Scarf osteotomy and forefoot surgery planning

© J ORTHOP TRAUMA SURG REL RES 2 (18) 2010
Review article

MICHEL MAESTRO, BRUNO FERRE, JULIEN CAZAL

Monaco Institute of Sports Medicine and Surgery, IM2S
11bis Avenue d'Ostende, 98000 Monaco

Address for correspondence/Adres do korespondencji:
Michel MAESTRO, Orthopaedic surgeon
Monaco Institute of Sports Medicine and Surgery, IM2S
11bis Avenue d'Ostende, 98000 Monaco
tel.: 00377 99 99 10 00, fax: 00377 99 99 10 38,
e-mail: maestrom@im2s.mc

Statistic

Word count	4210
Tables	0
Figures	12
References	15

Received: 29.01.2010
Accepted: 16.02.2010
Published: 20.04.2010

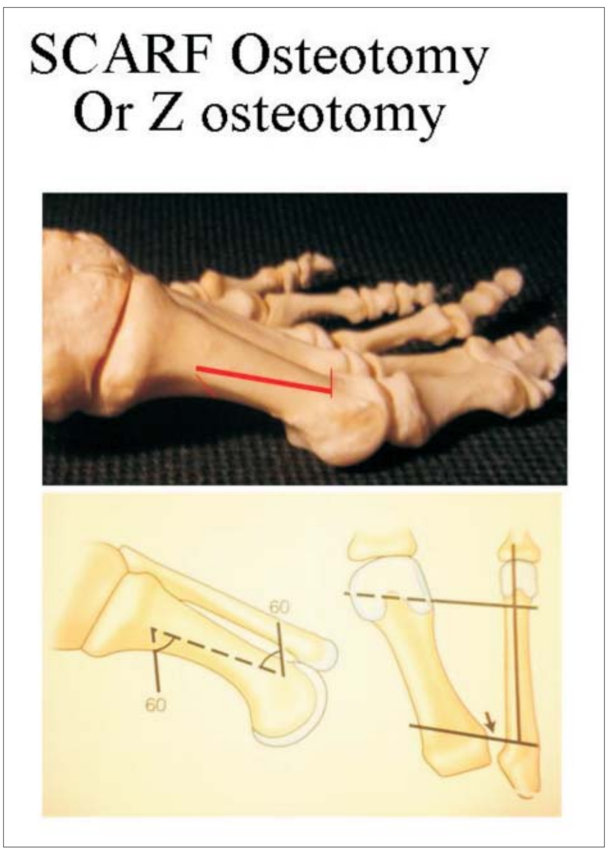
Summary
The scarf osteotomy is an old, versatile and useful osteotomy, now well recognised as reliable and effective to contribute to the correction of the majority of hallux valgus cases. The correction of severe deformities with a metatarsus varus angle > 18° and Distal Metatarsal Articular Angle (DMAA) >15° remains challenging. In order to improve 3D displacements of the metatarsal head, scarf design became more oblique, shorter, and if necessary a distal medial wedge was removed from the plantar fragment to supinate the head .
In case of large horizontal translation, there is no place to put any screw. Therefore a transosseous absorbable suture was placed, in order to obtain a constrained fixation distally, and an autologous bone graft was impacted proximally (the distal wedge of the dorsal M1 fragment). This procedure has been used to replace the screws since 1999. Immediate weight-bearing was allowed with a total contact cast sole for one or two weeks, followed by a postoperative shoe for a month.
Key words: hallux valgus, scarf osteotomy, osteosynthesis, fore-foot pre-operative planning

INTRODUCTION

The goal of hallux valgus surgery is to restore painless hallux mobility and strength and to restore the push off-axis.

The necessity of a M1 osteotomy is now well recognised in the surgical treatment of hallux valgus. However, a controlled lateral release with preservation of the lateral collateral ligament (in order to prevent iatrogenic hallux varus) and an extensor hallucis brevis tenotomy is mandatory after conservative bunionectomy. The addition of an osteotomy of the first phalanx (varus or Akin osteotomy, or varus shortening osteotomy) is necessary in the majority of cases. Finally, after bony realignment, the soft tissue reconstruction allows the replacement of the extensor hallucis longus on the centre of the joint and the medialisation of the abductor hallucis brevis with a medial capsulorrhaphy.

The Scarf osteotomy was first described by Burutaran (1973) (1) in order to obtain bone lenghtening. Gudas and Zigmunt performed Z-bunionectomies (1973). Weil and Borelli (1984) (2) and later Barouk (1991) used this technique in the surgical correction for hallux valgus deformity. The „pied innovation group“ (Augoyard, Benichou, Leemrijse, Maestro, Peyrot, Ragusa, Valtin) contributed to the development and the evolution of this first diaphyseal metatarsal osteotomy that became a meta-diaphyseal osteotomy.



After more than 35 years of evolution, the Scarf osteotomy is a reliable and secure technique, but difficult to perform and with a relatively long learning curve . The Scarf osteotomy can be used in the majority of cases (mild to severe deformity). (3-4-5-6)

It is radiologically stable with time and reduces the risk of transfer lesions by keeping the M1 head low. The osteotomy respects the high constraint locations in the M1 bone.

I. THE CLASSICAL SCARF BECAME “SCARF EVOLUTION” (7-8-9-10)

According to the following facts:

- the scarf “needs” an osteosynthesis with 2 screws, but the majority of complications is due to the osteosynthesis
- in case of revision surgery the removal of the screws poses an additional difficulty
- the surgery is more expensive
- screws often lead to pain and stiffness in plantar flexion and therefore have to be removed in about 20% of cases
- the distal screw limits the lateral displacement of the head and this is a disadvantage in severe cases of hallux valgus

So it was logical to evolve towards a fixation without screws.

The immediate advantage of this modification is the larger possible head displacement. Above all the increased horizontal translation, shortening (lengthening rarely), elevation (not recommended because the risk of transfer lesions) and lowering.

The DMAA correction became easier because of the coronal rotation with supination of the head. This is possible due to an associated medial wedge osteotomy and not marked by a rotation in the horizontal plane, which risks a deviation of the crista and might cause iatrogenic osteoarthritis.

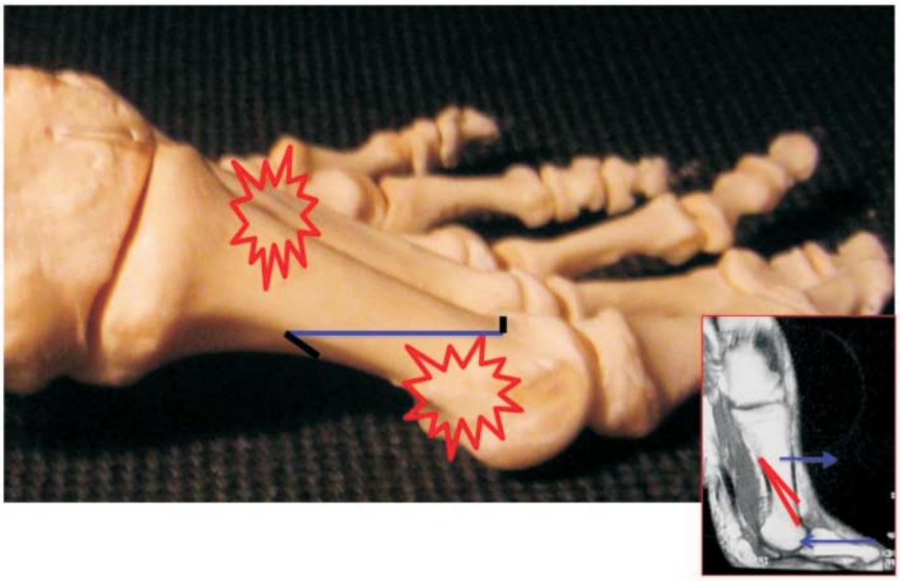
The osteotomy respects the high constraint locations in the M1 bone. (11)

Moreover, the “Scarf evolution” mimics the L osteotomy and is five times more stable.(12) than the classical scarf.

The M1P1-angle, the M1M2-angle and the DMA-angle in the different series of moderate and severe hallux valgus were measured on a weight-bearing dorso-plantar X-ray after bone fusion. Results: Two screws series (1993-1995), 49 cases: M1P1=12,67° +- 7,22°, M1M2= 7,93° +- 2,61°, DMAA= 13,5° +- 4,5°. One screw series (1996-1998), 37 cases: M1P1= 13,11° +- 6,67°, M1M2= 7,44° +-2,51°, DMAA= 6,89° +-4,27°. „No screw series” (since 1999), 33 cases: M1P1=7,07° +- 4,84°, M1M2= 6,51° +-2,36°, DMAA= 7° +- 3,8°.

The correction seems to be better without screw fixation, especially for M1P1- and M1M2-angles.

Osteotomy should respect the high constraint locations



Classical

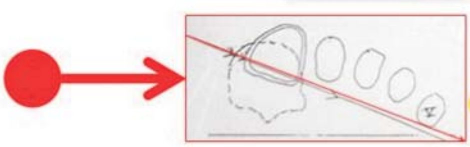
1-exposure

respect head blood supply

2-lateral release

respect LCL

3-cuts

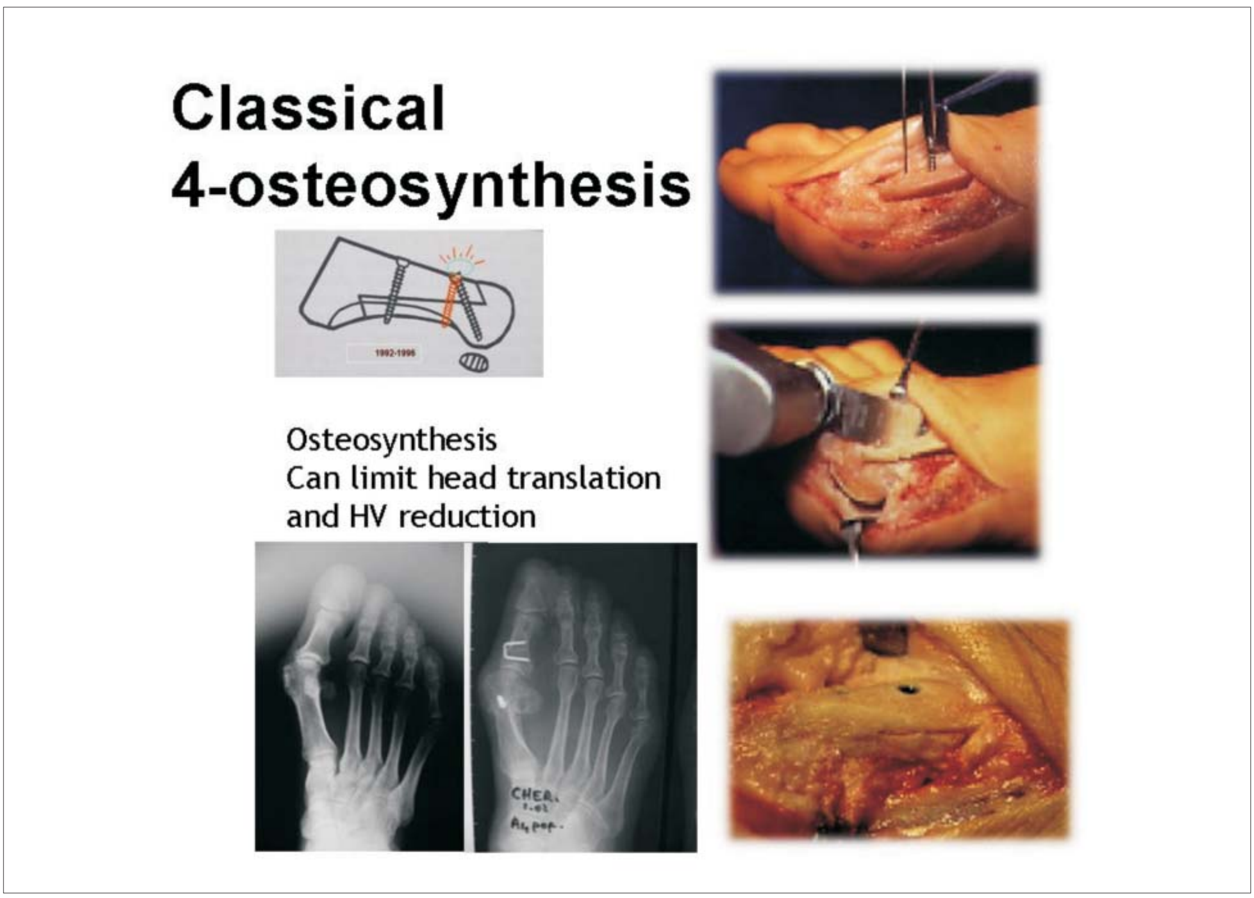


Obliquity of the horizontal cut avoiding head elevation

II. TECHNICAL PARTICULARITIES OF THE "SCARF EVOLUTION"

- Shorter approach
  Less extensive bone exposure in order to keep a maximum of soft tissue attachments for stability. "Just the room to make the cuts."
- The longitudinal cut is more oblique and shorter
  But in case of bone shortening the length must be sufficient, in order to keep the osteotomy site stable, since a slice of bone is removed both proximally and distally.
- The proximal cut is very oblique in order to get a "magpie tail"
  The distal cut is performed stepwise and can easily control the lateral translation and shortening in millimetrical way.
- A proximal autologous bone plug replaces the proximal screw. A transosseous suture locks the osteotomy distally and replaces the distal screw.
- Patient installation
  The feet are put over the edge of the operating table, without support under the heels.
  A sterile inflatable tourniquet is applied around the ankle (protected by synthetic cotton).
- Skin incision
  The skin is incised at the junction of the dorsal and plantar skin, avoiding going too far proximally and distally, and stops at about 1cm from the joint. The dorsal collateral sensitive nerve has to be visualised and protected. Normally it is not necessary to visualise the plantar collateral nerve.
- Exposure
  It is recommended to avoid a large exposure and rugination of the periosteum. First of all, a controlled lateral release is performed by a medial approach (13), above and underneath the lateral collateral ligament (LCL) which is preserved.
  Superior to LCL: the fibrous sling is cut to release the EHL.
  Inferior to LCL: the metatarsal-sesamoďd ligament is cut with the lateral part of the conjoint ligament, close to the base of the phalanx.
  The plantar aspect of the metatarsal shaft is exposed by rugination with care for the soft tissues below the head to preserve the blood flow.
- Bone cuts
  At the metatarsal level 3 cuts are done

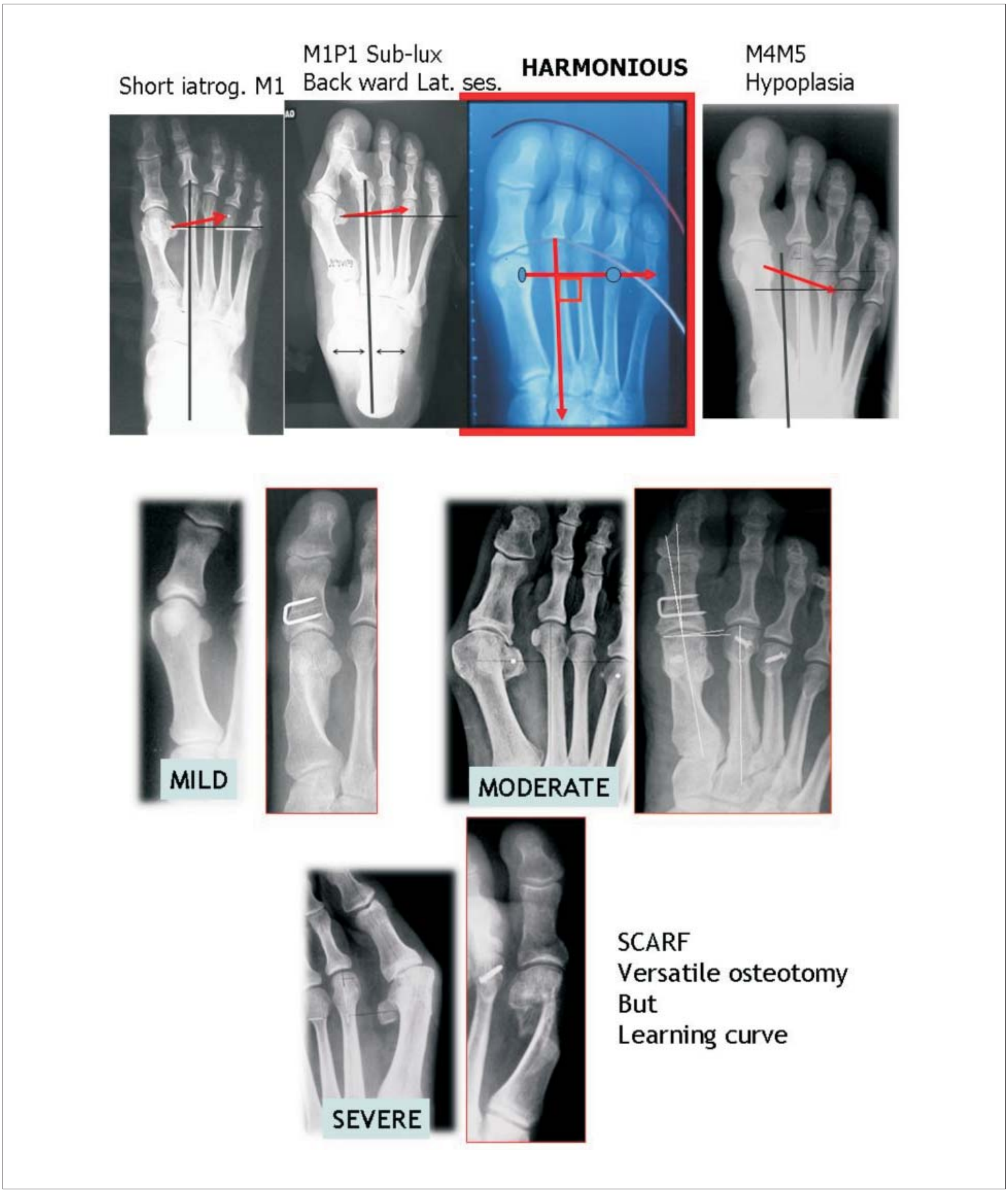
Longitudinal cut: it is in fact oblique along the middle part or the distal third, from the plantar to the dorsal aspect of the medial cortex. It is oriented in a downward lateral direction through the distal metaphysis (the presence of cancellous bone avoids the dorsal fragment to



be fit into the distal fragment), aiming toward the plantar aspect of the fifth metatarsal head (in order to lower the head of the first metatarsal with the lateral displacement).

Proximal cut: is done very obliquely towards the distal aspect (60°) in order to obtain a sort of magpie tail. If an important shortening is needed, a parallel recut will be done (in this case avoid a too short osteotomy and go to the proximal third of M1)

Distal cut: must secure the dorsal fragment into the plantar fragment. This cut is performed just behind the attachment of the synovial recessus, which is preserved. It is done in 2 stages: first, a short distal incomplete transversal cut and second, a proximal complete transver-



sal cut. The two cuts remain separated by a bone bridge. At the end of the complete transversal cut it is useful to introduce a thin bone chisel in the longitudinal cut distally and, while cutting with the saw, a downward force is applied to the plantar fragment. In this way, when the cut is completed, both fragments are separated, while avoiding to go too far in the cancellous bone of the head. Then the medial part of bone between these cuts is removed and a step is made.

2 aspects of the head displacement are controlled as follows:

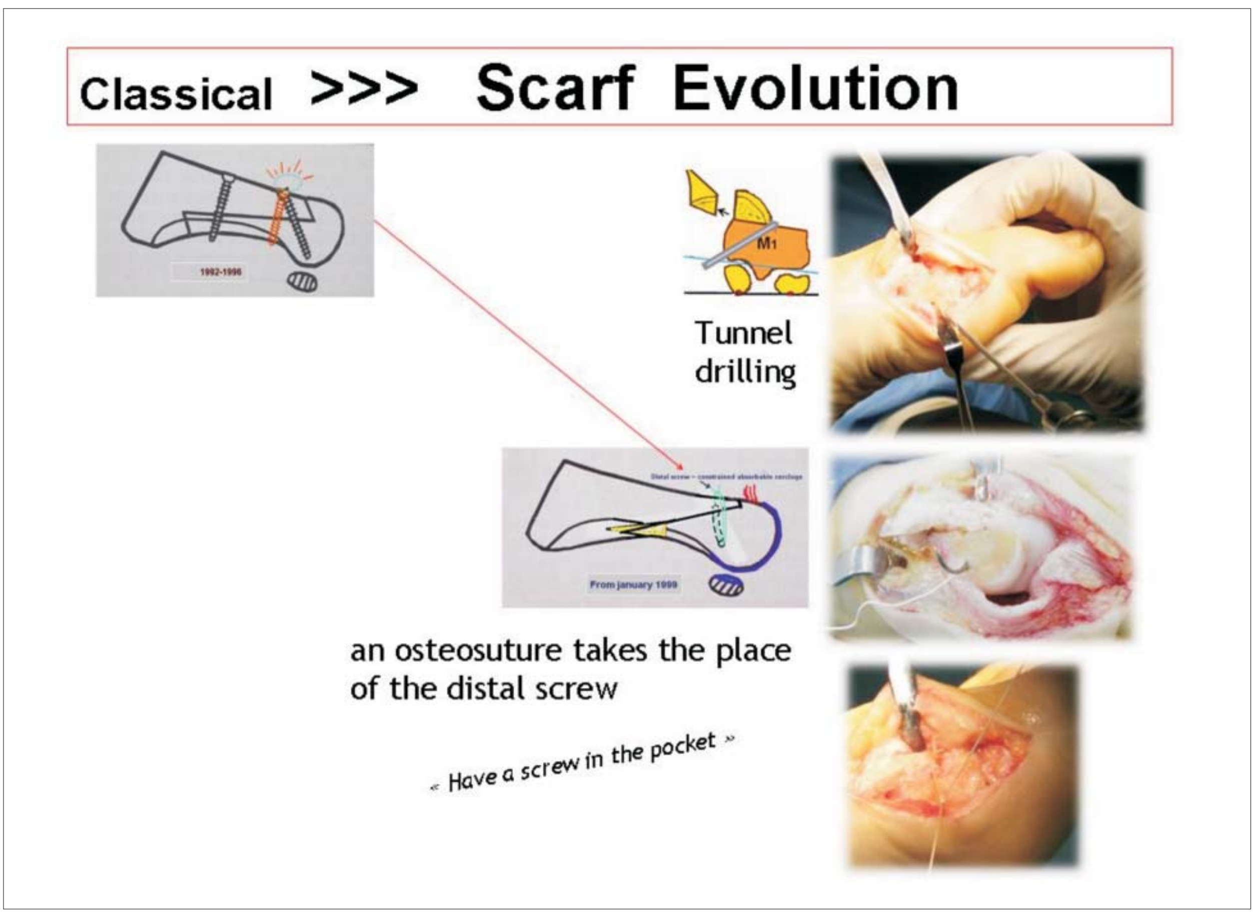
- the amount of lateral translation (keep a step cut of at least 1mm to secure the dorsal fragment), the step location is calculated more or less deep, according to the amount of lateral displacement (generally in the medial third)
- the shortening: 2 possibilities according to the desired metatarsal length
- no shortening is needed: the lateral cut after the step must be oblique in order to reach the level of the medial edge of the first part of the cut, the displacement will be a little bit difficult and must be done progressively.
- shortening is necessary: the amount is correlated to the length of the step, the displacement will be easier because of soft tissue decompression.

We prefer to do the step cut because the amount of shortening is precise. The backward obliquity of the cut would give the same result, but for us, it is less accurate.

Initially, Burutaran used the scarf to lengthen the metatarsal. It is certainly possible, but for us it is only applicable in cases of short first metatarsals in young patients with good soft tissue resilience. In other cases this method gives a great risk of joint stiffness.

The displacement of the osteotomy must be done slowly and accurately.

Firstly, the proximal part of the plantar fragment is handled with a clamp and is pushed laterally in order to put the medial part of the magpie-tail against the internal cortex of the lateral part of the shaft. Secondly, the dorsal fragment is pulled with the tip of a closed clamp and the plantar fragment (head) is pushed laterally with the thumb, protected by wet gauze. Generally, this manoeuvre is hindered by soft tissue attachments on the lateral aspect of the dorsal fragment. These attachments must be cut in a vertical and distal direction to release the dorsal fragment. This manipulation is sometimes not so easy. Then, this fragment can be nested and locked in the distal step, done in the head as it was described above.




More lateral head translation :7 to 12mm
Great stability= immediate weigth bearing
With sole cast protection
Classical >>> Scarf Evolution
Shorter approach
Less invasive Exposure
Just the room for cutting
Lateral release :
- intra articular approach
-respect of the LCL
(prevention iatrogenic hallux varus)

Head elevation always has to be avoided (except in case of anteromedial cavus foot), because of the risk of lateral transfer metatarsalgia.

Sometimes the thickness of the medial part of the head increases with the lateral translation, not only due to the obliquity of the longitudinal cut, but because a pronation of the metatarsal exists. In this case we do a cuneiform osteotomy of the plantar fragment (head) in its distal part in order to supinate the head (1mm for 10°).

This is for us the best method for DMAA correction (except in case of real lateral obliquity of the distal metatarsal articular surface). The rotation in the horizontal plane that is commonly used to reduce this parameter can cause iatrogenic osteoarthritis; if the crista is still present it risks to be deviated by the procedure. And, in addition, it does not solve the problem of the medial thickness of the head and the prominence of the dorsal fragment under the skin, which may cause pain when wearing shoes.

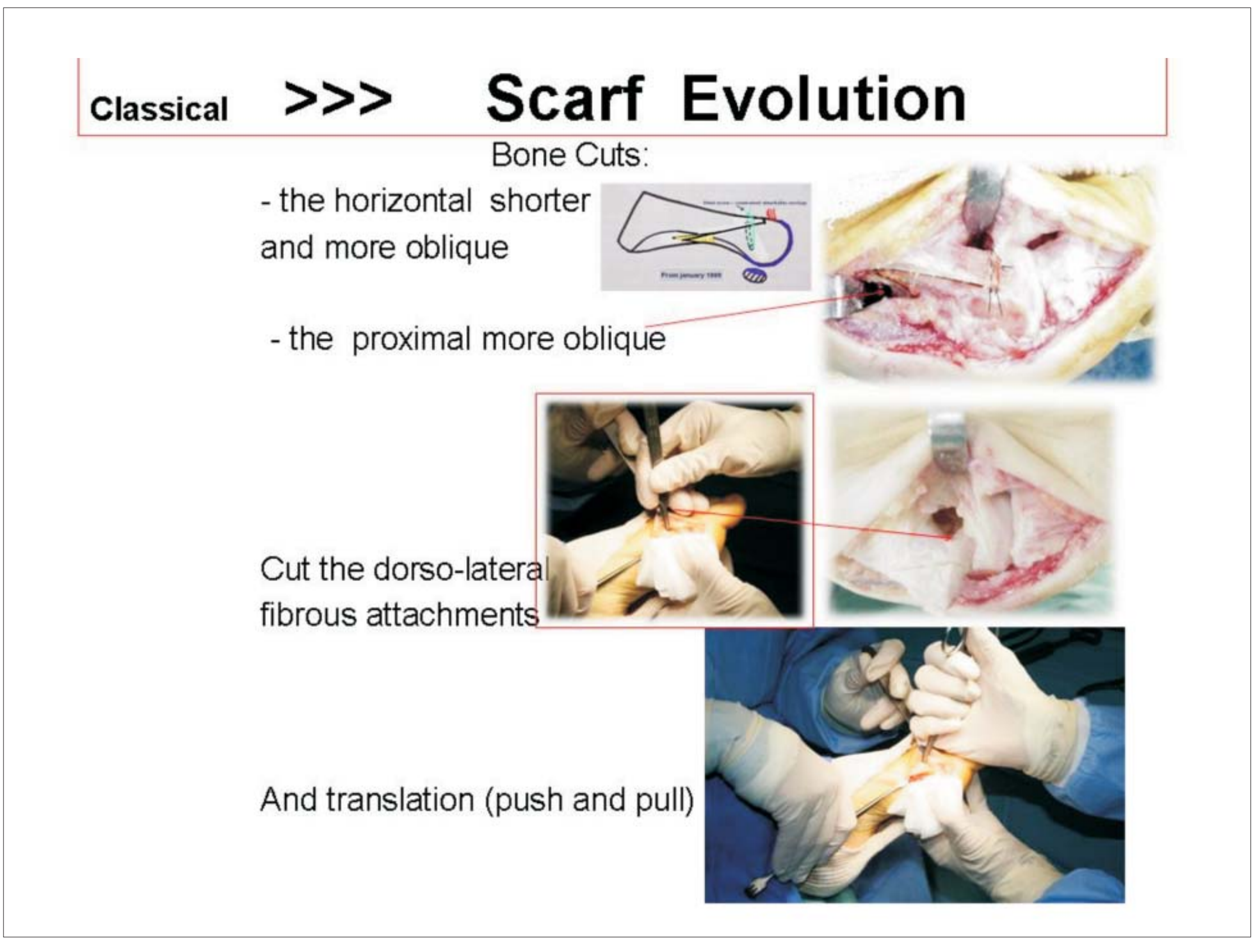
- Fixation
- The distal screw is replaced by an absorbable transosseous suture (Decimale 1): a tunnel is prepared with a drill (2mm diameter) from the plantar edge of the medial condyle, obliquely towards the outer edge of the dorsal fragment, in order to lock it against the head. The dorsal aspect of the dorsal fragment is grooved to secure the sutures. Two sutures are recommended.
- The proximal screw is replaced by an autologous bone plug: the piece of bone removed from the medial distal part of the dorsal fragment (before the transosseous suture). This bone plug has a spontaneous prismatic shape (6mmx3mm x14mm high). Rotated by 180° around its longitudinal axis, it will fit perfectly in the hole of the proximal shaft; its impaction will lock the proximal medial part of the magpie-tail against the M1 shaft.

At this stage the head will be placed perfectly on the sesamoid apparatus and the medial capsule is closed under slight tensioning, by 2 or 3 absorbable sutures.

It is now the moment to correct the hallux as follows:

A palm up test can be performed, in order to check the hallux alignment: then 4 possibilities can occur

a) good alignment: nothing more is to be done (about 10% of cases)
b) proximal valgus persists with a good length (square or Greek morphotype): an Akin osteotomy is performed in an oblique medial lateral direction, on the medial cortex beginning 1cm distal from the joint space. It is cut between two little curved Homann retractors, step



by step, until a good alignment of the hallux is obtained (about 70% of cases)
c) distal valgus persists: the correction is done in the same way, but at the distal level of the proximal phalanx (less than 3% cases). Therefore the skin incision is prolonged distally if the hallux is short or a new distal incision is done.
d) proximal valgus persists with excessive length of the hallux: a shortening is done with the valgus correction to obtain a square or greek morphotype (about 18% cases). We preserve the lateral and plantar cortex of the base of the phalanx and the distal fragment is nested into this.

The osteosynthesis is secured by soft tissue tensioning and the wound dressing, followed by a silicone toe spacer for 2 months. We stopped using staples in the majority of cases.

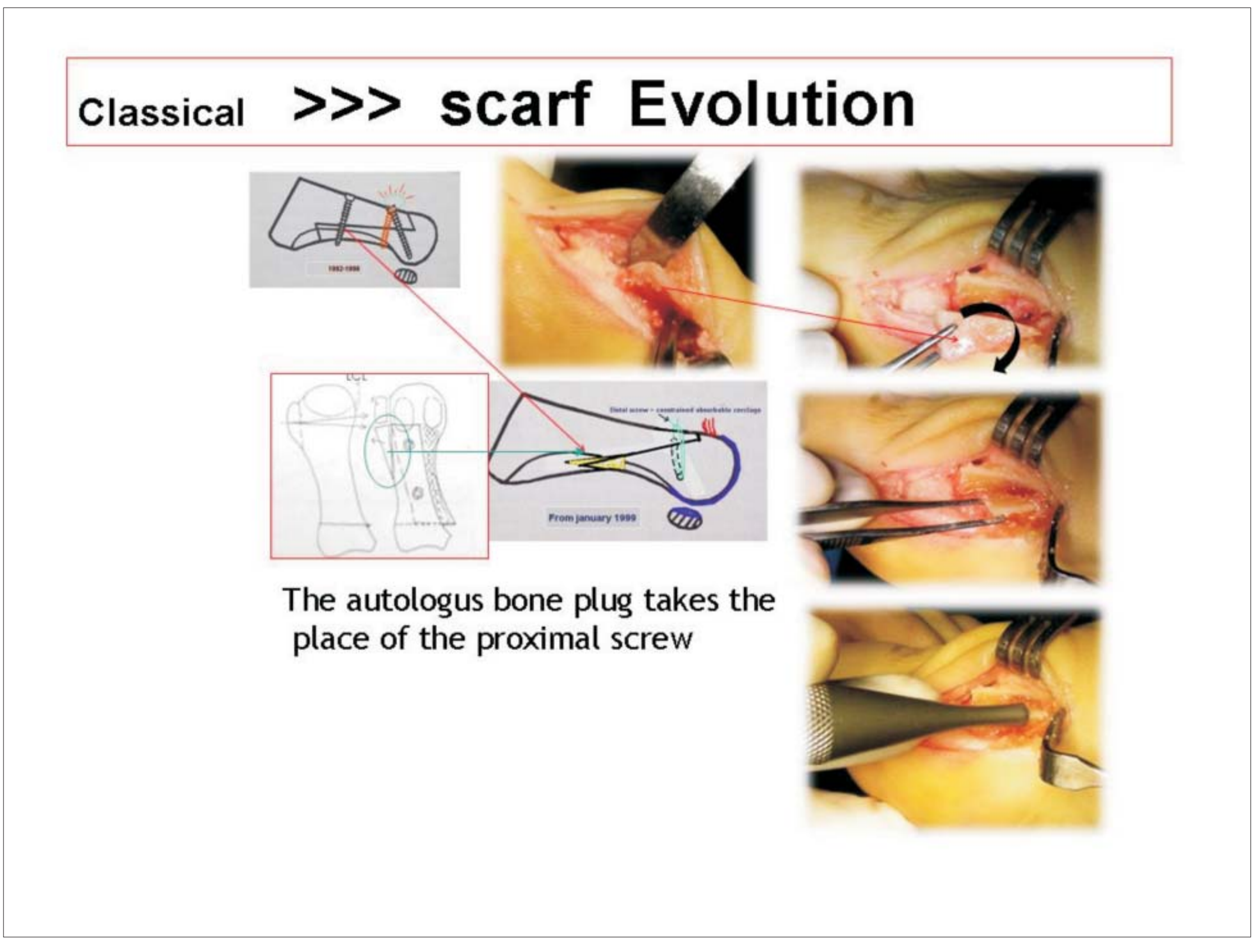
A fluoroscopic control is done to check the respect of the planning and the quality of the correction.

- Skin closure: the skin is closed with absorbable sutures, without any drain, the dressing is done with gauze and fatty dressing.
- Post-operative management:
  We make a total contact cast (TCC) sole which allows immediate weight bearing. The first dressing change is done at the end of the first week. Sometimes, depending on the patient's compliance, the same cast is worn for one more week, and then the cast is removed at the end of the second week. A new x-ray is done and the postoperative shoe with a normal sole is worn for a month. A third x-ray examination is then done.

III. COMPLICATIONS

In the first thousand cases (dec1999-dec 2006)

- 1,4 % severe complications: need for revision surgery
  - Loss of fixation (6)
  - Stiffness and osteoarthritis(3)
  - Hallux varus (3)
  - Troughing (2)
  - 0,03% Dorsal shaft prominence 3 cases needing bone abrasion
  - 12,9% mild or moderate complications: no need for revision surgery
  - Recurrence of HV (47) (all in severe deformities)
  - Delayed fusion (25)
  - Complex regional pain syndrome (reflex dystrophy) + stiffness (29)
  - Mild Hallux varus + stiffness (19)
  - Discrete Loss of fixation (9)
  - Fatigue fracture (0)



- One traumatic fracture after falling (cast healing) No infection, no fatigue fracture, no head necrosis, no wound problems (thanks to the TCC)

IV. PLANNING OF SURGERY: IN ORDER TO ANSWER SOME QUESTIONS

The planning has to be made and the desired displacement is to be calculated in three dimensions on a full weight-bearing X-ray, a dorso-plantar view with 15° downward slope of the x-ray beam.

Questions to be asked:

- Will the Scarf osteotomy be able to contribute in the recovery of the function of the first ray and will it prevent transfer metatarsalgia?
- Will a M1 shortening be needed?
- Will the Scarf osteotomy be compatible with the balancing of the architecture of the forefoot?

Principles of planning (14)

In the anatomy of the forefoot, the second metatarsal and the lateral sesamoid bone are two relatively fixed structures. This enables one to draw the architectural lines of the foot from a functional point of view. The lateral sesamoid bone can be considered as the keystone around which a pathological forefoot can be rebuilt.

In the beginning of our study in 1995 , we drew the M2 axis on a dorso-plantar X-ray on its straight medial border and then a perpendicular line from the center of the lateral sesamoid bone. This line passed through the central part of the head of the fourth metatarsal in many cases and was named the SM4 axis. Then the distance of the tip of each lesser metatarsal head to this transversal line was measured.

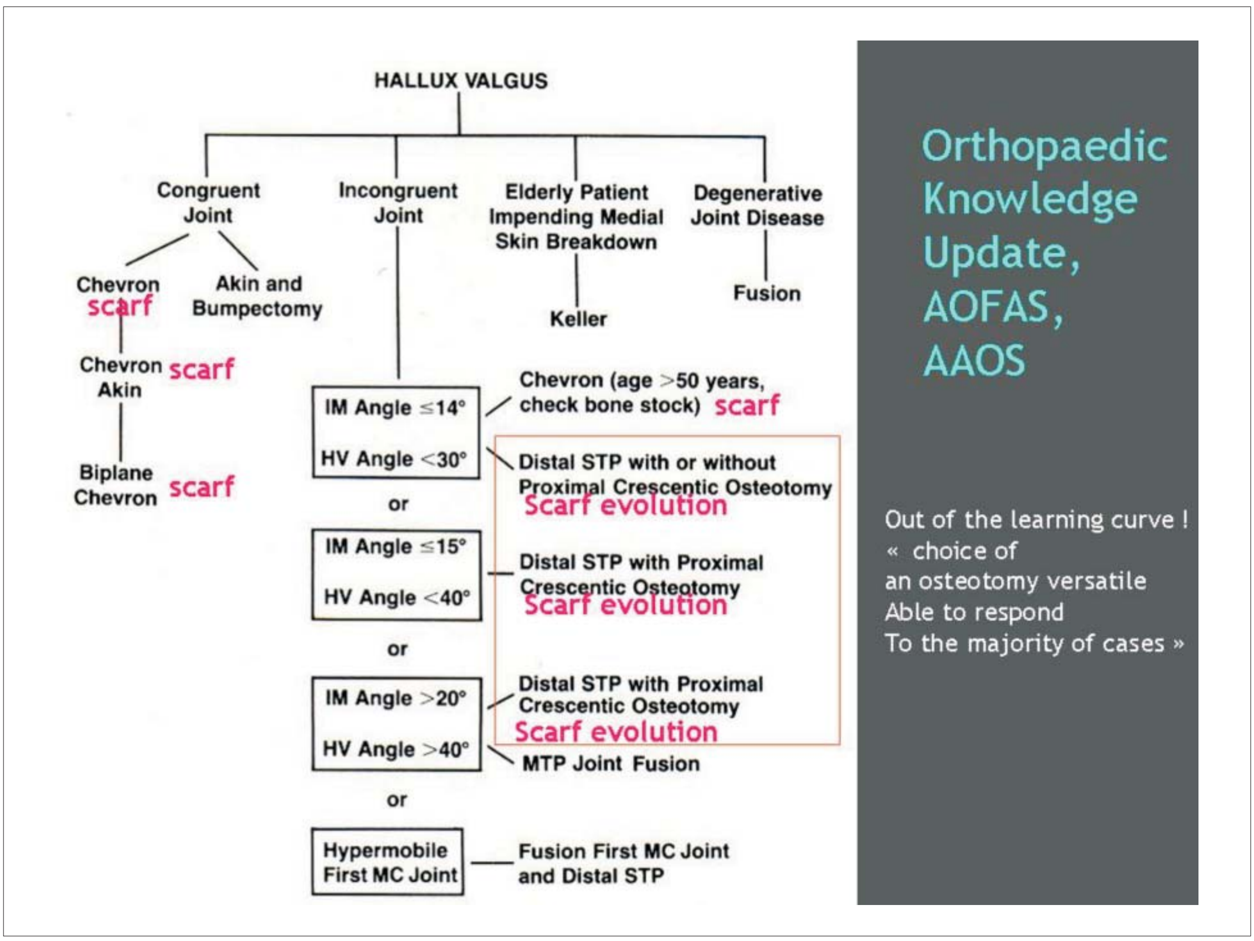
In a statistical study of 40 ‘‘normal’’ feet (16 males, 24 females; mean age: 55 years), we found that the metatarsal heads were positioned according to a geometrical progression by a factor of 2, thus constructing the distal parabola. The Lelievre formula (1 < 2 > 3 > 4 > 5) was quantified by the following results:

- M2: 3.37 mm ± 0.96 longer than M3
- M3: 6.54 mm ± 1.03 longer than M4
- M4: 12.00 mm ± 1.91 longer than M5

Between M2 and M3, the difference was statistically highly significant (X = 0.002). It is also the critical zone of the forefoot, where most of the pressure is present in half of the population.

Three levels of harmony seem to exist in the forefoot:

- one between the lateral sesamoid bone and the fourth metatarsal head,



- another between the length of the lesser rays
- and the third between the first and second metatarsal (M1 more than 7mm shorter than M2 is an anatomical first ray insufficiency).

For the previous study, the M2 axis was chosen as the axis of reference for measurements and reconstruction planning. Proximally, it travels in the majority of cases through the central part of the talar body on the lateral view and through the center of the hindfoot on the dorsoplantar view. Hereby it merges with the sagittal axis of the foot, i.e. the sagittal line drawn between the midpoint of the hindfoot and the second metatarsal tip. The sagittal axis, which permits control of the midfoot and hindfoot, had been chosen as the reference axis since 1999 and for the sake of commodity is still referred to as the M2 axis. Consequently, the SM4 axis passes slightly distally, through the middle third and not through the center of the fourth metatarsal head.

Some architectural landmarks are drawn on this dorsoplantar view center of the sesamoid bones and the fourth metatarsal head (middle third)

- tips of the metatarsal heads
- midpoint of the hindfoot (between the medial aspect of the talar head and the distal lateral edge of the calcaneus)
- sagittal line of the foot (sagittal foot axis), usually merged with the M2 axis (between the second metatarsal tip and the midpoint of the hindfoot).
- axis from the center of the lateral sesamoid bone, perpendicular to the sagittal foot axis, called the SM4 axis when it passes through the middle third of the fourth metatarsal head (in the absence of the lateral sesamoid, its level can be localized on the projection area of the lateral condyle of the first metatarsal head)
- axis perpendicular to the sagittal foot axis from the tip of M2 and M5.

It is necessary to check on the entire foot before measuring the relative length of the metatarsals to eliminate any proximal structural abnormality such as a metatarsus adductus or an excess of sagittal metatarsal obliquity, leading to metatarsalgia. This represents for us a contra-indication for a shortening metatarsal osteotomy in case of metatarsalgia.

Recently, Besse et al. used computer-assisted measurements (''Foot Log'') to obtain semi-automated measurements of X-rays, including some digitalized tools for computerized analysis. X-rays were previously digitalized with a Vidar VXR-12 Plus scanner and plotted by two observers. The data were automatically collected on Excel software and the statistical analysis done with the SPSS9-0 software.

We conducted a study of 154 feet: 50 hallux valgus deformities with a mean age of 50.8 years, 30 hallux rigidus deformities with a mean age of 54.7 years and 84 ''normal'' feet, including 34 feet from the previous series of measurements, with a mean age of 55.2 years and a more recent series of 50 feet with a mean age of 30.3 years. The following data were particularly analyzed:

- The distance between SM4 and M4 (ie, between the perpendicular line to the sagittal foot axis from the lateral sesamoid center and the fourth metatarsal head center one)
- The length of each metatarsal tip to SM4, allowing M1-M2 index calculation (first metatarsal tip/SM4 – second metatarsal tip/SM4) and three criteria to check on the lesser metatarsal distal parabola:
  - criterion 1 = M2-M3 (second metatarsal tip/SM4 – third metatarsal tip/SM4)
  - criterion 2 = M3-M4
  - criterion 3 = M4-M5

The intra-observer reproducibility was excellent (0,1 - 0,2 mm and 0,1 - 1° variations).

The interobserver reproducibility was excellent (0.1 - 0.5 mm and 0.1 - 1° variations).

In a French sample of 84 ''normal'' feet, four principal morphotypes were identified

The first, a harmonious type that can be called ''normal,'' was found in 31% of the feet. This morphotype is characterized by the SM4 line travelling through the middle third of the fourth metatarsal head and a geometrical progression of 2 of the lesser metatarsals. This is rarely exact (e.g. 3-6-12; 3.5-7-14; 4-8-16), but has a tolerance of 20% (± 1 mm for criterion 1 and 2, ± 2 mm for criterion 3).

The other three morphotypes were determined to be non harmonious.

- In the first of these, the middle metatarsals (M2-M3) were too long. This type was found in 30% of the feet and is characterized by the SM4 line travelling through the middle third of the M4 head; the geometrical progression of the lesser metatarsals is disturbed.
- the second is the M4-M5 hypoplasia , characterized by the SM4 line travelling distally to the middle third of the M4 head, and the geometrical progression of the lesser metatarsals can be disturbed or Normal
- the third is the M1 long (2%)

After this study, it appeared that only 48% of people have two identical feet.

Morphotypes in the pathological population: one morphotype becomes predominant. In the hallux rigidus group, the most representative morphotypes are M1 > M2 (6.5%) and M1 = M2 (48.4%), with too long middle metatarsals and a predominance of a long M2 (42%). In the hallux valgus group, the most representative morphotype is M4-M5 hypoplasia (62%) with long M2-M3 (24%). In severe cases of HV, M4-M5 hypoplasia represents 88% of the morphotypes. The genuine morphotype must be calculated after correcting the proximal displacement of the lateral sesamoid due to the M1-P1 subluxation.

Hypoplasia of the fourth and the second metatarsal was not observed in this sample.

When planning for surgery, it is important to determine the original morphotype, before the deformity occurred, and to determine whether or not it was harmonious, in particular in the presence of MTP dislocations or a subluxation of the first MTP joint. In such a case, a surgical correction could produce a new disharmonious unbalanced morphotype, predisposing for future pathology. The patient should be informed of this possibility.

It is also imperative that the amount of bone shortening be calculated.

Three steps are recommended for this

1. Correct the lesion and conserve the joint; for example, measure the overlapping of an MTP dislocation or the overlapping of a subluxation, between the metatarsal tip and the most proximal point of the phalanx. (The overlapping distance is measured between the perpendicular lines to the sagittal axis, otherwise known as the M2 axis, which are drawn from the metatarsal tip and the most proximal point of the phalanx.)
2. Measure the length differences of each metatarsal compared with the geometrical progression by a factor of 2 of the lesser metatarsals. This progression is on a base of 3, 3.5 or 4 mm, depending on the size of the forefoot and generally on the length difference between M5 and M4. The fourth and fifth ray are in the majority of cases not involved in the degenerative pathology. (eg, if this difference is 15, 16 or 17, it will be considered a geometrical progression by a factor 2 on a base 4, that is, 4-8-16).
3. Consider the different shortening amounts. The new architecture should be calculated based on the most important shortening and should be drawn on the original X-ray or on a sheet of tracing paper.

If there is an M1P1 subluxation, the M1 shortening will not dramatically alter the lateral sesamoid level. If the lateral sesamoid is under the M1 head, the M1 shortening will cause a backward sesamoid migration. Generally, extensive surgery is only performed if the shortening necessary to correct a lesion leads to a disharmonious new morphotype that is incompatible with a balanced pressure distribution and has a high risk of transfer lesions.

Three aspects of the forefoot should be considered (always in relation to the sagittal axis of the foot called M2 axis):

- alignment of the center of the lateral sesamoid bone and the M4 head (middle third)
- restoration of geometrical progression of the lesser metatarsals by a factor of two
- restoration of a plus/minus index (M1 = M2) or, preferably, a minus index (M1 < M2, 1 – 3 mm)

Following these rules one may avoid over- or undercorrection leading to complications.

But this not predicts every time a good result!

CONCLUSION

Since 1999 this technique "scarf evolution" is our routine technique for all the cases of hallux valgus deformity. The Scarf osteotomy is a very reliable technique with a lot of possibilities for correction, which avoids a complex decisional diagram. With the surgeon's increased experience, the use of a single method will improve the clinical results to the patient's benefit.

It is very easy to shift from the classical scarf toward "no screw fixation", but the previously stated advices have to be followed rigorously. Shifting from chevron to long chevron and to "scarf evolution" is easy too and allows to treat severe cases.

Iatrogenic hallux rigidus and mild hallux varus are due to excessive displacement (in fact the main risk of this technique is due to the possibility of important lateral head displacement.)

Throughing wich is the worse scarf osteotomy complication, is exceptional with this technique because the distal cut is in cancellous bone.

The most important concept is the use the soft tissue tensioning to stabilise the osteotomy and the realisation of the step in the distal cut.

« but when compared to other osteotomies, no technique was shown to be superior to any other « (15) this must be kept in mind , and the most important for the patient is to avoid complications, so the risk in doing several osteotomies is to stay a long time in the learning curve with a great potential risk of complications!

Thanks to Dr Elke Van Eynde for her help in reviewing this paper.

References

1. *Burutaran Jm : Hallux Valgus Y Cotedad Anatomica Del Primer Metatarsano (Correction Quirurgical). Actual Med. Chir. Pied, 1976, Xiii, 261-266.*
2. *Weil Ls, Borelli An : Modified Scarf Bunionectomy ; Our Experience In More Than 1000 Cases. J Foot Surg, 1991, 30, 609-622.*
3. *Aminian A.,Kelikian A.,Moen T. Scarf Osteotomy For Hallux Valgus Deformity: An Intermediate Follow-Up Of Clinical And Rx Outcomes Foot & Ankle Intern 2006; 27(11);883-886*
4. *Crevoisier X, Mouhsine E, Ortolano V, Udin B, Dutoit M : The Scarf Osteotomy For The Treatment Of Hallux Valgus Deformity : A Review Of 84 Cases. Foot Ankle Int, 2001, 22, 970 – 976.*
5. *Barouk Ls. Forefoot Reconstruction – Paris : Springer Verlag Ed. 2003.*
6. *Kristen Kh, Berger C, Stelzig S, Thalhammer E, Posch M, Engel A : The Scarf Osteotomy For The Correction Of Hallux Valgus Deformities. Foot Ankle Int, 2002, 23, 221-229.*
7. *Maestro M, Scarf Osteotomy With 2 Screws (49 Cases), 1 Screw (37 Cases), No Screw (33 Cases), Comparison Of The 3 Series, 4th Congress Of The European Foot And Ankle Society, March 21-23 2002- Sevilla, Spain*
8. *Besse Jl., Maestro M..Ostéotomie Scarf Du 1er Métatarsien.Rco 2007;93:515*
9. *Maestro M. -Scarf Osteotomy Without Screw Fixation . Interactive Surgery Vol. 2 Treatment Of The 1 St Ray .2007. Springer*
10. *Leemrijse T., Trbrak K.L'osteotomie Scarf Sans Vis Dans Le Traitement De L'hallux Valgus, Revue De 21 Cas Conférences Et Actualités Chirurgie De L'avant-Pied Et De La Cheville.Journée Des Spécialités Sofcot 2005- Sauramps Medical*
11. *Kristen K. Foot Ankle Clin. 2005 Mar; 10 (1): 1-14. The First Metatarsal Bone Under Loading Conditions: A Finite Element Analysis.)*
12. *Vienne P.;Favre P.; Meyer D.;Schoeninger R.;Wirth S. ; Comparative Mechanical Testing Of Different Geometric Designs Of Distal First Metatarsal Osteotomy ; Foot And Ankle Intern. 2007;28: 232-236*
13. *Maestro M. The Ruled Lateral Release Of The Metatarso Phalangeal And Metatarso Sesamod'd Joint In Hallux Valgus By The Medial Approach. Poster Efas Paris 23.25 Octobre 1997.*
14. *Maestro M, Besse J-L, Ragusa M, Berthonnaud E, A Forefoot Morphotype Study And Planning Method For Forefoot Osteotomy, Foot Ankle Clin N Am 2003; 8: 695– 710*
15. *Ferrari J, Higgins Jp, Prior Td. Interventions For Treating Hallux Valgus (Abductovalgus) And Bunions. Update Of: Cochrane Database Syst Rev. 2004;(1):Cd000964.*