

Revision Lapidus Arthrodesis: Rate of Union in 17 Cases

Graham A. Hamilton, DPM, FACFAS,¹ Samantha Mullins, DPM,² John M. Schuberth, DPM, FACFAS,³ Shannon M. Rush, DPM, FACFAS,⁴ and Lawrence Ford, DPM, FACFAS⁵

This multicenter study retrospectively reviewed the medical records and radiographs of 15 consecutive patients (17 feet; mean patient age, 54.1 years), who underwent revision "bone-block" Lapidus arthrodesis for a symptomatic nonunion. In all cases but one, the procedure was performed with ipsilateral autogenous bone grafting. All cases used either screw fixation or a combination of screw and plate fixation. Patients were monitored for a minimum of 6 months postoperatively to assess clinical and radiographic union. Successful union was seen in 14 (82%) of the 17 feet that underwent revision. Nonunion was documented in 3 (18%) cases. These results support a favorable rate of union with the described surgical technique. Chi-square tests of association were used to determine whether gender, fixation, bone stimulation, and smoking were predictive of or associated with bone healing. Active smoking in the perioperative period was a predictor of nonunion (P = .05). Based on these findings, the authors recommend aggressive preoperative counseling, and smoking should be considered a relative contraindication to revision surgery. (The Journal of Foot & Ankle Surgery 46(6):447-450, 2007)

Key words: revision arthrodesis, hallux valgus, metatarsocuneiform joint, Lapidus, nonunion

The modified Lapidus arthrodesis is a procedure commonly performed for the treatment of a hypermobile first ray resulting in symptomatic hallux valgus deformity, hallux limitus, lesser metatarsal overload, or first metatarsocuneiform arthrosis (1–5). Several publications evaluated functional outcomes of Lapidus arthrodesis and reported favorable results and patient satisfaction (6–10). This procedure however, is not without known complications, most notably nonunion. Several studies of the modified Lapidus arthrodesis for the treatment of hallux valgus deformity have commented on the rate of nonunion, ranging from 3.3% to 12% (6, 8, 10, 12–14). A recent, large multicenter study reported a nonunion rate of 5.3% with a curettage method (2). To date, there have been no studies on the rate of union after revision Lapidus arthrodesis. The pur-

pose of this retrospective review is to determine the rate of union after revision arthrodesis in a limited number of cases with autogenous bone graft from the ipsilateral calcaneus or distal tibia. Potential predictors of nonunion in these cases were also analyzed.

Materials and Methods

A multicenter retrospective review was performed. Medical charts, electronic databases, and radiographs were reviewed for 308 patients who underwent a modified Lapidus arthrodesis for a symptomatic hallux valgus deformity. All patients with a symptomatic nonunion after the primary operation were identified. Diagnosis of the index nonunion was confirmed by the treating surgeon and reviewed by the independent resident investigator (S. L. M.) at the time of data collection. This primary nonunion was defined both clinically and radiographically as failure of bone healing at the fusion site after 6 months, broken hardware, or both. Clinical nonunion was defined as a painful, swollen fusion site at the 6-month postoperative visit. Failure of osseous healing on radiographs was unequivocally defined as notable lucency or widening, sclerosis, broken hardware, or lack of bridging trabeculation at the fusion site. If broken hardware was not evident, but notable lucency was seen at the fusion site, the patient's condition was treated as a nonunion.

Fifteen consecutive patients (17 feet) were included in the study from December 2001 through January 2006. Patients who underwent a modified Lapidus arthrodesis and went on

Address correspondence to: Graham A. Hamilton, DPM, FACFAS, Department of Orthopedics and Podiatric Surgery, Kaiser Permanente Medical Center, 280 West MacArthur Blvd, Oakland, CA 94801. E-mail: Graham.A.Hamilton@kp.org.

¹Director of Research, Department of Orthopedics and Podiatric Surgery, Kaiser Permanente Medical Center, Oakland, CA, USA.

²Second-year Resident, Kaiser San Francisco Bay Area Foot and Ankle Residency Program, San Francisco, CA, USA.

³Chief, Foot & Ankle Surgery, Department of Orthopedics Surgery, Kaiser Permanente Medical Center, San Francisco, CA, USA.

⁴Department of Orthopedics and Podiatric Surgery, Kaiser Permanente Medical Center, Walnut Creek, CA, USA.

⁵Residency Director, Department of Orthopedics and Podiatric Surgery, Kaiser Permanente Medical Center, Richmond, CA, USA.

Copyright © 2007 by the American College of Foot and Ankle Surgeons
1067-2516/07/4606-0007\$32.00/0
doi:10.1053/j.jfas.2007.08.005

TABLE 1 Type and outcome of treatment in 17 patients who had revision bone block arthrodesis

Pt	Age (y)	M/F	Days to fusion	Graft	Results	Fixation	Complication	Bone stimulator	Comments
1	49	CK	F	95	ICBG	Fused	Screws		Smoking/WB
2	44	RS	M	n/a	ICBG	Nonunion	Plate, screws	Hardware removal	Smoking/WB
3	44	RS	M	n/a	Autologous allograft	Nonunion	Screws		Smoking/WB
4	62	RT	F	74	ICBG	Fused	Screws		
5	60	JJ	M	80	ICBG	Fused	Plate, screws	Broken screw	WB
6	55	LC	F	n/a	ITBG	Nonunion	Plate, screws	Hardware removal	Smoking/WB
7	55	LC	F	42	ICBG	Fused	Plate, screws		
8	59	MG	F	59	ICBG	Fused	Screws		Smoking
9	44	JT	F	80	ICBG	Fused	Plate, screws		Prednisone
10	52	JZ	M	141	ITBG	Fused	Plate, screws		
11	51	RW	F	38	ICBG	Fused	Plate, screws	Hardware removal	
12	63	M	F	57	ICBG	Fused	Plate, screws		
13	64	JP	F	67	ITBG	Fused	Screws		
14	46	SP	F	73	ITBG	Fused	Plate, screws	Hardware removal	
15	55	CP	F	81	ITBG	Fused	Plate, screws	Hardware removal	Smoking
16	47	TB	F	65	ITBG	Fused	Plate, screws	Hardware removal	Smoking
17	71	PC	F	47	ITBG	Fused	Plate, screws		

Abbreviations: ICBG, ipsilateral calcaneal bone graft; ITBG, ipsilateral tibial bone graft; WB, weight bearing; F, female; M, male.

to solid fusion, as well as those who had an asymptomatic nonunion and did not desire surgical revision, were excluded from the cohort.

The same radiographic and clinical criteria were again used at 6 months to determine whether union had been achieved in the 15 patients (17 feet) who underwent revision “bone-block” arthrodesis. The only difference between the primary and revision “bone-block” radiographic criteria in determining successful fusion was consolidation of the arthrodesis site with obliteration of the joint space and incorporation of the autogenous bone graft. The surgeons performed radiographic and clinical assessments at 2 weeks, 6 weeks, 3 months, and 6 months postoperatively. All data were then reviewed by one of the investigators (S. L. M.).

The following data from the patients’ medical records were recorded by the resident investigator (S. L. M.): age of patient, comorbidities, smoking status, compliance issues, index procedure technique and postoperative management, and revision procedure technique and postoperative management.

Data were compared by means of chi-square and Fisher exact tests.

Results

A total of 15 subjects, 17 feet (3 men: mean age, 50 years; range, 44–60 years; 12 women: mean age, 55.4 years; range, 44–71 years), were included in the study. The number of procedures contributed by the primary surgeons (G. H., S. M. R., L. A. F., J. M. S.) ranged from 1 to 4. Of the 17 revision procedures performed, 14 (82%) went on to complete union, whereas 3 (18%) failed to fuse.

In all cases, previous hardware was removed and the non-

union resected to healthy bleeding bone. The donor graft site involved harvest of a bicortical structural piece of bone from the ipsilateral distal tibia or the superior aspect of the ipsilateral calcaneus. In 8 cases, calcaneal graft was used; in 7 cases, distal tibial graft was used (Table 1). In 1 case, autologous cancellous bone chips and demineralized bone matrix were used. Internal fixation was achieved with long, solid screws or screws and a plate, depending on the surgeon. In 13 cases, 2 solid, crossed and stacked 3.5-mm cortex or 4.0-mm cancellous positional screws were used (Figure 1, A and B). In 4 cases, a single 3.5-mm or 4.0-mm positional screw was used along with a dorsal or dorsomedial 4- or 5-hole neutralization plate. Plate designs consisted of a standard 1/3 tubular compression plate or a reconstruction plate. Thirteen patients undergoing revision received bone stimulation immediately postoperatively. Twelve were external and 1 was internal. All bone stimulators were used throughout the entire postoperative course for an average time of 146 days. Four patients received no bone stimulation. Postoperatively, all patients were treated in a short-leg non-weight bearing cast for 6 weeks, with progression to a removable walking boot for 4 more weeks if radiographic consolidation was noted. Patients demonstrating incomplete radiographic consolidation at 6 weeks remained non-weight bearing in a short-leg cast for at least 4 more weeks. At an average of 10 weeks postoperatively, patients were advanced to regular supportive shoes with gradual return to regular activities as tolerated.

Two of the 3 cases that failed to unite were performed on the same foot by the same surgeon. Union was not achieved, and the patient remained symptomatic at the time of the review (Figure 2) The other case of nonunion underwent a second revision performed by a different surgeon and union



FIGURE 1 (A) Six-month anteroposterior and (B) lateral radiographs of revision bone block Lapidus arthrodesis with autogenous calcaneal bone graft demonstrate bony union.



FIGURE 2 Anteroposterior radiograph of repeat nonunion at the first metatarsocuneiform joint after revision bone block arthrodesis with screw fixation.

was achieved. The average time to radiographic union for all cases was 59 days. Of the 17 patients who underwent revision arthrodesis, 5 were active cigarette smokers. In all 3 cases that progressed to nonunion after revision, only 1 patient was able to quit smoking. Seven patients were non-compliant with their postoperative instructions, including all 3 nonunions. Patients who prematurely walked on the surgical limb and failed to adhere to bone-stimulator instructions were defined as noncompliant. No postoperative infections or wound complications occurred in any of the 17 cases.

Discussion

Nonunion is a well-documented potential complication of the modified Lapidus arthrodesis, ranging from 3.3% to 12%, and proves to be a challenging problem (6, 8, 10–15).

To our knowledge, no one has reported on the rate of union for revision “bone-block” Lapidus arthrodesis. Our multicenter, retrospective review reports union in 14 of 17 (82%) feet, after a minimum of 6 months.

In an attempt to determine predictors of nonunion in this group of patients, chi-square tests of association were used to determine whether gender, fixation, bone stimulation, and smoking were predictive of or associated with healing.

Smoking was a predictor of nonunion ($P = .05$). All other predictors were statistically insignificant. The adverse effects of cigarette smoking on osteogenesis are well documented (11, 14, 16). Five of the 12 (38.5%) cases of failed primary Lapidus procedures requiring revision for a symptomatic nonunion were smokers preoperatively. All 3 of the failed revision procedures were smokers as well. McInnis and Bouché reported 3 cases of symptomatic nonunion (12%) in 32 feet. Two of the 3 cases were cigarette smokers (8). Similarly, Coetzee et al (14) noted 3 cases of nonunion (11.5%), all of which occurred in smokers. They concluded that smoking should be a relative contraindication to the modified Lapidus procedure. For this reason, the primary surgeons selectively try to avoid performing primary Lapidus arthrodesis and revision arthrodesis in active smokers. Patients who do smoke and require a Lapidus arthrodesis should receive aggressive preoperative counseling and cessation support. From the data in this report, there is further evidence for viewing active smoking by a patient as a relative contraindication to performing revision surgery.

Compliance with strict early non-weight bearing postoperatively is essential to achieving successful union. All 3 cases, which resulted in nonunion, had repeated documentation in chart review of premature weight bearing in the immediate postoperative period despite disciplined counseling. Other authors have also reported higher rates of nonunion due to earlier weight bearing in the postoperative course (10, 12, 17).

Autogenous bone graft donor site (distal tibia versus calcaneus) did not affect outcome. Allograft was used in one case, which progressed to nonunion. This variable, however, could not be considered significant in attributing to the outcome because this patient failed to adhere to the postoperative protocol and continued to smoke.

Bone stimulation was used as adjunctive therapy in 13 cases, 3 of which failed to fuse. Four cases, which all went on to solid union, had no adjunctive therapy. There are arguments for and against bone stimulation technology, but this modality cannot be used as an alternative to meticulous surgical technique.

Limitations

Limitations to our study include its small population and its retrospective design. The retrospective design of this

study created the potential for intraobserver bias by having the primary surgeon assess radiographs to determine union or nonunion.

Conclusion

Our analysis of 17 cases reports a favorable rate of union (82%). Noncompliance in the postoperative course and cigarette smoking were both associated with increased rates of nonunion. We recommend strict patient counseling in the preoperative period to support compliance. Also, active cigarette smoking should be viewed as a relative contraindication to revision.

References

1. Bednarz PA, Manoli A II. Modified Lapidus procedure for the treatment of hypermobile hallux valgus. *Foot Ankle Int* 21:816–821, 2000.
2. Myerson MS, Badekas A. Hypermobility of the first ray. *Foot Ankle Clin* 5:469–484, 2000.
3. Bacardi BE, Boysen TJ. Consideration of the Lapidus operation. *J Foot Surg* 25:133–138, 1986.
4. Neylon TA, Johnson BA, Laroche RA. Use of the Lapidus bunionectomy in first ray insufficiency. *Clin Podiatr Med* 18:365–375, 2001.
5. Hansen ST Jr. Hallux valgus surgery. Morton and Lapidus were right! *Clin Podiatr Med* 13:347–354, 1996.
6. Catanzariti AR, Mendicino RW, Lee MS, Gallina MR. The modified Lapidus arthrodesis: a retrospective analysis. *J Foot Ankle Surg* 38:322–332, 1999.
7. Clark HR, Veith RG, Hansen ST Jr. Adolescent bunions treated by the modified Lapidus procedure. *Bull Hosp Joint Dis Orthop Inst* 47:109–122, 1987.
8. McInnes BD, Bouché RT. Critical evaluation of the modified Lapidus procedure. *J Foot Ankle Surg* 40:71–90, 2001.
9. Saffo G, Wooster MF, Stevens M, Desnoyers R, Catanzariti AR. First metatarsocuneiform joint arthrodesis: a five year retrospective analysis. *J Foot Surg* 28:459–465, 1989.
10. Myerson M, Allon S, McGarvey W. Metatarsocuneiform arthrodesis for management of hallux valgus and metatarsus primus varus. *Foot Ankle Int* 13:107–115, 1992.
11. Patel S, Ford LA, Etcheverry J, Rush SM, Hamilton GA. Modified Lapidus arthrodesis: rate of nonunion in 227 cases. *J Foot Ankle Surg* 43:37–42, 2004.
12. Sangeorzan BJ, Hansen ST Jr. Modified Lapidus procedure for hallux valgus. *Foot Ankle Int* 9:262–266, 1989.
13. Grace D, Delmonte R, Catanzariti AR, Hofbauer M. Modified Lapidus arthrodesis for adolescent hallux abducto valgus. *J Foot Ankle Surg* 38:8–13, 1999.
14. Coetzee JC, Resig SG, Kuskowski M, Saleh KJ. The Lapidus procedure as salvage after failed surgical treatment of hallux valgus: a prospective cohort study. *J Bone Joint Surg* 85A:60–65, 2003.
15. Ray RG, Ching RP, Christensen JC, Hansen ST Jr. Biomechanical analysis of the first metatarsocuneiform arthrodesis. *J Foot Ankle Surg* 37:376–385, 1998.
16. Haverstock BD, Mandracchia VJ. Cigarette smoking and bone healing: implications in foot and ankle surgery. *J Foot Ankle Surg* 37:69–74; discussion, 78, 1998.
17. Butson AR. A modification of the Lapidus operation for hallux valgus. *J Bone Joint Surg* 62B:350–352, 1980.