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Modified Lapidus Arthrodesis With Crossed Screw Fixation: Early Weightbearing in 136 Patients

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ABSTRACT

Modified Lapidus arthrodesis is a versatile and powerful procedure for correcting the hallux valgus deformity typically associated with significant metatarsus primus varus or increased first ray mobility. Traditionally, patients have remained non-weightbearing until the arthrodesis has consolidated. More recently, numerous studies have evaluated the outcomes of early postoperative weightbearing using a variety of fixation constructs. The present retrospective cohort study evaluated 136 consecutive patients who had undergone modified Lapidus arthrodesis for hallux valgus deformity with conventional, crossed, solid core, screw fixation, were enrolled in an early weightbearing protocol, and were followed for 12 months. All the patients were partial weightbearing in a protective boot a mean of 12.2 (SD ± 4.36) days after surgery, with full weightbearing at 34.4 (SD ± 11.89) days. Union was achieved in 133 patients (97.8%). Of the 3 (2.2%) patients with nonunion, 2 (1.5%) remained asymptomatic. The mean time to radiographic union was 65 (SD ± 37.24) days. Significant improvement was seen in the first intermetatarsal angle and hallux abductus angle after surgery ($p < .0001$). Deformity correction was not compromised by early weightbearing and was well maintained over time. These results support early weightbearing with traditional crossed screw fixation for modified Lapidus arthrodesis with outcomes and complication rates comparable to those previously published.

Long after its introduction in 1934 (1), arthrodesis of the first tarsometatarsal joint for the correction of hallux valgus deformity has gained popularity during the past few decades. Numerous studies have reported on the indications, surgical techniques, and outcomes of the modified Lapidus arthrodesis procedure (2–19). Although it was most commonly used for cases of more severe metatarsus primus varus, the indications have evolved over the years as the concept of medial column insufficiency has become accepted (2,3,9,10,20–24).

With experience, and emphasis in foot and ankle training, the technical difficulties of executing the procedure have become negligible. However, the postoperative convalescence and risk of nonunion have continued to serve as deterrents for many foot and ankle surgeons (2–5,12). Classically, the postoperative course has involved a prolonged period of immobilization and non-weightbearing (1–3,25). Historically, the reported nonunion rates have ranged from 3.3% to 12% (4,7–9). With meticulous preparation of the joint surfaces and improved fixation techniques, the nonunion rates have typically been well below 5% (12,13,17,19,26–32).

The decision to require a patient to be non-weightbearing after Lapidus arthrodesis is historical and was based on the early complications that were associated with poor fixation constructs. The morbidity of prolonged cast immobilization and non-weightbearing can be very challenging for many patients and might not be practical in all cases. The concern regarding an increased risk of nonunion with early weightbearing has largely been anecdotal. There has been recent interest in early weightbearing after the modified Lapidus arthrodesis (8,9,17–19,22,26–32). A number of studies have presented different fixation constructs and various timelines for early weightbearing, with reported rates of nonunion of 0% to 2.5% (17,19,26–32). Locked plating has generated interest for Lapidus arthrodesis because of reports of construct stability and its capacity to withstand early loading (17,19,29–35).

The purpose of the present retrospective cohort study was to evaluate the morbidity of early protected weightbearing after

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modified Lapidus arthrodesis using crossed, solid core screw fixation for hallux valgus correction in a large series of patients.

Patients and Methods

The Kaiser Permanente Northern California institutional review board approved the present study. A review was conducted of consecutive patients who had undergone modified Lapidus arthrodesis for moderate to severe metatarsus primus varus and hallux valgus deformity from September 2005 to April 2011 by the primary surgeons (S.P., D.R.C.). All the patients had received crossed, solid core, screw fixation, borne weight in a removable walking boot within 8 to 21 days postoperatively, and had a minimum of 12 months of continuous health plan membership and postoperative follow-up evaluations. The patients were excluded if they had undergone adjunct procedures that would have prohibited early weightbearing or if they had failed to adhere to the early weightbearing protocol.

The medical records (including operative reports) and radiographs were independently reviewed by 2 investigators who were not involved in patient care (J.R. and C.M.K., respectively). The demographic information collected included patient age, gender, body mass index, current tobacco use, hypertension, diabetes mellitus, rheumatoid arthritis, osteoporosis, cerebrovascular disease, chronic kidney disease, and peripheral neuropathy. The operative records were reviewed to determine the number of screws used for fixation. Additional procedures were also documented. The interval to partial weightbearing in a walking boot, full weightbearing in a walking boot, and ambulation in regular shoes was recorded. The interval to union was recorded by evaluating the radiographs at 2, 6, and 12 weeks and 6 and 12 months postoperatively. All radiographs were evaluated by 1 of us (C.M.K.).

The radiographs were assessed electronically using digital imaging (Stentor Intelligent Informatics, I-site, version 3.3.1, Phillips Electronics, Andover, MA), with measurements obtained using the digital calipers from the imaging system. The measurements were made from weightbearing radiographs before surgery, nonweightbearing radiographs immediately after surgery, and weightbearing radiographs at the final postoperative 12-month visit. Each radiographic parameter was measured once: the first intermetatarsal angle (IMA), hallux abductus angle (HAA), sesamoid position, and first ray elevation. The IMA was measured by the angle of the bisecting lines of the long axis of the first and second metatarsals (32). The HAA was measured by the angle of the intersecting lines that bisected the long axis of the first metatarsal and hallux proximal phalanx (36). The sesamoid position was measured by locating the position of the tibial sesamoid in relation to the long axis of the first metatarsal and assigned a number (36). The first ray elevation was the angle of the intersecting lines following the dorsal aspect of the first and second metatarsals.

The mean ± standard deviation was determined for the following measurements: IMA, HAA, sesamoid position, first ray elevation, and the interval to partial weightbearing, full weightbearing, and union. Student's paired t test was used to determine the difference in the preoperative IMA and HAA compared with the immediate postoperative measurements. The maintenance of angular correction was illustrated using a Student paired t test to compare the change in the IMA and HAA measured on the immediate postoperative radiographs to the final result at 12 months postoperatively. Significance was defined as $p < .05$. The incidence of complications was also evaluated.

The success of the early weightbearing protocol was defined by maintenance of the deformity correction at the 12-month follow-up visit and few complications, including a low incidence of arthrodesis delayed union or nonunion. The postoperative complications included delayed union or nonunion of the arthrodesis, hardware movement or failure, fracture, hallux varus, recurrent hallux valgus or bunion deformity, soft tissue infection, dehiscence, suture reaction, lesser metatarsalgia, and sesamoiditis. Delayed union was defined as incomplete bony trabeculation at the first tarsometatarsal arthrodesis on orthogonal radiographs, with persistent pain, warmth, and edema found by surgeon examination at 3 to 6 months postoperatively. These patients were protected in a walking boot, and some were treated with an external bone stimulator. Nonunion was defined as the absence of bony trabeculation, a visible space or notable widening, or sclerosis at the arthrodesis site, along with the aforementioned clinic findings at 12 months postoperatively. Hallux varus was defined as any medial deviation of the hallux relative to the first metatarsal based on radiographic bisection of the first metatarsal and hallux proximal phalanx. The surgeon determined the clinical significance. Deformity recurrence was defined by an increase in the IMA $>2°$ or HAA $>5°$ on the radiographs at 12 months postoperatively compared with the measurements on the immediate postoperative radiographs.

The technique for modified Lapidus arthrodesis was based in part on the mechanical loading concepts with crossed lag screw fixation established by Ray et al (37). A dorsal longitudinal incision was made medial to the extensor hallucis longus along the first ray from the lateral aspect of the first cuneiform to the base of the proximal phalanx of the hallux. The dorsomedial cutaneous nerve and extensor hallucis longus tendon were protected. The first metatarsophalangeal joint was longitudinally incised, and, in most cases, the conjoined adductor tendon in the first intermetatarsal space was resected to help mobilize the sesamoids. The first metatarsocuneiform joint was exposed through a transverse capsulotomy. The soft tissues about the joint, including the periosteum, were not removed from the bone. Disruption to the ligaments at the plantar aspect of the joint was minimal. The cartilage was removed with osteotomes, curettes, and a rongeur, taking care to reach the plantar-most aspect. Approximately 0.5 cm of the subchondral bone was preserved about the periphery of the joint to maintain the length and lend stability to the fixation construct. The remainder of the subchondral plate on each surface was broken apart with a drill bit and osteotome until a bleeding cancellous bone interface was established.

The first metatarsal was repositioned on the medial cuneiform to correct the metatarsus primus varus deformity. In some cases, the lateral one third of the first cuneiform at the fusion interface was planed with a power saw to facilitate deformity correction. An axial load was applied to the first metatarsal, compressing it against the first cuneiform. Fixation was accomplished with a minimum of 2 fully threaded, solid core, stainless steel screws across the fusion site. A 4.0-mm solid core cortical screw was axially inserted in standard lag fashion from the dorsal central surface of the first metatarsal at the proximal two thirds of the shaft oriented to the plantar-medial aspect of the medial cuneiform, nearly parallel to the weightbearing surface of the foot such that the screw axis was almost perpendicular to the fusion interface. Care was taken to countersink the first metatarsal for the screw head and to capture the plantar cortex at the medial cuneiform to attain bicortical purchase. The second screw (either a 4.0-mm cortical or 3.5-mm cortical screw) was placed more obliquely from the dorsal lateral aspect of the medial cuneiform originating 1.5 to 2 cm proximal to the fusion interface and oriented to the plantar-lateral aspect of the base of the first metatarsal, also with care to purchase the plantar cortex for a bicortical construct (Fig. 1). The first ray was then stressed in the transverse and sagittal planes. If the metatarsus primus varus deformity or hypermobility persisted, a third, fully threaded, screw (3.5-mm or 4.0-mm cortical screw) or suture endobutton (used in some cases by 1 surgeon [S.P.]) was placed from the medial base of the first metatarsal into the second metatarsal or second cuneiform to improve stability of the construct at the discretion of the surgeon (Fig. 2). In cases in which a screw was used, it was not lagged and was placed with the first ray held in satisfactory alignment. Care was taken to ensure the third point of fixation entered well away from the first screw to avoid creating a stress riser. A shear strain-relieved cancellous bone graft, harvested from the drill bits used to prepare the joint, was placed into the small defects created at the dorsomedial and dorsolateral aspects of the tarsometatarsal interface. If a hypertrophic medial eminence was present, it was removed in line with the long axis of the first metatarsal, taking care to preserve the groove for the tibial sesamoid. Finally, redundant medial metatarsophalangeal joint

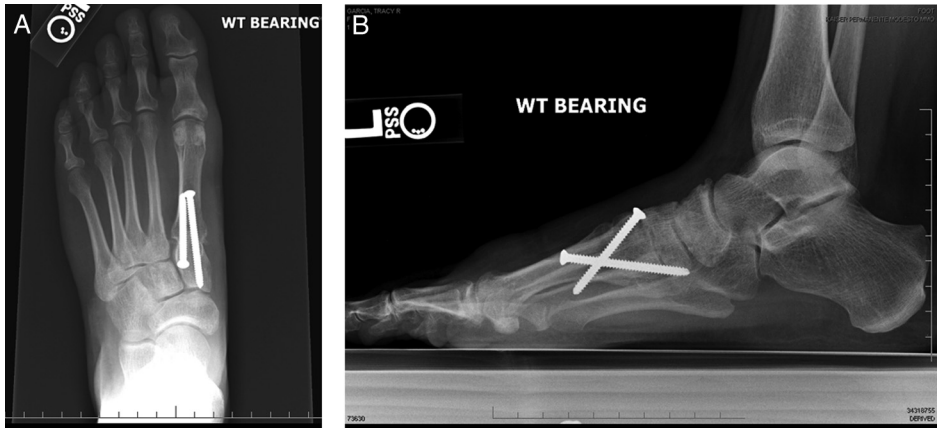

Fig. 1. Anteroposterior (*A*) and lateral (*B*) weightbearing radiographs depicting the 2-screw configuration. Note that each screw purchases 2 cortices.