Hallux Rigidus: Prevalence and Risk Factors

Yoshiyuki Senga

Mie University Graduate School of Medicine

Akinobu Nishimura (✉ meiten@clin.medic.mie-u.ac.jp)

Mie University Graduate School of Medicine

Naoya Ito

Ise Red Cross Hospital

Yukie Kitaura

Mie University Graduate School of Medicine

Akihiro Sudo

Mie University Graduate School of Medicine

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Abstract

Background: Hallux rigidus (HR) is a common degenerative arthritis of the first metatarsophalangeal joint. However, the epidemiology and risk factors of this pathology have yet to be clarified.

Methods: This cohort study estimated the prevalence of and clarified risk factors for radiographic HR in individuals over 50 years old.

Results: The prevalence of HR was 26.7% (161/604). Rates of grade 0, 1, 2, and 3 HR according to the Hattrup and Johnson classification were 73.3% (443/604), 16.4% (99/604), 8.0% (48/604), and 2.3% (14/604), respectively. Overall ratio of symptomatic HR was 8.1%. Univariate analysis revealed knee osteoarthritis (KOA), gout attack (GA), and hallux valgus (HV) as significantly associated with HR. The same factors were confirmed as independent risk factors for HR in multivariate analysis. All parameters were significantly associated with HR. Odds ratios of KOA, HV, and GA for HR were 1.73, 3.98, and 3.86, respectively. The presence or absence of KOA was significantly associated with severity of HR.

Conclusion: Our study revealed the prevalence of HR in the elderly (≥ 50 years) was 26.7%, and KOA, HV, and GA were independent risk factors for HR. KOA was associated with severity of HR.

Background

Hallux rigidus (HR) is a degenerative arthritis of the first metatarsophalangeal (1st MTP) joint, and the most common arthritic condition affecting the foot.[1] HR causes various symptoms, including local pain in the 1st MTP joint, plantar calluses, stiffness, and enlargement of the joint.[2] Radiographically, HR is characterized by joint space narrowing, osteophytic lipping of the metatarsal head and proximal phalanx, and sesamoid hypertrophy.[3] While arthritis can be caused by traumatic or iatrogenic injuries that directly damage the articular cartilage of the MTP joint, the most common etiology of HR is idiopathic.[1]

HR was initially described by Davies-Colley in 1887. While the pathology is sometimes seen in daily medical practice,[4] its prevalence and epidemiology remain unclear. Previous studies have reported a high prevalence of 1st MTP joint osteoarthritis (20–35%),[5–8] and an extremely high prevalence (61%) among the population aged over 80 years.[7] However, those studies just examined the prevalence of 1st MTP joint osteoarthritis among systematic osteoarthritis. Few studies have focused on the prevalence of HR. Furthermore, few well-designed studies have investigated risk factors for HR, although numerous risk factors have been proposed.[2] An in-depth study of HR as diagnosed using the Hattrup and Johnson classification was thus required to clarify the prevalence and risk factors of this entity.

The purpose of this cross-sectional study, using a population sample in Japan, was to investigate the prevalence of HR and its risk factors among Japanese community dwellers.

Methods

Sample collections

We have been conducting cohort studies among individuals over 50 years old to investigate factors associated with orthopedic-related diseases such as knee osteoarthritis (KOA) and osteoporosis every 2 years since 1997.[9, 10] The present study analyzed individuals recruited from residents of a mountain village in Japan. All investigations were conducted at the local hospital. Before presenting for direct examination, a baseline questionnaire was sent to each participant. Participants answered several questions on age, sex, history of smoking and drinking, foot pain, and medical history, including hypertension, hyperlipidemia, diabetes mellitus, and gout attack. We defined individuals over 65 years old as elderly. Foot pain was defined as pain lasting more than 1 day within the preceding 1 month. Symptomatic HR was defined as radiographic HR in a patient reporting foot pain. Direct examination consisted of physical measurements of height and weight, a medical interview, a physical examination by an orthopedic surgeon, and X-rays. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters. Participants also underwent bone mineral densitometry of the forearm to screen for osteoporosis, defined as a bone density of 70% or less of the young adult mean.

Participants

In this study, we analyzed data from the 7th to 10th checkups in 2009, 2011, 2013, and 2015. For those who participated in more than one of these four checkups, only the data from the first checkup were included. In total, 604 individuals participated in this study (mean age, 67.1 ± 6.4 years; 208 men, 396 women).

All procedures performed with participants were conducted in accordance with the ethical standards of the institutional and/or national research committee, and with the Declaration of Helsinki (1964) and its later amendments or comparable ethical standards. Written informed consent was obtained from all participant before enrollment.

Definitions of KOA and HR

Knee X-rays were taken with the patient standing, knee fully extended. KOA was scored according to the Kellgren-Lawrence grading system.[11] Radiographic KOA was defined as grade 2 or higher. We also took foot X-rays with the participant standing upright with both feet on the cassette, as described by Saltzman et al.[12] Severity of HR was scored based on the modified version of the Hattrup and Johnson classification.[13] Accordingly, severity of HR was classified as: Grade 0, normal; Grade 1, preservation of joint space, mild osteophyte formation; Grade 2, mild to moderate joint space narrowing, moderate osteophyte formation, subchondral sclerosis and cysts; and Grade 3, severe joint space narrowing, significant osteophyte formation, loose bodies, subchondral sclerosis and cysts (Figure 1). Radiographic HR was defined as grade 1 or higher, with normal appearance classed as grade 0. Cases with a HV angle of 20 degrees or higher were defined as showing HV.

Statistical analysis

The primary endpoint of this study was to clarify the prevalence of HR among individuals who were more than 50 years old. The secondary endpoint was to explore risk factors for HR. We compared baseline characteristics using Student's t-tests for continuous variables and Fisher's exact test for categorical variables. Logistic regression modeling was used to examine the relationship between predictor variables and HR. Univariate analysis was performed first, then multivariate analysis was performed by entering those factors showing significant differences in univariate analyses. The Cochran-Armitage trend test was used to examine the relationships between risk factors and severity of HR in a linear trend. All statistical analyses were performed using R version 3.3.2 statistical software (R Foundation for Statistical Computing, Vienna, Austria). All *P* values presented are two-sided and values of *P* < .05 were considered statistically significant.

Results

Prevalence of HR and participant characteristics

The prevalence of HR as diagnosed by X-ray examination was 26.7% (161/604) among the entire cohort. Rates of HR grades 0, 1, 2, and 3 were 73.3% (443/604), 16.4% (99/604), 8.0% (48/604), and 2.3% (14/604), respectively. The overall ratio of symptomatic HR was 16.1% (26/161) and the percentage of symptoms did not appear associated with severity of HR (Figure 2). We divided participants into HR(+) and HR(-) groups according to the presence or absence of HR. Table 1 shows a comparison of participant characteristics between groups. No significant differences in various factors were seen between groups, except for KOA, HV, diabetes mellitus, and gout attack.

Risk factors for HRs

We next examined risk factors for HR. Table 2 shows the results of uni- and multivariate analyses for predictors of HR among the population. Univariate analysis revealed BMI, KOA, HV, diabetes mellitus, and gout attack as significantly associated with HR. Multivariate analysis confirmed KOA, HV, and gout attack as independent risk factors for HR (KOA: odds ratio (OR) 1.73, 95% confidence interval (CI) 0.80–1.85, *P* < .05; HV: OR 3.98, 95%CI 2.68–5.92, *P* < .05; gout attack: OR 3.86, 95%CI 1.24–12.0, *P* < .05).

Relationship between KOA and severity of HR

Figure 3 shows the relationship between KOA and the severity of HR. KOA is significantly associated with the severity of HR. The frequencies of grades 0, 1, 2, and 3 were 23.9% (106/443), 37.4% (37/99), 50.0% (24/48), and 50.0% (7/14), respectively. The frequency of KOA was significantly associated with the severity of HR (*P* < .001).

Discussion

We investigated the prevalence of HR and its risk factors among individuals over 50 years old living in a village in Japan. We identified three important clinical issues: 1) the prevalence of HR among this sample

of a general population over 50 years old was 26.7%; 2) KOA, HV, and gout attack were independent risk factors for HR; and 3) KOA was associated with severity of HR.

The 26.7% prevalence of HR is similar to findings from previous studies (20–35%).[5–8] In most such studies, HR was diagnosed using the Kellgren-Lawrence grading system, whereas the present investigation diagnosed HR using the modified Hattrup and Johnson classification. Grade 2 in the Kellgren-Lawrence grading system is almost identical to Grade 1 in the modified Hattrup and Johnson classification. The cut-off criterion for diagnosing HR in this study thus resembled those in previous reports. This is presumably one reason the prevalence of HR in this study was similar to those in previous reports.

Several risk factors have been proposed in the literature, including female sex,[14] history of trauma,[15] rheumatoid arthritis,[16] long proximal phalanx of the hallux,[17] varus deformities of the forefoot or rearfoot,[17] HV deformity,[18] soft-tissue contracture,[19] short or long first metatarsal,[20] increased interphalangeal angle of the hallux,[21] family history,[14] and ill-fitting footwear.[22] However, none of these risk factors were determined from epidemiological studies of local residents. HV, KOA, and gout attack were identified as independent risk factors in this study. Previous reports have clarified that KOA is related to HV.[23] Interestingly, our study demonstrated KOA as an independent risk factor for HR, regardless of HV. Further, the severity of HR was higher in patients with KOA. This may reflect individuals with a genetic predisposition to cartilage damage developing KOA and HR. This possibility is strengthened by a study revealing that OA of the 1st MTP was associated with OA at differing sites, including the knee and interphalangeal joints.[8] In short, we confirmed a close relationship between KOA and HR in the present study.

Mertz reported that the individuals with HR experienced gout attack more often than those without HR.[24] Gout attack has also been reported to cause inflammation of the first metatarsophalangeal joint and erosion of the bone, which may result in HR.[25] Those hypotheses were supported by our study clarifying a history of gout attack as a strong risk factor for HR.

Several limitations to this study should be considered when interpreting the results. First, this study involved medical checkups in the limited local area of a mountainous, rural area in Japan, and the participants are not representative of the entirety of Japan. Second, this study was cross-sectional in design, and the results thus cannot be used to determine whether risk factors such as KOA cause HR or vice versa. Third, participants were relatively healthy elderly individuals, because they were able to walk to the local hospital. Fourth, we only obtained anteroposterior X-rays of the feet with the participant standing upright; lateral-view images were not taken.

Conclusion

In conclusion, we retrospectively examined the prevalence of HR and sought to identify associated risk factors among individuals over 50 years old. We found three important clinical issues: the prevalence of HR among individuals over 50 years old was 26.7%; KOA, HV, and gout attack were independent risk

factors for HR; and KOA was associated with the severity of HR. Larger, longitudinal studies are needed to confirm our findings.

Abbreviations

HR: Hallux rigidus

MTP: Metatarsophalangeal

KOA: Knee osteoarthritis

GA: Gout attack

HV: Hallux valgus

BMI: Body mass index

SD: Standard deviation

OR: Odds ratio

CI: Confidence interval

Declarations

Ethics approval and consent to participate: This study was approved by the institutional review board of Mie University Graduate School of Medicine. All of the participants provided written, informed consent. All method were performed in accordance with the relevant guidelines and regulations

Consent for publication: Not applicable

Availability of data and materials: The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

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Authors' contributions:

YS conceived of this study and participated in the study design, and performed data acquisition, analysis and interpretation, and drafted the manuscript. AN conceived of this study and participated in the study design, and helped to draft the manuscript. NI and YK contributed to the date collection. AS contributed to the study design and coordination. All authors read and approved the final manuscript.

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Tables

Table 1. Participant characteristics according to the presence or absence of hallux rigidus

Variable	Hallux rigidus (-) n=443	Hallux rigidus (+) n=161	p-value
Age (mean years $\pm$ SD)	66.9 $\pm$ 6.7	67.6 $\pm$ 5.5	0.24
Age (≥ 65)	326 (73.6%)	130 (80.7%)	0.087
Sex (female)	286 (64.6%)	110 (68.3%)	0.44
BMI	23.4 $\pm$ 3.3	23.7 $\pm$ 3.1	0.23
BMI (≥ 25)	117 (26.4%)	56 (34.8%)	0.053
Knee osteoarthritis	93(21.6%)	68 (39.1%)	*<0.001
Halux valgus	100(22.6%)	87 (54.0%)	*<0.001
Heberden's node	147 (33.2%)	64 (39.8%)	0.24
Vertebral fracture	62 (14.0%)	32 (19.9%)	0.12
Osteoporosis	106 (23.9%)	45 (28.0%)	0.29
Hypertension	172 (38.8%)	71 (44.1%)	0.26
Diabetes mellitus	33 (7.4%)	21 (13.0%)	*0.037
Hyperlipidemia	171 (38.6%)	57 (35.4%)	0.51
Gout attack	8 (1.8%)	8 (5.0%)	*0.044
Smoking	78 (17.6%)	29 (18.0%)	0.90
Alcohol	152 (34.3%)	52 (32.3%)	0.70

*p<0.05.

Table 2. Uni- and multivariate analyses of risk factors for hallux rigidus

Variable	Univariate		Multivariate	
	OR (95% CI)	<i>P</i>	OR (95% CI)	<i>P</i>
Age (≥ 65)	1.51 (0.96–2.35)	0.072		
Sex (female)	1.18 (0.81–1.74)	0.39		
BMI (≥ 25)	1.49 (1.01–2.19)	*0.045	0.98 (0.93–1.05)	0.59
Knee osteoarthritis	2.32 (1.59–3.40)	* <0.001	2.15 (1.41–3.28)	* <0.001
Hallux valgus	4.03 (2.75–5.91)	* <0.001	3.82 (2.58–5.66)	* <0.001
Heberden's node	1.30 (0.86–1.97)	0.22		
Vertebral fracture	1.49 (0.91–2.44)	0.12		
Osteoporosis	1.26 (0.84–1.89)	0.27		
Hypertension	1.24 (0.86–1.79)	0.25		
Diabetes mellitus	1.86 (1.04–3.33)	*0.036	1.95 (1.03–3.68)	0.059
Hyperlipidemia	0.87 (0.59–1.26)	0.45		
Gout attack	2.83 (1.04–7.67)	*0.041	3.27 (1.07–9.92)	*0.037
Smoking	1.03 (0.64–1.65)	0.91		
Alcohol	0.91 (0.62–1.34)	0.64		

Abbreviations: OR, odds ratio; CI, confidence interval; BMI, body mass index, * $p < 0.05$.

Figures

Figure 1

The Severity of hallux rigidus Grade 0: normal Grade 1: Preservation of joint space, mild osteophyte formation Grade 2: Mild to moderate joint-space narrowing, moderate osteophyte formation, subchondral sclerosis and cysts Grade 3: Severe joint-space narrowing, significant osteophyte formation, loose bodies, subchondral sclerosis and cysts

Figure 2

Ratio of symptomatic hallux rigidus according to severity

Figure 3

Relationship between hallux rigidus severity and knee osteoarthritis