



Prospective randomized comparative study on V-Y and pants-over-vest capsulorrhaphy in chevron and scarf osteotomy

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The contribution of capsulorrhaphy techniques at hallux valgus surgery to sustain the longevity of the achieved correction is not well documented. This study aims to evaluate the outcome of two different capsulorrhaphies (V-Y and pants-over-vest). 88 feet were prospectively included and followed for 2 years. Capsulorrhaphy type was determined by randomisation. Primary outcome was the correction of the intermetatarsal angle (IMA) and the metatarso-phalangeal angle (MPA). Secondary endpoints were the Kitaoka-MTP1-score and the SF-36. A linear model for repeated measures was used for statistical analysis. VY and PV showed a comparable evolution for IMA ($p = 0.42$) and MPA ($p = 0.36$). However, a tendency to loss of MPA correction was noted in the scarf group for PV as compared to VY ($p = 0.037$). Secondary outcomes showed no significant differences between PV and VY in evolution over time for SF-36 total ($p = 0.45$) nor for the Kitaoka score ($p = 0.15$). We observed a complication rate comparable with those previously reported.

The 2 year follow up did not reveal significant loss of correction of the IMA, regardless of the capsulorrhaphy used. The SF-36 and Kitaoka score results were stable over the study period.

INTRODUCTION

Hallux valgus is a common, multifactorial and complex disorder of the first ray (from midfoot to the toe), frequently associated with disorders of the lesser toes. The term hallux valgus is used if the valgus angle of the first metatarsophalangeal joint

exceeds 15 to 20 degrees. Universally, an increased angle between the first and second metatarsal (more than 8 to 9 degrees) is present and very often a pronation of the great toe is associated with this disorder (17). Elmslie defined the disorder in 1926 as: “a lateral deviation of the big toe at the metatarsophalangeal joint; this deformity can be accompanied with joint subluxation, pronation, and attenuation of the medial soft-tissue structures such as the joint capsule and the abductor hallucis tendon” (8).

Recent studies confirmed that patients with hallux valgus suffer pain, have difficulties in finding

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appropriate shoe ware and have a reduced functional capacity that results in a significant reduced health quality of life measured with self-reported outcome scores (6,12). It was demonstrated that patients with hallux valgus require a significantly longer reaction time for emergency brake, what makes driving a car difficult (9). Therefore, a durable correction of this misalignment in symptomatic cases is mandatory.

More than 130 surgical techniques have been described to treat this pathology, almost exclusively describing the bony procedure. A plethora of literature is available on the outcome and on the specific indications, but little attention is paid to the associated soft-tissue procedures. Especially, information is lacking on how to close the capsule (capsulorrhaphy), in order to sustain the longevity of the achieved correction. Usually, closing the capsule (with or without tension) is mentioned as one of the last steps at hallux valgus surgery, but the exact technique is not explained nor the reason for using that technique.

Of the limited number of papers specifically describing a capsulotomy (tear-drop) (7) or a capsulorrhaphy (cerclage fibreux (17,18), inverted L or hockeystick, V-Y, teardrop, Z) (21), only a few really explain how and why the soft-tissue procedure is performed. Furthermore, to our knowledge, these soft tissue procedures were never compared among each other using the same bony procedure.

The primary aim of this study was to compare the potency of the V-Y and pants-over-vest (PV) capsulorrhaphy in preventing loss of correction (measured by comparing the intermetatarsal angle (IMA) and the metatarsophalangeal angle (MPA)) for both chevron and scarf osteotomy. Secondary outcomes were the effect of the capsulorrhaphy on the physical and emotional evolution after the hallux valgus surgery in both the chevron and scarf group, measured by SF-36 (22), and the Kitaoka MTP1 forefoot score (11). The complication rate has been evaluated as well.

PATIENTS AND METHODS

The study protocol was approved by the institution's review board and written informed consent was

obtained. All patients were included and treated at our Foot and Ankle unit. In most patients conservative treatment such as shoe modifications and/or orthotic devices failed. Exclusion criteria were patients under 18 years, rheumatoid diseases, diabetes mellitus or severe vascular disease.

Operative procedures

First choice procedure was a distal chevron-osteotomy, while in cases of (suspected) problems with postoperative nonweightbearing the deformity was corrected with a scarf osteotomy. The chevron osteotomy used for this study was the Johnson modification of the distal Mitchell osteotomy (10), fixed with a cannulated Bold® screw (Integra-LS, Lyon, France) to obtain immediate fixation. The scarf osteotomy was performed by a three cut Z-osteotomy. The distal cut was made just extra-articular of the synovial insertion of the first metatarsal phalangeal (MTP1)-joint from dorsal to plantar. A proximal plantar to dorsal cut was made approximately 4 cm more proximal. The third cut connected the two previous cuts. The plantar half was translated laterally. The two fragments were fixed with two Bold screws (1,2,4).

Both osteotomies were, if indicated, combined with an Akin osteotomy to correct the interphalangeal angle, or with surgery to the lesser toes for associated lesser toe deformities.

The patients were randomised single blind (patient was not informed on the type of capsular procedure performed) to have either a Y-shaped capsular incision with a V-Y capsulorrhaphy (VY) or a longitudinal capsular incision with a "pants-over-vest" capsulorrhaphy (PV) (17).

In brief, the Y-shaped capsulotomy was performed, keeping a triangular capsular flap attached to the base of the proximal phalanx of the hallux. The third leg of the incision started at the top of the triangle and was aimed at the mid-medial line of the metatarsal shaft, where the medial eminence met the shaft. After the bony procedure, the triangular portion of the capsule was advanced into the third limb of the Y incision, converting it into a V. The toe was held in a corrected position while the capsule was sutured with appropriate tension (Fig. 1).

For the pants-over-vest procedure a longitudinal capsular incision was performed at the mid-medial line. Capsulorrhaphy was performed by pulling the inferior sleeve to proximal and dorsal, and fixing it upon the superior part with absorbable sutures while keeping the hallux in a corrected position (Fig. 2). In both procedures, no capsular tissue was removed.

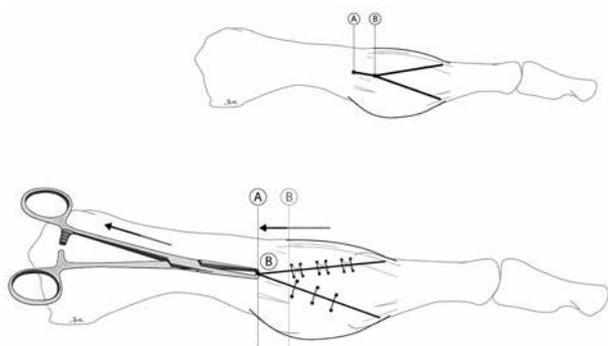


Fig. 1. — Drawing of the technique of the V-Y capsulorrhaphy. The appropriate tension on the capsule is applied by bringing point B to point A and fixing it by a suture in the soft tissues.

Postoperative care and followup

Postoperative care was slightly different for the first 5 weeks. The chevron group had 2 weeks of nonweight-bearing cast, followed by 3 weeks full weightbearing in a synthetic cast-shoe. The scarf group received a postoperative bulky dressing with a special protective shoe for 5 weeks; allowing immediate weightbearing. All patients were seen in the outpatient clinic 2 weeks after surgery for clinical check-up and removal of the stitches. Further followup was performed 5 weeks, 9 weeks, 6 months, 1 and 2 year postoperatively. For both osteotomy types, the consolidation was checked by a postoperative X-ray at 5 weeks. When consolidation had been achieved, patients were allowed to ambulate without protection.

Outcome measurements

A Short Form 36 general health-status instrument (SF-36) (22) and a Kitaoka/American.

Orthopaedic Foot and Ankle Society (AOFAS) first metatarsal joint (MTP-1) forefoot score (11) were obtained preoperatively and compared with those at 6 months, 1 and 2 year postoperatively. Standard anteroposterior and medio-lateral weightbearing plain X-rays were taken preoperatively and at 5 weeks, 1 and 2 years. The angles between the first and second metatarsal (IMA), and between the first metatarsal and the hallux (MPA) were determined. All measurements were performed using the standard tools available in the Picture Archiving and Communication System of our institution.

At the 6 month follow up visit, patients were asked if they would have the same type of surgery again.

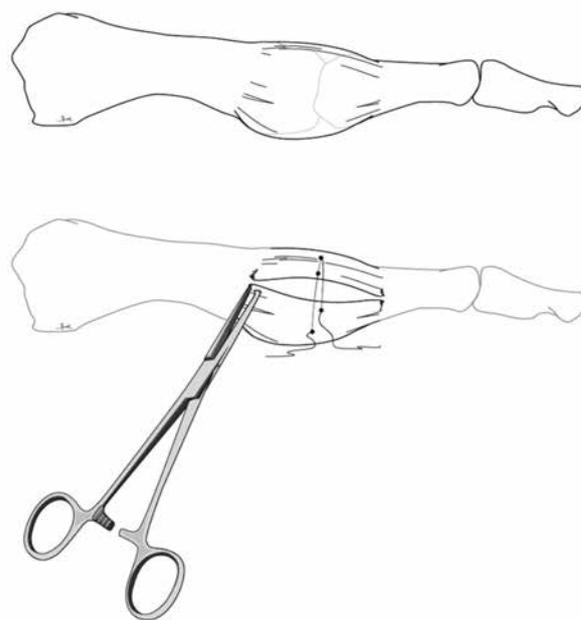


Fig. 2. — Drawing of the technique of the PV capsulorrhaphy. The appropriate tension on the capsule is applied by pulling the plantar part to proximal and dorsal and fixing the dorsal part deep of the plantar part.

When collecting the data, the investigator was blinded to the type of capsulorrhaphy performed.

Statistics

A linear model for repeated measures has been used to evaluate possible differences in evolution of the angle measurements and the scores (Kitaoka, total SF-36, and the SF-36 mental and physical subscales) between both groups (VY and PV). Since there are three postoperative moments in time, the test of interest has three degrees of freedom. Because the randomisation has been stratified on chevron/scarf, this factor was included in the model. By including an interaction between group (chevron/scarf) and type of capsulorrhaphy, the effect of type of capsulorrhaphy has been compared between chevron and scarf as well. To meet the distributional assumptions of the linear model, the SF-36 scores have been transformed, but graphical presented results were back-transformed on the original scale.

All analyses have been performed using the statistical package SAS (version 9.2; SAS Institute Inc., Cary, NC), using the procedure PROC MIXED for the linear model. For the two primary outcomes, a p-value was considered significant if smaller than 0.025 (a

Table I. — preoperative data

Group (M/F)	Age		IMA		MPA	
	Mean	SD	Mean	SD	Mean	SD
C + VY (2/26)	50,9	8,9	11,1	2,5	26,3	7,3
C + PV (4/26)	51,9	13,5	11,7	2,7	27,1	6,4
S + VY (2/10)	60,1	8,6	14,1	3,0	36,0	5,7
S + PV (0/18)	59,7	13,2	13,2	3,4	31,7	7,5

IMA : intermetatarsal angle, MPA : metatarso-phalangeal angle, M : male, F : female, C : chevron, S : scarf, VY : V-Y capsulorrhaphy, PV : pants-over-vest capsulorrhaphy ; SD=standard deviation.

Bonferroni correction was used to keep the overall confidence level at 95%). For the secondary outcomes, the alpha-level was set at 5% and no corrections for multiple testing were considered.

RESULTS

During the 24 month inclusion, 95 patients were considered candidates for inclusion in the study. Subsequently, two patients were excluded because further preoperative investigations revealed presence of rheumatoid disease, and seven patients did not attend their appointment for surgery (Fig. 3). Ultimately, 88 feet were operated on in 86 patients (eight men, 78 women of which two bilateral). These 88 feet were divided in the chevron (58 feet, 56 patients) and scarf (30 feet, 30 patients) subgroups. Further randomisation resulted in four subgroups (Table I). Seventeen patients were lost to followup and four patients withdrew from the study, hence 21 feet could not be used for statistical analysis.

The baseline characteristics of the each capsulorrhaphy group (VY versus PV) within each osteotomy group (chevron or scarf) were clinically comparable (Table I). The evolution of the values for IMA and MPA for all groups is shown in Fig. 4. VY and PV showed a comparable evolution for IMA ($p = 0.42$) and MPA ($p = 0.36$). Although, with the numbers available, the comparison in evolution between VY and PV was not statistically different between the scarf and the chevron group (interaction between group and type of capsulorrhaphy : $p = 0.50$ for IMA and $p = 0.17$ for MPA), a tendency to loss of MPA correction was noted in the scarf group for PV as

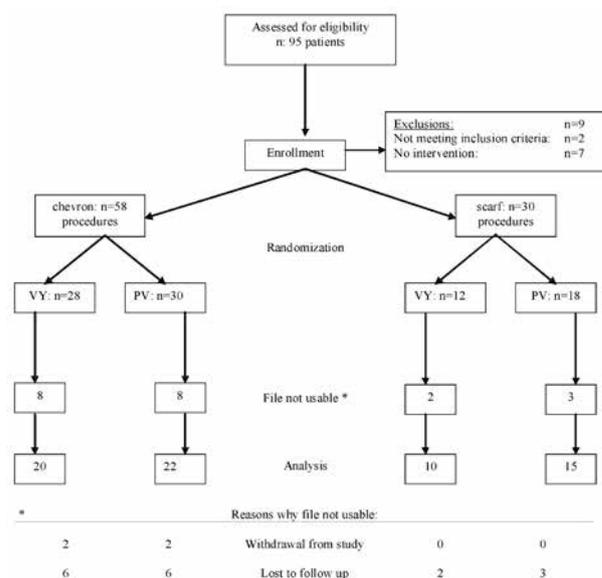


Fig. 3. — flow chart

compared to VY (Figure 2d, $p = 0.037$)

For the secondary outcomes there were no significant differences between PV and VY in evolution over time for SF-36 total ($p = 0.45$), neither for the mental ($p = 0.95$) and physical subdivisions ($p = 0.17$) (Table II), nor for the Kitaoka score ($p = 0.15$). In the scarf group a slight reduction in the Kitaoka score was observed for PV compared to VY, but far from significant ($p = 0.18$) (Fig. 5).

Complications were divided in procedure related and non-procedure related incidents (Table III). The general complication rate was 26.1%. After deduction of the “not procedure related” complications, complication rate dropped to 18.2%, which could be further divided in 10.7% for the chevron + VY, 20.0% for the chevron + PV, 8.3% for the scarf + VY and 33,3% for scarf + PV subgroup.

Half of the patients in the chevron group would have surgery again. This percentage was 75% in the scarf + VY group and 61% in the scarf + PV group (Table IV).

DISCUSSION

This study investigated a possible difference in outcome after two different capsulorrhaphy techniques for hallux valgus surgery. Primary outcome

Table II. — Descriptive information (mean (SD)) of the SF-36 scores (22)

	time	SF-36 total	SF-36 mental	SF-36 physical
chevron, VY	Pre-op (n=28)	77,9 (16.5)	79,7 (14.9)	74,4 (17.4)
	6 months (n=18)	80,1 (21.3)	80,9 (19.4)	77,4 (21.7)
	1 year (n=15)	84,7 (19.2)	85,8 (15.4)	81,3 (21.6)
	2 year (n=16)	78,4 (18.9)	80,4 (15.1)	73,6 (22.2)
chevron, PV	Pre-op (n=29)	76,8 (15.2)	80,1 (13.6)	71,9 (16.8)
	6 months (n=19)	82,1 (13.5)	82,1 (11.9)	79,6 (15.0)
	1 year (n=17)	81,8 (15.5)	81,0 (12.2)	79,4 (16.4)
	2 year (n=21)	80,2 (16.8)	78,2 (14.4)	77,3 (21.2)
scarf, VY	Pre-op (n=12)	77,9 (9.6)	79,2 (9.7)	74,3 (12.3)
	6 months (n=10)	74,4 (16.2)	71,6 (15.7)	74,6 (17.0)
	1 year (n=8)	75,0 (16.0)	71,4 (16.4)	73,3 (16.8)
	2 year (n=10)	78,2 (10.3)	79,5 (7.8)	75,5 (15.1)
scarf, PV	Pre-op (n=18)	76,3 (14.4)	81,3 (10.8)	71,7 (15.6)
	6 months (n=13)	78,9 (14.3)	79,0 (10.3)	75,5 (16.4)
	1 year (n=9)	81,2 (12.0)	80,4 (6.3)	80,9 (17.1)
	2 year (n=13)	80,8 (22.4)	79,2 (20.0)	77,8 (23.3)

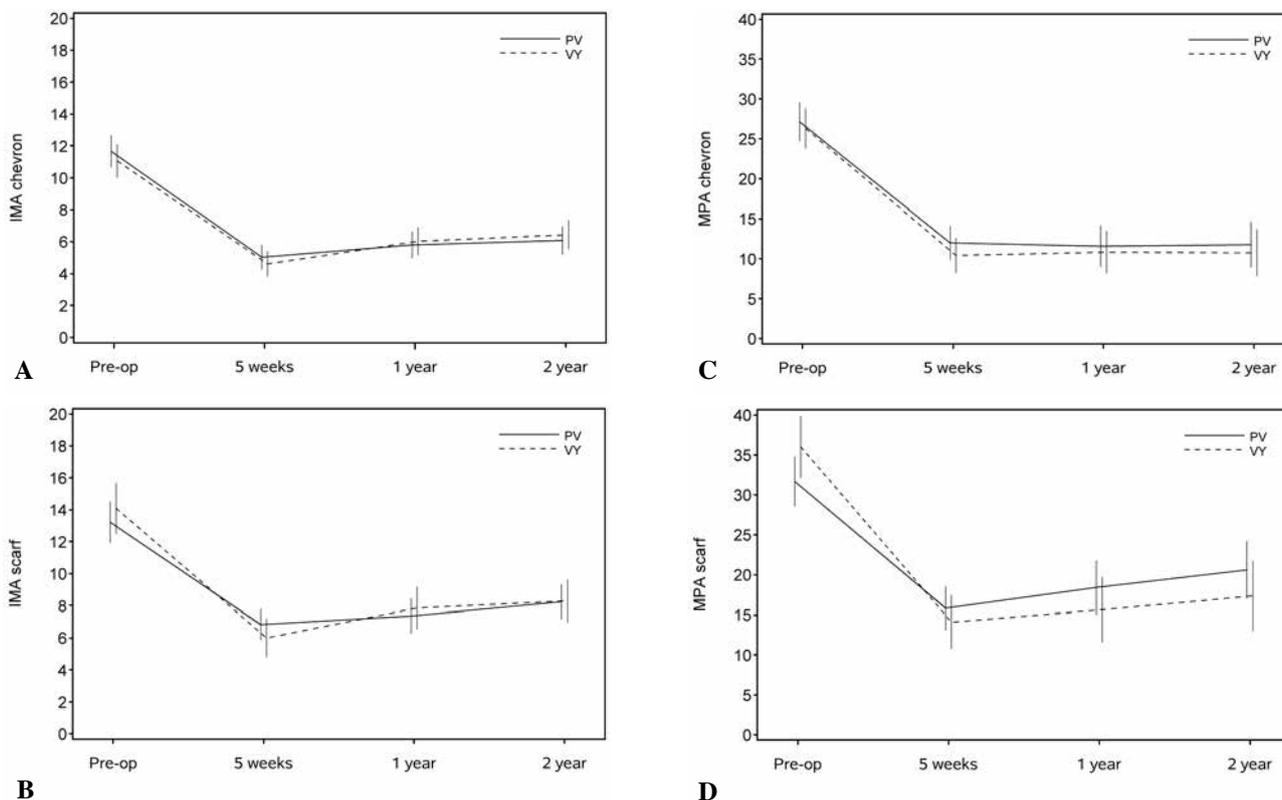


Fig. 4. — Evolution of the mean radiological angles pre operative and at follow up (vertical lines show the 95% confidence intervals for the mean). A : IMA in the chevron group ; B : IMA in the scarf group . C : MPA in the chevron group ; D : MPA in the scarf group.

Table III. — Complications noticed during postoperative followup.

	C+VY		C+PV		S+VY		S+PV	
Procedure related	Irritation screw	3	Hypoaesthesia	1	3rd screw *	1	Fracture MT	3
	Delayed union	1	Hallux rigidus	1			Recurrence	2
	Akin		2 nd screw *	1			Hallux rigidus	1
	Intra-articular # Akin	1	Hallux varus	1				
Not procedure related	CRPS	1	Irritation screw	1				
	Myocard infarction	1	Osteochondral lesion MTP	1				
			CRPS	1	CRPS	1		
					Hemiplegia after stroke	1		

* : 2nd and 3rd screw were added if routine fixation did not provide sufficient mechanical stability

Table IV. — Patients' willingness to undergo the same surgery

	Yes	No	?
C + VY (28)	50%	36%	14%
C + PV (30)	50%	33%	17%
S + VY (12)	75%	17%	8%
S + PV (18)	61%	33%	6%

focussed on the IMA and the MPA. Both the chevron and scarf technique resulted, with the numbers available, in a significant decrease in IMA and MPA. There was no statistical significant difference in outcome after V-Y or PV capsulorrhaphy. However, in the scarf group the MPA angle showed a tendency to increase after PV capsulorrhaphy.

Different techniques have been described to perform an imbrication of the MTP1 joint capsule to allow larger corrections of a hallux valgus deformity (17,18). Historically we use two different types of capsulorrhaphies. The tension in the VY capsulorrhaphy has an obvious force vector from distal to proximal, which pulls on the base of the proximal phalanx of the first toe. This kind of force would suggest a reduction of the MPA. On the other hand, the tension in the PV capsulorrhaphy is pulling the inferior slip of the capsule to medial and dorsal that not only brings the sesamoids in a better position, but also pulls on the adductor muscle and the deep transverse ligament. This tension also reduces the IMA (21). There is no consensus in the literature regarding capsule resection to prevent recurrence of a bunion, or maintenance of all the available tissue to put tension on the capsule and obtain a larger correction in MPA, IMA or both (7,8,15,16,19-21,23). To secure or reinforce the capsule, Gould fixed it using

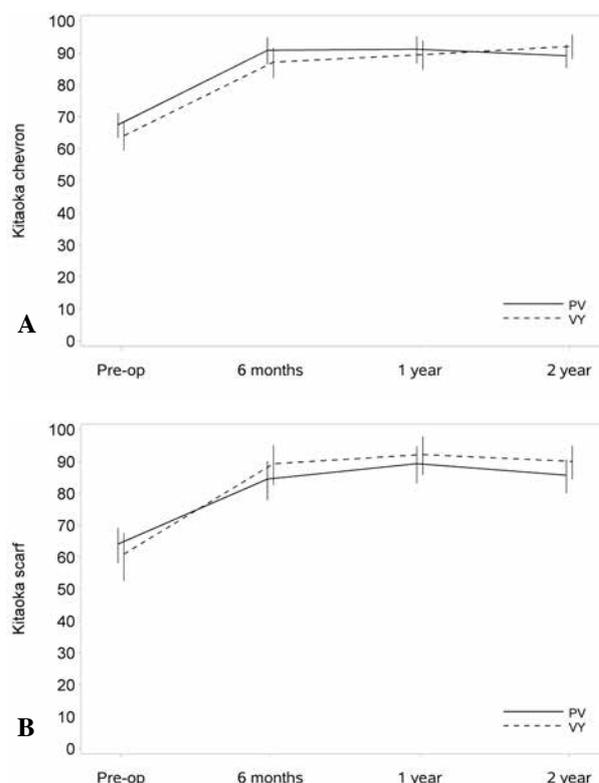


Fig. 5. — evolution pre operative and at followup for the mean Kitaoka-score in the chevron (a) and the scarf (b) group (vertical lines show the 95% confidence intervals for the mean).

suture anchor (8), while both Franzreb and Us described a transosseous fixation of the resorbable sutures used (5,20).

Considering the literature, no unanimity is present concerning the fixation of the osteomy. Some surgeons rely on the effect of the capsulorrhaphy to

reposition and hold the bony fragments in a correct position (3,18,20). Others do not believe that the capsule can hold this correction until there is bony consolidation. They prefer to fix the osteotomy either with a bone peg, percutaneous K-wires, intraosseous suture anchors or a screw fixation (2,10,13,14,17,19). The advantage of screw fixation is immediate stability, allowing the patient to ambulate earlier without the presence of percutaneous material. However, hardware can cause irritation that may necessitate removal.

Short term result of the capsulorrhaphies have been described in the literature (2,7,8,20), but the question if it helps to maintain correction in the medium term is still open. Nery *et al* described their 2 year follow up for biplanar chevron osteotomies, but apparently they did not consider reefing the capsule having an influence on the final outcome (13). On the contrary, Goldfarb *et al* considered the capsular correction as important, if not more important, than the osseous work performed (7). Schneider *et al* presented their 5 year follow up of chevron osteotomies and rely completely on the soft-tissue to hold the osteotomy in a corrected position and prevent secondary loss of correction in the long term (18). In the present study, with the numbers available, the 2 year follow up did not reveal significant loss of correction of the IMA. However, a possible trend was noticed comparing the 2 year results of MPA correction in the scarf groups, where, contrarily to the VY group, the PV group had lost some degrees of correction.

The influence of surgery on the patients' health related quality of life was measured with the SF-36 (22). The clinical outcome was assessed with the Kitaoka score (11) and lastly patients were asked if they should have this surgery again. The SF-36 results were stable over the complete followup period for the 4 treatment groups, as were those for the Kitaoka score. The minimal trend of a diminished score at 2 years followup noticed in the scarf+PV group can be due to the minimal loss of correction noticed in that group, as the alignment counts for 15% of the score.

The rate of patient choosing to have this type of surgery again was only 56%. Residual pain and discomfort at the sixth postoperative months could

have had a negative influence on the patient satisfaction when asked if they would have the same intervention done again. However, no negative general evolution was seen in the SF-36 at 6 month and especially not in the chevron group. Therefore, currently we have no clear explanation for this rather low percentage.

The complication rate was important, but comparable with complication rates in the literature (2). A few minor complications such as hardware irritation were solved by a day-case removal of the hardware. For the two recurrences, one was asymptomatic and did not need revision surgery so far, for the second recurrence revision was planned, but cancelled by the patient because of the diagnosis of a malignancy for which treatment was started. For the cases that developed degeneration or rigidity, a further observation has been proposed. When only the procedure related complication are considered, more complications were noted in both pants over vest groups. However, we do not have any explanation for this, especially when considering the kind of complications in both groups (see table III). We suppose that this divergence is due to the relatively small size of the groups.

The decision to select the scarf surgery was based on the assumption that the patient will not be able to refrain from weightbearing on the operated foot during 2 weeks, consequently the size of the groups treated with scarf surgery is considerably smaller than the groups treated with chevron surgery. Therefore the comparison of the V-Y or the PV capsulorrhaphy can only be done within the group treated with the same surgical procedure. It was not the objective of this study to compare scarf and chevron osteotomy. Another limitation of the study consists in the high number of feet lost to followup (17/88) and those that did withdraw from the study. However, those lost to followup were equally distributed over the four groups. Reason for withdrawal was in all cases that the patient did not want to further spent supplementary time during the visits filling out the score forms. Furthermore, a lateral release to facilitate the correction was not done systematically in all cases and omitted in case of a flexible and/or minor deformity, at the surgeon's personal judgement.

CONCLUSION

A large number of techniques for the surgical reconstruction of hallux valgus deformity have been extensively described. However, little attention is paid to the capsulorrhaphy. In our study we compared the effect of V-Y and pants-over-vest capsulorrhaphy. Although, with the numbers available, no statistical significant differences were found, a trend in loss of correction in the combination of scarf with the “pants-over-vest” capsulorrhaphy was observed. These findings may be of clinical importance if they can be confirmed in a study including a larger number of patients. Also a longer followup period has to be considered.

Meanwhile, this study changed our attitude in the choice of the capsulorrhaphy. As in our hands we consider the PV-technique easier to perform this has become our first choice. However, in cases where a meniscal structure is present, this is easily lesioned by the longitudinal incision of the capsule and therefore we prefer the VY-technique in younger patients.

Conflict of interests

The work of GAM was founded in part by a Clinical Doctoral Scholarship of the Research Foundation – Flanders (FWO).

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