, n (%)	0 (0.0%)	3 (2.0%)	0.247
Site: Right, n (%)	74 (49.3%)	75 (50.0%)	0.908

Preoperatively, hallux valgus angle (HVA) and intermetatarsal angle (IMA) were comparable between the two groups. Baseline clinical outcomes differed by sex, with male patients showing lower AOFAS scores and higher MOXFQ walking and social subscores than female patients. Preoperative bony foot width was greater in male patients than in female patients (108.3 ± 6.0 vs. 97.7 ± 6.0 mm, p < 0.001).

Radiographic outcomes over time are presented in Table 2. Both male and female groups showed significant correction of HVA and IMA after surgery, which was maintained throughout the follow-up period. At 3 months postoperatively, mean HVA improved to 1.1 ± 6.8° in males and 1.5 ± 6.4° in females (p = 0.606). At 1 year postoperatively, HVA remained stable in both groups (2.3 ± 6.6° vs. 1.8 ± 6.2°, p = 0.495). Similar patterns were observed for IMA, with no significant differences between groups at any postoperative time point. Bony foot width decreased significantly after surgery in both groups; however, male patients consistently exhibited a larger absolute bony foot width than female patients at all postoperative time points (all p < 0.001).

Table 2
Radiographic outcomes at 3 months and 1 year postoperatively according to sex.

Outcome	Male Post_OP_3mo	Female Post_OP_3mo	p (Post_OP_3mo)	Male Post_OP_1yr	Female Post_OP_1yr	p (Post_OP_1 year)
HVA (°)	1.1 ± 6.8	1.5 ± 6.4	0.606	2.3 ± 6.6	1.8 ± 6.2	0.495
IMA (°)	4.3 ± 2.3	4.7 ± 2.2	0.156	4.8 ± 2.7	4.7 ± 2.4	0.878
Bony foot width	97.5 ± 5.5	88.2 ± 5.0	< 0.001	96.8 ± 5.9	87.4 ± 5.1	< 0.001

Clinical outcomes are summarized in Table 3. Despite worse baseline clinical scores, male patients showed significant postoperative improvement. At 3 months postoperatively, male patients had significantly lower VAS scores and higher AOFAS scores than female patients. MOXFQ pain and walking subscores were also significantly lower in male patients at this time point. By 1 year postoperatively, these differences were no longer observed. At final follow-up, VAS, AOFAS, and all MOXFQ subscores were comparable between male and female groups (all $p > 0.05$). Temporal changes in VAS, AOFAS, MOXFQ pain, walking, and social subscores are illustrated in Fig. 4 (A–E).

Table 3
Clinical outcome scores at 3 months and 1 year postoperatively according to sex.

Outcome	Male Post_OP_3mo	Female Post_OP_3mo	p (Post_OP_3mo)	Male Post_OP_1yr	Female Post_OP_1yr	p (Post_OP_1 year)
VAS	0.2 ± 0.4	0.5 ± 0.8	< 0.001	0.1 ± 0.4	0.2 ± 0.5	0.193
AOFAS	91.2 ± 2.0	90.3 ± 3.0	0.002	93.9 ± 4.1	93.6 ± 4.4	0.532
MOXFQ pain	12.0 ± 6.0	16.0 ± 10.1	< 0.001	11.2 ± 5.6	12.3 ± 6.9	0.129
MOXFQ walking	9.4 ± 4.6	11.2 ± 7.1	0.009	7.3 ± 3.6	7.9 ± 4.6	0.221
MOXFQ social	10.3 ± 6.8	11.8 ± 8.0	0.092	8.3 ± 4.9	8.9 ± 5.6	0.359

Changes in radiographic and clinical outcomes from baseline are summarized in Table 4. Male patients showed greater improvement in several clinical outcome measures from baseline to 3 months postoperatively. However, the magnitude of improvement from baseline to final follow-up did not differ significantly between male and female patients for any radiographic or clinical outcome measure. Although absolute bony foot width differed significantly between sexes, the degree of postoperative reduction in bony foot width was comparable between groups.

Table 4
Changes from baseline in radiographic and clinical outcomes according to sex.

Outcome	Male ΔPre→3mo	Female ΔPre→3mo	p (Δ3mo)	Male ΔPre→1yr	Female ΔPre→1yr	p (Δ1 year)
HVA (°)	-30.1 ± 8.8	-29.6 ± 9.0	0.621	-28.9 ± 8.8	-29.3 ± 8.6	0.7
IMA (°)	-9.9 ± 3.0	-9.5 ± 3.3	0.257	-9.5 ± 3.3	-9.5 ± 3.4	0.99
Bony foot width	-10.8 ± 4.1	-9.5 ± 3.8	0.003	-11.5 ± 4.8	-10.3 ± 4.3	0.027
VAS	-3.0 ± 1.1	-2.6 ± 1.3	0.002	-3.0 ± 1.2	-2.8 ± 1.1	0.17
AOFAS	24.5 ± 13.5	20.6 ± 10.4	0.004	27.2 ± 12.1	23.9 ± 9.2	0.007
MOXFQ pain	-35.6 ± 14.9	-29.1 ± 15.5	< 0.001	-36.3 ± 15.0	-32.8 ± 13.3	0.034
MOXFQ walking	-30.6 ± 12.1	-26.0 ± 11.2	< 0.001	-32.7 ± 11.7	-29.4 ± 9.9	0.007
MOXFQ social	-35.4 ± 16.9	-29.1 ± 14.9	< 0.001	-37.4 ± 16.4	-31.9 ± 15.0	0.003

Postoperative complications are summarized in Table 5. Overall complication profiles were comparable between male and female groups. Grade 1 complications occurred in 4.7% of male feet and 8.7% of female feet (p = 0.165), with transient neurapraxia being the most common event in both groups. Other Grade 1 complications, including delayed wound healing and superficial cellulitis, were rare. Grade 2 complications were observed in 8.0% of male feet and 5.3% of female feet (p = 0.355). The most frequent Grade 2 events included transfer metatarsalgia in male patients and symptomatic delayed union in female patients, although the incidence of individual complications did not differ significantly between groups. Grade 3 complications occurred in 15.3% of male feet and 10.0% of female feet (p = 0.165). Common Grade 3 complications included prominent bone, hallux varus, and postoperative stiffness. No cases of deep infection requiring surgery or conversion to open surgery were observed in either group. Overall, no significant differences in complication rates or severity were identified between male and female patients.

Table 5
Postoperative complications stratified by Clavien–Dindo grade according to sex(13) (14) (15).

Complication	Male (n = 150)	Female (n = 150)	p-value
Any Grade 1 complication	7 (4.7%)	13 (8.7%)	0.1650
Delayed wound healing	1 (0.7%)	2 (1.3%)	1.0000
Superficial cellulitis	1 (0.7%)	0 (0.0%)	1.0000
Transient neurapraxia	6 (4.0%)	11 (7.3%)	0.2120
FHL tendon injury	0 (0.0%)	0 (0.0%)	1.0000
Any Grade 2 complication	12 (8.0%)	8 (5.3%)	0.3550
Additional intraoperative fixation	0 (0.0%)	1 (0.7%)	1.0000
Symptomatic delayed union	2 (1.3%)	6 (4.0%)	0.2820
Symptomatic displacement	0 (0.0%)	0 (0.0%)	1.0000
Transfer metatarsalgia	6 (4.0%)	2 (1.3%)	0.2820
Conversion to open surgery	0 (0.0%)	0 (0.0%)	1.0000
Symptomatic recurrence	4 (2.7%)	1 (0.7%)	0.3710
Any Grade 3 complication	23 (15.3%)	15 (10.0%)	0.1650
Screw failure (fracture/cutout/prominent)	2 (1.3%)	1 (0.7%)	1.0000
Scar revision	1 (0.7%)	1 (0.7%)	1.0000
Prominent bone	12 (8.0%)	6 (4.0%)	0.1450
Deep infection requiring surgery	0 (0.0%)	0 (0.0%)	1.0000
Hallux varus	5 (3.3%)	5 (3.3%)	1.0000
1st MTP osteoarthritis	1 (0.7%)	1 (0.7%)	1.0000
Stiffness	5 (3.3%)	4 (2.7%)	1.0000

Discussion

Male patients undergoing minimally invasive distal transverse metatarsal osteotomy -Akin osteotomy (MITA) for hallux valgus presented with worse baseline clinical function than female patients and showed greater early postoperative improvement at 3 months. By 1 year, however, clinical and radiographic outcomes were comparable in male and female patients. These findings suggest that sex-related differences are most evident in the early recovery phase, whereas the 1-year effectiveness and durability of MITA appear similar between sexes.

Hallux valgus is more prevalent in women in population-based studies, while most surgical outcome series have been derived largely from female cohorts, which limits understanding of sex-related differences in presentation and recovery(16). In our matched cohort, male patients reported worse baseline function, with lower AOFAS scores and higher MOXFQ walking and social subscores. As the MOXFQ is a validated and responsive patient-reported outcome measure for foot and ankle surgery, these differences likely reflect a clinically meaningful functional burden rather than measurement variability (17). The AOFAS hallux MTP-IP scale has also demonstrated acceptable reliability and validity in operatively treated hallux valgus populations, supporting its use for between-group comparisons (18).

As expected given propensity score matching on preoperative HVA and IMA, radiographic severity did not differ between sexes at baseline. With radiographic severity balanced by matching, the clinically meaningful observation is that male patients still reported worse baseline function despite comparable structural deformity, suggesting that sex-related differences in presentation may be influenced by factors beyond radiographic severity alone, such as symptom perception and reporting, activity-related burden, or treatment-seeking behavior. Prior sex-comparative studies have reported a similar pattern in which overall clinical outcomes are broadly comparable between sexes, whereas radiographic correction may show small sex-related differences in some series(8). A propensity score–matched study likewise reported similar mid-term outcomes between sexes, while suggesting that male patients were less likely to have their preoperative expectations met, underscoring the importance of counseling and baseline perception(2).

Despite worse baseline function, male patients demonstrated greater clinical improvement at 3 months, with greater early pain relief and functional gains than female patients. Although the present study cannot determine the underlying mechanisms, this pattern may reflect baseline functional differences and sex-related variation in postoperative activity modification or symptom reporting. These early differences should be interpreted as a difference in recovery trajectory rather than evidence of superior long-term results. The minimally invasive nature of MITA may also contribute to faster early recovery, consistent with prior comparative studies and meta-analytic evidence showing meaningful early improvements after minimally invasive hallux valgus correction (19) (20).

By 1 year postoperatively, clinical outcomes between male and female patients converged. No significant differences were observed in VAS, AOFAS, or any MOXFQ subscores at final follow-up. Radiographic correction of HVA and IMA was similarly maintained in both groups, indicating that sex did not modify the durability of angular correction over the first postoperative year. This aligns with previous literature in open techniques showing broadly comparable clinical outcomes between sexes, and with matched-cohort evidence suggesting similar overall outcome attainment(8). From a procedural perspective, our findings are also consistent with large-cohort MITA data showing reliable improvement in radiographic parameters and foot width measures through 1 year, supporting MITA as an effective and reproducible method of deformity correction(7).

Male patients demonstrated greater absolute bony foot width at all evaluated time points, consistent with known sexual dimorphism in skeletal morphology (21). However, the magnitude of postoperative reduction in bony foot width was comparable between sexes, suggesting that the transverse-plane corrective effect of MITA on forefoot morphology is consistent across different baseline skeletal dimensions. Importantly, larger absolute bony foot width in male patients did not translate into inferior clinical or radiographic outcomes, indicating that skeletal size alone should not be considered a limiting factor for successful correction with MITA.

Overall complication rates were low and did not differ significantly between male and female patients. These findings parallel existing large-cohort MITA reports describing a defined complication profile with generally favorable safety through 1 year(7). The absence of sex-related differences in complications also suggests that the observed early recovery differences are unlikely to be explained by sex-specific adverse event patterns.

Clinically, the pattern of worse baseline function, greater early improvement, and equivalent long-term outcomes has practical implications for counseling. Male patients may present with more pronounced preoperative functional limitation yet can expect substantial early symptomatic and functional improvement after MITA, whereas female patients may experience a more gradual early recovery while achieving comparable outcomes by 1 year. Such framing may help set realistic expectations and improve satisfaction, particularly in light of prior work suggesting potential sex differences in expectation fulfillment despite similar objective outcomes(2).

This study has several limitations. First, its retrospective design introduces the potential for selection bias, although balanced cohorts were constructed to mitigate baseline imbalances between male and female feet. Second, outcomes

were analyzed on a per-foot basis; therefore, bilateral cases may introduce within-patient correlation that is not fully accounted for in foot-level analyses. Third, follow-up was limited to 1 year, precluding evaluation of longer-term outcomes such as recurrence, progressive degenerative changes, or late hardware-related symptoms. Finally, although all included feet underwent minimally invasive distal transverse metatarsal osteotomy – Akin osteotomy (MITA) as the primary corrective procedure, some cases required additional concomitant forefoot procedures to address associated pathologies. These adjunctive interventions were not analyzed separately and may have influenced preoperative and postoperative clinical outcome measures, limiting the ability to isolate the effect of MITA alone.

Conclusions

Male patients undergoing MITA for hallux valgus present with worse baseline functional impairment than female patients. However, they experience greater early postoperative improvement and achieve clinical and radiographic outcomes comparable to those of female patients at 1 year postoperatively. These findings indicate that sex influences the early postoperative recovery trajectory but does not appear to affect long-term outcomes. MITA can be considered a reliable surgical option for hallux valgus correction irrespective of patient sex.

Abbreviations

MITA
minimally invasive distal transverse metatarsal osteotomy–Akin osteotomy
HVA
hallux valgus angle
IMA
intermetatarsal angle
VAS
visual analog scale
AOFAS
American Orthopaedic Foot & Ankle Society
MOXFQ
Manchester–Oxford Foot Questionnaire

Declarations

Ethics approval and consent to participate

This retrospective study was reviewed by the Public Institutional Bioethics Committee designated by the Ministry of Health and Welfare, Republic of Korea, and confirmed to be exempt from ethics review by the Korea National Institute for Bioethics Policy (KoNIBP) (Exemption No. P01-202602-01-046). Because this study was based on anonymized data, informed consent to participate was deemed unnecessary by the committee. The study was conducted in accordance with the Declaration of Helsinki and relevant guidelines and regulations.

Consent for publication

Not applicable.

Competing Interests

The authors declare that they have no competing interests.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Author Contribution

S.G.S. proposed the research topic, designed the study protocol, and supervised the overall conduct of the study as the corresponding author. T.B.K. was responsible for data organization and analysis, performed radiographic angle measurements, conducted the statistical analyses, reviewed the relevant literature, and drafted the manuscript, including preparation of all figures and tables. J.H.L. collected the clinical data, performed the anonymization process, and provided de-identified information to the study investigator; he also contributed to study design and IRB-related procedures. D.O.L. performed the surgical procedures for the patients included in this study and contributed to clinical interpretation, appraisal, and discussion of the study findings. K.J.C. provided general clinical input and participated in manuscript discussions. All authors reviewed and approved the final manuscript.

Acknowledgements

Not applicable.

Data Availability

The datasets generated and analyzed during this study are not publicly available due to institutional policy and privacy considerations, but are available from the corresponding author on reasonable request.

References

1. Matsumoto T, Higuchi J, Maenohara Y, Chang SH, Iidaka T, Horii C, et al. The discrepancy between radiographically-assessed and self-recognized hallux valgus in a large population-based cohort. BMC Musculoskelet Disord. 2022;23(1):31.
2. Lim WSR, Liow MHL, Rikhraj IS, Goh GS, Koo K. The effect of gender in hallux valgus surgery. A propensity score matched study. Foot Ankle Surg. 2019;25(5):670-3.
3. Partio N, Maenpaa H, Huttunen T, Haapasalo H, Laine HJ, Mattila VM. Incidence of hallux valgus primary surgical treatment. Finnish nationwide data from 1997 to 2014. Foot Ankle Surg. 2019;25(6):761-5.
4. Isham SA. The Reverdin–Isham procedure for the correction of hallux abducto valgus. A distal metatarsal osteotomy procedure. Clin Podiatr Med Surg. 1991;8(1):81–94.
5. Redfern D, Vernois J. Minimally invasive chevron akin (MICA) for correction of hallux valgus. Techniques in Foot & Ankle Surgery. 2016;15:3–11.
6. Lewis TL, Lau B, Alkhalfan Y, Trowbridge S, Gordon D, Vernois J, et al. Fourth-Generation Minimally Invasive Hallux Valgus Surgery With Metaphyseal Extra-Articular Transverse and Akin Osteotomy (META): 12 Month Clinical and Radiologic Results. Foot Ankle Int. 2023;44(3):178 – 91.
7. Lee JH, Kang T, Yoo TW, Lee D, Seo SG. Outcomes and Complications for Minimally Invasive Distal Transverse Metatarsal Osteotomy-Akin Osteotomy (MITA) for Hallux Valgus: 493 Cases. J Orthop Surg Res. 2025;20(1):980.

8. Choi GW, Kim HJ, Kim TW, Lee JW, Park SB, Kim JK. Sex-related differences in outcomes after hallux valgus surgery. Yonsei Med J. 2015;56(2):466 – 73.
9. Kang T, Lee D, Yoo TW, Seo SG. Minimally Invasive Distal Transverse Metatarsal Osteotomy – Akin Osteotomy (MITA) for Recurrent Hallux Valgus: A Report of Four Cases. Journal of Korean Foot and Ankle Society. 2024;28(3):114-8.
10. Huskisson EC. Measurement of pain. Lancet. 1974;2(7889):1127-31.
11. Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot Ankle Int. 1994;15(7):349 – 53.
12. Dawson J, Coffey J, Doll H, Lavis G, Cooke P, Herron M, et al. A patient-based questionnaire to assess outcomes of foot surgery: validation in the context of surgery for hallux valgus. Qual Life Res. 2006;15(7):1211-22.
13. Sink EL, Leunig M, Zaltz I, Gilbert JC, Clohisy J, Academic Network for Conservational Hip Outcomes Research G. Reliability of a complication classification system for orthopaedic surgery. Clin Orthop Relat Res. 2012;470(8):2220-6.
14. Dodwell ER, Pathy R, Widmann RF, Green DW, Scher DM, Blanco JS, et al. Reliability of the Modified Clavien-Dindo-Sink Complication Classification System in Pediatric Orthopaedic Surgery. JB JS Open Access. 2018;3(4):e0020.
15. Lewis TL, Mason L, Gordon D, Ray R. The Clavien-Dindo complication classification modified for foot and ankle orthopaedic surgery. Foot Ankle Surg. 2022;28(6):800-2.
16. Nguyen US, Hillstrom HJ, Li W, Dufour AB, Kiel DP, Procter-Gray E, et al. Factors associated with hallux valgus in a population-based study of older women and men: the MOBILIZE Boston Study. Osteoarthritis Cartilage. 2010;18(1):41 – 6.
17. Morley DJ, C.; Doll, H.; Lavis, G.; Sharp, R.; Cooke, P.; Dawson, J. The Manchester–Oxford Foot Questionnaire (MOXFQ): Development and validation of a summary index score Bone & Joint Research. 2013;2(4):66–9.
18. Tan CC, Sayampanathan AA, Kwan YH, Yeo W, Singh Rikhraj I, Yeo NEM. Validity and Reliability of the American Orthopaedic Foot and Ankle Society Score for the English-Literate Singapore Population With Hallux Valgus. Foot Ankle Spec. 2024;17(4):329 – 35.
19. Kaufmann G, Dammerer D, Heyenbrock F, Braito M, Moertlbauer L, Liebensteiner M. Minimally invasive versus open chevron osteotomy for hallux valgus correction: a randomized controlled trial. Int Orthop. 2019;43(2):343 – 50.
20. Ji L, Wang K, Ding S, Sun C, Sun S, Zhang M. Minimally Invasive vs. Open Surgery for Hallux Valgus: A Meta-Analysis. Front Surg. 2022;9:843410.
21. Liu Y, Antonijevic D, Li R, Fan Y, Dukic K, Micic M, et al. Study of Sexual Dimorphism in Metatarsal Bones: Geometric and Inertial Analysis of the Three-Dimensional Reconstructed Models. Front Endocrinol (Lausanne). 2021;12:734362.

Figures

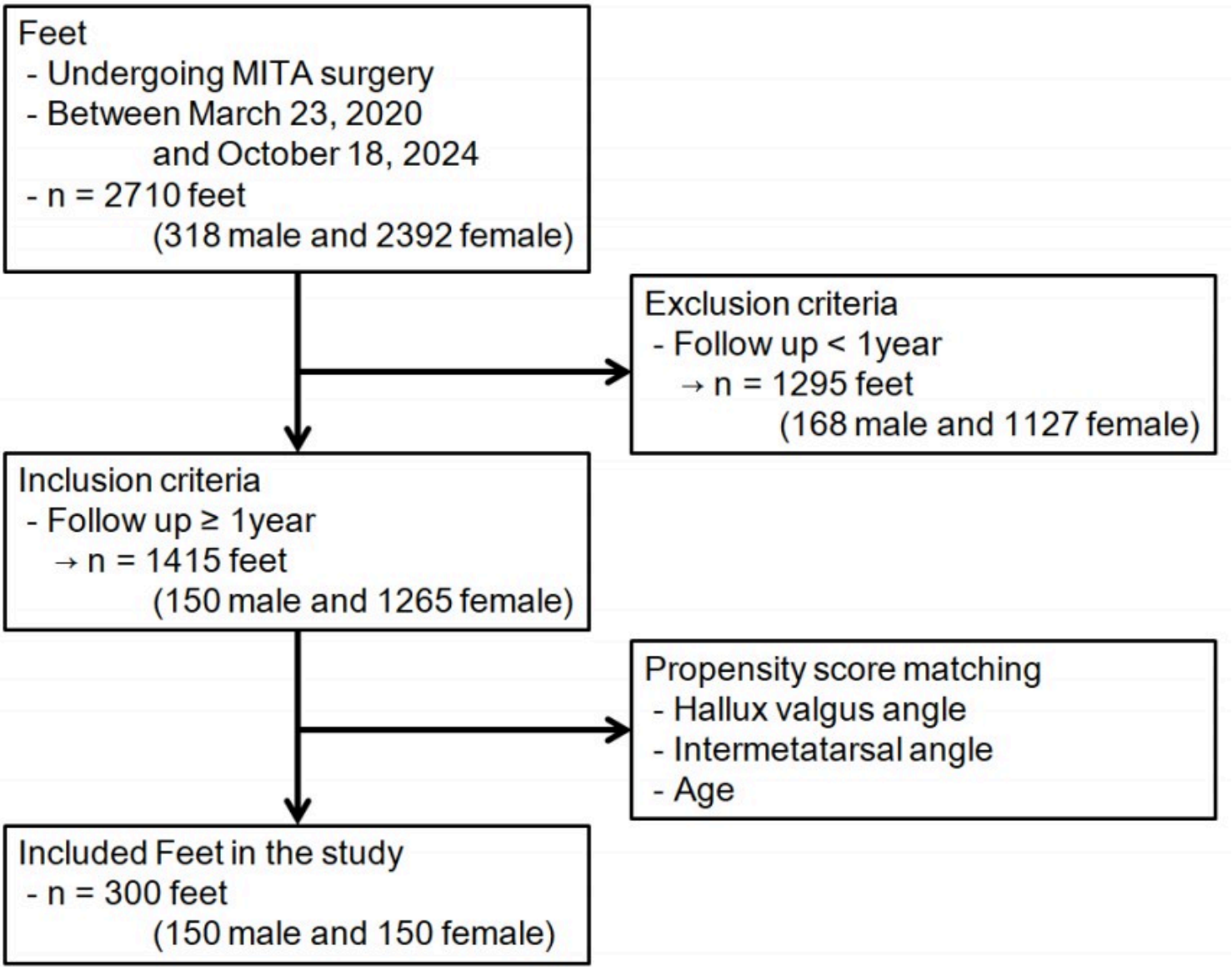

Figure 1

Flow diagram of patient selection and study cohort formation. A total of 2,710 feet underwent minimally invasive distal transverse metatarsal osteotomy – Akin osteotomy (MITA) during the study period. After applying the minimum follow-up criteria and propensity score matching, 300 feet (150 male and 150 female) were included in the final analysis.

Figure 2

Serial weight-bearing anteroposterior radiographs of the foot in a 59-year-old male patient showing **A** preoperative, **B** postoperative at 3 months prior to screw removal, and **C** postoperative at 19 months after surgery.

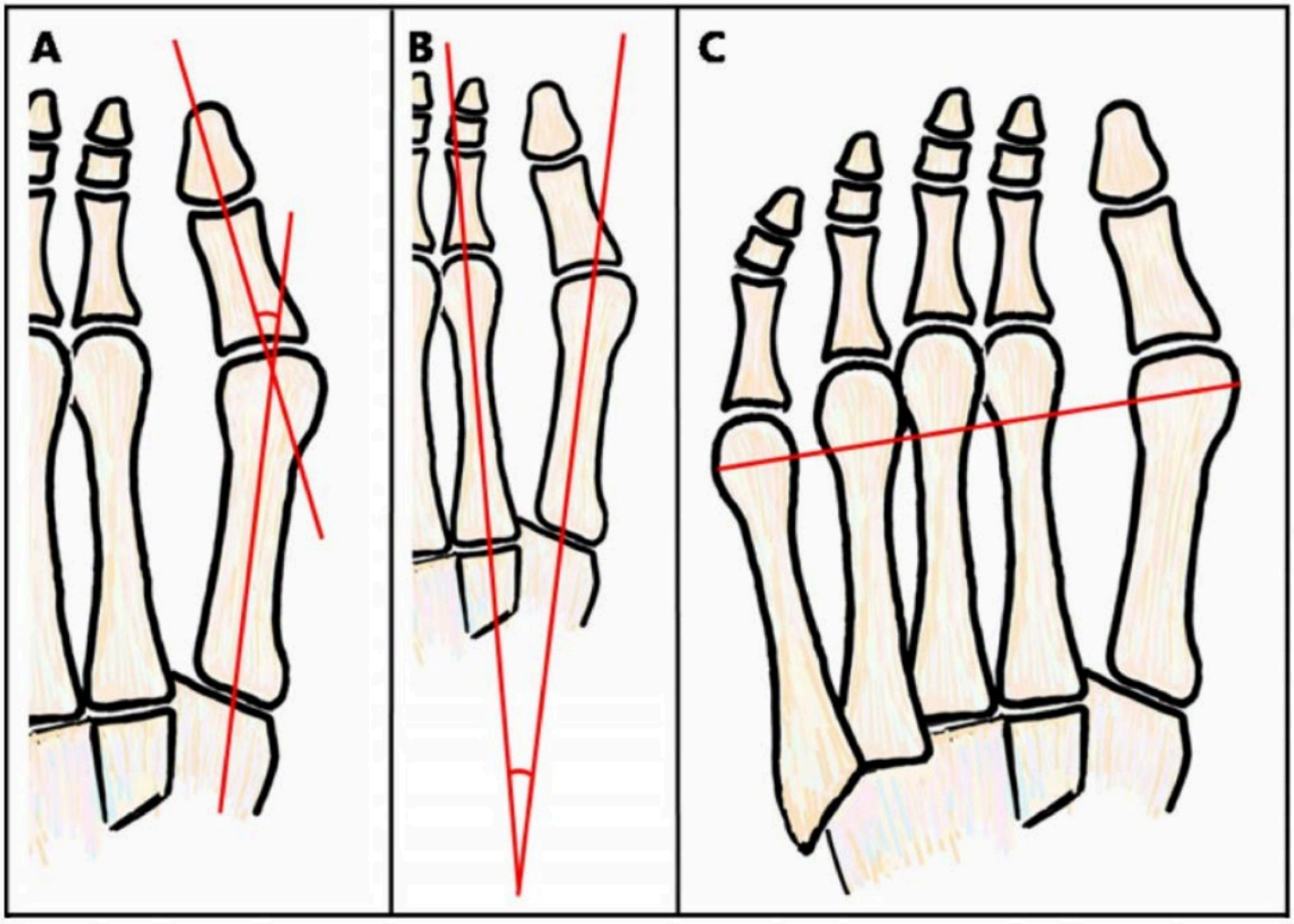

Figure 3

Radiographic measurements of the foot: **A** Hallux valgus angle, **B** Intermetatarsal angle, and **C** Bony foot width. Reproduced from Lee et al. (7) under the terms of the Creative Commons Attribution License.

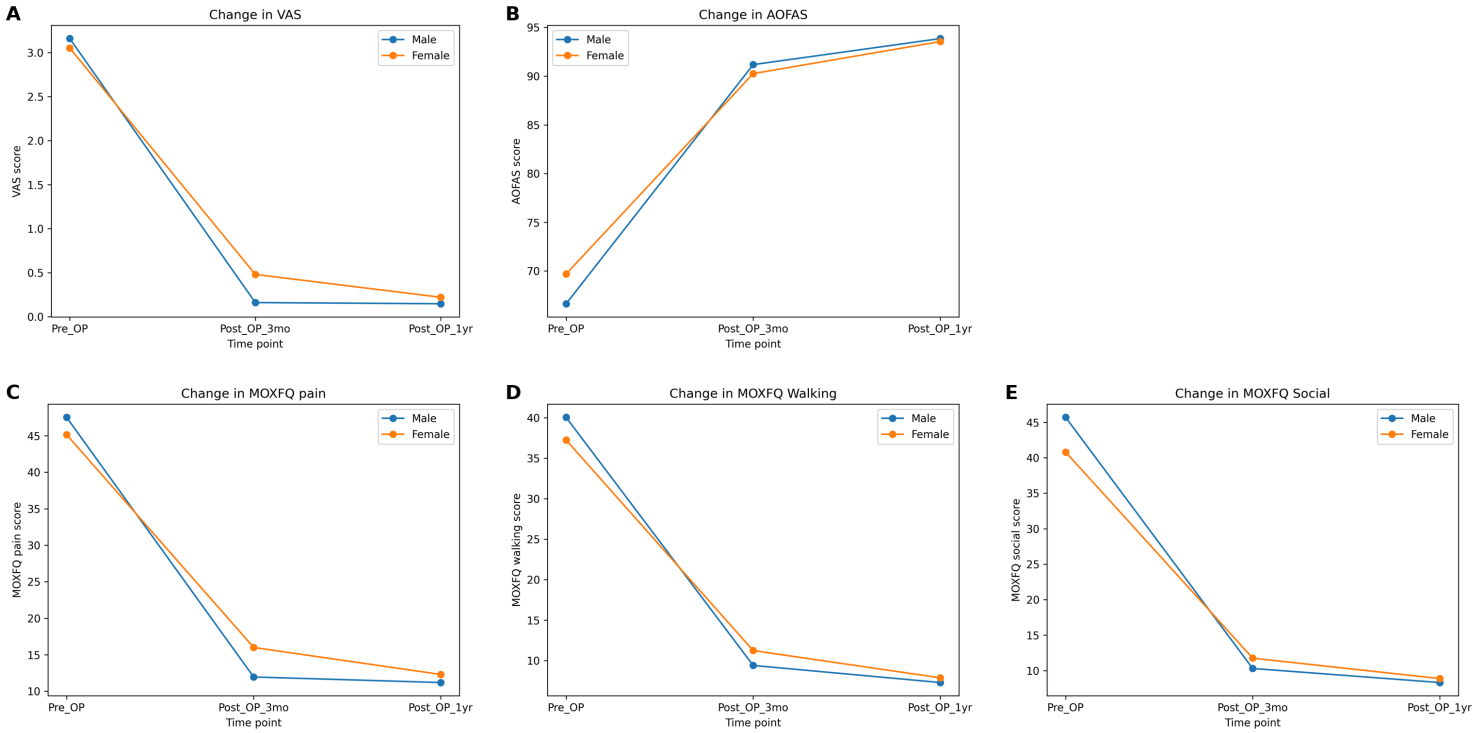

Figure 4

Clinical outcome scores over time according to sex. **A**VAS pain score, **B** AOFAS score, **C** MOXFQ pain, **D** MOXFQ walking, and **E**MOXFQ social scores are shown at the preoperative assessment, 3 months postoperatively, and 1 year postoperatively. Both male and female groups demonstrated marked improvement across all clinical domains with similar temporal trends.