Foot and Ankle Surgery 25 (2019) 670–673

Contents lists available at ScienceDirect

Foot and Ankle Surgery

journal homepage: www.elsevier.com/locate/fas

The effect of gender in hallux valgus surgery. A propensity score matched study

Winston Shang Rong Lim*, Ming Han Lincoln Liow, Inderjeet Singh Rikhraj, Graham Seow-Hng Goh, Kevin Koo

Singapore General Hospital, Department of Orthopaedic Surgery, 20 College Road, 169856, Singapore

ARTICLE INFO

Article history:
Received 19 June 2018
Received in revised form 23 July 2018
Accepted 1 August 2018

Keywords:
Hallux valgus
Patient-reported outcomes
Expectations
Gender

ABSTRACT

Background: Males and females who undergo hallux valgus (HV) surgery have different expectations.
Methods: Data from 439 patients, with 26 males, were prospectively collected between 2007–2015. Propensity score matching (PSM) of one male to two females was performed using logistic regression of six variables to minimize selection bias. Hallux visual analogue scale (VAS) scores, AOFAS scores, SF-36, satisfaction and expectation scores were analysed at two years.
Results: There were no significant differences in patient demographics after PSM. At two years, males and females attained similar VAS and AOFAS scores but males had significantly lower SF-36 general health score (males 68.7, females 79.3). 26.9% of males and 21.2% of females were not satisfied after surgery. Higher proportion of males did not have their expectations fulfilled (males 19.2%, females 5.8%) although this was not statistically significant.
Conclusions: Both genders attain similar outcome at two years. There is a trend towards lower expectation fulfilment in males after surgery.

1. Introduction

Hallux valgus is a common forefoot deformity where the hallux deviates laterally and first metatarsal head becomes prominent medially. Patients with symptomatic hallux valgus typically complain of bunion pain, difficulty with footwear, skin irritation and ulceration [1]. It is widely recognised to be a disease more prevalent in female patients across all ages than in males [2]. Inappropriate footwear choices [3] and differences in osseous anatomy such as a smaller and more rounded metatarsal head [4] may predispose women to developing hallux valgus.

Differences in surgical outcomes between genders have been well studied in various other orthopaedic surgeries [5–7] such as total joint arthroplasty. A local study examining the gender difference in total knee replacement found that women had poorer preoperative function but greater improvement than men after surgery [6]. It is also well known that there are differences in pain perception between males and females. Women tend to experience greater clinical pain, suffer greater pain-related distress [8] and may over-report functional limitations [5]. Given the higher prevalence of hallux valgus in females, it would be important to determine if gender is a risk factor for poorer outcome after surgery.

Tai et al. found that males and females who undergo hallux valgus surgery may have different expectations [9], which may consequently affect their satisfaction of the surgery. Currently, there is a paucity of literature examining health-related quality of life outcomes and satisfaction between both genders undergoing surgery. In investigating the effect of gender, which cannot be assigned randomly, covariate imbalance between males and females presents an obstacle to this study. The propensity score matching method is an effective method to minimize selection bias and ensure covariate balance [10]. We aim to determine if there are any differences in clinical outcomes between males and females undergoing hallux valgus surgery. We hypothesize that both genders will attain similar outcomes after surgery.

2. Materials and methods

Appropriate ethics approval was obtained from our institution's review board prior to conduct of this study. Prospectively collected patient data of all hallux valgus surgery performed at our hospital from 2007 to 2015 was analysed. The minimum follow up was 2 years.

Our inclusion criteria were (1) Age ≥18 years; (2) primary hallux valgus correction surgery; (3) preoperative hallux valgus

* Corresponding author at: Academia Level 4 Department of Orthopaedic Surgery, Singapore General Hospital, 20 College Road, 169856, Singapore.
E-mail address: winston.lim@mohh.com.sg (W.S.R. Lim).

https://doi.org/10.1016/j.fas.2018.08.003
1268-7731/

angle (HVA) >15°. Our exclusion criteria were (1) patients with rheumatoid arthritis; (2) patients with symptomatic tarso-metatarsal osteoarthritis.

There were 438 patients with complete data who fulfilled the above criteria from 2007 to 2015. Of these, 26 patients were male and 412 patients were female. This ratio of 1 male for every 15 female is similar to what has been reported [3]. Propensity scores generated using logistic regression were used to adjust for confounding variables of age, body mass index, preoperative HVA, hallux visual analogue scale (VAS), American Orthopaedic Foot and Ankle Society (AOFAS) scores and Short Form-36 (SF-36) scores. The propensity score is the conditional probability of assignment to a particular treatment given a vector of observed covariates [11]. This allowed the matching of male (n = 26) to female (n = 52) patients in a 1:2 ratio using the nearest neighbour method [12]. The patient demographics before and after propensity score matching are displayed in Table 1. The surgical technique at our institution has been previously described [13], which is a distal metatarsal osteotomy such as a chevron osteotomy for preoperative HVA less than 30°. For preoperative HVA more than 30°, a proximal metatarsal shaft osteotomy such as a scarf osteotomy was performed. An Akin's osteotomy was performed if the hallux valgus interphalangeus was more than 10°. The number of patients who underwent each type of osteotomy is displayed in Table 2.

Functional outcome assessment involved the hallux VAS, AOFAS Hallux Metatarsophalangeal-Interphalangeal score and SF-36 Quality of life score. These were assessed and compiled by independent orthopaedic technicians preoperatively and postoperatively at 2 years. While VAS scores of the individual lesser toes were also recorded, these were not analysed as lesser toe metatarsalgia is not the focus of this study.

Table 1
Patient demographics before and after propensity-score matching (1:2 ratio).

Before PSM	Male (n = 26)	Female (n = 412)	p-value
Age (years)	49.8 ± 17.5	55.2 ± 11.8	**0.03**
BMI (kg/m^2)	24.5 ± 4.4	24.0 ± 4.0	0.52
Hallux VAS	4.2 ± 2.6	4.4 ± 2.9	0.75
AOFAS score	56.2 ± 17.2	57.0 ± 16.2	0.81
SF-36 physical function	85.2 ± 11.0	79.7 ± 17.1	0.11
SF-36 role physical	37.5 ± 43.7	59.2 ± 42.6	**0.01**
SF-36 bodily pain	51.0 ± 27.2	52.2 ± 19.4	0.76
SF-36 general health	76.3 ± 22.3	76.1 ± 18.2	0.96
SF-36 vitality	74.6 ± 18.2	73.7 ± 20.3	0.82
SF-36 social function	80.3 ± 31.7	87.0 ± 23.3	0.17
SF-36 role emotional	100.0 ± 0.0	95.3 ± 20.1	0.24
SF-36 mental health	81.7 ± 15.1	84.7 ± 13.8	0.29
SF-36 PCS	44.1 ± 8.4	46.2 ± 9.2	0.24
SF-36 MCS	55.0 ± 10.4	55.2 ± 9.7	0.90
After PSM	**Male (n = 26)**	**Female (n = 52)**	**p-value**
Age (years)	49.8 ± 17.5	49.3 ± 13.3	0.89
BMI (kg/m^2)	24.5 ± 4.4	24.6 ± 4.3	0.93
Hallux VAS	4.2 ± 2.6	3.8 ± 2.9	0.57
AOFAS score	56.2 ± 17.2	59.4 ± 16.0	0.41
SF-36 physical function	85.2 ± 11.0	81.7 ± 17.3	0.36
SF-36 role physical	37.5 ± 43.7	55.3 ± 44.6	0.10
SF-36 bodily pain	51.0 ± 27.2	51.5 ± 19.6	0.93
SF-36 general health	76.3 ± 22.3	76.0 ± 19.2	0.96
SF-36 vitality	74.6 ± 18.2	71.3 ± 20.5	0.48
SF-36 social function	80.3 ± 31.7	80.3 ± 25.2	1.00
SF-36 role emotional	100.0 ± 0.0	93.6 ± 20.9	0.12
SF-36 mental health	81.7 ± 15.1	85.9 ± 11.7	0.18
SF-36 PCS	44.1 ± 8.4	45.3 ± 9.3	0.57
SF-36 MCS	55.0 ± 10.4	54.6 ± 9.9	0.88

Bold values indicate statistically significant results.
BMI: body mass index, VAS: visual analogue scale, AOFAS: American Orthopaedic Foot and Ankle Society, SF-36 PCS: Short form 36 physical component score, SF-36 MCS: Short form 36 mental component score.

Table 2
Type of osteotomy performed for hallux valgus correction, by gender.

	Male (n = 26)	Female (n = 52)	p-value
Proximal osteotomy without Akin's	7	18	0.495
Proximal osteotomy with Akin's	7	15	0.859
Distal osteotomy without Akin's	11	15	0.237
Distal osteotomy with Akin's	1	4	0.516

The hallux VAS assesses for pain over the first toe, with 0 being no pain and 10 being the worst possible pain. It has good validity and internal consistency when used as a measurement for pain [14]. The AOFAS score is a forefoot specific outcome measure with 40 points assigned to pain, 45 to function and 15 to alignment. The minimal clinically important difference (MCID) is defined as the smallest change in the measure that patients perceive as meaningful [15]. In the context of hallux valgus surgery, the MCID of the AOFAS has been reported by various authors to be 25–29 [15,16]. We adopted the value of 29 in our study as it was determined by the anchor-based approach to patient-reported satisfaction with surgical outcome [16].

The SF-36 score consists of 8 subscales: physical functioning, physical role, bodily pain, general health, vitality, social functioning, emotional role and mental health. Two summary scores — Physical Component Score (PCS) and Mental Component Score (MCS) aggregate the most highly correlated subscales.

Satisfaction and expectation fulfilment scores were rated out of a maximum of six or seven respectively on Likert scale, with lower scores indicating better results. A satisfaction score of ≥4 indicated dissatisfaction and an expectation fulfilment score of ≥5 indicated a lack of expectation fulfilment. Pre and postoperative hallux valgus angle (HVA) and the inter-metatarsal angle (IMA) between the 1st and 2nd metatarsals at two-year follow-up were obtained from weight-bearing radiographs.

Statistical analysis was performed with SPSS v20.0 (IBM) statistical software. The Student's unpaired t-test was used to compare quantitative variables between the two groups. Categorical data such as satisfaction/expectation and the proportion of patients meeting the MCID thresholds were analysed using either Fisher's exact test or Chi-square test. A p value of 0.05 or less was considered to be statistically significant.

3. Results

3.1. Preoperative demographics

Before propensity score matching, male patients undergoing hallux valgus surgery were significantly younger than female patients (male 49.8, female 55.2. P = 0.03). Males also had significantly lower score in the SF-36 subscale for role limitation due to physical health preoperatively (males 37.5, females 59.2. P = 0.01), suggesting that younger males with hallux valgus deformities report poorer physical health.

After propensity score matching, there were no significant differences in preoperative demographics between males and females. Pre-operative VAS scores, AOFAS scores and SF-36 scores were similar for both groups (Table 1). The severity of hallux valgus deformity was similar both groups too (Table 6).

3.2. Postoperative functional and radiological outcomes

At two years, there were no significant difference in hallux VAS or AOFAS scores between both genders. Males reported poorer general health compared to females (68.7 ± 20.6 vs 79.3 ± 17.8, P = 0.02). There were no other significant differences in postoperative Health-Related Quality of Life (HRQoL) indices of SF-36, PCS,

Table 6
Radiological outcomes.

	Male (n = 26)	Female (n = 52)	p-value
Pre-operative HVA	29.3 ± 8.4	28.2 ± 9.3	0.63
Post-operative HVA	14.7 ± 6.5	12.5 ± 7.8	0.25
Pre-operative IMA	14.4 ± 3.2	13.9 ± 3.4	0.53
Post-operative IMA	9.4 ± 3.3	8.3 ± 3.1	0.17

HVA: hallux valgus angle, IMA: 1st/2nd inter-metatarsal angle.

MCS (Table 3). A lower proportion of males were satisfied with their surgery (males 73.1%, females 78.8%. P = 0.58) and felt that their expectations were fulfilled (males 80.8%, females 94.2%. P = 0.11) (Table 4). However, with the numbers available, these were not found to be of statistical significance. 54% of males and 46% females attained MCID at two-years (Table 5).

With regard to surgical correction of the hallux valgus deformity, both males and females achieved adequate deformity correction with surgery. There were no significant differences in the postoperative radiographic measurements (Table 6).

Table 4
Satisfaction and fulfilment of expectations at two-year follow-up.

	Two-years		p-value
	Male (n = 26)	Female (n = 52)	
Satisfied (%)	73.1	78.8	0.58
Dissatisfied (%)	26.9	21.2	
Expectations fulfilled (%)	80.8	94.2	0.11
Expectations unfulfilled (%)	19.2	5.8	

Satisfaction: 76.9%.
Expectation fulfilment: 89.7%.

Table 5
Minimal clinically important difference (MCID) attainment at two-year follow-up.

	Two-years		p-value
	Male (n = 26)	Female (n = 52)	
MCID attained (%)	53.8 (14)	46.2 (24)	0.63
MCID not attained (%)	46.2 (12)	53.8 (28)	

4. Discussion

In our study, both genders with symptomatic hallux valgus that underwent corrective surgery experienced a reduction in VAS and improvement in AOFAS scores. Postoperatively, there were no significant differences in hallux VAS and AOFAS scores between both genders. There were greater improvements in the SF-36 physical component score compared to the mental component score for both genders (PCS — males 44.1–52.9, females 45.3–51.4; MCS — males 55.0–53.8, females 54.6–56.2). Large improvements were seen in the SF-36 component — role limitation due to physical health problems (males 37.5–80.8, females 55.3–80.8). This suggests that hallux valgus mainly affects a patient's physical function and correction of the deformity enables patients to return to higher physical function.

Our study found that a lower proportion of males undergoing hallux valgus surgery had their expectations fulfilled. This could possibly be due to the different expectations that males and females have regarding hallux valgus surgery. In a study by Tai et al. [9], male patients prioritized the ability to return to work over bunion pain and cosmesis, whereas female patients placed more emphasis on bunion pain and improvement in forefoot appearance. A higher proportion of males had their expectations left unmet when compared to females (males 19.2%; females 5.8%), and satisfaction rates were lower in males (73.1%) compared to females (78.8%) after surgery. However, both of these were not found to be statistically significant. A recent review of a single surgeon's outcomes by Choi et al. [17] found that both males and females attained similar postoperative AOFAS scores (males 84.8; females 87.8. P = 0.093). A higher proportion of their male patients (18.2%), compared to female patients (7.3%) were not satisfied with their surgery, but this was not found to be statistically significant (P = 0.075). This is similar to our study findings in regard to satisfaction rates.

Despite adequate correction the hallux valgus deformity, more than 20% of both genders remain dissatisfied with the surgery. Satisfaction after hallux valgus surgery was studied by Milnes et al. [18]. The authors reported that women <50 years were less satisfied than women >50 years after hallux valgus surgery. Interestingly, this was despite both age groups attaining identical postoperative mean AOFAS scores. Reasons for lower satisfaction as reported by Milnes et al. included continued pain, transfer metatarsalgia, scar sensitivity and inability to wear high heels. Qualitative research will be needed to identify reasons for dissatisfaction and the trend towards poorer expectation fulfilment in males compared to females.

In our study, similar proportions of males (53.8%) and females (46.2%) attained the MCID for the AOFAS score, suggesting that both males and females are able to achieve satisfactory outcomes postoperatively. In addition, as attainment of the MCID reflects a clinical improvement from the patient's own perspective, its use complements the AOFAS score in assessing patients after hallux valgus surgery [19]. Using a high MCID value of 29 in our study may be the reason why a low proportion of our patients attained this value after operation. If we had used a lower MCID value of 25, as suggested by Dawson et al. [15], a higher proportion of our patients would have attained the MCID. Thus, the MCID is a new parameter that may be useful in evaluating surgical success after operation and further studies to validate this tool is warranted.

The mean age of male patients at time of surgery was lower than the female patients (male 49.8; female 55.2. P < 0.05) prior to propensity score matching. This could be because hallux valgus in males is thought to be a predominantly hereditary deformity with early onset when compared to females [3]. Katz et al. [5] suggested that women may present later as they may be more averse to taking risks than men and avoid surgery because of its potential complications. They may face subtle barriers to access to surgery such as a general regard for functional loss to be less important for women than men.

Table 3
Clinical, patient-reported and Health-related Quality-of-life Outcome (HRQoL) measures.

	Male (n = 26)	Female (n = 52)	p-value
Hallux VAS	0.5 ± 1.4	0.6 ± 1.8	0.88
AOFAS score	86.4 ± 12.3	87.4 ± 11.2	0.74
SF-36 physical function	89.0 ± 13.3	87.2 ± 14.7	0.60
SF-36 role physical	80.8 ± 31.1	80.8 ± 32.7	1.00
SF-36 bodily pain	68.1 ± 24.2	65.2 ± 23.7	0.61
SF-36 general health	68.7 ± 20.6	79.3 ± 17.8	**0.02***
SF-36 vitality	70.8 ± 18.2	75.5 ± 18.5	0.29
SF-36 social function	98.1 ± 9.8	93.8 ± 16.5	0.22
SF-36 role emotional	96.2 ± 19.6	97.4 ± 11.1	0.71
SF-36 mental health	85.8 ± 10.2	84.7 ± 14.4	0.72
SF-36 PCS	52.9 ± 8.0	51.4 ± 6.7	0.37
SF-36 MCS	53.8 ± 7.2	56.2 ± 9.6	0.26

VAS: visual analogue scale, AOFAS: American Orthopaedic Foot and Ankle Society, SF-36 PCS: Short form 36 physical component score, SF-36 MCS: Short form 36 mental component score.
* p < 0.05 = statistically significant.

This study needs to be interpreted in light of its limitations. Our sample size of male patients seeking hallux valgus surgery was small. This was overcome with the use of propensity score matching, allowing us to match our male patients in a 1:2 ratio to females with similar preoperative functional scores and radiological deformity. While the AOFAS score, VAS and SF-36 are widely used and validated in foot and ankle research [20], the same cannot be said of satisfaction and expectation scores. A wide variety of scales have been used by various authors in an attempt to quantify patient satisfaction. Some have used qualitative categories [18] (eg. very satisfied, satisfied, neither, dissatisfied, very dissatisfied), while others have attempted to use a Likert scale [21]. To our knowledge, there is no validated nor widely used instrument to measure patient satisfaction in foot and ankle research. This may limit comparison of satisfaction outcomes between different studies. In addition, our patient questionnaire only evaluates satisfaction and expectation fulfilment after surgery. Future improvement could include patient specific expectations pre-operation and these be evaluated post-operation to see if they have been met.

In conclusion, our study has demonstrated that both males and females can experience reduction in hallux pain, better physical function, improved health-related quality of life (HRQoL) outcomes and satisfaction after hallux valgus surgery. Propensity matching has shown that there are no statistically significant differences in the outcomes with regard to the various scores used in our study. However, surgeons should be cognizant that a more than 20% of patients remain dissatisfied after surgery, with males having poorer satisfaction rates and lower fulfilment of expectations when compared to females. Future research should focus on identifying risk factors for dissatisfaction and poorer expectation fulfilment in patients undergoing hallux valgus surgery.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

The authors have no conflict of interests to declare.

References

[1] Coughlin M.J., Jones CP. Hallux valgus: demographics, etiology, and radiographic assessment. Foot Ankle Int 2007;28:759.
[2] Nix S, Smith M, Vicenzino B. Prevalence of hallux valgus in the general population: a systematic review and meta-analysis. J Foot Ankle Res 2010;3:21.
[3] Nery C, Coughlin MJ, Baumfeld D, Ballerini FJ, Kobata S. Hallux valgus in males—part 1: demographics, etiology, and comparative radiology. Foot Ankle Int 2013;34:629.
[4] Ferrari J, Malone-Lee J. The shape of the metatarsal head as a cause of hallux abductovalgus. Foot Ankle Int 2002;23:236.
[5] Katz JN, Wright EA, Guadagnoli E, Liang MH, Karlson EW, Cleary PD. Differences between men and women undergoing major orthopedic surgery for degenerative arthritis. Arthritis Rheum 1994;37:687.
[6] Lim JB, Chi CH, Lo LE, Lo WT, Chia SL, Yeo SJ, et al. Gender difference in outcome after total knee replacement. J Orthop Surg (Hong Kong) 2015;23:194.
[7] Jawa A, Dasti U, Brown A, Grannatt K, Miller S. Gender differences in expectations and outcomes for total shoulder arthroplasty: a prospective cohort study. J Shoulder Elbow Surg 2016;25:1323.
[8] Paller CJ, Campbell CM, Edwards RR, Dobs AS. Sex-based differences in pain perception and treatment. Pain Med (Malden, Mass) 2009;10:289.
[9] Tai CC, Ridgeway S, Ramachandran M, Ng VA, Devic N, Singh D. Patient expectations for hallux valgus surgery. J Orthop Surg (Hong Kong) 2008;16:91.
[10] Austin PC. Statistical criteria for selecting the optimal number of untreated subjects matched to each treated subject when using many-to-one matching on the propensity score. Am J Epidemiol 2010;172:1092.
[11] Rosenbaum RP, Rubin D. The central role of the propensity score in observational studies for causal effects. 1983.
[12] Austin PC. A comparison of 12 algorithms for matching on the propensity score. Stat Med 2014;33:1057.
[13] Chen JY, Ang BF, Jiang L, Yeo NE, Koo K, Singh Rikhraj I. Pain resolution after hallux valgus surgery. Foot Ankle Int 2016;37:1071.
[14] Price DD, McGrath PA, Rafii A, Buckingham B. The validation of visual analogue scales as ratio scale measures for chronic and experimental pain. Pain 1983;17:45.
[15] Dawson J, Doll H, Coffey J, Jenkinson C. Responsiveness and minimally important change for the Manchester-Oxford foot questionnaire (MOXFQ) compared with AOFAS and SF-36 assessments following surgery for hallux valgus. Osteoarthritis Cartilage/OARS Osteoarthritis Res Soc 2007;15:918.
[16] Chan HY, Chen JY, Zainul-Abidin S, Ying H, Koo K, Rikhraj IS. Minimal clinically important differences for american orthopaedic foot & ankle society score in hallux valgus surgery. Foot Ankle Int 2017;38:551.
[17] 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;56:466.
[18] Milnes HL, Kilmartin TE, Dunlop G. A pilot study to explore if the age that women undergo hallux valgus surgery influences the post-operative range of motion and level of satisfaction. Foot (Edinburgh, Scotland) 2010;20:109.
[19] Pinsker E, Daniels TR. AOFAS position statement regarding the future of the AOFAS Clinical Rating Systems. Foot Ankle Int 2011;32:841.
[20] Hunt KJ, Hurwit D. Use of patient-reported outcome measures in foot and ankle research. J Bone Joint Surg Am 2013;95:e118.
[21] Mouton A, Le Strat V, Medevielle D, Kerroumi Y, Graff W. Patient's satisfaction after outpatient forefoot surgery: study of 619 cases. Orthop Traumatol Surg Res OTSR 2015;101:S217.