

The BRT Proximal Metatarsal Osteotomy

Basal elevation osteotomies of the metatarsals performed in patients with metatarsalgia or *pes cavus* have given unpredictable results. We have devised a new oblique proximal osteotomy which is immediately accurate and stable post-operatively, resulting in a significant improvement of this kind of osteotomy.

History, Definition

Since several years, we have performed oblique proximal metatarsal osteotomies for metatar-

salgia. P. Rippstein fixed these osteotomies by AO screw but with some problems notably with the screw head. L. S. Barouk and E. Toullec fixed these osteotomies by staples with some similar fixation problems. In March 2000, we met each other at Schulthess Clinic in Zurich and we decided to join our experiences of this osteotomy, to define and improve both the cut and the fixation, and at last to make a prospective study.

This metatarsal osteotomy is a dorsal closing wedge. Its cut is very oblique (60°) providing long fragment contact area. Therefore it is not only basal but also proximal. This osteotomy is almost on an horizontal plane. A proximal hinge is carefully preserved, in a cancellous part where the bone cannot break.



Fig. 18a1. The BRT* lesser metatarsal osteotomy.

BRT: Barouk Rippstein Toullec. From the left to the right: L. S. Barouk (Bordeaux), P. Rippstein (Zurich), E. Toullec (Bordeaux).

1. The BRT oblique osteotomy for metatarsal elevation provides a good stability because a proximal plantar hinge is preserved, and it is solidly secured with a FRS (or scarf screw) (2).

* Barouk (Bordeaux), Rippstein (Zurich), Toullec (Bordeaux).

These elements still provide a primary stability. However we perform the fixation with the scarf screw. The screw is set perpendicularly to the osteotomy cut; it provides a strong fixation. The use of the new FRS self-cutting screw is another improvement for producing predictable and reliable results.

Local Anatomy as Applied to the BRT Osteotomy

The proximal part of the metatarsals:

Bone Aspects

- The plantar edge is plantarly curved, provi-

ding favorable conditions for an oblique proximal and plantar cut.

– The articular and intermetatarsal surfaces are located partly the dorsal part, and therefore preserved from the osteotomy cut.

– The fifth metatarsal has a flattened proximal part where the osteotomy is more delicate to perform.

– The first metatarsal has a particularly voluminous proximal plantar part.

Vascular Aspect

– The dorsal and plantar vascular arches are not a problem for performing this osteotomy. The only problem arises from the perforating arteries: Each one must be protected when performing the cut, particularly the first perforating artery.

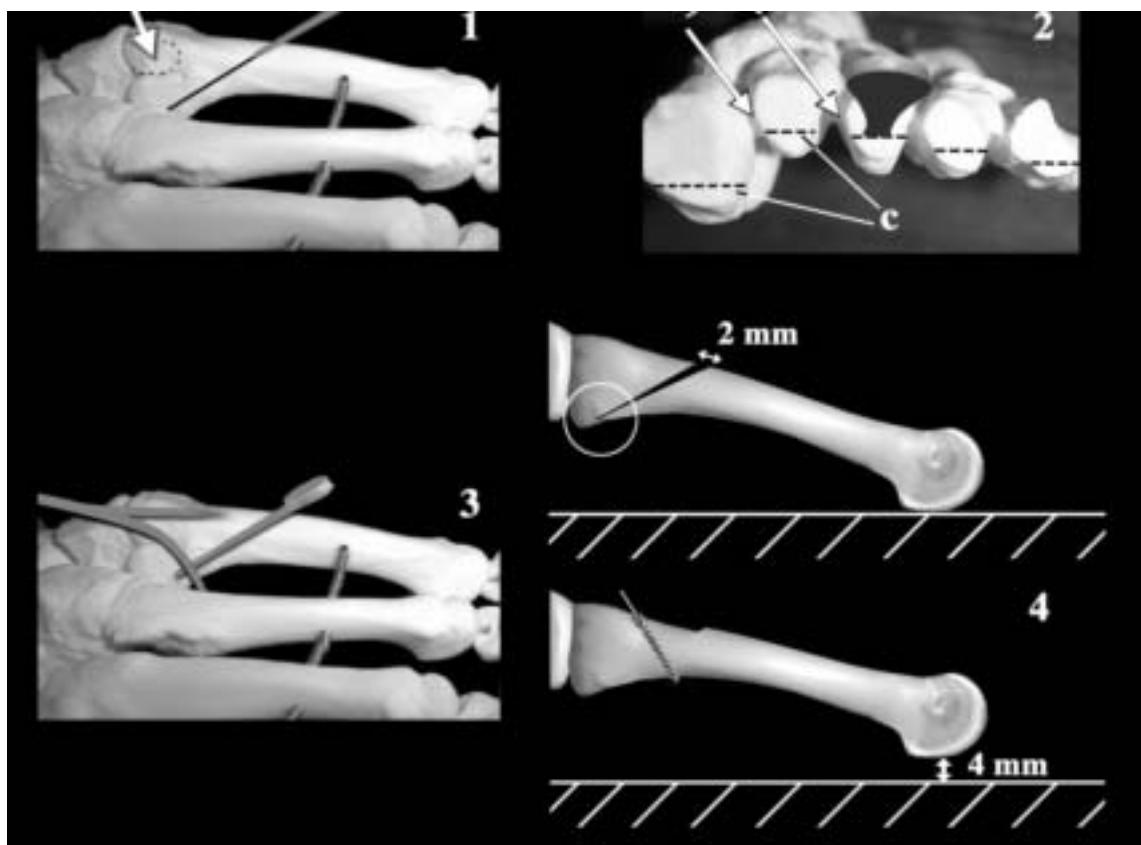


Fig. 18a2. BRT osteotomy. Anatomy.

- 1, 2. This osteotomy is extra-articular, its cut is located plantarly from the intermetatarsal joints.
3. Care has to be taken not to jeopardize the perforating arteries, notably the first perforating one.
4. The dorsal wedge has to be very thin: a 2 mm large wedge elevates the metatarsal head of 4 mm.

Technique

Osteotomy of the Three Central Metatarsals

– *Approach.* Skin incision: Dorsal, one incision for one or three metatarsals. The proximal intermetatarsal edge is checked with the scarf graduated ruler.

– *The osteotomy* begins dorsally at 1.5cm from this edge. It is 60° plantar and proximal directed, respects the intermetatarsal articular surfaces and reaches the proximal and plantar parts of the metatarsal in a part where the can-

cellous bone and the cortex provide favorable conditions to preserve the proximal hinge with sufficient elasticity when closing the osteotomy.

– *A second cut* may be performed but it is better to enlarge the first one instead of performing a second cut, in order to avoid too much elevation.

Three rules for this osteotomy:

a) To have sufficient obliquity in order to reach the very plantar aspect proximally and to have a long cut.

b) To carefully preserve the proximal hinge.

c) Not to elevate the metatarsal too much.

– *The amount of metatarsal elevation, i.e. the size of the bony wedge which will be removed,*

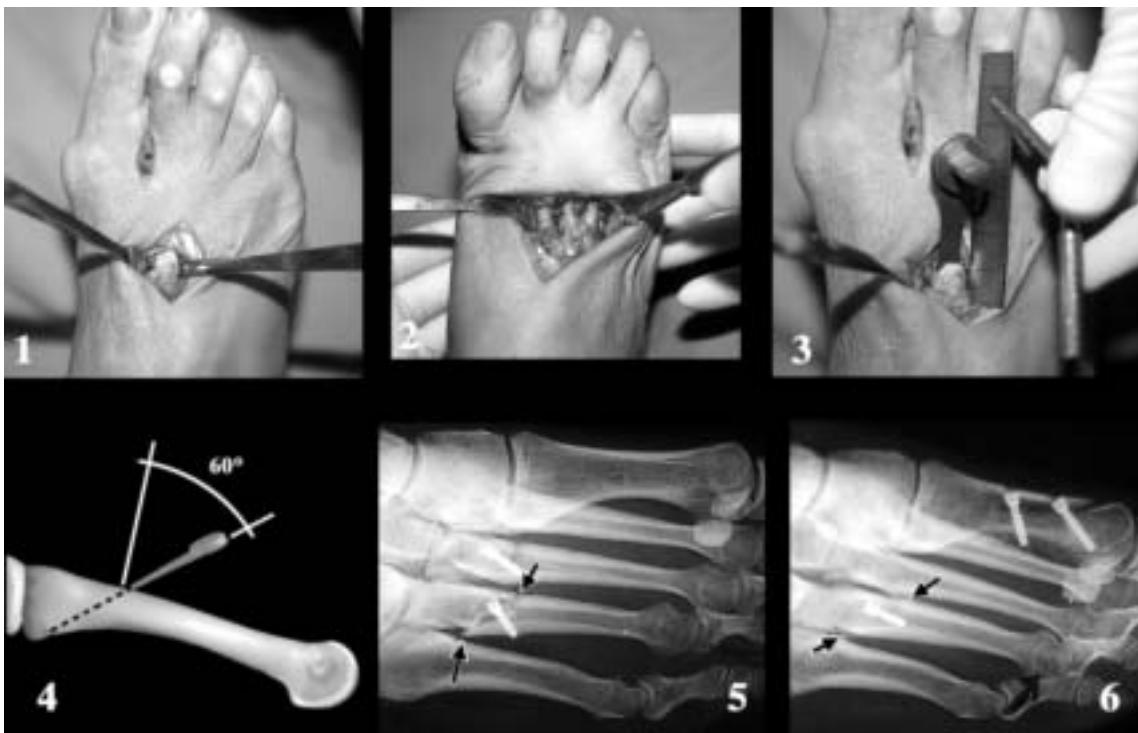


Fig. 18b1. BRT osteotomy. Operative technique 1.

1, 2. Approach through a longitudinal incision for one or for the three median metatarsals.

3. The cut begins on the dorsal metatarsal aspect 1 to 1.5 centimetre from the intermetatarsal proximal edge.

4. The cut has a 60° plantar and proximal oblique direction.

5. Cut not enough oblique: Rupture of the plantar cortex.

6. Correct obliquity of the cut: The proximal hinge is preserved.

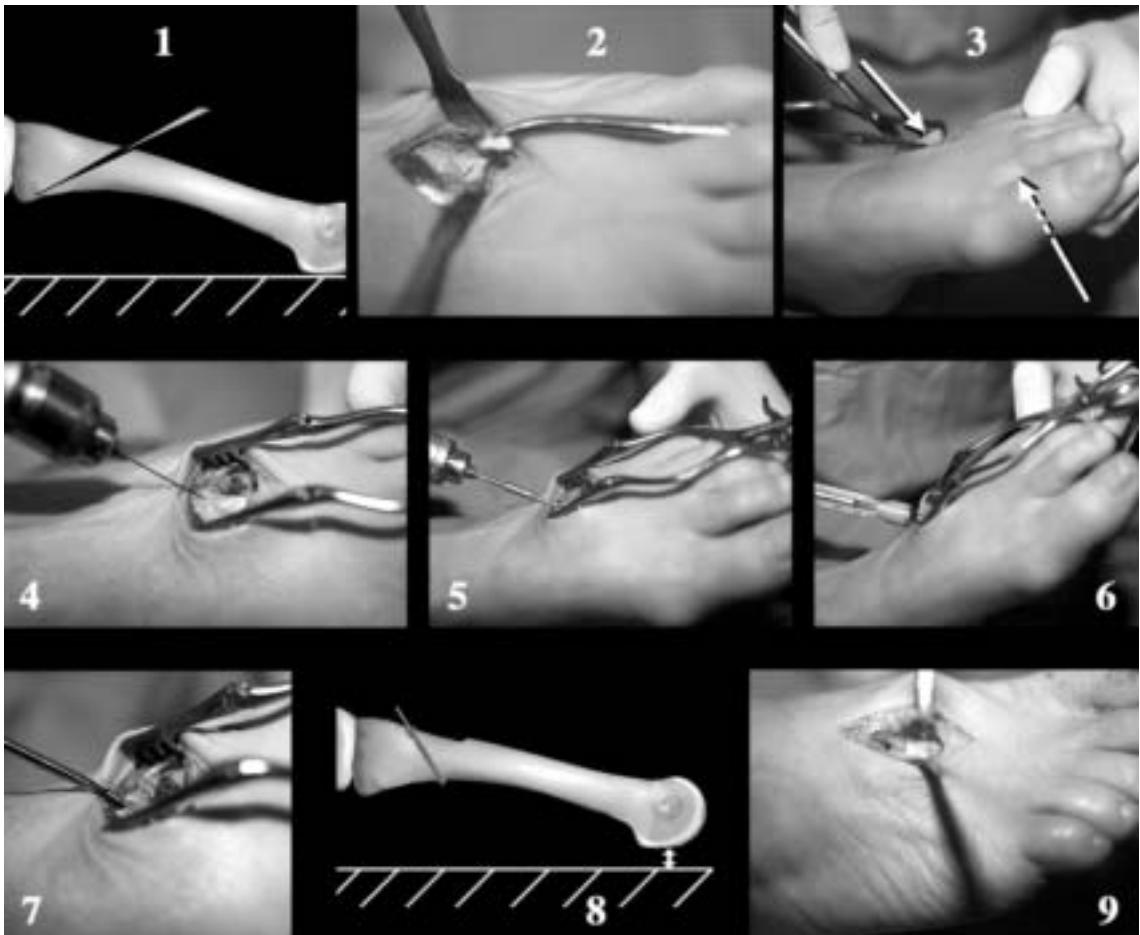


Fig. 18b2. BRT osteotomy. Operative technique 2.

Removing of the dorsal distal wedge (1, 2).

Captation of the fragments (3).

4, 5. Firstly K-wiring, then setting of the cannulated drill.

6. Screw measuring with a depth gauge.

7, 8, 9. Setting of the screw which ensures the fragmental contact.

has to be clinically assessed during the surgery, above all by palpating the metatarsal heads, which is common for all osteotomies without exposure of the metatarsal heads. We can also assess this elevation amount by plantar flexion of the MTP, which indicates the position of the metatarsal heads (Fig. 18b3). At last, the oblique X-ray view (or fluoroscopy) may also be useful. Only 2mm distance between the two fragments in the dorsal aspect elevates the metatarsal head up to 4mm.

– *The fixation:* After closing the osteotomy wedge, the distal fragment is held in a dorsal position while the dorsal fragment is maintained. A Kirchner wire is first set, then a cannulated drill (or directly a threaded pin). Then we measure screw to be placed with a depth gauge. The screw is a threaded head, preferably the FRS self-cutting screw, set around K-wire. We observe the good coaptation of the fragment due to the screw compression effect.



Fig. 18b3. BRT osteotomy. Operative technique 3.

- 1, 2. Since this osteotomy is clinically assessed, the callus has to be previously removed.
3. Another clinical assessment of the metatarsal head position in a sagittal plane is made by plantar MTP flexion.
4. In this position, pre and postoperative aspects of the same foot.
5. The medial oblique X-ray view can also help to assess the metatarsal sagittal position. *Care has to be taken not to elevate too much the metatarsal.*



Fig. 18b4. BRT osteotomy. Operative technique 4.

- 1, 2. When MTP joint release is necessary, it is performed through another incision.

Osteotomy of the First Metatarsal

A medial incision can be used. When it is extended forwards, we easily reach the MTP joint. Generally, the wedge to be removed has

to be longer, because the first metatarsal is shorter ones and than the other, more plantar sloped. The elevation has to be large, above all in medial *pes cavus* surgery. The preservation of the proximal hinge is therefore more deli-

cate but is important. Fixation has to be strong. Preferably we use one or two "20" memory staples.

Combined Procedure

MTP surgery is performed through a separated incision, except sometimes for the first metatarsal.

Osteotomy of the Fifth Metatarsal

The proximal part is flattened comparatively to the other lesser metatarsals so that the osteotomy has to be more horizontal to carefully preserve the proximal hinge.

Remark: actually, I have modified the BRT technique for the 1st ray: I perform a less oblique cut and I use the 20 memory staple which ensures a very strong fixation. Some remark for the 5th ray.

Postoperative Period

– Only two weeks with heel support shoes are sufficient.

– Thanks to the strong fixation we observe no significant edema nor pain. The MTP joint motion is notably preserved. Full weight bearing is allowed after two weeks; we immediately observe that metatarsalgia is relieved without transfer on the adjacent metatarsals.

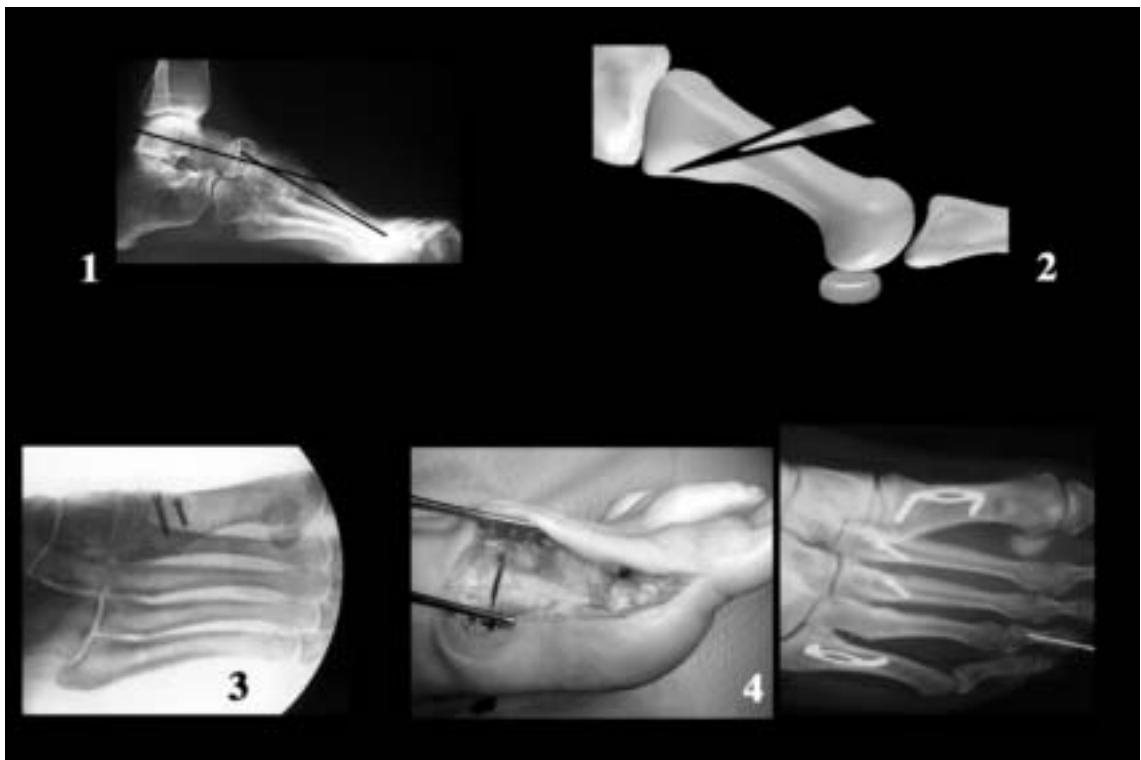


Fig. 18b5. BRT osteotomy. Technique for the first metatarsal.

The first metatarsal is performed through a medial incision which furthermore allows to reach the first MTP joint for releasing. The wedge to be removed should be thicker than for the lesser metatarsals, above all in the *pes cavus* correction. The proximal hinge is more fragile: One or preferably two FRS screws are necessary to ensure the fixation or, preferably, the use of the "20" memory staple (preferably use two staples) but in this case with a *more vertical cut*. Some observation for the 5th metatarsal.

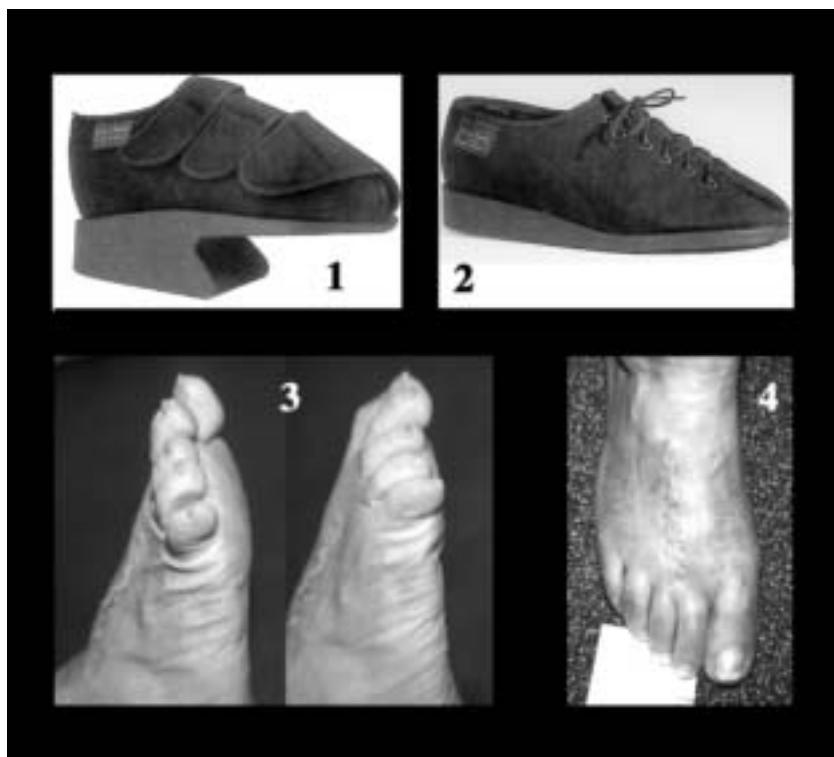


Fig. 18c1. BRT osteotomy. Postoperative aspects.

1. Heel support shoe to be worn only for the first 15 days postoperative, then comfort shoe for one month (2), here Type II shoe (Alba).
- 3, 4. One month postoperative: Active MTP motion and toes ground contact.

Drawbacks

– Peroperative injury of perforating artery, without significant consequence.

– The breaking of proximal hinge can be easily avoided with respect of the operative technique (long and horizontal cut). However, in the three encountered cases, the screw fixation avoided too much elevation.

– Recurrence of metatarsalgia: We observed it only once due to insufficiency of correction.

– Transfer metatarsalgia: Since our rule is not to elevate the metatarsal too much and thanks to strong fixation, no secondary displacement was observed. So, transfer metatarsalgia is due to our assessment of the elevation amount. In fact, it very rarely occurs in the BRT osteotomy.

Advantages

The BRT osteotomy is very easy to perform, accurate, predictable as far as the surgeon can assess and check the amount of metatarsal elevation. The MTP range motion is not decreased, local edema, pain or fibrous tissue problem are almost never observed. The strong fixation allows very early functional recovery. We do not have long-term results at the moment, but we think that they will not change since there is no secondary displacement. BRT osteotomy is only devised for *metatarsal* elevation but it can be combined with other procedures for hammer or claw toe correction or *pes cavus*.

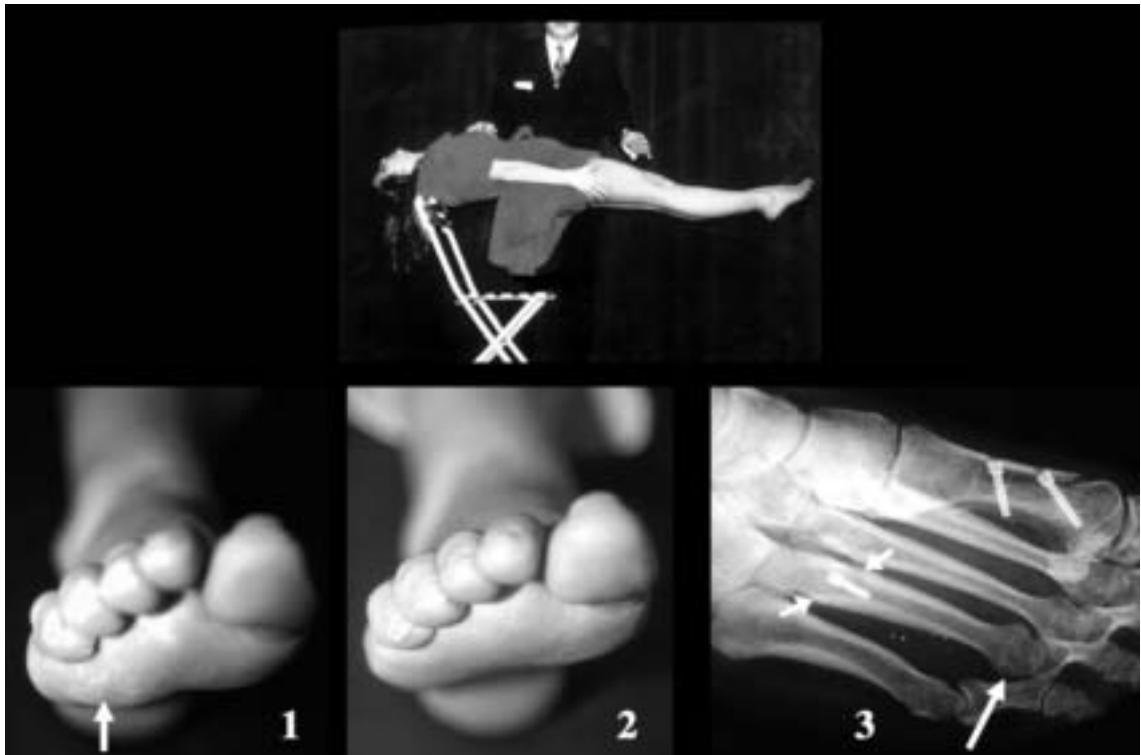


Fig. 18c2. BRT osteotomy. Isolated head pressure (of a metatarsal).

1. Isolated plantar keratosis is an excellent indication for this osteotomy.
2. The same foot two months after the osteotomy.
3. Medial X-ray oblique view of the same foot.

Indications and Results

The BRT osteotomy is only devised for metatarsal elevation. So its indication are metatarsalgia and pes cavus.

BRT Osteotomy in Metatarsalgia

Isolated plantar callus is an excellent indication for BRT osteotomy of the corresponding metatarsal.

Similarly, the BRT osteotomy can relieve metatarsalgia on several rays.

2nd ray metatarsalgia with hallux valgus deformity can be treated either by M1 scarf lowering for mild deformity without excess of 2nd metatarsal length, or by Weil osteotomy of the 2nd metatarsal when it is too long. At last, BRT 2nd metatarsal osteotomy is indicated when the metatarsalgia is moderate or severe but without excess of length of the 2nd ray and without possibility to lower the 1st metatarsal – i.e. small first intermetatarsal angle.

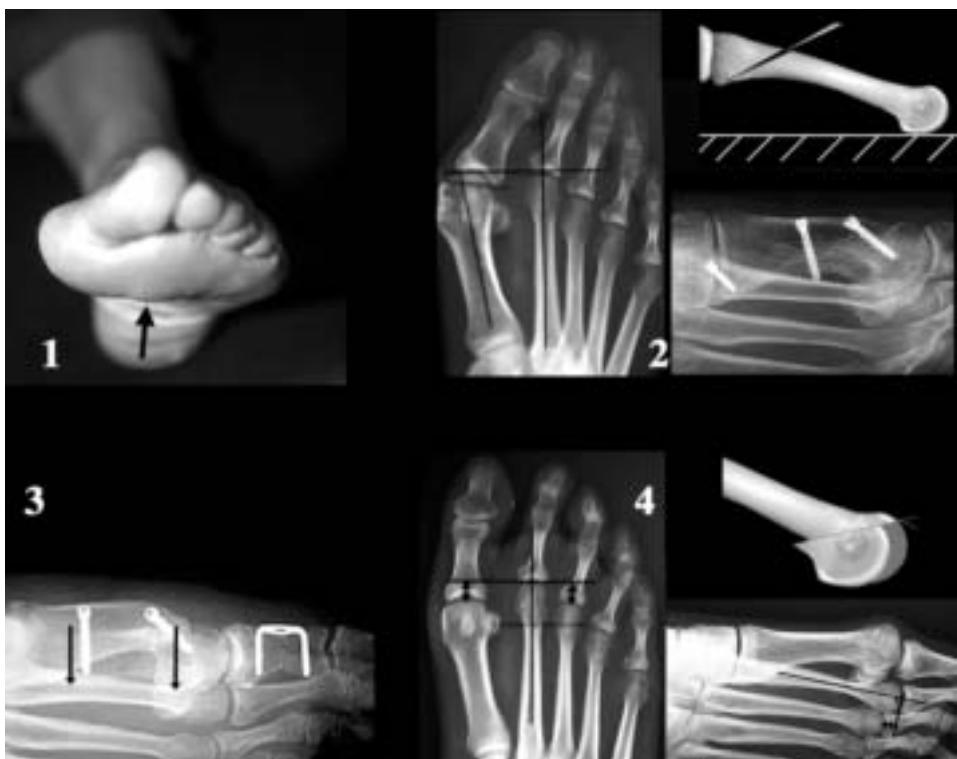


Fig. 18c3. Place of the BRT osteotomy for 2nd ray metatarsalgia combined with hallux deformity.

2. The BRT osteotomy is indicated when the hallux valgus correction does not allow to lower enough the first metatarsal (small intermetatarsal angle).
3. With a large intermetatarsal angle, the *scarf osteotomy* provides a large lowering of the first metatarsal which is enough for 2nd ray metatarsalgia relieving.
4. When the 2nd metatarsal is very long comparatively to the 1st and the 3rd metatarsals, both in a dorso-planter and a medial oblique X-ray view, the *Weil osteotomy* has to be performed instead of the BRT osteotomy.

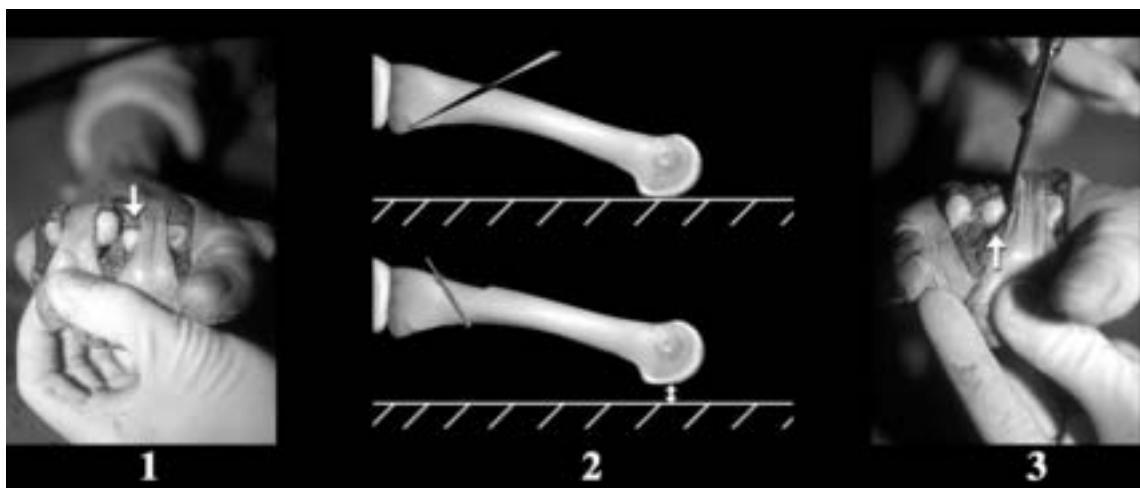


Fig. 18c4. BRT osteotomy in addition to Weil osteotomy.

It is performed when a metatarsal head remains too low. This case is rarely encountered.



Fig. 18c5. BRT osteotomy. Other indications for metatarsalgia.

1. The 3rd metatarsal osteotomy is combined to 2nd cuneo-metatarsal fusion.
2. BRT osteotomy for metatarsalgia with sesamoidal metatarsal arthritis.
3. Indication of BRT osteotomy on the 2nd and 3rd metatarsals for metatarsalgia with trophic troubles and hallux valgus.

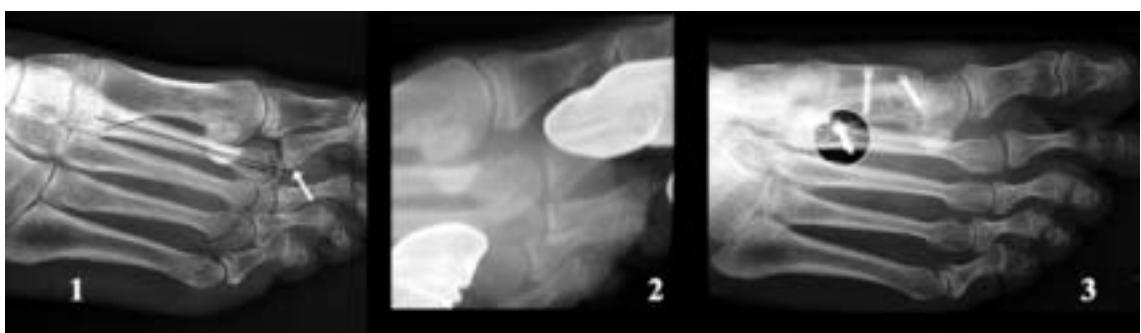


Fig. 18c6. BRT osteotomy. Emerging MTP subluxation.

It seems to be an indication of this osteotomy, but we have to take care of incomplete correction.

BRT Osteotomy in Emerging MTP Subluxation

This is perhaps a place to this procedure in this indication, in combination with the corresponding MTP toe surgery.

BRT Osteotomy in Pes Cavus

Initially we performed only basal elevation osteotomy in the 1st metatarsal and we observed the limits of this procedure – *i.e.* some transfer metatarsalgia on the 2nd and 3rd ray, or on the contrary, insufficiency of M1 elevation. However we observe the good results with this osteotomy regarding notably the correction of the rear foot varus; since we can now easily perform basal osteotomy elevation in the lesser

metatarsals, we can elevate the 1st metatarsal as far as necessary, and combine with BRT osteotomy on the lesser metatarsal as required.

The combined procedures we use are the equinus correction by Achilles tendon lengthening or gastrocnemius proximal desinsertion. The *calcaneum osteotomy* can be performed, this kind of extra-articular surgery was recently emphasized by J. Sammarco. For mild and moderate *pes cavus* – *i.e.* the main cases encountered – the calcaneum osteotomy combined with BRT osteotomy and distal extra-articular correction of claw toe (mainly by soft tissue procedure and K-wiring of the toe) appear to be an excellent solution of the problems of *pes cavus*.

The Weil lesser metatarsal osteotomy is a reliable solution only in *pes cavus* with severe claw toe. For the other cases, the BRT osteotomy gives good results: the two procedures may be also combined.

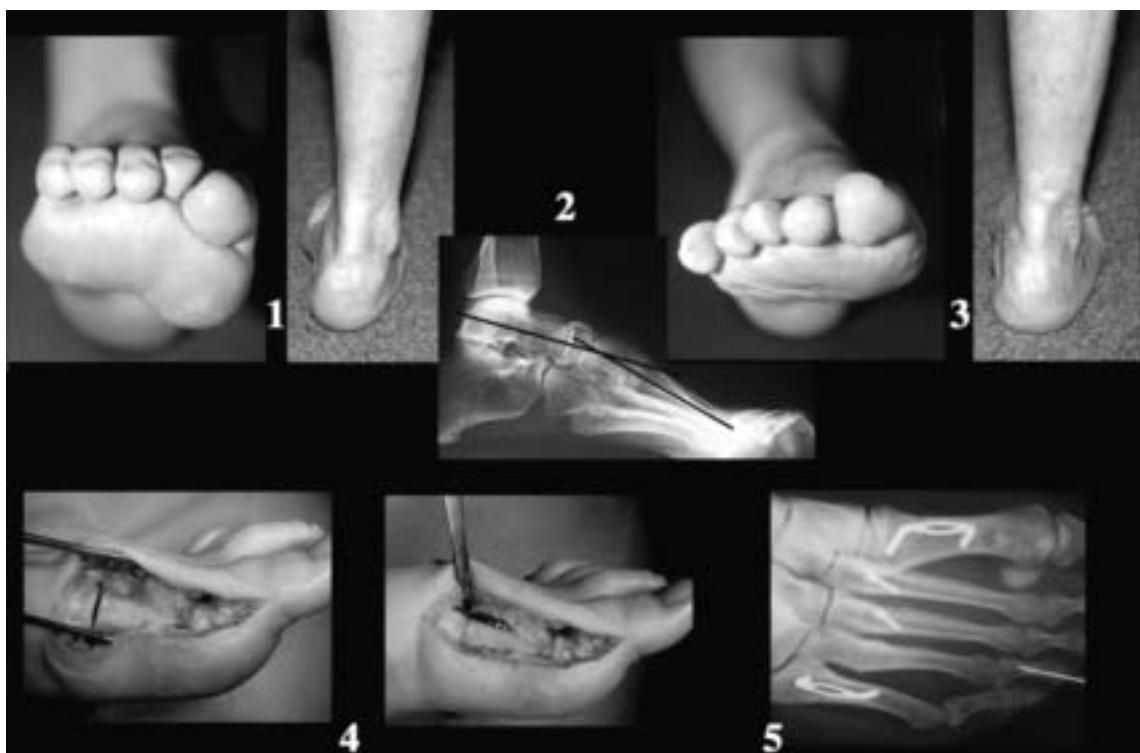


Fig. 18d1. Pes cavus BRT osteotomy of the 1st metatarsal.

1, 2, 3. The excess of plantar slope of the 1st metatarsal, which contributes to give a rear foot varus, can be corrected by the BRT osteotomy, as a consequence of correction of the forefoot supination.

4. Intraoperative aspects. We note that the wedge to be removed is larger than for the lesser metatarsals.

5. Post operative ray with fixation by the "20" memory staple (use of two staples is preferable). This staple may be also used in the fifth metatarsal.

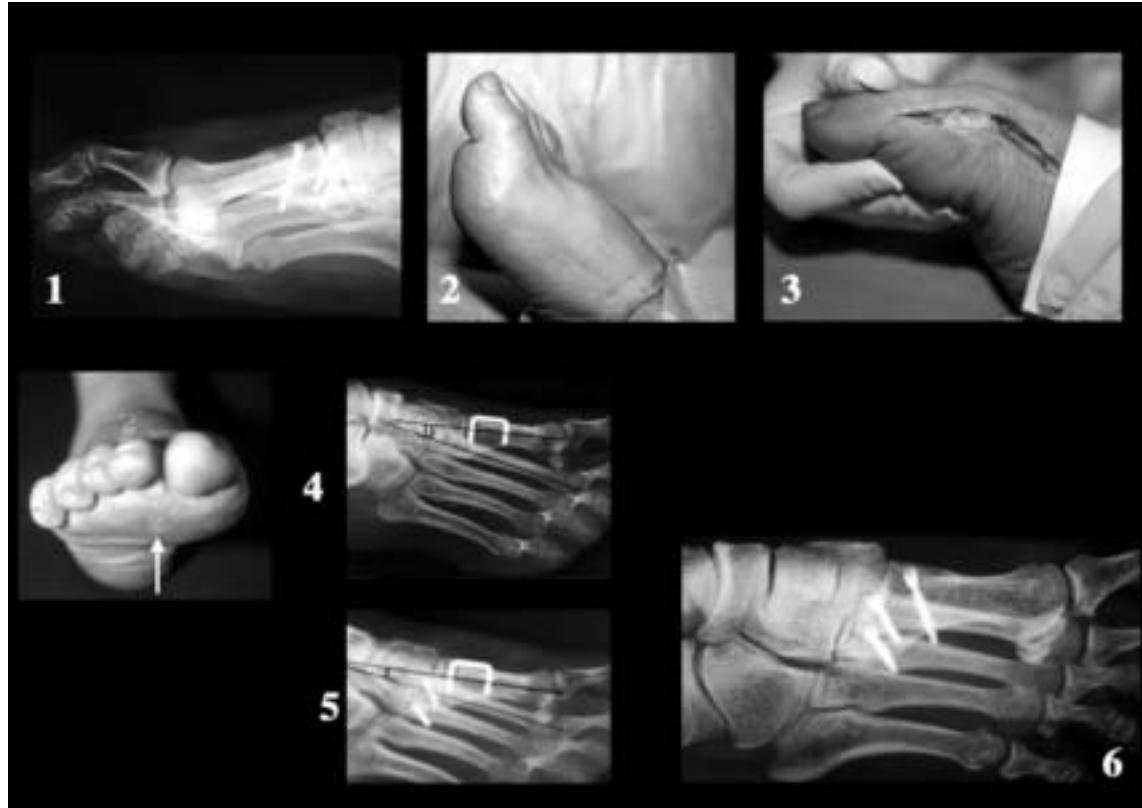


Fig. 18d2. Pes cavus and BRT osteotomy 2.

Some problems resulting for *isolated* 1st metatarsal osteotomy.

- 1, 2. Excess of MTP dorsal flexion.
3. Correction by secondary MTP surgical release (1 year).
4. Too much elevation of the 1st metatarsal: Transfer metatarsalgia on the 2nd ray.
5. Good result after performing BRT osteotomy on the 2nd and 3rd metatarsals.
6. Now, in case of large elevation of the 1st metatarsal, we perform in the same time the required elevation of the lesser metatarsals.



Fig. 18d3. Pes cavus and BRT osteotomy. Treatment of metatarsalgia and claw toes in pes cavus.

- 1, 2. Operative views: We perform BRT osteotomies as required on the corresponding metatarsals, combined with tendons lengthening (extensor, flexor tendons) and toes K-wiring.
- 3, 4. The same foot four months after the operation (right foot operated on).
5. Standing sagittal X-ray preoperative and four months after the operation.

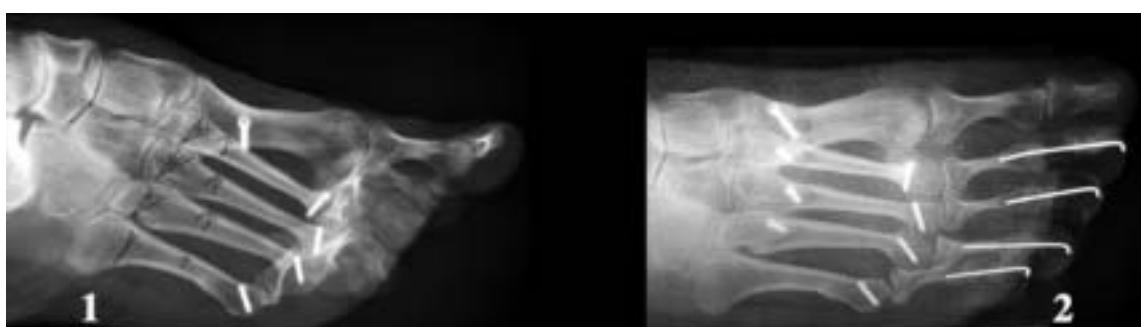


Fig. 18d4. Pes cavus and BRT osteotomy. Revision after Weil osteotomy.

1. Sometimes, pes cavus is not a good indication of single Weil lesser metatarsal osteotomy.
2. Same foot, correction of recurrent hammertoe and metatarsalgia by BRT osteotomy. In severe claw toe observed in pes cavus, the best way is to combine Weil and BRT osteotomy.



Fig. 18d5. Pes cavus: BRT osteotomy combined with calcaneum osteotomy.

Instead of Lisfranc's osteotomy for pes cavus correction, combination of calcaneum osteotomy (Myerson) and BRT osteotomy is an extra-articular effective solution.

BRT Osteotomy in Iatrogenic Forefoot

Iatrogenic problems require reliable solution for patients: When recurrence or transfer

metatarsalgia occurs, the BRT osteotomy is a good and accurate solution, furthermore it is a “light” surgery, not followed by pain nor edema.



Fig. 18e1. BRT osteotomy and *iatrogenic metatarsalgia* 1.

1. Transfer metatarsalgia on the 2nd ray after scarf for hallux valgus.
2. Revision by BRT osteotomy on the 2nd and 3rd metatarsals.
3. Basal chevron osteotomy on the 3rd metatarsal: Transfer metatarsalgia on the 2nd ray: Indication for BRT 2nd metatarsal osteotomy.
4. BRT osteotomy performed for remaining metatarsalgia on the 4th ray.
- 5, 6. Weil osteotomy not performed on the 5th ray: Remaining metatarsalgia relieved by BRT osteotomy.

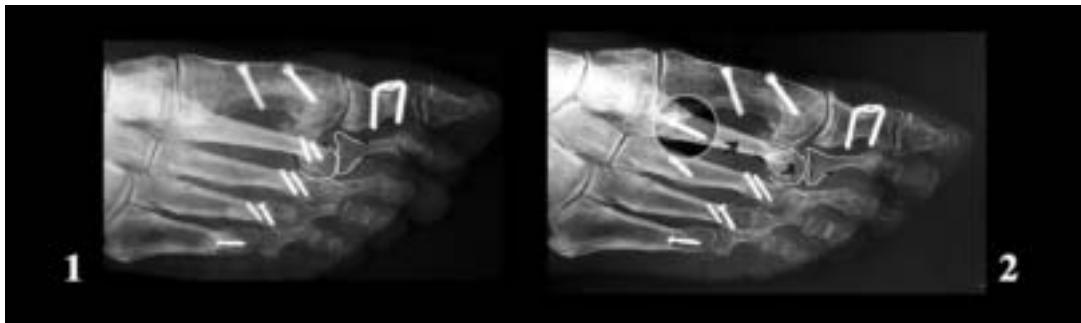


Fig. 18e2. BRT osteotomy and iatrogenic metatarsalgia 2: revision in remaining subluxation on the 2nd MTP joint.

In this case, neither the Girdlerstone – Taylor's procedure –, nor the double layer Weil osteotomy was performed, so that there were remaining 2nd ray metatarsalgia and MTP subluxation: Revision by soft tissue and BRT osteotomy with: good results.

Conclusion

As compared to previous oblique metatarsal osteotomies, *BRT osteotomy is accurate and solidly secured by the screw fixation*; its results are predictable as far as the surgeon can assess the amount of metatarsal elevation – *i.e.* that

there is no secondary displacement of the osteotomy. It is indicated in treating:

1) Primary or iatrogenic metatarsalgia without MTP incongruence.

2) *Pes cavus*.

At last, it perfectly completes the Weil osteotomy.