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Joint-Preserving Surgery for Hallux Valgus Deformity in Rheumatoid Arthritis

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Background: Rheumatoid arthritis (RA) is a chronic autoimmune disorder that frequently causes forefoot deformities. Arthrodesis of the first metatarsophalangeal joint is a common surgery for severe hallux valgus. However, joint-preserving surgery can maintain the mobility of the joint. This study aimed to investigate the clinical and radiographic outcomes of distal chevron metatarsal osteotomy (DCMO) for correcting hallux valgus deformity associated with RA.

Methods: Between August 2000 and December 2018, 18 consecutive patients with rheumatoid forefoot deformities (24 feet) underwent DCMO for hallux valgus with/without lesser toe surgery. Radiological evaluations were conducted, assessing the hallux valgus angle, the intermetatarsal angle between the first and second metatarsals, and the Sharp/van der Heijde score for erosion and joint space narrowing. Clinical outcomes were quantified using a visual analog scale for pain and the American Orthopaedic Foot and Ankle Society forefoot scores to measure function and alignment.

Results: The mean hallux valgus angle decreased from 38.0° (range, 25°–65°) preoperatively to 3.5° (range, 0°–17°) at the final follow-up ($p < 0.05$). The mean intermetatarsal angle decreased from 14.9° (range, 5°–22°) preoperatively to 4.3° (range, 2°–11°) at the final follow-up. ($p < 0.05$). Regarding the Sharp/van der Heijde score, the mean erosion score (0–10) showed no significant change, decreasing from 3.83 (range, 0–6) preoperatively to 3.54 (range, 0–4) at the final follow-up ($p = 0.12$). Recurrent hallux valgus was observed in 1 patient and postoperative hallux varus deformity was observed in 2 feet. Spontaneous fusion of the metatarsophalangeal joint developed in 1 case.

Conclusions: DCMO resulted in satisfactory clinical and radiographic outcomes for correcting RA-associated hallux valgus deformity.

Keywords: *Rheumatoid arthritis, Hallux valgus, Arthrodesis, Metatarsal bone, Osteotomy*

Rheumatoid arthritis (RA) is a chronic autoimmune disorder frequently causing forefoot deformities; 89% of RA patients have symptomatic rheumatoid forefoot deformities.[1] The metatarsophalangeal joint (MTPJ) is affected first in 17% of RA patients.[1] Individuals affected by RA often exhibit hallux valgus and lesser toe deformities, such as hammer toes or MTPJ subluxation.[2] Arthrodesis of the first MTPJ is a common surgical intervention for hallux valgus deformity in RA,[3,4] and few studies have investigated joint-preserving surgery.[5] Joint preserving is rarely performed due to concerns about progressive joint destruction and recurrence of hallux valgus deformity.[6-8] Although arthrodesis of the first MTPJ stabilizes the medial column,[9] it has several disadvantages, primarily the movement of the MTPJ becomes impossible, nonunion

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rates have been reported to reach up to 26%,[3,9,10] and first interphalangeal joint (IPJ) arthritis after first MTPJ arthrodesis has been reported in 38%–60% of patients.[3,11]

There is a gradual shift towards joint-preserving surgery to avoid the disadvantages associated with arthrodesis and to retain the potential for future revision surgeries in the event of further joint degeneration.[12] Furthermore, newly developed RA medicine can delay the progression of joint destruction, thereby increasing the need for preserving joint mobility. Previous studies have shown good results using bunionectomy with a scarf or Ludloff osteotomy for hallux valgus deformity in RA patients.[7,12,13]

However, the outcomes of distal chevron metatarsal osteotomy (DCMO) for hallux valgus deformity in RA patients remain unclear. There are some reports about the risk of avascular necrosis (AVN) of the first metatarsal head after DCMO combined with lateral release.[14,15] The hypothesis of this study was that DCMO, a joint-preserving surgery, would be effective enough for the treatment of hallux valgus deformity in RA patients. This study aimed to investigate the clinical and radiographic outcomes of DCMO with lateral release to correct hallux valgus deformity in RA patients.

METHODS

All the authors declare that the procedures were performed in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 and 2008. This study was approved by the relevant Institutional Review Board (IRB No. 2020-0213). Informed consent was waived due to retrospective nature of this study.

In this retrospective study, we reviewed RA patients who underwent DCMO for hallux valgus correction with or without lesser toe surgery. All patients were diagnosed with RA at the Department of Rheumatology and were receiving medication. The inclusion criteria were (1) a previous diagnosis of RA and prescribed medications with intraoperative findings of erosion and/or destructive changes of the first metatarsal head (cartilage), (2) DCMO for hallux valgus correction with or without lesser toe surgery, and (3) a minimum follow-up of 36 months. Patients treated with other metatarsal osteotomies were excluded. Patients who underwent arthrodesis surgery to treat severe joint destruction over hallux arthritis stage 4 were excluded.

Eighteen consecutive patients (15 women and 3 men; mean age, 59.3 years; range, 47–78 years) with rheumatoid forefoot deformities (24 feet) treated between August 2000 and December 2018 were included. Indications for surgery were painful hallux valgus deformity with or without lesser toe deformities. The mean body mass index of the patients was 25.3 kg/m^2 (range, 19–33 kg/m^2). The mean follow-up period was 65.6 months (range, 36–107 months). All patients had been diagnosed with RA preoperatively and were taking medication. The mean preoperative duration of RA was 7.8 years (range, 3–15 years). Six women underwent bilateral procedures. Overall, there were 6 surgeries each on the right side, left side, and bilaterally (Table 1).

Twenty-four feet underwent DCMO to treat hallux valgus, and Akin osteotomies were additionally performed on 11 feet. Seventeen feet required additional procedures such as resection arthroplasty or Weil osteotomy for lesser toe deformity and painful plantar callosity. All surgical procedures were performed by 1 experienced senior surgeon (HSL).

Surgical Techniques

DCMO for hallux valgus

DCMO and distal soft-tissue realignment procedures were performed on all patients. The distal soft-tissue procedure included lateral soft-tissue release, bunionectomy, and medial capsular plication.[16] In cases of joint space narrowing due to the progression of arthritis, impaction was performed to induce shortening of the first metatarsal. In

Table 1. Demographic Data

Variable	Value
Age (yr)	59.3 (47–78)
Sex	
Female	15
Male	3
Side	
Right foot	6
Left foot	6
Both feet	6
Body mass index (kg/m^2)	25.3 (19–33)
Follow-up period (mo)	65.6 (36–107)
Duration of RA before surgery (yr)	7.8 (3–15)

Values are presented as mean (range) or number.
RA: rheumatoid arthritis.

17 feet where resection arthroplasty or Weil osteotomy was required for the second ray, intentional shortening of the first metatarsal was induced for improved joint space narrowing. In the other 7 feet where lesser-toe surgery was not necessary, DCMO was performed with an effort to minimize the shortening of the first metatarsal.

Bone grafting was performed using bone fragments generated from ostectomy in areas with lower bone density or subchondral cysts associated with RA. Akin phalangeal osteotomy was performed if residual deformity remained (Fig. 1).[16]

Fig. 1. Follow-up results of a 52-year-old woman at 72 months. Preoperative severe hallux valgus that improved after distal chevron metatarsal osteotomy (DCMO). The preoperative hallux valgus angles were 59° and 57° for the left and right feet, respectively. The Sharp/Heijde score for the first metatarsophalangeal joint improved from 5 preoperatively (erosion score, 3 +; joint space narrowing score, 2) to 2 postoperatively (erosion score, 1 +; joint space narrowing score, 1).

Surgery for lesser toe deformity

In 17 feet with lesser toe problems, corrective surgery for lesser toe deformities was performed after the above-mentioned procedures. Distal metatarsal osteotomy (Weil osteotomy) and plantar plate repair were performed to correct dislocated MTPJ with painful plantar callosities (Fig. 2). Resection arthroplasty was performed for patients with chronic MTPJ dislocation (Fig. 3). Weil osteotomy or resection arthroplasty was performed as needed on any of the second through fifth rays. Overall, Weil osteotomy was predominantly performed on the second and third rays, while resection arthroplasty was performed on the fourth and fifth rays. In most cases, surgeries for multiple lesser toes within a single foot were performed. There were 2 cases where Weil osteotomy was performed only on the second ray without surgery on the other lesser toes. Flexor tendon tenotomy and pinning were performed to correct hammer toe deformities. One patient with a severe fixed hammer toe underwent arthrodesis of the proximal IPJ.

Postoperative Rehabilitation

A 1.5-cm gauze spacer was used to maintain shape for 6 weeks postoperatively. Patients were allowed immediate full weight-bearing with hard-soled shoes. Early ambulation is crucial in patients with RA due to hand deformity

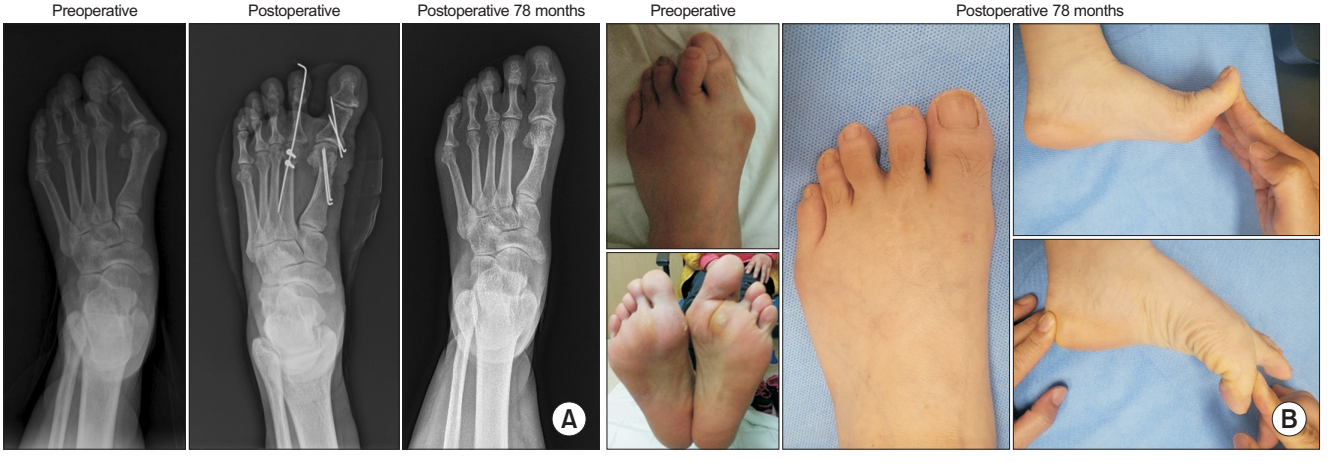

Fig. 2. Follow-up results of a 46-year-old woman at 78 months. (A) Preoperative severe hallux valgus with second hammer toe deformity that improved after distal chevron metatarsal osteotomy and Weil osteotomy with plantar plate repair of the second metatarsophalangeal joint. (B) Clinical photographs showing improved hammer toe and hallux valgus deformities, along with good range of motion.

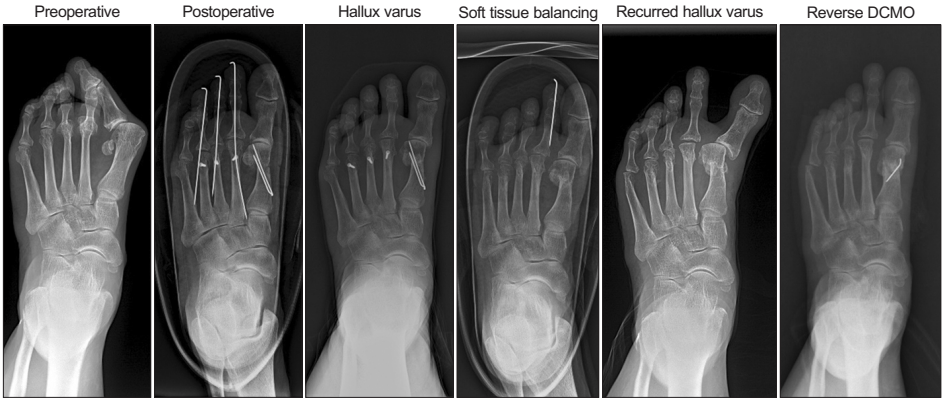

Fig. 3. A 60-year-old woman with postoperative hallux varus recurrence. DCMO: distal chevron metatarsal osteotomy.

and pain associated with the condition. Passive range of motion (ROM) exercises for the MTPJ were initiated after 2 postoperative weeks to prevent joint stiffness. Patients were permitted to wear their regular footwear after 6 postoperative weeks.

Radiographic Analysis

Preoperative and final follow-up assessments of the hallux valgus angle and the first-to-second intermetatarsal angle (IMA) were conducted using weight-bearing plain radiographs.[17] The severity of changes in the first MTPJ was evaluated on follow-up radiographs using the Sharp/van der Heijde scoring system (Fig. 1),[18] which is a widely recognized radiological method for quantifying joint damage in RA clinical trials and cohort studies. Two orthopedic surgeons (HSL, YRC) independently reviewed the radiographic data, recorded the measurements, and calculated the average for each parameter.

Clinical Analysis

Preoperative and final follow-up visual analog scale score and American Orthopaedic Foot and Ankle Society (AOFAS) forefoot score[19] and subjective satisfaction were used to assess clinical outcomes. We monitored for complications, such as first metatarsal head AVN, hallux valgus recurrence, postoperative hallux varus deformity, ROM limitations, infection, and postoperative transfer lesion of the second or third metatarsal head.[20,21] A hallux valgus angle < 15° and an IMA < 9° were considered normal, with postoperative recurrence of hallux valgus defined as a hallux valgus angle ≥ 15° on anteroposterior standing radiographs.[22] Lesser toe problems are common in feet affected by RA. These included hammer toe deformity, subluxation or dislocation of the MTPJ, and painful plantar callosities; we systematically evaluated for these at the initial assessment and follow-up assessments.

Statistical Analysis

All continuous variables are presented as mean ± standard deviation. The Wilcoxon signed-rank test was used to compare preoperative and postoperative findings. Bonferroni correction was applied to avoid false-positive results due to inflated type I error across multiple tests, where $p < 0.0167$ (calculated as 0.05/3) was considered statistically significant. Otherwise, $p < 0.05$ was considered statistically significant. Intraclass correlation coefficients were used to determine inter-reader agreement in interpreting radiographic data. Inter-reader agreement was graded as poor (< 0.40), moderate (0.40–0.59), good (0.60–0.80), or excellent (> 0.80).[23] Statistical analyses were performed using JMP Pro version 13.2 (SAS Institute).

RESULTS

Radiographic Results

At the final follow-up, the mean hallux valgus angle decreased from 38° (range, 22°–65°) preoperatively to 3.5° (range, 0°–17°) ($p < 0.05$), and IMA decreased from 14.9° (range, 5°–22°) to 4.3° (range, 2°–11°) ($p < 0.05$). Both angles indicating the degree of hallux valgus were significantly improved. Regarding the Sharp/van der Heijde score at the first MTPJ, the mean erosion score (0–10) showed no significant change, decreasing from 3.83 (range, 0–6) preoperatively to 3.54 (range, 0–4) at the final follow-up ($p = 0.12$). However, the mean joint space narrowing score (0–4) decreased significantly from 3.0 (range, 2–4) to 1.7 (range, 1–2) ($p < 0.05$) (Table 2). The inter-reader agreements were excellent for all radiographic analyses (Table 3).

Clinical Results

The visual analog scale pain score decreased from a preoperative mean of 4.7 (range, 3–7) to 0.7 (range, 0–4) at the final follow-up ($p < 0.05$), while the mean AOFAS score

Table 2. Changes in Mean Radiological Indices on Weight-Bearing Foot Anteroposterior Radiographs Preoperatively and at Final Follow-up

Variable	Preoperative	Final follow-up	*p*-value
Hallux valgus angle (°)	38.0 (22–65)	3.5 (0–17)	< 0.05
Intermetatarsal angle (°)	14.9 (5–22)	4.3 (2–11)	< 0.05
Sharp/Heijde score (0–14) at first MTPJ	6.83 (2–10)	5.21 (1–6)	0.1
Erosion score (0–10)	3.83 (0–6)	3.54 (0–4)	0.1
Joint space narrowing score (0–4)	3.0 (2–4)	1.7 (1–2)	< 0.05

Values are presented as mean (range).
MTPJ: metatarsophalangeal joint.

Table 3. Inter-reader Agreement

Variable	Preoperative		Final follow-up	
	ICC	95% CI	ICC	95% CI
Hallux valgus angle (°)	0.96	0.91–0.98	0.94	0.91–0.98
Intermetatarsal angle (°)	0.98	0.93–0.99	0.97	0.96–0.98
Sharp/Heijde score at first MTPJ				
Erosion score	0.89	0.86–0.91	0.92	0.88–0.94
Joint space narrowing score	0.86	0.75–0.97	0.89	0.81–0.94

ICC: intraclass coefficient, CI: confidence interval, MTPJ: metatarsophalangeal joint.

increased from 64.2 (range, 47–80) to 86.8 (range, 52–95) ($p < 0.05$). Patient satisfaction with the surgical outcomes was reported as excellent in 12 feet (50%), good in 10 feet (41.7%), fair in 2 feet (8.3%), and poor in 0 feet.

Complications

There were no cases of postoperative infection or AVN, nonunion, delayed union, or refracture during the follow-up period. However, recurrence of hallux valgus deformity occurred in 1 foot. The preoperative hallux valgus angle was 47°, and the IMA was 17°, indicating a severe deformity with subluxation of the second and third MTPJs. A severe RA nodule was found intraoperatively and removed. Resection arthroplasties of the second, third, and fourth MTPJs were simultaneously performed. Postoperatively, the hallux valgus angle was 5°, and the IMA was 2°. The postoperative IMA was maintained, but the hallux valgus angle increased again to 9° at 2 years and 15° at 3 years postoperatively. However, the patient felt no discomfort, with no additional problems with the lesser toes; therefore, conservative follow-up was continued.

Postoperative hallux varus deformity was observed in 2 feet. One foot had a hallux varus angle of 9° and an IMA of 2° at the final follow-up. No additional surgery was performed as the patients felt no discomfort, and the degree of the deformity was not visually severe. The other foot had a hallux varus angle of 5° and an IMA of 3° at 3 postoperative months. Soft-tissue balancing (medial

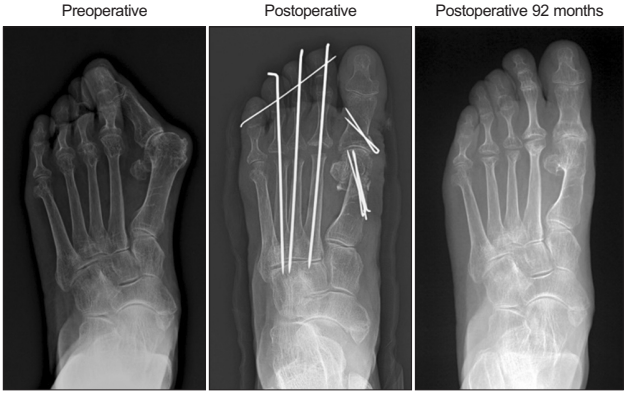

Fig. 4. Follow-up of a 62-year-old woman at 92 months. Preoperative severe hallux valgus with dislocation of the second, third, and fourth metatarsophalangeal joints, which improved after distal chevron metatarsal osteotomy and resection arthroplasty of the second, third, and fourth metatarsophalangeal joints.

release and lateral plication) of the first MTPJ was performed; however, the varus angle progressively worsened. At 16 postoperative months, the hallux varus worsened to 30°; therefore, reverse DCMO[24] was performed (Fig. 3).

ROM limitations were observed in 1 foot. For this patient, DCMO for severe hallux valgus and resection arthroplasty on the dislocated second, third, and fourth MTPJs were performed. At the 92-month follow-up evaluation, joint space narrowing with limitation of motion of the first MTPJ was observed; however, lesser toe deformities had not progressed, and the patient expressed satisfaction with the outcome (Fig. 4). Persistent plantar callosity under the second metatarsal head occurred in 4 feet, all after Weil osteotomy. One patient was followed up conservatively; however, additional surgery was performed on 3 feet (revision Weil osteotomy on 1 and resection arthroplasty on 2).

DISCUSSION

In this study, we revealed the clinical and radiological results of DCMO with open lateral soft-tissue release for the correction of hallux valgus deformity in patients with RA, presenting satisfactory clinical and radiological results after a relatively long-term follow-up period of 65.6 months (range, 45–107 months). With advancements in pharmacological treatment for RA, approaches to orthopedic surgery for the RA-affected foot have evolved.[25,26]

Arthrodesis of the first MTPJ is a common procedure for hallux valgus deformities associated with RA.[3,4,6] Coughlin has recommended fusion of the first MTPJ with resection arthroplasty of the lesser toes.[3] However, arthrodesis restricts the movement of the first MTPJ, it causes abnormalities in the toe-off process during the gait cycle, and it may cause secondary IPJ problems. Progressive IPJ arthritis after arthrodesis of the MTPJ ranged from 38% to 60% in 2 major series of first MTPJ arthrodesis.[3,27] The trend toward joint-preserving surgery for rheumatoid hallux valgus deformity is on the rise due to its association with enhanced function and patient satisfaction.[5,12,13,28]

However, concerns remain regarding persistent pain, recurrence of deformity, joint stiffness, and the development of hallux varus following such procedures. Barouk and Barouk's study[28] on 55 feet among rheumatoid patients undergoing scarf osteotomy for hallux valgus demonstrated sustained correction over an average follow-up of 6 years and 3 months. Berg et al.[5] found an improvement in mean hallux valgus angle from 41° to 28° at 6 years' follow-up in 20 RA patients who underwent scarf osteotomy. Most patients (79%) were satisfied. Chao et al.[13] analyzed 37 feet with hallux valgus in 27 RA patients treated with first MTPJ-preserving procedures; the majority underwent Ludloff osteotomies, followed by scarf osteotomies, and a minority had chevron osteotomies. Twenty feet had Ludloff osteotomies, 15 had scarf osteotomies, and 2 had chevron osteotomies. Although they reported favorable clinical and radiological outcomes, the deformity progressed in some cases, necessitating arthrodesis in 2 feet.

Arthritis evaluation is a critical aspect when reporting the results of joint-preserving surgery in the RA-affected foot. The Sharp/van der Heijde method[18] is instrumental for assessing erosions and joint space narrowing in both hands and feet, with scores ranging from 0 to 448. A maximum of 5 and 10 points per joint can be allocated for erosions in the hands and feet, respectively, across 32 joints in the hands and 12 in the feet. Joint space narrowing is scored from 0 to 4 in 30 joints of the hands and 12

Fig. 5. Follow-up results of a 57-year-old woman at 48 months. (A) Preoperative hallux valgus with a severe osteolytic lesion of the first metatarsal head, which improved after distal chevron metatarsal osteotomy (DCMO) with medial rotation of the metatarsal (MT) head. (B) Clinical photographs showing the range of motion of the first metatarsophalangeal joint at 4 postoperative years. (C) Illustration of medial rotation of distal fragment for distal metatarsal articular angle correction by pulling the lateral side and impacting the medial side of the distal fragment.[16]

joints of the feet. The total score, a sum of erosion and joint space narrowing scores, serves as the primary metric for analyses.[18]

Historically, most hallux valgus corrections were achieved using scarf osteotomy.[29] However, this technique raises concerns about troughing, which is more likely in osteoporotic bones characteristic of an RA-affected foot. Given that the osteotomy is performed in a more proximal region of the metatarsal bone, the distal fragment tends to rise, increasing the likelihood of malunion and subsequent degenerative changes. Etani et al.[30] compared the outcomes in patients with noninflammatory arthritis and RA using a modified scarf osteotomy with medial capsular interposition, in conjunction with metatarsal shortening offset osteotomy.

DCMO has several advantages, including a lack of troughing risk, increasing the joint space through shortening of the metatarsal bone and facilitating distal metatarsal articular angle correction during the procedure (Fig. 5). Recent studies have reported good clinical and radiological results achieved with shortening of the first metatarsal bone for the treatment of hallux rigidus, degenerative arthritis of the first MTPJ. Saur et al investigated the outcomes of distal oblique first metatarsal osteotomy for stage 1 to 3 hallux rigidus; the clinical score improved significantly.[31] Ceccarini et al.[32] found that shortening osteotomy of the first metatarsal bone effectively corrected stiffness, alleviated pain, and enhanced ROM. Notably, for hallux rigidus, achieving satisfactory results through shortening as a joint-preserving strategy, as opposed to arthrodesis, was feasible. Given that RA joints typically exhibit more damage than those affected by osteoarthritis, the shortening approach may be particularly beneficial. DCMO facilitates shortening, which can be easily achieved by impaction at the osteotomy site, conferring an advantage for RA-affected feet.

There were no statistically significant differences in joint erosion preoperatively and postoperatively. RA-related bone erosion, resulting from autoimmune-driven excessive bone resorption and inadequate formation, differs fundamentally from mechanical wear. However, the progression of arthritis might be slowed due to the potential prevention of degenerative changes following the reduction of subluxated MTPJ.

Some feet had osteolytic lesions of the first metatarsal head. Favorable outcomes were obtained using autologous bone grafts harvested during bunionectomy for osteolytic lesions. When DCMO was performed, the first metatarsal head was rotated medially in the axial plane of the foot to change the articular surface (Fig. 5).[16]

Seventeen feet in this study required additional surgery for lesser toe problems. Among them, abnormal forefoot parabola developed in 12 feet; of these, postoperative complications occurred in 5. Hallux varus developed in 2 feet, hallux valgus recurred in 1 foot, and painful plantar callosities occurred in 2 feet. In the remaining 7 feet, which maintained a normal forefoot parabola, there was no complication (Figs. 2 and 4).

Regarding the 2 feet with postoperative hallux varus, 1 foot showed a non-progressive deformity that did not require further surgery. However, in the other foot, hallux varus progressively worsened, necessitating 2 surgical corrections.[24] In RA, laxity of the joint is common due to synovitis and inflammatory tissue degeneration, suggesting that hallux varus may result from these conditions even after minor overcorrection during valgus correction. Due to the typically severe hallux valgus deformity in RA feet, surgeons often inadvertently overcorrect, necessitating cautious operative management.

There was no transfer metatarsalgia or relative second metatarsal lengthening in all feet. Most patients in this study underwent Weil osteotomy or resection arthroplasty for the lesser toe, so the relative length of the first metatarsal was usually not an issue. In cases of arthritic joint with severe subluxation in the first MTP joint commonly observed in RA, there is a need to shorten the first metatarsal. Additionally, a previous study reported that mild shortening of the first metatarsal during DCMO was not problematic for transfer lesions of the lesser toe.[33]

This study's limitations include its retrospective design and the absence of a control group, precluding direct comparisons of joint-preserving efficacy against arthrodesis or other techniques. Additionally, we adopted several procedures for lesser toe deformities depending on the condition of individual toes; therefore, our clinical scores may not be attributed solely to the procedures for correcting hallux valgus. Finally, the small sample size and lack of patients with high disease activity undergoing joint-preserving procedures made it difficult to assess the relationship between disease activity and recurrence. DCMO with lateral soft-tissue release to correct hallux valgus deformity in RA patients was found to provide satisfactory clinical and radiographic outcomes, sustained over a mean follow-up period of 65.6 months.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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