Outcomes in chevron osteotomy for Hallux Valgus in a cohort of 438 procedures.

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Abstract

Introduction

The goal of this study was to evaluate the effect of the chevron osteotomy for hallux valgus on patient's daily lives using the Foot and Ankle Outcome Sore (FAOS). Secondary outcome measures were radiological correction, complication rate, and re-operations.

Methods

All 438 chevron procedures (336 patients) in the period between January 2010 and October 2014, were retrospectively evaluated with a follow up of at least 6 months.

Results

For the FAOS, 60% of the patients responded with scores ranging between 71 and 88 during an average follow-up of 36 months. Patients with undercorrection or reoperation scored significantly lower on the FAOS.

Conclusion

Chevron osteotomy offers good PROM scores on FAOS. However, results of the FAOS appear to modulate with physician based outcomes and therapeutic incidents like undercorrection and reoperation. Improvement of outcome may therefore well be possible by increased attention on these surgical details.

Key-words

Hallux valgus

Chevron osteotomy

Patient reported outcome measures

Foot and Ankle Outcome score

Introduction

Hallux valgus is the most common deformity of the forefoot.(1) The global prevalence reaches up to 23% in those aged between 18- to 65-year and to 35% in the population over 65.(2) With a prevalence of 30% in females compared 13% in males it is apparent that females are more likely to develop hallux valgus.(2) The main symptom is pain of the hallux arising from the formed bunion at the medial aspect of the first metatarsal head. Complaints may prevent the patient's ability to wear fashion shoes. Furthermore, daily activities may be restricted and quality of life decreased.(3)

Surgery for hallux valgus is indicated if pain persists after conservative treatment. More than 130 surgical techniques have been described for the treatment of hallux valgus.(4) The distal chevron osteotomy is a well-known and widely accepted intervention for the treatment of mild to moderate deformities.(4, 5) This technique was first described in 1962, and produces a V-shaped cut of the first metatarsal after which the distal fragment is displaced laterally.(1) The technique is popular because of its simplicity and low invasiveness, leading to excellent procedural outcomes.(4, 6) A recent meta-analysis by Smith and colleagues reported a mean correction of the intermetatarsal angle (IMA) of 5.3 degrees.(7) Frequent seen complications include recurrence (2.7 – 16 %), transfer metatarsalgia (8.3 – 14%), and avascular necrosis of the metatarsal head (0 – 20 %).(8-12)

In addition to surgical outcomes, disease specific and Patient Reported Outcome Measures (PROMs) are a growing phenomenon to monitor the effectiveness of an intervention by the patient's opinion.(13) These questionnaires should contain items that are relevant to the patient.(13) Although articles on hallux valgus surgery report significant improvement in outcome measures after surgery, these results are mostly

gathered by means of more physician-based questionnaires like the American Orthopaedic Foot and Ankle Society Scales.(6, 14-16)

Therefore, the goal of this study was to evaluate the effect of the chevron osteotomy for hallux valgus on patient's daily living using a validated hallux valgus specific PROM. Also, surgical related outcomes, such as adverse events, re-surgery, and radiographic correction, of the chevron technique were noted. An additional objective was to assess possible differences in PROM in cases with undercorrection and complications.

Materials and Methods

We conducted a retrospective study of patients who underwent a chevron procedure for hallux valgus. All patients who were operated between January 2010 and October 2014, performed in Máxima Medical Center Veldhoven/Eindhoven or Catharina Hospital Eindhoven in the Netherlands were eligible for inclusion. The participating hospitals performed chevron osteotomies in mild to moderate cases of hallux valgus defined as an IMA of 15 degrees or less.

Patients were included in the current study if they were 18 years or older at the time of the primary distal chevron osteotomy. The exclusion criteria were previous surgical intervention of the first ray, chevron osteotomy combined with major forefoot surgery, and missing pre or postoperative radiographs. All patients who fulfilled these criteria were invited to fill in the FAOS. Patients with insufficient command of the Dutch language were excluded for the PROM. Furthermore, patients with other current foot complaints were also excluded.

The institutional review boards approved the present study. Written informed consent was obtained from those patients taking part in the cross-sectional part for PROM assessment.

Surgical procedure and related outcomes

Multiple orthopaedic surgeons carried out the primary distal chevron osteotomy as correction for hallux valgus. At two hospital sites also residents performed the procedures. The chevron technique was performed by means of a dorsomedial incision over the first metatarsophalangeal joint (MTPJ) deepened to the capsule and metatarsal shaft. The medial eminence was exposed and excised with a power saw. Subsequently the V-shaped osteotomy of the distal first metatarsal was made guided by a Kirschner

Wire aimed to the fourth/fifth MTPJ. The head fragment was translated laterally followed by cannulated screw fixation (Bold®, Integra LS, Zaventem, Belgium). The remaining medial spike was trimmed off. The medial joint capsule was closed in order to achieve further reduction of the sesamoids. The chevron method could be combined with an extra osteotomy (biplane chevron) to correct an increased distal metatarsal articular angle.

The chevron osteotomy is often combined with other small procedures of the forefoot. An Akin procedure, indicated in the presence of concurrent hallux interphalangeus, was made by a closing wedge osteotomy of the proximal phalanx. The osteotomy was fixed with a cannulated screw or staple (Solustaple®, Integra LS, Zaventem, Belgium). A distal soft tissue procedure (DSTP) was carried out either trans-articular or by means of a separate dorsal incision over the first intermetatarsal space, based on the surgeon's experience. The procedures on the first ray could also be combined with hammertoe correction or Wilson osteotomy of the fifth metatarsal.

After surgery patients were provided with a special postoperative shoe for six weeks. This shoe allows full weight bearing during rehabilitation while reducing stress and load in the forefoot region.

Patients' files were manually searched for the patient characteristics. Complications and reoperations were also noted for analysis.

Radiographic measurements

Lateral and anteroposterior weight-bearing radiographs were made preoperatively and at six weeks postoperative evaluation. One trained observer digitally measured the IMA and the hallux valgus angle (HVA) using template software (ICIS view 2014.1, Agfa HealthCare) on a digital workstation (Fig. 1). The IMA is formed by the longitudinal

bisection of the shafts of the first and second metatarsal. The HVA is formed by the intersection of a line drawn through the long axis of the first metatarsal and the long axis of the proximal phalanx.(17) To minimize the amount of intraobserver variability we used the Miller method, in which a line is drawn from the center of the head of the first metatarsal through the center of the base of the first metatarsal.(18, 19)

Undercorrection, also designated as recurrence, was defined as a postoperative HVA greater than 20 degrees with less than 10 degrees of angular correction.(20) All cases with a negative value of the difference between postoperative and preoperative HVA were labeled as hallux varus.

Patient Reported Outcome Measure (PROM)

Eligible patients received an invitation to complete the validated Dutch version of the FAOS.(21) This questionnaire consists of 42 items covering five subscales: Pain, Symptoms, Function in daily living (ADL), Function in sport and recreation (SPORT&REC), and foot and ankle-related Quality of Life (QoL). Taken the last week into account, each item is scored by the patient on a 5-point Likert scale. The score for each subscale ranges between 0 and 100, where a score of 100 indicates no problems and 0 indicates extreme problems. Participants with bilateral chevron osteotomies completed the FAOS subscales Pain, and other Symptoms for each side separately; and the other subscales once. Participants were able to complete the questionnaire online (Research Manager v5.0.0.4) or on paper by mail.

To gain more insight in the patient's motivation for surgery and the ability to wear fashion shoes, the following yes/no questions were additionally asked: "Would you recommend the chevron procedure to other people with similar complaints?" "If the condition would be present on both feet, would you prefer to have surgery for both feet

simultaneously?" "Are you able to wear all desirable shoes?" "Do you (still) use modifications made to shoe or sole?" "Are you able to wear high heels again?"

Statistical analysis

Bilateral chevron osteotomies were considered as separate cases in the statistical analyses. Results were notes as mean ± standard deviation after assessment of normal distribution. In order to explore whether the completed could be considered as a representative group, the patient characteristics were compared between the procedures with completed FAOS and those without. The Pearson Correlation and Point Biseral Correlation were used to further explore the role of the difference between variables within de completed FAOS group. Paired Student's T-tests were used to compare preoperative and postoperative radiologic measurements. Independent Student's T-tests were performed to compare FAOS subscale scores between cases of undercorrection or not and reoperation or not. IBM SPSS Statistics for Macintosh version 23.0 was used for all statistical analysis. A p-value of less than 0.05 was considered significant.

Results

Of the 496 chevron procedures, 438 (336 patients) fulfilled the in- and exclusion criteria (Fig. 2). Of these, a number of 415 procedures met the criteria for PROM (FAOS) assessment. A total response of 250 completed questionnaires (60%) was achieved.

The patient characteristics are presented in Table 1. A comparison of the cases with (FAOS+) and without (FAOS-) completed questionnaire showed that the FAOS+ group was significantly older (mean age 54.5 versus 46.0 years, p-value <0.001) and contained more bilaterally operated cases (80 versus 22, p-value <0.001).

The outcome of the FAOS is presented in Table 2. With a mean follow up of 163 (± 68) weeks the mean scores were: 83 (± 21) for the subscale PAIN, 82 (± 18) for SYMPTOMS, 88 (± 18) for ADL, 74 (± 30) for SPORT&REC, and 71 (± 29) for QoL. Table 3 represents the FAOS between groups: undercorrection versus no undercorrection, and reoperation versus no reoperation. To assess whether the results of the patients who completed the FAOS were representative for the whole population, we assessed whether age and bilateral operated cases were related to the FAOS score. No correlation was found.

Concurrent procedures, complications and reoperations are listed in Table 4. A DSTP and an Akin were the two most frequently combined procedures, respectively 292 (66.7%) and 129 (29.5%) of the cases. The most occurring complications were radiologic undercorrection in 51 cases (11.6%) and complaints of the hardware (screw used for fixation of the chevron) in 40 cases (9.1%). A total of 124 (28.3%) complications were reported, which led to a reoperation in 59 cases (13.5%). All cases of symptomatic hardware led to a reoperation for removal of the fixation screw. Three reoperations (6%) were due to radiological undercorrection.

Table 5 represents the radiologic outcome measurements. The mean postoperative improvement of the IMA was 6.1° (p-value <0.001), and 13.7° for the HVA (p-value <0.001).

Based on the additional questions, the chevron procedure would be recommended to others by 71% of the participants. A hypothetical simultaneously carried out chevron-osteotomy would not be preferred by 74% of the participants, particularly because it would compromise daily activities too much in the early postoperative period. Of all patients who filled in the PROM, 59% was not able to wear all desirable shoes and 34% still used modifications made to shoe or sole. Over half of the women (55%) who wore high heels before surgery were able to wear high heels again.

Discussion

The main purpose of this study was to evaluate PROM and surgery related outcomes in a large cohort of chevron osteotomies as correction of hallux valgus. We found good patient-based results using the FAOS and significant reduction of the IMA and HVA. However, these findings were achieved in the light of a high rate of complications and reoperations. Furthermore, patients with radiological undercorrection and reoperation scored significantly lower on multiple subscales of the FAOS.

To our knowledge this is the first study using the FAOS as PROM after chevron osteotomy for the treatment of hallux valgus. The FAOS has been validated and translated into Dutch with acceptable construct validity, reliability, and responsiveness for the assessment of hallux valgus patient based outcomes.(21, 22) Although a recent review about PROMs in hallux valgus surgery preferred the Manchester-Oxford foot questionnaire (MOXFQ) and the self-reported foot and ankle score (SEFAS) to the FAOS as disease specific PROM we chose the FAOS, since at the moment of study this was the only relevant PROM that had been validated for the Dutch language.(13) Also, another recent review regarded the FAOS as the most appropriate PROM for general foot and ankle problems.(23)

One reported disadvantage of the FAOS is the tendency to ceiling effects for the ADL and sports subscale.(22) Indeed, in the present study we found ceiling effects for all subscales with rates of the maximal score between 23.6% and 43.2% of all cases. The presented ceiling effects indicate that the questionnaire's maximal score is reached, without leaving room for discrimination among patients with no complaints. Another explanation of the ceiling effects is that genuinely good results were achieved. The latter was confirmed by further exploration of the cases with a maximal FAOS score, showing

that these patients also scored well on the additional questions with almost no reoperations and complications.

The FAOS results of the present study, with scores for the different subscales varying between 71 and 88, indicate good scores for those subjects who completed the questionnaire. Comparison of the FAOS between groups showed that the patients with undercorrection scored significantly lower on 3 subscales, and patients with a re-operation on 4 scales (Table 3). This indicates that although the overall scores are acceptable, especially the selected cases with reoperations and radiological undercorrection maintain significant shortcomings in pain and symptom reduction, function in daily living, quality of life, and function in sport and recreation with regard to the treated hallux valgus. Since not all patients included in our study filled in the FAOS, we assessed whether the patients who did fill in the FAOS were representative for the whole study population. Further analysis demonstrated that the differences in age and bilateral versus unilateral between those patients who filled in and those who did not, were not correlated with the FAOS score. Therefore, we considered the patients who filled in the FAOS as a representative group. The FAOS results are acceptable and applicable to all patients undergoing chevron osteotomy in our clinic.

The present study found significant correction for both the IMA and HVA on the six weeks postoperative radiographs. Measurements were carried out once by one rater. Prior research reported excellent intra- and interobserver reproducibility for digital measurements.(24) A recent study by Park and colleagues (2013) showed comparable clinical and radiographic outcomes between the trans-articular or dorsal web-space approaches for DSTP. (15) Therefore, the present study made no analytical difference between the two approaches. The corrections of IMA were a little better than those quoted in literature, 6.1 versus the mean of 5.3 degrees by the review of Smith et al. (7)

Other results of angular correction were similar to those reported in the recent literature.(6, 8, 14, 15, 25) However, limited patient numbers, different measurement methods, and divergent indications for the chevron complicate direct comparisons between those studies and our project.

The rate of transfer metatarsalgia was probably underreported due to incomplete documentation.(8, 9) The rate of 11.6% undercorrection found in the present study corresponds with rates reported, albeit with varying definitions and periods of follow-up, in the literature.(12) Interestingly, only 6% of the undercorrection measured at 6 weeks postoperatively led to a re-intervention. Undercorrection, also referred to as recurrence, remains one of the most common complications after hallux valgus surgery.(12) Contributing factors to undercorrection include patient-related factors such as anatomical predisposition, comorbidities, compliance after surgery, and surgery-related factors like choice of the technique and technical competence.(12, 26) To minimize the chance of recurrence, these factors should be evaluated preoperatively.(12)

The authors recognize limitations of the present study. First, the retrospective collection of the data on surgical outcomes possibly increased the risk of incompleteness of the data and selection bias. Furthermore, chevron osteotomies could be combined with other minor forefoot surgery, what might have led to an underestimation of the PROM results. However, combining these procedures is common in daily practice as the osseous correction of the chevron improves the IMA, where the DSTP results in HVA correction and sesamoid reduction.(27) We therefore believe our results give a genuine picture of daily practice.

Moreover, the FAOS was conducted cross-sectionally and only post-operative. As a result, no comparison between preoperative and post-operative patient-based

outcomes could be made and follow-up time differed between patients. Therefore, future research should include preoperative assessment of hallux valgus specific PROMs as well.

Another limitation is the amount of loss-to-follow up leading to a final response rate of those who filled in the FAOS of 60%. However, statistical analyses (table 1) of the patient characteristics between the responders and non-responders proved the studied cohort to be a good reflection of the mild to moderate hallux valgus population in our clinic.

In conclusion, chevron osteotomy for hallux valgus offers acceptable scores of the PROMs and good radiological improvement. However, orthopaedic surgeons should bear in mind that patients with radiological undercorrection or with a reoperation score significantly lower on the FAOS. Therefore, increased attention for these technical details may have a direct impact on patient reported outcome. Furthermore, patients should always be notified about the fairly high rate of reoperations, complications, and the possible consequences on their daily lives.

References

1. Wulker N, Mittag F. The treatment of hallux valgus. Dtsch Arztebl Int 109: 857, 2012

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 3: 21, 2010

3. Chhaya SA, Brawner M, Hobbs P, Chhaya N, Garcia G, Loredo R. Understanding hallux valgus deformity: what the surgeon wants to know from the conventional radiograph. Curr Probl Diagn Radiol 37: 127, 2008

4. Robinson AH, Limbers JP. Modern concepts in the treatment of hallux valgus. The Journal of bone and joint surgery British volume 87: 1038, 2005

5. Bai LB, Lee KB, Seo CY, Song EK, Yoon TR. Distal chevron osteotomy with distal soft tissue procedure for moderate to severe hallux valgus deformity. Foot Ankle Int 31: 683, 2010

6. Lee KB, Cho NY, Park HW, Seon JK, Lee SH. A comparison of proximal and distal Chevron osteotomy, both with lateral soft-tissue release, for moderate to severe hallux valgus in patients undergoing simultaneous bilateral correction: a prospective randomised controlled trial. Bone Joint J 97-B: 202, 2015

7. Smith SE, Landorf KB, Butterworth PA, Menz HB. Scarf versus chevron osteotomy for the correction of 1-2 intermetatarsal angle in hallux valgus: a systematic review and meta-analysis. J Foot Ankle Surg 51: 437, 2012

8. Buciuto R. Prospective randomized study of chevron osteotomy versus Mitchell's osteotomy in hallux valgus. Foot Ankle Int 35: 1268, 2014

9. Heerspink FO, Verburg H, Reininga IH, van Raaij TM. Chevron Versus Mitchell Osteotomy in Hallux Valgus Surgery: A Comparative Study. J Foot Ankle Surg, 2014

10. Lee KT, Park YU, Jegal H, Lee TH. Deceptions in hallux valgus: what to look for to limit failures. Foot Ankle Clin 19: 361, 2014

11. Malal JJ, Shaw-Dunn J, Kumar CS. Blood supply to the first metatarsal head and vessels at risk with a chevron osteotomy. The Journal of bone and joint surgery American volume 89: 2018, 2007

12. Raikin SM, Miller AG, Daniel J. Recurrence of hallux valgus: a review. Foot Ankle Clin 19: 259, 2014

13. Schrier JC, Palmen LN, Verheyen CC, Jansen J, Koeter S. Patient-reported outcome measures in hallux valgus surgery. A review of literature. Foot Ankle Surg 21: 11, 2015

14. Lechler P, Feldmann C, Kock FX, Schaumburger J, Grifka J, Handel M. Clinical outcome after Chevron-Akin double osteotomy versus isolated Chevron procedure: a prospective matched group analysis. Archives of orthopaedic and trauma surgery 132: 9, 2012

15. Park YB, Lee KB, Kim SK, Seon JK, Lee JY. Comparison of distal soft-tissue procedures combined with a distal chevron osteotomy for moderate to severe hallux valgus: first web-space versus transarticular approach. The Journal of bone and joint surgery American volume 95: e158, 2013

16. Trnka HJ, Zembsch A, Easley ME, Salzer M, Ritschl P, Myerson MS. The chevron osteotomy for correction of hallux valgus. Comparison of findings after two and five years of follow-up. The Journal of bone and joint surgery American volume 82-A: 1373, 2000

17. LAPORTA DM, Melillo TV, Hetherington VJ. Preoperative assessment in hallux valgus. Hallux valgus and forefoot surgery: 107, 1994

18. Schneider W, Csepan R, Knahr K. Reproducibility of the radiographic metatarsophalangeal angle in hallux surgery. The Journal of bone and joint surgery American volume 85-A: 494, 2003

19. Miller JW. Distal first metatarsal displacement osteotomy. Its place in the schema of bunion surgery. The Journal of bone and joint surgery American volume 56: 923, 1974
20. Coughlin MJ, Jones CP. Hallux valgus and first ray mobility. A prospective study. The Journal of bone and joint surgery American volume 89: 1887, 2007
21. van den Akker-Scheek I, Seldentuis A, Reininga IH, Stevens M. Reliability and validity of the Dutch version of the Foot and Ankle Outcome Score (FAOS). BMC Musculoskelet Disord 14: 183, 2013
22. Chen L, Lyman S, Do H, Karlsson J, Adam SP, Young E, Deland JT, Ellis SJ. Validation of foot and ankle outcome score for hallux valgus. Foot Ankle Int 33: 1145, 2012
23. Weel H, Zwiers R, Sierevelt IN, Haverkamp D, van Dijk CN, Kerkhoffs GM. [Dutch-language patient-reported outcome measures for foot and ankle injuries; a systematic review]. Ned Tijdschr Geneeskd 159: A8831, 2015
24. Srivastava S, Chockalingam N, El Fakhri T. Radiographic angles in hallux valgus: comparison between manual and computer-assisted measurements. J Foot Ankle Surg 49: 523, 2010
25. Fakoor M, Sarafan N, Mohammadhoseini P, Khorami M, Arti H, Mosavi S, Aghaeeaghdam A. Comparison of Clinical Outcomes of Scarf and Chevron Osteotomies and the McBride Procedure in the Treatment of Hallux Valgus Deformity. Arch Bone Jt Surg 2: 31, 2014
26. Okuda R, Kinoshita M, Yasuda T, Jotoku T, Kitano N, Shima H. The shape of the lateral edge of the first metatarsal head as a risk factor for recurrence of hallux valgus. The Journal of bone and joint surgery American volume 89: 2163, 2007
27. Chen YJ, Hsu RW, Shih HN, Huang TJ, Hsu KY. Distal chevron osteotomy with intra-articular lateral soft-tissue release for treatment of moderate to severe hallux valgus deformity. J Formos Med Assoc 95: 776, 1996