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Is generalized ligamentous laxity a prognostic factor for recurred hallux valgus deformity?

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ABSTRACT

Background: This study was performed to evaluate the intermediate-term clinical outcomes after proximal chevron osteotomy for hallux valgus in patients with generalized ligamentous laxity, and to determine the effect on postoperative recurrence of deformity.
Methods: There were 23 cases in laxity group (Beighton score ≥5 points) and 175 in non-laxity group with a mean followup of 46.3 months. Clinical evaluation consisted of the AOFAS score, Foot and Ankle Ability Measure (FAAM), and radiographic measurement of hallux alignment. Risk factors associated with postoperative recurrence were evaluated using univariate analysis.
Results: Recurrence rates were 21.7% in the laxity group and 17.1% in non-laxity group ($P = .218$). There were no significant differences in clinical and radiographic measurements at final followup between the 2 groups. Preoperative HVA and IMA were found to be predictive factors of recurrence (OR = 6.3, 4.2; $P = .001$, .018, respectively).
Conclusion: There were no statistical differences in the clinical and radiographic outcomes between hallux valgus with and without generalized ligamentous laxity. Generalized ligamentous laxity demonstrated no definitive effects on postoperative recurrence of hallux valgus deformity.

1. Introduction

Postoperative recurrence of hallux valgus deformity is known to be one of the most common complications after surgical correction [1–4]. With various definitions of postoperative recurrence, prevalence rates of recurred hallux valgus deformity following the first metatarsal corrective osteotomy vary in the literature from 2.7% to 25% [3–9]. Further surgical treatment for a recurred hallux valgus deformity relies on the ability of the surgeon to identify the cause of the postoperative recurrence. The cause of recurrence of hallux valgus deformity is usually multifactorial [3]. Patient-related factors include preoperative anatomic predisposition, medical comorbidities, and compliance with postoperative instructions. Surgeon-related factors include the choice of appropriate surgical procedure, and the technical competency. Of these related factors, anatomic predisposition of the patients with hallux valgus and insufficient technical competency of surgeon have been widely analysed to improve the clinical outcomes following surgical treatment. A round-shaped lateral edge of the first metatarsal head, incomplete reduction of the sesamoids, high values of hallux valgus angle (HVA) or inter-metatarsal angle (IMA), high values of distal metatarsal articular angle (DMAA), insufficient plication of the medial capsule, incomplete lateral soft tissue release, increased distal metatarsal articular angle, and insufficient correction of the metatarsus primus varus have been reported to be risk factors for the postoperative recurrence of hallux valgus deformity [2,10–14].

The prevalence of generalized ligamentous laxity (hypermobility syndrome or joint hyperlaxity) was reported to be about 10%–30% [15–18]. An adverse effect of the generalized ligamentous laxity on joint stabilization procedures using a soft tissue repair or reconstruction has been described in the various joints [19–23]. However, it remains unclear whether generalized ligamentous laxity is a risk factor for recurred hallux valgus deformity. Pathophysiology of hallux valgus deformity includes a imbalance of tendon, ligament and joint capsule around the first metatarso-phalangeal joint. The hyperlaxity of the first MTP joint capsule may be closely related to the progression or recurrence of hallux valgus deformity.

To the best of our knowledge, few studies [5,24] have analyzed the relationship between the generalized ligamentous laxity and

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the postoperative recurrence of hallux valgus deformity. The objective of the present study was to evaluate the intermediate-term clinical outcomes after surgical treatment for hallux valgus in patients with generalized ligamentous laxity, and to determine the effect on postoperative recurrence of deformity.

2. Patients and methods

2.1. Study subjects

Between March 2008 and August 2014, a total of 226 feet from 194 female patients were treated with a proximal metatarsal chevron osteotomy for symptomatic hallux valgus. One hundred sixty-nine (198 feet) out of these patients were followed for more than 2 years postoperatively and constituted the study cohort. The Beighton and Horan criteria were applied obviously to evaluate a generalized ligamentous laxity: (1) passive dorsiflexion of the little fingers beyond 90° (right, left); (2) passive apposition of the thumbs to the flexor aspects of the forearms (right, left); (3) hyperextension of the elbows beyond 10° (right, left); (4) hyperextension of the knees beyond 10° (right, left); and (5) forward flexion of the trunk with the knees straight so the palms of the hands rest easily on the floor. Generalized ligamentous laxity was defined as a Beighton score equal or more than 5 points on a 9-point scale [25]. All physical examinations and operations were performed by one senior surgeon (BKC). Eventually, there were 18 patients (23 feet; laxity group) with and 151 patients (175 feet; non-laxity group) without the generalized ligamentous laxity. At the time of surgery, the mean age of the patients was 36.8 years (range 18–55 years) in laxity group and 39.2 years (range 19–58 years) in non-laxity group. The mean length of followup was 45.5 months (range 24–74 months) in laxity group and 47.1 months (range 24–76 months) in non-laxity group.

The indications for surgery were: (1) patients with symptomatic moderate to severe hallux valgus deformity (HVA $\geq$25° or IMA $\geq$15°); and (2) patients unresponsive to at least 3 months of conservative management including shoe modification, nonsteroidal anti-inflammatory medications, and bunion pad. Patients with previous surgical history in the ipsilateral foot or rheumatoid arthritis were excluded from the present study. Postoperative recurrence of hallux valgus deformity was defined as a HVA more than 20° at final followup visit regardless of the clinical symptoms [2,11]. The study protocol and investigation were conducted with Institutional Review Board approval, and written informed consent was obtained.

2.2. Surgical procedures

All moderate to severe hallux valgus deformities were corrected using a proximal metatarsal chevron osteotomy combined with a distal soft tissue procedure. The osteotomy site was fixed with two 2.0 mm Kirschner wires. Distal soft tissue procedure through the first web space approach consisted of the transverse metatarsal ligament release, adductor hallucis tenotomy, and lateral capsular release. All patients received a plication of the medial capsule and an excision of the medial eminence. In 28 cases with nonflexible hammer toe deformity combined with a painful plantar callosity, the second metatarsal shortening osteotomy (Weil osteotomy and a mini-screw fixation) was concomitantly performed. In 16 cases with hallux valgus interphalangeus, the first proximal phalangeal wedge osteotomy (Akin osteotomy and a 1.4 mm k-wire fixation) was concomitantly performed.

A hard-soled shoe and partial weight bearing ambulation (heel touch gait) were maintained for 8 weeks. Active and gentle passive range of motion (ROM) exercises were encouraged after 4 weeks. After Kirschner wires were removed 8 weeks after surgery, full-weight bearing and return to normal activity level were permitted.

2.3. Clinical and radiological assessment

Clinical evaluation consisted of the American Orthopaedic Foot and Ankle Society (AOFAS) scores, Foot and Ankle Ability Measure (FAAM) scores. The AOFAS hallux rating score is a 100-point physician-based scale comprised of three subcomponents (pain, function, and alignment). FAAM [26] is self-estimated test that consists of two subscales evaluating activities of daily living (21 questions) and sports activities (8 questions). Results were represented as scores changed on the basis of 100 points. Range of motion (extension-flexion arc) of the first MTP joint was evaluated using goniometry.

Radiographic measurement to evaluate the changes of hallux alignment included hallux valgus angle, intermetatarsal angle, distal metatarsal articular angle, and position of the medial sesamoid on the weight-bearing radiograph. The medial sesamoid position was graded on a scale of 0–3 and was determined in relationship to the bisection of the first metatarsus [13]. All measurements were independently performed by 2 orthopaedic surgeons. Measures were repeated twice using a digital PACS image system, and subsequently averaged.

2.4. Statistical analysis

The statistical analysis was performed using SPSS program (version 20.0; SPSS Inc, Chicago, IL, USA), and P values $<$ .05 were considered statistically significant. The significances of differences between preoperative and postoperative variables in same individuals were analysed using Wilcoxon signed-rank test. Clinical and radiological outcomes were compared between the laxity and non-laxity groups using Mann–Whitney and Fisher's exact test. Associations between postoperative recurrence of hallux valgus deformity and potential risk factors including the generalized ligamentous laxity were examined using the univariate analysis (with odds ratio and 95% confidence interval).

3. Results

3.1. The effects of generalized ligamentous laxity on the clinical outcomes

There were no statistically significant differences in mean AOFAS score, FAAM score, and ROM of the hallux between the laxity and non-laxity groups at final followup (P = .505, .803, .783, respectively) (Table 1). There were 3 cases (1.7%) of asymptomatic hallux varus deformity in the non-laxity group.

3.2. The effects of generalized ligamentous laxity on the radiological outcomes

There were no statistically significant differences in mean HVA, IMA, DMAA and displacement of the medial sesamoid between the laxity and non-laxity groups at final followup (P = .621, .965, .692, .789, respectively) (Table 1).

3.3. The effect of generalized ligamentous laxity on a recurrence of hallux valgus

Postoperative recurrence of the hallux valgus deformity, defined as a HVA more than 20° at final followup regardless of the clinical symptoms, was found in 35 (17.7%) out of the 198 cases at a mean followup of 46.3 months. Cases with recurred hallux valgus consisted of 5 cases (prevalence rate of 21.7%) in laxity group

Table 1
Comparison of the clinical and radiological outcomes between laxity and non-laxity groups (Mann–Whitney and Fisher's exact test).

	Laxity group[a] (n = 23)	Non-laxity group[a] (n = 175)	P-value
AOFAS score			
Preoperative	56.1 ± 9.2	54.9 ± 9.8	.564
Final followup	89.5 ± 8.8	90.8 ± 8.7	.505
FAAM score			
Final followup	88.7 ± 9.1	89.6 ± 8.5	.803
Hallux active ROM (°)			
Preoperative	65.5 ± 8.5	63.4 ± 9.1	.398
Final followup	59.8 ± 8.4	58.6 ± 8.2	.783
Hallux valgus angle (°)			
Preoperative	35.8 ± 8.4	34.7 ± 8.8	.775
Final followup	16.8 ± 4.9	15.5 ± 5.3	.621
Intermetatarsal angle (°)			
Preoperative	17.3 ± 3.3	17.6 ± 3.4	.854
Final followup	9.3 ± 2.2	9.4 ± 2.1	.965
DMAA (°)			
Preoperative	11.8 ± 4.1	12.1 ± 4.3	.817
Final followup	8.9 ± 3.4	9.3 ± 3.5	.692
Sesamoid position (grade)			
Preoperative	2.6 ± 0.4	2.5 ± 0.5	.935
Final followup	1.3 ± 0.3	1.1 ± 0.2	.789
Postoperative recurrence (n)	5 (21.7%)	30 (17.1%)	.218
Revision surgery (n)	1 (4.3%)	6 (3.4%)	.796

Abbreviations: AOFAS, American Orthopaedic Foot & Ankle Society; FAAM, Foot and Ankle Ability Measure; ROM, range of motion; DMAA, distal metatarsal articular angle.
[a] The values are given as the mean with standard deviation.

and 30 cases (prevalence rate of 17.1%) in non-laxity group. There was no statistically significant difference in postoperative recurrence rate between the 2 groups ($P = .218$). Most recurrences were mildly painful in daily and occupational activities, and thus only 7 cases (3.5%) of revision surgeries were required.

3.4. The risk factors associated with the postoperative recurrence of hallux valgus

There were statistically significant differences in mean HVA and IMA between the recurred and non-recurred groups at final followup ($P < .001$, $< .001$, respectively) (Table 2). On the contrary, there were no significant differences in postoperative AOFAS score, FAAM score, ROM of the hallux, DMAA and displacement of the medial sesamoid between the 2 groups ($P = .105$, .225, .241, .382, .093, respectively). In terms of preoperative factors, mean HVA and IMA in the recurred group were significantly larger than those in non-recurred group ($P = .001$, .035, respectively).

Univariate analysis demonstrated an association between the preoperative factors and the recurrence of hallux valgus. Cases with preoperative HVA $\geq 40°$ had a greater risk of postoperative recurrence than those with preoperative HVA $< 40°$ ($P = .001$) (Table 3). Cases with preoperative IMA $\geq 18°$ had a greater risk of postoperative recurrence than those with preoperative IMA $< 18°$ ($P = .018$). The generalized ligamentous laxity appeared to be not a risk factor associated with recurrence of hallux valgus deformity ($P = .806$).

4. Discussion

This retrospective comparative study reports the clinical outcomes after surgical treatment for hallux valgus in patients

Table 2
Comparison of clinical and radiological outcomes between the recurrence and non-recurrence groups (Mann–Whitney and Fisher's exact test).

	Recurred group[a] (n = 35)	Non-recurred group[a] (n = 163)	P-value
AOFAS score			
Preoperative	53.8 ± 9.5	57.2 ± 8.9	.174
Final followup	88.2 ± 8.3	92.1 ± 7.7	.105
FAAM score			
Final followup	87.9 ± 8.8	90.4 ± 8.6	.225
Hallux active ROM (°)			
Preoperative	64.7 ± 8.5	64.2 ± 8.7	.906
Final followup	57.9 ± 8.9	60.5 ± 7.8	.241
Hallux valgus angle (°)			
Preoperative	38.3 ± 7.5	32.2 ± 7.7	.001
Final followup	22.1 ± 2.4	10.2 ± 4.3	<.001
Intermetatarsal angle (°)			
Preoperative	18.5 ± 3.9	16.4 ± 3.7	.035
Final followup	11.9 ± 3.2	6.8 ± 2.9	<.001
DMAA (°)			
Preoperative	12.7 ± 4.1	11.2 ± 4.3	.141
Final followup	9.6 ± 3.4	8.6 ± 3.5	.382
Sesamoid position (grade)			
Preoperative	2.8 ± 0.6	2.3 ± 0.5	.167
Final followup	1.5 ± 0.4	0.9 ± 0.3	.093

Abbreviations: AOFAS, American Orthopaedic Foot & Ankle Society; FAAM, Foot and Ankle Ability Measure; ROM, range of motion; DMAA, distal metatarsal articular angle.
[a] The values are given as the mean with standard deviation.

Table 3
Univariate comparisons of the prognostic factors affecting the postoperative recurrence of hallux valgus deformity.

Preoperative variables	Recurred group (n = 35)	Non-recurred group (n = 163)	Odds ratio (95% CI)	P-value
Generalized ligament laxity				
Yes	5 (14.3%)	18 (11.1%)	1.34 (0.2–5.6)	.806
No	30 (85.7%)	145 (88.9%)		
Preoperative HVA				
≥40°	19 (54.3%)	26 (15.9%)	6.3 (1.92–23.5)	.001
<40°	16 (45.7%)	137 (84.1%)		
Preoperative IMA				
≥18°	17 (48.6%)	30 (18.4%)	4.2 (1.15–15.8)	.018
<18°	18 (51.4%)	133 (81.6%)		

Abbreviations: HVA, hallux valgus angle; IMA, intermetatarsal angle; CI, confidence interval.

with generalized ligamentous laxity with followup ≥2 years, and the effect on postoperative recurrence of deformity. The most important finding of this study was that no definitive relationship between generalized ligamentous laxity and postoperative recurrence of hallux valgus deformity was found. In addition, a generalized ligamentous laxity demonstrated no significant effects on the clinical and radiographic outcomes at intermediate-term followup after a proximal metatarsal chevron osteotomy.

Postoperative recurrence of hallux valgus deformity is known to be one of the most common complications after surgical correction [1,3,4,6]. With various definitions of recurrence, prevalence rates of recurred hallux valgus following the first metatarsal corrective osteotomy vary in the literature from 2.7% to 25% [3–9]. Identifying the risk factors related to postoperative recurrence can enable modification of surgical procedures and improve clinical outcomes. The predictive factors affecting recurrence of hallux valgus deformity have variously been reported as followings; a round-shaped lateral edge of the first metatarsal head [11], preoperative HVA >40° [12], preoperative MTP joint congruity [6], incomplete reduction of the sesamoids [2], DMAA and IMA [27]. By contrast, postoperative HVA ≤15° and IMA <10° were reported as decreased risk factors [12].

No consensus exists regarding whether a generalized ligamentous laxity predisposes to the postoperative recurrence of hallux valgus. We could find little available information on the relationship between generalized ligamentous laxity and postoperative recurrence [5,24]. Despite a concern regarding adverse effects of the generalized ligamentous laxity on joint stabilization surgeries using the soft tissue procedures, the present study demonstrated no definitive correlation between a generalized ligamentous laxity and recurrence of hallux valgus deformity at intermediate-term followup. On the contrary, our radiographic results indicated that a preoperative HVA ≥40° or IMA ≥18° can be a significant risk factor for recurrence, as noted previously by other authors.

Hypermobility of the first ray is defined as excessive motion of the first metatarsal in the sagittal and transverse planes, and remains controversial regarding its existence and relevance in patients with hallux valgus deformity [3]. A hypermobile first ray is usually an isolated finding in the foot, but is occasionally associated with generalized ligamentous laxity [28]. In preoperative evaluation of the present study, the presence of definitive hypermobility of the first ray was noted only in 3 patients with generalized ligamentous laxity. Although they showed a hypermobility of the first tarsometatarsal joint, two out of the 3 patients achieved satisfactory clinical results without recurrence of deformity. As a procedure in the treatment of hallux valgus, Myerson et al. [29] reported that metatarsocuneiform arthrodesis (Lapidus procedure) is indicated in patients with a hypermobile first ray, particularly when associated with generalized ligamentous laxity or severe metatarsus primus varus. It is still controversial what is indication for tarsometatarsal arthrodesis in terms of amount of hypermobility of the first ray.

The present study has some limitations. Firstly, an assessment of generalized ligamentous laxity and hypermobility of the first ray was performed only by the corresponding author. Although Remvig et al. [25] reported that the Beighton and Horan criteria for diagnosis of generalized joint laxity was highly valid, we could not completely convince of the accuracy of physical examination because a evaluation of intraobserver reproducibility was not assessed. Secondly, the satisfactory clinical outcomes after surgical treatment for hallux valgus in patients with generalized ligamentous laxity can not be generalized for all cases, because this study includes only the intermediate-term results following the proximal chevron osteotomy. The conclusion for patients with other surgical procedures to correct the hallux valgus deformity needs to be addressed in further studies. Thirdly, study subjects were limited to adult female due to a rarity of male patients with both generalized ligamentous laxity and hallux valgus deformity.

5. Conclusions

There were no statistical differences in the clinical and radiographic outcomes between hallux valgus with and without generalized ligamentous laxity. Generalized ligamentous laxity demonstrated no definitive effects on postoperative recurrence of hallux valgus deformity at intermediate-term followup.

Conflict of interest statement

The authors have no conflict of interest to report and have received no financial support for the completion of this work.

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