ORIGINAL ARTICLE

DOES HALLUX VALGUS SURGERY MODIFY THE GAIT PARAMETERS? LITERATURE REVIEW

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ABSTRACT

Background: the deformation of the hallux into a valgus constitutes the most frequent deformation of the forefoot and one of the most performed corrective surgeries in the region. This deformation is the cause of many biomechanical disorders and causes gait disturbances. This review aims to analyze the restoration of space-time and kinematic parameters of walking in the aftermath of corrective surgery for hallux valgus.

Methods: four studies were analyzed according to the main criteria of walking speed, support time, step length and kinematics of the ankle and foot before and after the intervention.

Results: If some of the results obtained in the analyzed works show an improvement of these criteria in post-operative, the subjects having benefited from hallux valgus surgery seem to present some persistent issues in the spatiotemporal and kinematic parameters.

Conclusion: This work does not demonstrate the superiority of one surgical technique over another in the recovery of gait. This recovery does not seem absolute, but this review highlights above all the lack of literature on this subject.

Keywords: hallux valgus, surgery, walking, spatiotemporal parameters, kinematics.

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INTRODUCTION

According to the work of *Hagedorn and al* [1], the hallux valgus (HV) represents the acquired deformity of the forefoot most often found in an adult population representing at least 26.3% of the acquired deformities. HV presents a prevalence, according to *Nix and al* [2], for 18-65-year-olds of 23%, confirmed by the work of *Carvalho and al* in 2015 [3], and 35.7% for the group of the most 65 years old. *Piclet-Legré* [4] found in 2017 a sex ratio of 1/15 patient against the female population, while for *Nix and al* (2010) [2], the deformation is found before 65 years in a woman in 4, then in a woman in 3 after 65 years. And today there are more than 70,000 interventions per year in France, therefore a real public health problem.

The deformation mechanism follows a common pattern: according to *Rush's* work from 2000 on cadaveric entities [5], it is an instability of the Cuneo-metatarsal which allows the medialization of the head of the 1st metatarsal, placing the latter in varus relative compared to the axis of symmetry of the foot, validated by *Hecht and Lin* in 2014 [6]. This variation of M1 leads, by catch-up mechanism, to a valgisation of P1 from hallux at the risk of being at the origin of a dislocation of the sesamoids in the inter-metatarsal space. As a result, the metatarsal head protrudes, and there is a thickening of the capsular fibrocartilage where osteophytes can develop in an arthritic process.

The deformation process is authorized due to an imbalance of the ligament forces to the disadvantage of the medial part at the level of the metatarsophalangeal (MTP) of the hallux. Just like the muscular forces, resulting from the long tendons (flexor hallucis longus and Extensor Hallucis Longus) of the muscles found an extrinsic origin at the foot, will tend to take the bowstring and to force the valgisation of the MTP of the hallux as we explain *Hecht (2014) and Lin* or *Piclet-Lebré (2017)* [4,6].

The first inter-metatarsal space is used to classify the evolution of the deformation process and, through it, the severity of the HV. This classification uses top view radiography to calculate the intermetatarsal angle as described by *Condon and al (2012)* [7]. The severity of HV can also be assessed via the metatarsophalangeal angle or more systemically by the functional scale developed by the American Orthopaedic Foot and Ankle Society (AOFAS).

There does not appear to be a specific etiology for HV. Rather, the literature refers to a set of factors that favor and then aggravate the deformation. The factors are therefore distinguished according to their origins: intrinsic or extrinsic. Among the intrinsic factors, ligament laxity and in particular, the Cuneo-metatarsal instability, according to *Johnson and Kile (1994)* [8] and of the metatarsophalangeal of the hallux represents a risk of developing an HV. Just like the collapse of the medial arch of the foot leading to false flat valgus feet according to *Golightly and al (2015)* [9]. Among the extrinsic factors, *Menz and al* (2016) [10] explain that the wearing of pointed shoes and shoes with heels could participate in the development and the aggravation of the symptomatology of the HV.

The deformation leads to two main complaints, which will push subjects to consult an orthopaedist: difficulty in putting on shoes and pain in support, on a more ad hoc basis. According to *Nix and al (2012)* [11], these two deficiencies will have repercussions on the function of the foot, repercussions correlated with the evolution of the pathology over the years. Thus, the pain modulates the plantar supports and consequently, the posture under load comes to be modified. By modifying the posture, it is the whole dynamic balance but also ambulation that can be achieved. HV is associated with poorer walking performance and decreased balance. This is an independent risk factor for falls in the elderly, as pointed out by *Mickle and al* (2009) [12].

The work of *Hwang and al* (2005) [13] described kinematic disorders of the different segments of the foot presenting with HV during walking. The hallux showed a valgus position throughout the walking cycle and pronation pronounced at the time of propulsion. A more forefoot flexion and a more plantar flexion suggest a flattening of the arch. Also found is a decrease in walking speed and a reduction in the phase of support on foot undergoing deformation.

It is, therefore, legitimate to wonder whether corrective surgery for hallux valgus can restore physiological parameters of walking.

MATERIAL AND METHOD

Interested in the consequences on the course of corrective surgery for hallux valgus, the keywords were determined via CisMef in international language: these are "hallux valgus," "bunion," "gait," " motion," "walking" and "kinematic." The research equation obtained is (hallux valgus OR bunion OR scarf osteotomy OR lapidus osteotomy OR chevron osteotomy OR Austin osteotomy) AND (gait OR walking analysis OR kinematics OR motion analysis).

Querying the PubMed scientific database on December 3, 2019, yielded 456 results. To limit the number of results, the following filters have been applied: "Publication dates: 15 years", "Species: Humans," 225 results are obtained. Articles with titles that included our search terms have been included. Only clinical studies were included. Querying the Cochrane scientific database on December 3, 2019, yielded 13 results. To limit the number of results, articles dating from before 2004 have been excluded. Only studies written entirely in the English language were included for analysis.

After reading the titles and summaries, five articles were selected for full reading via the Pubmed database and none based on the Cochrane database. The criteria for inclusion of the articles are studies dealing with gait analysis, whatever the technique used for this on human subjects have benefited from a more or less recent intervention for correcting the HV, according to various techniques. Original articles, case reports, literature reviews and meta-analysis, were excluded. Works dealing with non-operated HV, interventions other than simple correction of HV such as MTP arthrodesis were not selected. The same applies to articles dealing with HV secondary to a

systemic neurological or inflammatory pathology or even juvenile HV, as are articles dealing with the benefits of various rehabilitation protocols. Studies were analyzing other parameters than walking was not taken into account.

To refine the selection, and evaluation of the study methodology was carried out. Those not following the IMRAD structure, presenting significant biases or not presenting their results have been discarded. After complete reading, four studies were included for the comparative analysis. The development of the research is summarized in Figure 1. In total, there are at least two operating techniques (Scarf and Lapidus) which are compared via 75 patients and 24 control subjects.
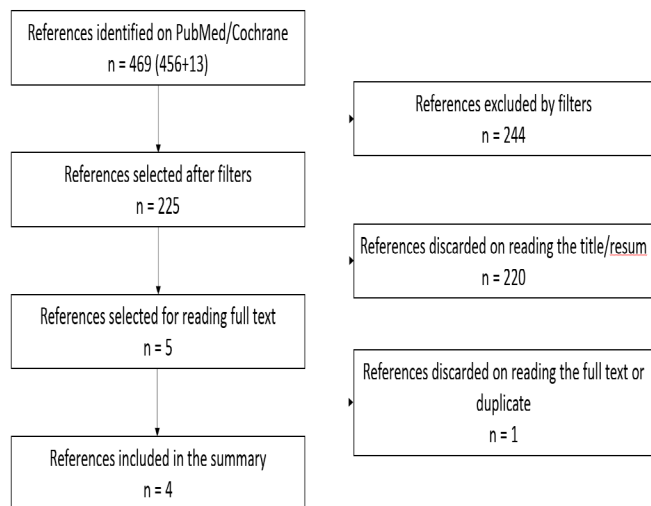

Figure 1: Flowchart

RESULTS

All the results are presented in Table 1 in the appendix.

Spatiotemporal walking parameters

WALKING SPEED

Of the spatiotemporal parameters of walking, this is the walking speed most studied by the selected tests.]Walking speed seems to be reduced significantly in subjects with deformity and who have not yet benefited from corrective surgery with an average of 1.0 ms^{-1}, compared to the standard which is 1.1 ms^{-1}, such as shows *Canseco and al* (2012) [14]; or in comparison to a control group (1.15 ms^{-1} for HV subjects versus 1.25 ms^{-1} for the control group), according to *Klugarova and al (2016)* [15]. The work of *Sadra and al (2013)* [16] does not show any difference in walking speed between a group with hallux valgus deformation and a control group.

In the post-operative, in the short term, ten weeks post-operative, *Sadra and al (2013)* [16] find a significant reduction in walking speed (1.08 ms^{-1}) compared to the pre-operative speed (1, 25 ms^{-1}) and normal ambulation in control subjects (1.24 ms^{-1}). At four months post-operative, *Klugarova and al (2016)* [15] find that corrective surgery for LV causes a more significant reduction in walking speed (1.07 ms^{-1} than subjects with deformity without having benefited from surgery (1.15 ms^{-1}). In the longer term, *Canseco and al (2012)* [14], who studies the evolution of walking before and after the corrective intervention, had found a reduction in walking speed preoperatively and the lack of improvement in this parameter with surgery (1.0 ms^{-1}), in agreement with the work of *Moerenhout and al (2019)* [17] which find an average speed of 1.1 ms^{-1}.

Thus, the deformation would lead to a reduction in walking speed, and surgery would not restore normal walking speed, even in the long term.

STEP LENGTH

After having benefited from corrective surgery, *Sadra and al (2013)* [16] do not find a significant difference in step length between the control group, subjects with deformation and operated subjects, in early postoperative (1.3 m on average for the first two verses 1.2 m for operated subjects). *Canseco and al* [14] show a shortened step length in preoperative compared to the standard (1.1m for 1.3 in normal times) and the absence of improvement of this parameter with surgery (1.2 m on average). This information is validated by the work of *Moerenhout and al (2019)* [17], who at one-year post-operation also found no improvement in the length of the step (1.2 m on average over the three measurements taken).

The deformation in HV would lead to a reduction in the length of the step and surgery would not restore normative values according to this parameter.

SUPPORT TIME

According to the work of *Klugarova and al (2016)* [15], at four months post-operative, subjects operated on for HV have a significantly different support time between the operated limb and the asymptomatic with a longer support time for the last with 44.88% against 42.13% of the walking cycle, excluding the double press phase. However, overall, the data for the operated group did not differ significantly from that of the control group according to the unipodal support time parameter.

The *Canseco's* team (2012) [14] finds that HV subjects have, on walking, a support time on the limb, which presents the deformation significantly longer than an asymptomatic population (64.3% against 62.3% of the walking cycle). In the post-operative period, this support time tends to normalize and no longer differs from asymptomatic subjects from 7 months post-operative. This contradicts the work of *Moerenhout and al (2019)* [17] who did not find any significant change in the duration of support between the pre-operative measurement and the measurements at six months than one-year post-operatively with time. Support on the operated limb of 59.8 seconds on average over the three measures. *Sadra and al* (2013) [16] also found no significant difference between a healthy group, a group of subjects with deformity and an operated group of HV.

The support time on the limb presenting the deformation could be longer than that of an asymptomatic population, but the intervention would tend to normalize this parameter in the long term.

Kinematic

According to *Morenhout and al (2019)* [17], in the sagittal

plane, there is a significant decrease in range of motion in toe/forefoot mobility, comparable to the MTP joint, and barefoot/leg (comparable to the ankle) between pre-operative and post-operative measures. HV subjects have average mobility of MTP of 32.9 ° against 26.8 ° at six months post-surgery and 28.2 ° at one year. However, the mobility of the hallux in the frontal and transverse planes seems to have returned to normal within one year of operation. This is in agreement with the study by *Canseco and al* [14] which concludes that the kinematics of hallux is restored after corrective surgery.

According to the work of *Klugarova and a (2016)l* [15], patients with HV have shown a smaller maximum of plantar flexion when the foot leaves the ground with an average of 10.36 ° and this value is even more reduced after surgery (6, 72 °). The range of mobility of the ankle does not differ between the group had undergone corrective surgery, and the control group. *Morenhout and al (2019)* [17] describe that HV subjects have average ankle mobility of 31.7 ° versus 25.7 ° at six months post-operative and 26.1 ° at one year. The authors conclude that there was no significant improvement at 12 months versus six months of follow-up. This is in disagreement with the work of *Klugarova and al* who find no difference in ankle mobility despite the precocity of the measurements (4 months post-operative). However, the work of *Canseco and al (2012)* [14] finds that there are still problems with the kinematics of the midfoot, hindfoot and tibia after surgery, this time in agreement with the work of Morenhout and al. The kinematics of the ankle-foot assembly would still present problems after corrective surgery for the HV.

DISCUSSION

Study parameters

HV is a deformation of the first ray of the foot, which sometimes leads to support pains but still postural disorders which can have repercussions on ambulation according to *Hwang and al* (2005) [13]. The literature review by *Nix and al* [18], written in 2013, concludes that deformation in HV seems to have a significant impact on various gait parameters such as a reduction in gait speed or impaired support. Both according to the space-time parameters and according to the kinematics. Therefore, the gait in subjects with HV deformation is not physiological. The surgical choice generally comes after several years of evolution and the walking pattern may be modified tending to a limp dodging the step.

The studies selected for the analysis tend to agree on the fact that there is a more or less significant reduction in walking speed before the operation. This parameter would need to be correlated with the intensity of the pain before correction. In postoperative, the authors tend to conclude on a slower walking speed than an asymptomatic population without distinction between operating techniques or postoperative time. The study by *Saro and al (2007)* [19] shows that the average speed values in the long-term post-operative period (1 year) could depend on the operative technique. In their study, the subjects operated by the Lindgren technique move more slowly than the subjects operated by chevron osteotomy, which move at speed comparable to the norm.

The work of the *Moerenhout (2019)* and *Canseco (2012)* teams [14, 17] agree on a reduction in the length of the steps of subjects with HV deformation and on the fact that surgery does not improve this phenomenon. The review by *Nix and al* [18] on non-operated HV subjects did not find any conclusion on the length of the steps before the intervention because of this parameter, already little studied, differ depending on the study. It is possible to assume that this parameter is adjustable according to the pain of the patients in charge. However, pain does not always correspond to the reason for consultation and is therefore not found in all HV subjects.

The work of *Canseco and al (2012)* [14] highlights that the support time is increased on the limb presenting the deformation in disagreement with the work of *Sadra and al (2013)* [16]. This disagreement is balanced by the fact that the study conducted by *Sadra and al* compares an HV group undergoing surgery to a significantly younger control group. However, all the authors seem to agree on the fact that the support time normalizes in the long term. It is conceivable to assume that subjects with HV deformation only wander with reduced support time, because of the pain in charge. However, the evolution of this pain, favorable with the operating delay, would restore this gait parameter physiologically. The review by *Nix and al (2013)* [18] does not conclude this parameter due to a lack of studies.

The studies analyzed seem to conclude on a restoration of the kinematics of hallux after intervention but not on that of the ankle. Indeed, whatever the surgical techniques studied, they all consist of a more or less important osteotomy of the first metatarsal. None are interested in the other bones or joints of the ankle-foot assembly. But the link between the foot and the ankle on the postural or dynamic level is no longer to be done. Thus, if the biomechanics of the first ray is restored by surgery, the disorders caused on the rest of the foot and ankle by the deformation and its consequences are not effectively restored by surgery. However, in the studies analyzed, the subjects had sometimes had to wear a plaster cast (Klugarova and al (2016) [15]) sometimes had a support restriction (Moerenhout and al (2019) [17]), which could have disturbed the results of the kinematic analysis.

The systematic review of the literature published by *Cochrane (2009)* [20] does not highlight the march as much in its spatiotemporal parameters as in kinematics in its analyzed results. *Klugarova and al's* literature review (2017) [21] also struggles to extract objective data regarding the study of gait after HV surgery, due to lack of work. It is impossible for us to conclude from the restoration of gait after hallux valgus corrective surgery because of the number of studies or systematic reviews published. The lack of literature in this area must be filled.

Methodological considerations

This work is not intended to be exhaustive and has some

limitations. Analysis of the level of evidence of the selected studies was not carried out, making the bibliography non-homogeneous in terms of quality. Furthermore, only four studies could be included in the analysis making the conclusions drawn here to be taken in hindsight. The studies analyzed present for some small cohorts by group (<15 patients) thus reducing the power of the results; some do not have a control group. The subjects from the groups to be compared are not necessarily stratified according to their physical characteristics (height, weight, age), making the comparisons questionable. Furthermore, of the two databases questioned, only one was able to give usable results, reducing the power of the results obtained.

CONCLUSION

In the literature included at the heart of this review, a certain number of gait parameters have been reported. The analysis revealed key variables for which differences were observed between asymptomatic subjects, subjects with deformity, and subjects who underwent corrective surgery. In operated patients, walking speed and step length are reduced compared to a healthy population, but surgery would tend to normalize support times and especially the kinematics of hallux. This analytical work mainly highlights a lack of literature on the consequences of corrective surgery for hallux valgus in walking or other functional parameters.

ABBREVIATIONS LIST:

- Hallux Valgus = HV
- Metatarsophalangeal = MTP

REFERENCES

[1] Hagedorn TJ, Dufour AB, Riskowski JL, Hillstrom HJ, Menz HB, Casey VA, et al. Foot Disorders, Foot Posture, and Foot Function: The Framingham Foot Study. Milanese S, éditeur. PLoS ONE. 5 sept 2013;8(9):e74364.

[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. déc 2010;3(1):21.

[3] Carvalho CE, da Silva RA, Gil AW, Oliveira MR, Nascimento JA, Oliveira DAAP-. Relationship between foot posture measurements and force platform parameters during two balance tasks in older and younger subjects. J Phys Ther Sci. 2015;27(3):705-10.

[4] Piclet-Legré B. Hallux valgus : Mises au point de l'AFCP. 2017. 1 vol. (XVII-242 p.).

[5] Rush SM, Christensen JC, Johnson CH. Biomechanics of the first ray. Part II: Metatarsus primus varus as a cause of hypermobility. A three-dimensional kinematic analysis in a cadaver model. J Foot Ankle Surg. mars 2000;39(2):68-77.

[6] Hecht PJ, Lin TJ. Hallux Valgus. Med Clin North Am. mars 2014;98(2):227-32.

[7] Condon F, Kaliszer M, Conhyea D, Donnell TO, Shaju A, Masterson E. The First Intermetatarsal Angle in Hallux Valgus: An Analysis of Measurement Reliability and the Error Involved. Foot Ankle Int. août 2002;23(8):717-21.

[8] Johnson K, Kile T. Hallux valgus due to cuneiform-metatarsal instability. J South Orthop Assoc. 1994;3(4):273-82.

[9] Golightly YM, Hannan MT, Dufour AB, Renner JB, Jordan JM. Factors Associated With Hallux Valgus in a Community-Based Cross-Sectional Study of Adults With and Without Osteoarthritis: Hallux Valgus in Adults With and Without OA. Arthritis Care Res. mai 2015;67(6):791-8.

[10] Menz HB, Roddy E, Marshall M, Thomas MJ, Rathod T, Peat GM, et al. Epidemiology of Shoe Wearing Patterns Over Time in Older Women: Associations With Foot Pain and Hallux Valgus. J Gerontol A Biol Sci Med Sci. déc 2016;71(12):1682-7.

[11] Nix SE, Vicenzino BT, Smith MD. Foot pain and functional limitation in healthy adults with hallux valgus: a cross-sectional study. BMC Musculoskelet Disord. déc 2012;13(1):197.

[12] Mickle KJ, Munro BJ, Lord SR, Menz HB, Steele JR. ISB Clinical Biomechanics Award 2009. Clin Biomech. déc 2009;24(10):787-91.

[13] Hwang SJ, Choi HS, Cha SD, Lee KT, Kim YH. Multi-Segment Foot Motion Analysis on Hallux Valgus Patients. In: 2005 IEEE Engineering in Medicine and Biology 27th Annual Conference. Shanghai, China: IEEE; 2005. p. 6875-7.

[14] Canseco K, Long J, Smedberg T, Tarima S, Marks RM, Harris GF. Multisegmental Foot and Ankle Motion Analysis After Hallux Valgus Surgery. Foot Ankle Int. févr 2012;33(2):141-7.

[15] Klugarova J, Janura M, Svoboda Z, Sos Z, Stergiou N, Klugar M. Hallux valgus surgery affects kinematic parameters during gait. Clin Biomech. déc 2016;40:20-6.

[16] Sadra S, Fleischer A, Klein E, Grewal GS, Knight J, Weil LS, et al. Hallux Valgus Surgery May Produce Early Improvements in Balance Control: Results of a Cross-Sectional Pilot Study. J Am Podiatr Med Assoc. nov 2013;103(6):489-97.

[17] Moerenhout K, Chopra S, Crevoisier X. Outcome of the modified Lapidus procedure for hallux valgus deformity during the first year following surgery: A prospective clinical and gait analysis study. Clin Biomech. janv 2019;61:205-10.

[18] Nix SE, Vicenzino BT, Collins NJ, Smith MD. Gait parameters associated with hallux valgus: a systematic review. J Foot Ankle Res. déc 2013;6(1):9.

[19] Saro C, Andrén B, Felländer-Tsai L, Lindgren U, Arndt A. Plantar pressure distribution and pain after distal osteotomy for hallux valgus. The Foot. juin 2007;17(2):84-93.

[20] Ferrari J, Higgins JP, Prior TD. Interventions for treating hallux valgus [abductovalgus] and bunions. 2009;48.

[21] Klugarova J, Hood V, Bath-Hextall F, Klugar M, Mareckova J, Kelnarova Z. Effectiveness of surgery for adults with hallux valgus deformity: a systematic review. JBI Database Syst Rev Implement Rep. juin 2017;15(6):1671-710.

Appendix

Table 1: Comparative table of studies

Study	Hallux valgus surgery affects kinematic parameters during gait	Hallux Valgus Surgery May Produce Early Improvements in Balance Control: Results of a Cross-Sectional Pilot Study	Outcome of the modified Lapidus procedure for hallux valgus deformity during the first year following surgery: A prospective clinical and gait analysis study	Multisegmental Foot and Ankle Motion Analysis After Hallux Valgus Surgery
First autor	Klugarova	Sadra	Moerenhout	Canseco
Release date	2016	2013	2019	2012
Type of study	Controlled clinical trial	Pilot cross-sectional study	Uncontrolled, non-randomized clinical trial	Uncontrolled, non-randomized clinical trial
Population	17 patients, unspecified on the operating technique 13 control subjects	29 patients operated by Scarf 11 control subjects Significantly younger control group	10 patients operated by Lapidus	19 patients, unspecified on the operating technique
Intervention	Quantified gait analysis	Market analysis by LEGSys from BioSensics	Gait analysis by 3D inertial sensors (Physiolog, BioAGM)	Quantified gait analysis
Evaluation	QGA by Vicon system and Plug in gait model	Analysis of spatiotemporal parameters of walking	Analysis of spatiotemporal parameters, kinematics and plantar pressures	QGA by Vicon system with analysis of spatiotemporal parameters and kinematic analysis of the ankle and foot
Duration	Preoperative 4 months post-operative	Preoperative 10 ± 2,3 weeks post-operative	Preoperative 6 months post-operative 1-year post-operative	45 days preoperative 7 to 60 months post-operative

RESULTS

Walking speed	Reduced speed: 1.15 ms^{-1} for HV subjects versus 1.25 ms^{-1} for the control group Reduced speed after surgery (1.07 ms^{-1}) than HV subjects (1.15 ms^{-1}).	No difference between an HV group and a control group Significant reduction in walking speed (1.08 ms^{-1}) compared to preoperative speed (1.25 ms^{-1}) and normal walking in control subjects (1.24 ms^{-1})	No improvement in walking speed after surgery with an average of 1.1 ms^{-1}	Speed significantly reduced in HV subjects (1.0 ms^{-1}), compared to the standard which is 1.1 ms^{-1} and no improvement near surgery
Step length		No significant difference in step length between the control group, the HV subjects and the operated subjects (1.3 m for the first two versus 1.2 m for the operated subjects)	No improvement in the length of the step between pre and post-operative (1.2 m on average over the 3 measurements)	Shortened step length in preoperative compared to the standard (1.1m for 1.3 in normal times) and the absence of improvement of this parameter with surgery (1.2m on average)
Support time	Different operated subjects between the operated limb and the asymptomatic with a longer support time for non-HV with 44.88% for 42.13% but no difference compared to asymptomatic subjects	No significant difference between a healthy group, a group of subjects presenting the deformation and an operated group of the HV	No significant change in the duration of support between the pre-operative measurement and the 6-month and then 1-year post-operative measurements with a support time on the operated limb of 59.8 s on average over the 3 taking measurements	HV subjects significantly longer than an asymptomatic population (64.3% versus 62.3% of the walking cycle) Operated subjects = normalized values
Kinematic	Preoperatively, patients with HV showed a smaller maximum of plantar flexion when the foot leaves the ground (10.36 °) and this is even more reduced after surgery (6.72 °)		HV subjects have an average mobility of MTP of 32.9 ° against 26.8 ° at 6 months post-operative and 28.2 ° at one year. Regarding the ankle, HV subjects have an average mobility of 31.7 ° against 25.7 ° at 6 months post-surgery and 26.1 ° at one year	Preoperatively, the hallux is positioned in valgus during the whole walking cycle. In the transverse plane, the maximum pronation of hallux during the pre-oscillatory was significantly higher (p 0.0007). The position of the hallux at the end of the oscillating phase was significantly more supine. In post-operative, these values find an aspect comparable to the norm. The kinematics of the hallux are restored after corrective surgery. There are disturbances in the midfoot, hindfoot and tibia kinematics that have not returned to normal after surgery.