



The Weil Osteotomy in Metatarsalgia

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Summary

The surgical treatment of static pain in Metatarsalgia II – IV and its MTP joints using the Weil osteotomy, has over the last 10 years become an increasingly accepted method. As one would aspect, it is used in the bone correction treatment of the so-called “Overload-syndrome” of the lateral metatarsal head and joint. This is usually the result of a transfer metatarsalgia, with the accompanying hallux valgus. The most common cause of which is the compression of the hallux valgus to the lateral toes combined with an over-length of the lateral metatarsal. The metatarsal pain syndrome generally precedes a chronic degeneration of the plantar plate under the lateral MT heads. The continual static and functional strain leads to a chronic pressure or stretching of the plantar plate. This can cause its decompensation or rupture. Then the metatarsal head pushes through the plantar plate rupture and causes pain and plantar callosities by direct pressure under the skin. With stretching or rupture of the collateral tendons and the capsule an “Intrinsic over pull” results. This collapses the MTP joint function and develops into a sub-/luxation of the MTP-joint and chronic joint capsule pain.

X-rays of the fully weight-bearing foot will record the form and position of the MTP joint and the true relative length of all metatarsal in conjunction with one another. Normal anatomical length must be compared with pathological variations to enable recognition of pathological entities of the forefoot, as changes after a previous operation, trauma, Freiberg disease or congenital short metatarsal. These conclusions may be obtained using the Metatarsal-Index (MI) (Morton 1948, Debrunner et al. 1977, Maestro 1994). The MI is defined by using the absolute length of the first metatarsal. In Metatarsal Index minus the 1st metatarsal is shorter than the 2nd. The MI is surgically implemented to align the metatarsal, thus achieving the best weight transfer onto the front of the foot (LeLièvre, 1971). With the surgical shortening and achieving a physiological arch of the metatarsal, pressure upon the metatarsal head and the MTP joint can be relieved. The MTP joint luxation or subluxation and secondary non contracted claw deformities, caused by “Intrinsic over pull”, can efficiently be reduced as well. Thus bone alignment of the pathology and metatarsal parable in the area of MTP joints can be reconstructed and corrected in a controlled and pre-planned operation.

Our experiences show that this method can successfully be used to reduce overload pressure on the MTP head and joint following the Metatarsal Index minus. We perform this technique in metatarsalgia by shortening the metatarsal and to realign the disorder of M I after trauma, inherited short metatarsal and as a modification of the dorsal wedge-resection osteotomy, in case of Freiberg disease. Furthermore this technique is recommended in cases of secondary transfer metatarsalgia, after operations with shortened 1st metatarsal (metatarsal osteotomy, Hueter-Majo, Keller procedure et al) and after isolated resection the lateral metatarsal heads.

Key words: metatarsalgia, Weil osteotomy

INTRODUCTION

The surgical treatment of static pain in the metatarsale and the MTP joints using the Weil osteotomy has become an increasingly accepted method over the last 10 years. Usually it is used as a bony correction of the so called "Overload syndrome". This is often the result of a transfermetatarsalgia, with the accompanying progressive "hallux valgus". The most common cause is insufficiency of the first high ray and the compression of the "Hallux valgus" onto the lateral toes which leads to an overlapping second toe and a secondary overload and irritation of the second MTP joint. On the other hand pressure on the lateral metatarsal heads results when the lateral metatarsals are relatively longer than the first. Chronic high pressure on the metatarsal heads will cause a chronic static and dynamic irritation of the plantar plate.

The physiological parable of the metatarsal arch can be measured by the Metatarsal Index (MI). The MI is defined by using the absolute length of the first metatarsal. The MI is surgically implemented to align the metatarsals, thus achieving the best weight transfer onto the front of the foot (LeLièvre 1971). With the surgical shortening and in severe cases lifting of the metatarsal, pressure on the metatarsal head and the MTP joint-capsule can be relieved. Thus, the MTP instability, luxation or subluxation and the secondary non-claw contraction deformity of the toe, can efficiently be reduced.

DEFINITION OF METATARSALGIA

In general Metatarsalgia is understood as pain localised in the front of the foot, in the area of the metatarsal heads, the metatarsophalangeal joint or even the metatarsal itself. Metatarsalgia however is not a diagnosis but rather a group of symptoms that are exactly to be analysed. Causes can be various and must be thoroughly examined.

CLASSIFICATION

Metatarsalgia can be split into *three groups*.

- *Primary and secondary group*: both result from static and dynamic problems or even an overload of the otherwise painless distribution of bodyweight onto the metatarsal heads, the joint capsule and the strained plantar plate.
- *Third group*: the origin of metatarsalgia in this group is neither static nor dynamic. We find diseases like rheumatoid arthritis, synovial cysts, osteonecrosis (Freiberg's infraction), neuropathy pain like entrapments or Morton-Disease, degenerate joint changes etc.

The *primary type* is split into *structural* and *functional* headings. The functional derives from external factors such as shoes that are too short or too tight. This disturbs the toe joints to the extent that the tendons will shorten, causing secondary claw toes. This can lead to painful sub-luxation or luxation of the MTP joints and a chronic irritation, resulting in front foot pain. With increasing age and chronic pressure on the plantar plate

degenerate and becomes thinner, which in turn increases callosity and pain inflicted on the metatarsal head and MTP joints.

Structural primary metatarsalgia is inherited. An instance of this is a pattern of different types of metatarsals all with a relative shortening of the first opposite the lateral metatarsals (Viladot (1984)). These appear in 56% of the population. Jakob (1991) described a definitive increase in pressure underneath the II and III metatarsale head, whilst pushing off of the foot. This also explains stress fractures in chronically overloaded metatarsals. Previously described external factors lead to similar developments such as toe deformation and joint sub-luxation or luxation of the MTP joints with their consecutive problems.

Special reasons for a *secondary Metatarsalgia* are found in inherited shortening of the lateral metatarsals, post trauma and iatrogenic with isolated shortening or lifting of the first or lowering of one of the lateral metatarsals or more often shoes that are either too short, too tight or have high heels with chronic front pressure onto the great and lesser toes.

PATHOPHYSIOLOGY

The metatarsal pain syndrome generally precedes a chronic overload of the metatarsal heads and degeneration of the plantar plate under the lateral MT heads. This can develop into a flat foot with hallux valgus, influenced not only by the position of the metatarsals but also from too short or too tight shoes.

The continual static and functional strain leads to a chronic pressure or stretching of the plantar plate. This can cause decompensation or rupture, the metatarsal head and then they push through the rupture; there it can be felt through the skin (callosity) covering the thinned-out plantar fat pad.

With the rupture or stretching of the plantar plate, the collateral tendons and the capsules, an over pull of the intrinsic structures results. This collapses the MTP joint function and develops into a hypertension of the phalanx with claw toe, sub / luxation of the MTP joint and chronic joint capsule pain (Fig: 1).

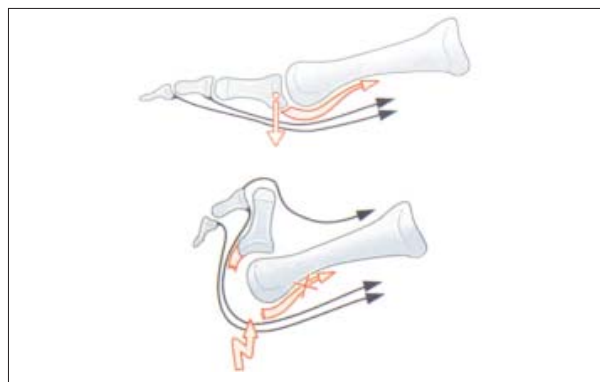


Fig. 1. Elongation and rupture of the plantar plate results in hypertension of the phalanx with sub/ luxation of the MTP joint and claw toe

CLINICAL EXAMINATION

Previous the clinical examination it is imperative that the history has to be researched thoroughly; precise details of locality, cause, spread, intensity and quality of pain in the forefoot must be recorded. This examination gives indications or confirmations about the form, position, deformity, swellings and inflammation of the foot, as well as localisation and spreading of the plantar callosity under the metatarsal heads. Pain caused by pressure from shoes that are too tight or too short, painful plantar callosity and dorsal swelling in the region of the metatarsal heads and joints II-IV are classic symptoms of a metatarsalgia.

The manual examination of the MTP-joints generally gives an indication or confirmation or the localised area of pain and consequently a diagnosis. A "Joint-Play" in translation direction (positive "Drawer sign") or a forceful dorsi-plantarflexion is painful and significant for an alteration of the capsule and the plantar plate. Dependant on the amount of joint pathology involved, the examiner will notice the stability or instability (luxation or subluxation) of the joint. Either bending the joint capsule or compressing the forefoot both ways will cause pain.

Inflammatory arthritis, synovial cysts, osteonecrosis (Freiberg's infraction), or degenerate joint changes and foremost neuropathy pain (Morton-Disease) etc as differential diagnosis have to be considered.

An injection of a local anaesthetic directly into an affected joint, results in an immediate reduction or complete relief from pain. This will confirm the clinical diagnosis with pain that originates from the joint.

In case of an increased swelling or secondary damage of the joint MRI can be extremely useful in confirming and documenting the result.

X-RAY

It is always recommended to do an x-ray of the foot judging whether the bone deviates from the norm or not. This will record the form and position of the MTP joint and the true relative length of the metatarsals in conjunction with one another. Normal anatomical metatarsal lengths must be compared with pathological variants to enable recognition of pathological entities of the forefoot. These may be obtained using the Metatarsal-Index, (Morton 1948; Debrunner et al. 1977; Maestro 1994).

Three metatarsal forms are created independent from the length of the metatarsals.

- *Index plus:* 1st metatarsal is longer than the 2nd
- *Index plus minus:* 1st and 2nd metatarsal are of the same length
- *Index minus:* 1st metatarsal is shorter than the 2nd

The inherited as well as acquired, iatrogenic Index-Minus form, as described by Morton (1948), can lead to a transfer-metatarsalgia with overload problems in the lateral metatarsals. Most often this is caused or accompanied by a hallux valgus deformity. The larger the hallux valgus and the index-minus angle, the sooner a metatar-

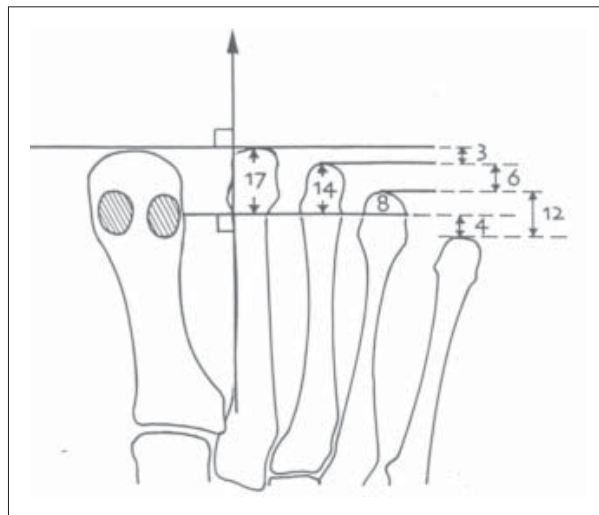


Fig. 2. The determination of the optimal length of the metatarsals. Maestro's line is drawn at a right angle of the axis of M2 and passes through the centre of the lateral sesamoid. It normally crosses the centre of the head of M4. The length of the metatarsals usually decreases in geometric procession

sal malfunction develops in conjunction with the clinical scenario of an "Over load Syndrome" of the neighbouring MTP joints and MT heads.

To determine the optimum length of the metatarsal, it is necessary to measure the X-ray done in standing AP position. The Maestro's line is determined by a right angle through the longest axis of M2 continuing through the centre of the lateral sesamoid. This would normally cross the centre of the M4 head. The length of the metatarsal normally reduces laterally in geometric steps.

According to Maestro, the ideal length relationship, (Index plus-minus), occur then, when $M1=M2$ and the length difference of the metatarsal from M2 to M5 is doubled (Fig. 2).

INDICATIONS FOR THE WEIL OPERATION

Metatarsalgia can be treated conservatively in 90% of the time. The indication for the Weil osteotomy is the chronic metatarsalgia unresponsive to conservative care, intractable keratosis associated with pan metatarsal structural imbalance like elongated metatarsals and dislocated metatarsal joints. Good results are also seen in early stages of rheumatoid arthritis (Barouk).

While walking the peak of power loading starts at the centre of the heel (1st peak) and ends between first and second toe (2nd peak) (Debrunner and Jacob, 1998). At the second peak the great toe bears one third or more of the body weight through two sesamoid bones. The Weil-Osteotomie allows a shortening and lifting of the metatarsal in the area of the distal shaft. This may compensate the extra length of the metatarsals and reduce the pressure on the MT heads and joints. Therefore it may be used correcting both chronic static and dynamic front foot pain caused by no physiological bone changes of the metatarsal-parable or those described previously. A ge-

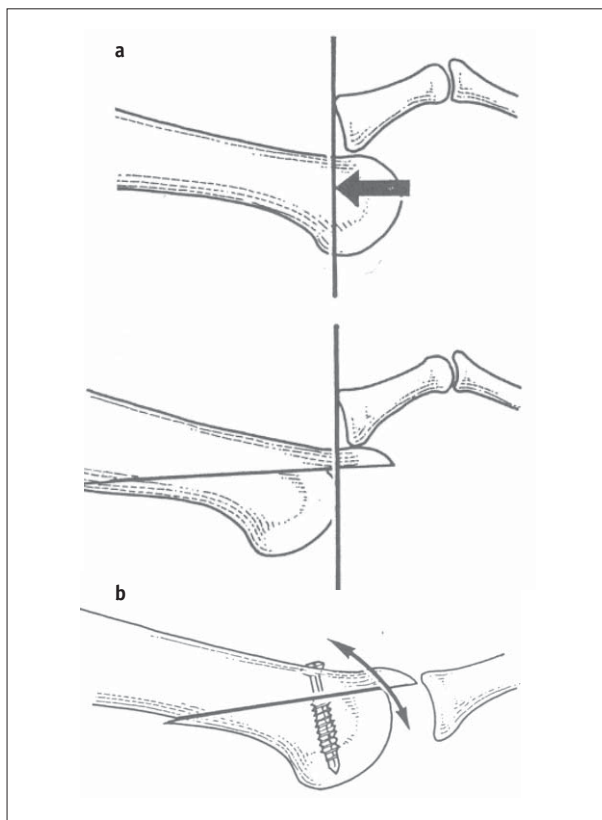


Fig. 3a-b. The osteotomy is horizontal, parallel to the sole and starts at the superior limit of the articular cartilage of the MT-head. Resection of the tip of the dorsal fragment. Reposition and screw/pin fixation

neral indication for this operation is the inherited MT Index-minus with the second metatarsal being considerably longer than the first. The resulting secondary effects, such as pain caused by instability, subluxation and luxation of the 2nd MTP joint, as well as the other lateral neighbouring joints can be corrected by his method. The aim is to reduce the pressure underneath the metatarsal heads by shortening and lifting of the metatarsals in the area of the distal shaft.

Special indications for the Weil osteotomy are given, either if the physiological alignment of the metatarsal row has been changed by a previous operation with shortening or lifting of the 1st metatarsal, or a congenital short 1st metatarsal, or if the lateral metatarsal has been disturbed by Freiberg's disease (Fig.4), or post trauma.

As the shortening or lifting of the metatarsal is always the goal of the Weil operation, this action is controlled by the Metatarsal-Index plus-minus. There is no place for this operation in a physiological alignment of the metatarsal arch with a radiological index plus-minus or minus and in stable painless joints with any damage of the capsule, ligaments or the joint surface. Don't operate on healthy joints!

In some cases the following methods are still indicative to relieve the pressure on the plantar plate; the plantar DuVries condylectomy, the dorsal closed-wedge Leventen osteotomy, or the Helal metatarsal osteotomy.

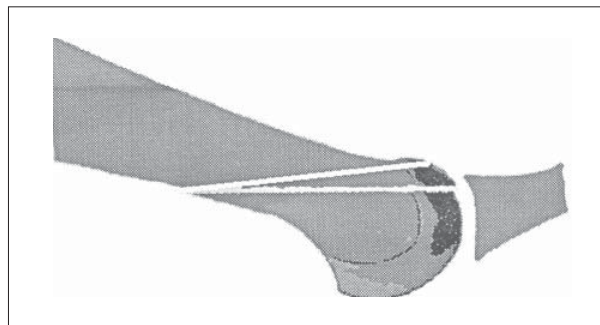


Fig. 4. Tilt-up Osteotomy

The Helal metatarsal osteotomy however is usually performed without any osteosynthesis and therefore the bone healing process is uncontrolled and has a high failure rate (painful pseudarthrosis etc). Comparison the results of the Helal and Weil technique, Trnka et al (1999) recorded a recurrence of metatarsalgia in a percentage of 27% / 0%, a secondary transfer-metatarsalgia in 41% / 0%, a joint stability after MTP-reconstruction in 36% / 84% and a pseudarthrosis of the metatarsal in 10% / 0%.

In our opinion the corrections on metatarsals and MTP joints should be done as far as controlled and stable by osteosynthesis. An operation on the MTP joint should only be done in cases of any accompanying pathologies of the MTP joints.

PRINCIPLE OF THE WEIL OPERATION

Lowell S. Weil has been using his method of operation since the beginning of the 90's and has carried out more than 1000 operations (personal statement). It is worth noting that in literature there very few references to neither the details of operation nor their results. Even Weil has published nothing of consequence.

The horizontal osteotomy should result more in shortening and / or elevating than in plantarisation of the metatarsal head. The extended horizontal osteotomy ensures a good bone contact and a speedy bone healing of the osteotomy. Screws or pins are used for a stable Osteosynthese. The Weil technique can be performed in several variations: shortening, elevation medial translation, lateral translation and/or transverse plane rotation of the distal metatarsal.

In case of a complete MTP joint luxation the collateral ligaments, plantar capsules and the plate must be freed in order to plantar and repose the intrinsic-muscles in a functional position.

After the metatarsal osteotomy the shortened tendons are relatively released and secondary flexible claw toes can be stretched again. In cases with severe contractions it may be necessary to perform further adjustments to soft tissue, tendons and toes.

OPERATION TECHNIQUE

Generally the operation can be performed in regional or foot block anaesthesia. A dorsal S-shaped cut along the

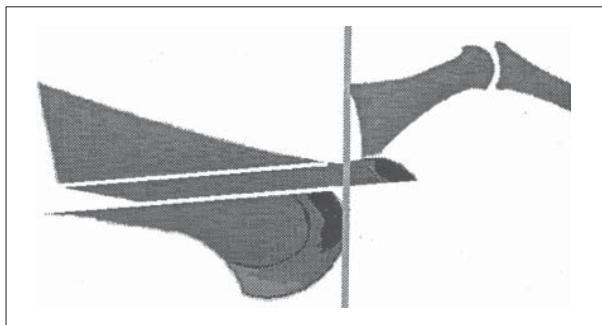


Fig. 5. Double Weil Osteotomy. Shortening and elevation

length of the affected metatarsal joint, or between two metatarsals will expose the extensor tendon. If the position of the toe is neither laterally nor medially deviated (splay toe) and/or the extensor tendon shortened the tendon may be divided longitudinally and the joint opened. If however the toe is located in medially or laterally position (digitus valgus/varus), then the joint capsule should be released medially or laterally. After mobilisation and reposition of the joint, eventually by releasing the collateral ligaments, the MTP head may be exposed. An oscillating micro saw is used to carry out the previously described horizontal osteotomy. Shortening of 1-3 mm is more common for isolated metatarsalgia.

The bone cut begins at dorsal aspect of cartilage. The smallest possible angle of osteotomy is 10° and will cause plantar displacement after more than 3mm of shortening. After more than 3mm of shortening, it is necessary to remove a slice of bone to elevate the metatarsal as well as shorten. The head will then spontaneously or with gentle pressure allow itself to be repositioned. Whilst the osteotomy surfaces are compressed together they are then fixed diagonally with a mini screw or threaded pin. In cases of shortening greater than 4 mm, we suggest two screws or pins.

Particular attention must be applied to the shortening of the metatarsal and to the exact position and rotation of the head to prevent a medial or lateral deviation of the toe or to correct toe deformities. To avoid a mistake an

intraoperative X-ray is recommended. On the other hand metatarsals may be shortened, elevated, tilted, or rotated to correct splay toe or cross over toe deformities.

The joint capsule must be closed under tension to avoid a joint instability and later on cock up toes. Postoperative the joint must be free and mobile but not instable. In the case of bony or soft tissue over correction the joint becomes too loose and not stable. This results in a "floppy toe" and a continuing or secondary lateral transfer metatarsalgia. In case of under correction the joint becomes too stiff or remains sub-located or located.

The *post operative care* depends on the extent of the operation, (amount of operated metatarsals, additional correction of the 1st MT etc), the individual pain, swelling and the stability of the osteotomy. Bandage of all operated toes in 5 degrees of plantarflexion, resting the foot for 4 to 5 days using crutches, then guarded weight bearing in surgical shoes, bandage removed in one to two weeks and active plantarflexion exercises to avoid lack of to purchase are recommended.

SUMMARY

Even if there are only few literary case histories on Weil's osteotomy technique over the last years, it has well established itself in the treatment of metatarsalgia. This procedure is not only helpful in all cases of metatarsalgia that are related to a chronic irritation and instable MTP-joint to the extent of luxation following a primary or secondary Metatarsal-Index-minus. With this controlled technique the bony alignment of metatarsal parable of the MTP-joints can be reconstructed and corrected. Our experiences show that this method can also be used to correct metatarsals after trauma, inherited short metatarsal, and to perform the dorsal wedge-resection (tilt-up) osteotomy as seen in case of Freiberg Disease. Furthermore this technique is recommended in cases of secondary transfer metatarsalgia, after operations with shortened 1st metatarsal (metatarsal osteotomy, Hueter-Majo, Keller procedure et al) and after isolated resection the lateral metatarsal heads.