

THE MODIFIED LAPIDUS ARTHRODESIS FOR THE CORRECTION OF THE HALLUX VALGUS DEFORMITY: Retrospective Analysis of 182 Cases

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Among the numerous procedures described for the correction of metatarsus primus varus, fusion of the first metatarsocuneiform joint (the Lapidus procedure) continues to gain in popularity. Lapidus published his original article in 1934¹ and modified the previous published techniques by adding the roughening of the adjacent aspect of the second metatarsal in order to induce intermetatarsal fusion. Since then, numerous publications discussed the indications for the procedure, and especially highlighted hypermobility of the first ray as one of the contributing factors to the development of the deformity.¹⁻¹¹

Biomechanical studies have not yet defined the apex of the hypermobility of the first ray and the objective assessment of the degree of the excessive motion.¹²⁻¹⁴ The clinical evaluation of deformed feet locates that pathological motion at the first metatarsocuneiform joint. The correct application of the procedure allows for complete reduction of the intermetatarsal angle and the definitive stabilization of the first ray. The improved fixation technique decreases the non-union rate, but still requires a 6 to 8 week period of non weightbearing.⁸ The results of a retrospective analysis of 182 out of a total of 254 cases between 1995 and 2002 are presented.

MATERIALS AND METHODS

Between 1995 and 2002 the closing wedge metatarsocuneiform arthrodesis was performed in 254 patients (230 female, 24 male). A clinical and radiographic follow-up was carried out in 182 patients (170 females and 12 males). The follow-up time ranged from 15 to 84 months. The average age of the patients was 44.3 years (range 21 - 69 years).

CLINICAL FINDINGS

The evaluation of the first ray should be done under full-weightbearing and non-weightbearing conditions. Special interest is directed to the first MCJ and its motion both in the sagittal and transverse plane. The sagittal

plane motion is examined by stabilizing the lesser metatarsals with one hand and manipulating the first ray with the thumb and index finger of the other hand. The transverse plane motion is evaluated by squeezing the fore-foot and the midfoot between the thumb and index fingers. Both tests reveal the instability of the first ray, but the exact apex of the instability has not yet been defined clearly, as it is difficult to separate the first metatarsocuneiform motion from the cuneiform-navicular joint mobility. All patients who were treated with the FMCJ fusion in our series demonstrated a hypermobility of the first ray.

Other clinical signs show the instability of the first ray, including: dorsal exostosis at the first MCJ, hyperkeratotic lesion under the second metatarsal, capsulitis of the second MPJ, hammertoe deformity of the second toe, and lateral metatarsalgia.

RADIOLOGIC FINDINGS

The average preoperative intermetatarsal angle was 17° (range 13-28° and could be reduced to 3° (range 0-6°). The relative elevation of the first metatarsal to the second metatarsal can be easily determined by the divergence of the dorsal cortices and was present in 87%. The radiographs very frequently show a gaping between the medial and intermediate cuneiform. The geometry of the 1st MCJ typically shows a flat joint with a more oblique articulating surface.

INDICATIONS AND CONTRAINDICATIONS

The indication for the Lapidus procedure is based on both clinical and radiological findings. The patients show a moderate to severe metatarsus primus varus, a hypermobile first ray and sometimes degenerative changes in the 1st MCJ. Other indications include hallux limitus and rigidus and combined deformities of the foot that require first ray stabilization.

The Lapidus procedure has few contraindications

that have to be taken into consideration. These are open epiphysis, short first metatarsal, severe osteoporosis, metabolic bone disease, non-compliant patient, and very obese patients.

SURGICAL TECHNIQUE

The procedures were carried out by two surgeons under regional or general anesthesia in combination with an ankle block. An ankle tourniquet was generally used and set to 250 mm/Hg. The skin incision is carried out as a curved-linear incision starting 2 cm proximal to the 1st MCJ at its most dorsal aspect. The incision is lengthened to the dorso-medial aspect of the 1st MPJ. Dependant on the deformity and the rigidity of the 1st MPJ, a typical lateral release is performed without necessitating a separate incision. A T-type medial capsular incision reveals the MPJ and the cartilage can be examined. The medial exostectomy should be performed after the reduction of the IM- angle in order to prevent excessive bone resection. The soft tissue dissection is carried at the level of the MCJ without compromising the vascular structure and especially the dorso-medial cutaneous nerve. After meticulous dissection of the joint area including the soft tissue attachments and the plantar ligaments, the resection is planned. Care has to be taken to remove as little bone as possible to prevent excessive shortening. The cartilage of the base of the 1st metatarsal is removed perpendicular to its long axis with a saw. A lateral based wedge is taken from the cuneiform dependent on the required correction. Usually the base of the wedge is about 2-3mm. The cut has to be right behind the cartilage of the cuneiform itself, not behind the cartilaginous overlap. The cuts of the metatarsal and the cuneiform have to be parallel in the sagittal plane without removing a plantar wedge. Due to the depth of both bones it is critical to use the long saw-blade for the completion of the cuts. The bone segments are removed - sometimes a laminar spreader may be helpful - and the IM angle can be corrected by putting the hallux into varus and thus reducing the 1st metatarsal to the 2nd metatarsal. Sometimes the lateral base of the 1st metatarsal is prominent and has to be resected in order to allow for correct positioning of the 1st metatarsal. Care has to be taken to avoid compromising the vascular structures in the 1st interspace. To compensate for the inevitable shortening, the plantar translation of the first ray of about 2-3 mm is required. The correct positioning can be checked by loading the foot and evaluating the position of

the metatarsal heads. The 1st metatarsal should be at the level of the second or slightly below. Once the correct position is achieved, the fusion site may be fenestrated and fixated to the surgeon's preference. Two screws or a screw and a threaded k-wire provide excellent stability. A plate may be used but does not allow for earlier weight-bearing. The medial eminence of the 1st metatarsal head is resected parallel to the medial aspect of the foot preserving the medial groove. A cast immobilisation was not required, but may be useful for the first 2 weeks.

A cam walker and crutches were used for the whole period of none weight-bearing of 6-8 weeks. No additional bunion splint was necessary. Physical therapy for the first MPJ usually starts after wound healing if necessary. LMH is advocated until partial weight-bearing of at least 20 kg was allowed.

RESULTS

The follow-up study was performed in 182 out of a total of 254 patients. The patient-charts and the radiographs were reviewed and patients interviewed. The average follow-up time was 32 months (range 15-84) following surgery. A total of 155 (85%) of the patients reported complete relief of the symptoms. An improvement of the preoperative condition was found in 16 (9%) of the patients. Among those were the 2 (1.1%) patients that had a superficial infection. Eleven (6%) of the patients were not satisfied, although the appearance of the foot did not show any residual deformity. Among these patients were 4 (2, 2%) patients with a non-union, 4 (2.2%) with a persistent lateral metatarsalgia and 3 (1.6%) with symptoms that had no objective correlation to the surgery. An increase in swelling was reported by 75% of the patients at about three months after surgery that resolved after the application of lymphatic drainage treatment.

The evaluation of the radiographs revealed, that the IM angle could be reduced from 17° on average preoperative (range 13°-28°) to 3° on average postoperative (range 0°-6°).

In 4 cases (2.2%) a hallux varus condition was noted. A non-union occurred in 9 cases (5%) with 2 patients being symptomatic. One of the patients underwent revisional surgery with interpositional bone-graft and the other healed uneventfully after the application of an external bone stimulating device. The position of the sesamoids could be reduced to normal in 148 (82%). The shortening of the first metatarsal was 4mm on average.

DISCUSSION

One of the predisposing factors for the development of a metatarsus primus varus is the instability of the first ray.^{6,10,13,14} Hansen stated that the "arthrodesis of the first tarsometatarsal joint is the cornerstone of reconstructive forefoot surgery".⁴ Lapidus¹ felt, that the apex of the excessive motion is at the first metatarso-cuneiform joint. As a logical consequence he advocated the fusion of that joint in order to both correct a bunion deformity and stabilizing the first ray. Several studies^{12,13,15} tried to find objective criteria for the hypermobility of the first ray, none of the studies, however, was able to accomplish that goal. Root et al¹⁶ illustrated in his biomechanical studies, that the pronation in the STJ during midstance will cause a change of the lever arm of the PL tendon. The 1st metatarsal becomes unstable and hypermobility occurs. This was confirmed by other authors.¹⁹⁻²¹ The instability may lead to different deformities of the foot as the metatarsus primus varus, metatarsus primus elevatus, hallux valgus and hallux rigidus.

The clinical evaluation of the foot reveals the hypermobility of the first ray when stabilizing the lesser metatarsals with one hand and putting the 1st metatarsal through its range of motion. It is still up to the surgeon's assessment whether the joint is stable or not. The relative overload of the second ray^{2,5,8} leads to a hyperkeratotic lesion under the 2nd metatarsal with subsequent capsulitis of the 2nd MPJ and the development of a hammertoe deformity.

A middle aged patient with a hypermobile first ray with an increased IM-angle $1/2$ of more than 15° under full weight-bearing is the ideal candidate for the Lapidus procedure. We reserve that procedure for patients with a closed epiphysis as Myerson⁵ recommended; Grace¹¹ included one patient out of 30 with an open growth plate into his study on the treatment of the adolescent hallux valgus with the modified Lapidus procedure.

The radiographs usually show a gaping between the medial cuneiforms, an increased intermetatarsal angle and often a medial cortical hypertrophy of the 2nd metatarsal¹⁷ or a stress fracture of that bone. The appreciation of the signs of hypermobility both clinically and radiographically requires the indication for the fusion of the 1st metatarsocuneiform joint.

The geometry of the FMCJ may be a predisposing factor of the instability.¹⁸ Females more often demonstrate an oblique articulating surface, which causes instability in the transverse plane; the joint is more transverse in males

and more stable in the transverse plane. This supports the fact, that the incidence of hallux valgus is much higher in the female population.

The instability in the FMCJ in combination with a flat and oblique joint contour is more likely to lead to a metatarsus primus varus than other joint conditions.¹⁸ Debrunner²² states, that he doubts the influence of the geometry on the development of a hallux valgus. According to his opinion, a lateral release alone may correct the deformity without osteotomy, which is in sharp contrast to the surgical experience and other studies.¹⁵

The inevitable shortening of the first metatarsal after the FMCJ fusion was 4mm on average in our series. It is due to the width of the saw blade in addition to the minimal bone resection from the cuneiform. The shortening was compensated in our series by plantar translation of the first metatarsal of about 2-3 mm as proposed by Catanzariti.⁶ The plantar wedge resection⁵ is definitive in its correction and difficult to alter. A plantar wedge of 5mm at the FMCP will cause a plantar positioning of the first metatarsal head of 6.1mm provided an average length of 70 mm.¹² In the author's hands the plantar translocation is easier to perform, can be visually estimated and corrected if necessary.

In our series 4 (2.2%) patients complained about sub-second metatarsalgia which was due to inadequate plantarflexion. Other authors report on up to 25% symptomatic callosities under the lesser metatarsals.¹⁰ The shortening is a problem that was recognized by other authors as a critical factor for the overload of the lesser metatarsals.^{2,5,8} The plantar translocation of the first metatarsal could obviously reduce that complication.

A non-union rate of 9 (5%) in our series is documented. Other authors reported on a higher incidence of about 10%.⁵ There is no significant correlation between the fixation device and the incidence of a non-union so far. The author's preference is the fixation with one cannulated 4.0 cancellous screw and one smooth K-wire. The screw is placed from distal dorsal lateral to proximal plantar medial. The K-wire is placed from distal medial dorsal to proximal plantar lateral. The postoperative course should include a time of non weight-bearing of at least 6-8 weeks. For the non-union rate this seems to be more important than the fixation device.

Due to medical-legal regulations in Germany a prophylaxis against DVT is imperative. LMH has to be applied until partial weight bearing of at least 20 kg is allowed. This is necessary even if the foot is not immobilized but in a cam walker as used in our series.

CONCLUSION

The retrospective study of 182 patients out of a total of 254 patients that were treated with a modified Lapidus procedure is presented. 85% of the patients reported a complete relief of the symptoms. 9% felt an improvement and 6% were not satisfied. The typical "Lapidus patient" is about 40 years old, female and demonstrates a marked hallux valgus with a hypermobile first ray. The X-rays usually will not provide much additional information to the indication. Despite the fact, that the objective criteria of the hypermobility are still not defined, nobody denies the excessive motion as a symptom, which is easily reproducible with some routine. The correction of the IM angle to its physiological degree and the stabilisation of the concomitant hypermobility of the FMCJ can be accomplished by the Lapidus procedure simultaneously, thus creating a more physiological weight-bearing pattern of the foot. The rate of complications is acceptable and is dependant on the patient selection and surgeon's experience. The modified Lapidus procedure provides excellent and permanent results in the correction of the hallux valgus deformity.

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