Modified Rerouting Procedure for Failed Peroneal Tendon Dislocation Surgery

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Abstract Recurrent dislocation of the peroneal tendons following operative treatment is relatively uncommon, but can be difficult to treat. We asked whether subligamentary transposition of the peroneus brevis tendon, fibular grooving, and reattachment of the superior peroneal retinaculum for failed peroneal tendon dislocation surgery would achieve a stable fixation of the peroneal tendons and whether there would be restrictions of ROM or instability of the hindfoot. We reviewed six female patients (mean age, 24.5 years) with general laxity of joints preoperatively and at 6 weeks and 3, 6, and 12 months postoperatively. Within 1 year postoperatively no recurrence was found. In two ankles the extension was restricted 5° to 10°. In another pronation and supination was restricted 5° each. Stability of the ankle increased in four patients and stayed unchanged in two. AOFAS score increased from a mean value of 36 ± 20.6 preoperatively to 90 ± 7 postoperatively at 1 year. We conclude transposition of the peroneus brevis tendon is a reasonable treatment for failed peroneal tendon dislocation surgery.

Level of Evidence: Level IV, therapeutic study (prospective case series). See Guidelines for Authors for a complete description of levels of evidence.

Introduction

Recurrent dislocation of the peroneal tendons following operative treatment is relatively uncommon [1–8, 10, 12, 13, 15–19, 21–25, 28, 29, 32–38, 40–46, 48–50, 53–55, 59, 61, 62, 64–69, 71, 74–76]. Nevertheless, recurrences have been described following most of the multiple operative procedures recommended for the stabilization of the peroneal tendons [12, 22, 33–35, 41, 43, 50, 59, 69].

Knowledge about the functional anatomy of the ankle, including valgus and varus deformity of the hindfoot, axis of motion of the talocrural, subtalar, Chopart and Lisfranc joints, variants of dorsal surface the distal fibula, the ligaments, tendons, and retinacula, is essential to understanding the multifactorial genesis of the instability of the peroneal tendons [9, 14, 20, 37, 57, 63, 73].

Hypermobility syndrome is reportedly another predisposing factor for peroneal tendon dislocation through weakness of the retinacula and the high risk for a hindfoot valgus and flatfoot deformity [47]. The bony contour of the dorsal surface of the distal fibula seems less important for this disorder [15, 51, 52, 58, 63]. In an unpublished cadaveric study, we identified the peroneus brevis as the primary muscle causing dislocation of the peroneal tendons (Fig. 1). We further observed that the space behind the fibulocalcaneal ligament (FCL) may be too small for both peroneal tendons in some individuals. These observations led us to the idea of modifying the rerouting operation to reach a stable retromalleolar fixation of the peroneal tendons with reduced irritation of the FCL and the peroneal

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Each author certifies that his or her institution has approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Fig. 1 In a case of complete luxation, the peroneus brevis tendon lies ventral to the peroneus longus tendon.

Fig. 2 Dissection of the fibulocalcaneal ligament (FCL) is shown.

tendons. We presumed that in patients with failed surgery for peroneal tendon dislocation we could medialize the peroneus brevis tendon behind the FCL and suture the superior peroneal retinaculum (SPR) to hold the peroneus longus tendon; we thereby would theoretically reduce the lateralizing forces of peroneus brevis tendon.

The purposes of the study were to discover if this procedure (1) achieved stable fixation of the peroneal tendons, (2) led to any restrictions of hindfoot mobility, and (3) affected the stability of the ankle.

Materials and Methods

We prospectively reviewed six women of a mean age of 24.5 years (range, 15–36 years) who had recurrent peroneal tendon dislocation following surgery. Before the first surgery, all six patients had painful luxation of the peroneal tendons. Four had sustained acute ankle trauma (fell from a bicycle, fell over a hurdle, stepped into a hole while walking in a pasture, soccer injury), one patient had chronic pain since a fall 4 years prior, and one patient did not recall any trauma. Four patients had been treated by a modification of the Viernstein and Kelly technique described by Viernstein and Rosemeyer [70] and Wirth [75]. Three of these four developed a nonunion of the bone graft (followup of 10–31 months). In the fourth, the graft fractured 3 months after surgery without a trauma. A fifth patient developed a nonunion of the graft after a bone graft transposition in the so-called DuVries technique previously described by Kelly [30] 7 months after surgery. In the sixth patient, recurrence followed deepening of the dorsal surface of the distal fibula and reconstruction of the SPR by an Achilles tendon flap (Jones procedure [26]) 14 months postoperatively. At the initial examination, the passive hyperextension of the metacarpophalangeal joint of the

Fig. 3 The fat tissue between the FCL and the lateral capsule of the subtalar joint is resected.

index fingers (MCP II) and the elbows was determined as an indicator for general laxity of the joints. All patients had increased passive hyperextension of the MCP II joints of 85° to 100° (mean, 95°) and the elbows of 10° to 20° (mean, 15°). We observed no differences between right and left. All patients had a discernable limp prior to surgery. The minimum followup between first and revision surgery was 3 months (mean, 11 months; range, 3–31 months).

Under spinal or general anesthetic, the patient was placed with a bolster under the buttock of the operated side. A tourniquet was applied at the thigh and inflated to 350 mm Hg following exsanguination of the leg. The scar of the SPR was divided near to its attachment at the fibula and the bone graft. Dead bone graft was removed in all five patients treated with bony procedures. We excised scar from the peroneal tendon sheath. We divided the FCL near its calcaneal insertion (Fig. 2) and removed the fat between the lateral capsule of the subtalar joint and the FCL (Fig. 3). After transposition of the peroneus brevis tendon, we reattached the FCL at its anatomical position (Fig. 4).

Fig. 4 Back-and-forth atraumatic resorbable suture of the FCL after transposition of the peroneus brevis tendon is used.

Because of the resulting deformity following the transposition of bone grafts, the peroneal groove was deepened in five patients. The scar of the SPR was reattached with sutures at the fibula through drill holes.

Postoperatively, all patients were immobilized in a short cast for 3 weeks with partial weight bearing of 15 kg, followed by another 3 weeks with full weight bearing in the cast in five patients. One patient with signs of a mild chronic regional pain syndrome (CRPS) Type 1 was changed to an ankle splint (Aircast®, Freiburg, Germany) 3 weeks postoperatively. In all other patients the cast was removed at 6 weeks and all wore an ankle splint (Aircast®) for another 12 weeks.

Clinical examination of all patients was performed by one of us (RG), who was one of the treating surgeons before revision surgery as well as at 6 weeks, and 3, 6, and 12 months postoperatively. ROM of both ankles was clinically measured using a goniometer. Manual posterior stress testing on the talus and varus/valgus stress on the ankle and subtalar joint were performed to evaluate stability and pain of the fibular ligaments. Stability of the peroneal tendons was tested through maximal active extension of the ankle in maximal pronation of the foot against resistance by the observer. Patients walked barefooted back-and-forth 20 meters each on level ground three times (normal gait, walking on the toes, walking on the heels) to detect abnormal gait pattern. Because our experience suggests these patients have abnormal gait, we examined the weight-bearing areas of the sole on a “mirror table” [27].

Preoperatively and 6 and 12 months postoperatively, patients answered the AOFAS ankle-hindfoot scale [31]. They also recorded their ankle pain using a VAS from 0 (pain-free) to 10 (highest pain they could imagine) [11]. To avoid bias, the patients answered the questionnaire prior to the first contact with the physician at each time of followup

and the investigator did not receive the questionnaire before the evaluation was completed.

Results

Stable fixation of the peroneal tendons was achieved in all patients through the first year postoperatively. Twelve months postoperatively one patient had some discomfort behind the malleolus lateralis caused by a keloid without any sign for dislocation or snapping of the tendons. Mean VAS for pain decreased from 6 preoperatively to 1 six months after surgery and finally to 0 one year postoperatively (Table 1). The mean value of the AOFAS ankle-hindfoot scale increased from 36 ± 20.6 preoperatively to 90 ± 7.0 at 1-year followup (Table 2).

The ROM of the ankle was initially restricted after 6 weeks of cast immobilization but increased over time. After 1 year, the ROM level of the contralateral side was reached in four cases. The other two showed a restriction in dorsal extension of 5° and 10° respectively (Table 3). At

Table 1. Evaluation of ankle pain using a visual analogue scale (VAS)

Patient	Age (years)	VAS (pain)				
		Preoperative	6 Weeks	3 Months	6 Months	12 Months
S. B.	32	7	–	–	0	0
C. M.	23	5	–	–	1	1
K. K.	17	8	–	–	1	0
A.-K. J.	15	7	–	–	1	0
S. B.	36	8	–	–	2	1
K. S.	24	3	–	–	0	0
Mean	24.5	6	–	–	1	0
Median	23.5	7			1	0

VAS 0 = no pain, VAS 10 = maximal pain.

Table 2. AOFAS ankle-hindfoot scale

Patient	Age (years)	AOFAS (max. 100)		
		Preoperative	6 Months	12 Months
S. B.	32	20	89	95
C. M.	23	69	82	85
K. K.	17	20	72	95
A.-K. J.	15	31	82	95
S. B.	36	16	63	76
K. S.	24	59	79	95
Mean	24.5	36	78	90
Standard deviation	7.5	20.6	8.3	7.0
Median	23.5	25.5	80.5	95

Table 3. Increase of extension and flexion of the ankle joint over time (ROM of the contralateral side in parentheses)

Patient	Age (years)	Extension/Flexion of the ankle joint				
		Preoperative	6 Weeks	3 Months	6 Months	12 Months
S. B.	32	20/0/45 (30/0/50)	10/0/30	10/0/25	20/0/40	30/0/50 (30/0/50)
C. M.	23	30/0/50 (30/0/50)	10/0/30	5/0/15	25/0/45	30/0/45 (30/0/45)
K. K.	17	0/0/20 (25/0/45)	5/0/30	10/0/25	20/0/40	30/0/45 (30/0/45)
A.-K. J.	15	10/0/30 (30/0/50)	10/0/20	5/0/20	20/0/45	25/0/45 (30/0/45)
S. B.	36	0/0/20 (20/0/45)	0/0/15	0/0/10	10/0/30	10/0/45 (20/0/45)
K. S.	24	30/0/50 (30/0/50)	5/0/20	10/0/25	20/0/40	30/0/45 (30/0/45)
Mean	24.5	15/0/36 (28/0/48)	7/0/24	7/0/20	19/0/40	26/0/46 (28/0/46)

Table 4. Increase of pronation (eversion) and supination (inversion) over time. (ROM of the contralateral side in parentheses)

Patient	Age (years)	Pronation/Supination of the foot				
		Preoperative	6 Weeks	3 Months	6 Months	12 Months
S. B.	32	0/5/70 (30/0/80)	–	–	10/0/65 (30/0/80)	20/0/75 (25/0/80)
C. M.	23	30/0/80 (30/0/80)	–	–	25/0/70 (30/0/80)	25/0/75 (25/0/75)
K. K.	17	0/5/40 (20/0/70)	–	–	10/0/60 (20/0/70)	25/0/75 (25/0/75)
A.-K. J.	15	0/0/60 (30/0/80)	–	–	20/0/70 (30/0/80)	25/0/80 (25/0/80)
S. B.	36	0/0/40 (10/0/65)	–	–	10/0/70 (10/0/70)	10/0/70 (10/0/70)
K. S.	24	20/0/80 (20/0/80)	–	–	10/0/60 (30/0/80)	25/0/80 (25/0/80)
Mean	24.5	8/0/62 (23/0/76)	–	–	14/0/66 (25/0/77)	22/0/76 (23/0/77)

12 months followup, one patient had a minimal limitation of 5° for pronation and supination each (Table 4). One mild CRPS Type 1 was observed 3 weeks postoperatively. The patient recovered and the symptoms completely disappeared between the 6-month and 1-year followup.

Twelve months postoperatively all ankles were stable. Compared to preoperatively, the posterior instability of the talus diminished in four patients and remained unchanged in two; stability of the ankle in varus/valgus direction increased or remained unchanged in three patients each. Compared to the contralateral side, the operated ankle showed a higher stability in two and an equal stability in three patients. In one case the stability of the treated ankle increased but remained less than that of the unaffected side. All but one patient preoperatively had an increased hindfoot valgus of about 10° that persisted through followup. The mild hindfoot valgus deformity was not addressed because all patients were pain-free in their subtalar joints without any sign of fibulocalcaneal impingement. One year after surgery we observed no asymmetry of gait or the weight-bearing areas of the feet.

Discussion

Recurrent dislocation of the peroneal tendons is uncommon but has been described for most of the multiple operative

procedures recommended for the stabilization of the peroneal tendons [12, 22, 33–35, 41, 43, 50, 59, 69]. We modified the rerouting procedure by transposing only the peroneus brevis tendon behind the FCL. The purposes of the study were to discover (1) if this procedure was likely to achieve a stable fixation of the peroneal tendons, (2) if the procedure led to any restrictions of hindfoot mobility, and (3) if the procedure affected the stability of the ankle.

There are several limitations to our study. First, the number of patients was small. Recurrent peroneal luxation is a rare complication following operative stabilization; we found no other article on the treatment of this disorder in the English and German literature. Second, the followup was short at just 1 year. Five of the six recurrences in our study appeared within the first year following initial surgery; therefore we presume 1 year followup is adequate to detect most recurrences. Third, our primary outcomes came from a clinical examination performed by the same investigator who was the treating surgeon; we do not know the interobserver variability of these examinations. Despite asking the patients for their opinion prior to the first contact with the physician, bias is possible because the investigator was one of the surgeons.

We found transposition of the peroneus brevis tendon behind the FCL, deepening of the fibular groove, and fibular reinsertion of the scar of the SPR prevented subluxation of the peroneal tendons following failed

Table 5. Studies on rerouting procedures for peroneal tendon dislocation

Author	Total number				Number at followup					Surgery		Complications		
	a	p	♀	♂	a	p	♀	♂	Followup	Prim	Rev	Inst.	ROM	Rec
Platzgummer [53]	10	10	6	4	7	7	?	?	2–11 (y)	6	1	0	0	0
Martens et al. [38]	11	9	2	7	11	9	2	7	30.5 (m)	10	1	0	0	0
Pöll and Duijfjes [54]	10	9	4	5	10	9	4	5	6(m)–8.5(y)	10	0	0	1	0
Ferroudji et al. [17]	19	19	4	15	19	19	4	15	2–24 (m)	19	0	0	1	1
Steinböck and Pinsger [65]	17	16	?	?	13	12	7	5	1.8–13.5 (y)	13	0	0	0	0
Wang et al. [72]	17	17	0	17	17	17	0	17	2–5 (y)	17	0	0	0	0
Gaulke et al. (current study)	6	6	6	0	6	6	6	0	12 (m)	0	6	0	3	0
Total	86	82	18	33	83	79	23	49		75	8	0	5	1

a = number of ankles treated for peroneal tendon luxation; p = number of patients with peroneal tendon luxation; ♀ = number of female patients; ♂ = number of male patients; prim = primary surgery; rev = revision surgery; inst. = instability of the ankle and/or subtalar joints; ROM = limitation of ROM of the ankle joint; Rec = recurrence of peroneal tendon luxation, y = years; m = months.

peroneal tendon subluxation surgery. Our observations suggest that even the lax superior peroneal retinaculum in hypermobile patients gives a stable fixation for the peroneus longus tendon if the lateralizing force of the peroneus brevis is neutralized by the FCL. Following bony procedures, we believed additional deepening of the fibular groove important. Therefore we are unable to differentiate which of these procedures had the proportionally greater effect on our outcomes. We could not find any reports solely regarding transposition of the peroneus brevis tendon. In contrast, the transposition of both peroneal tendons behind the FCL is well-known as a “rerouting procedure” in the literature (Table 5). In 1967, Platzgummer [53] reported seven patients following transposition of both peroneal tendons behind the FCL by dividing and suturing the ligament near to its fibular attachment with additional deepening of the fibular groove. One female was treated for recurrence following reconstruction of the SPR via periosteal flap from the distal fibula. During the followup of 2 to 11 years, no recurrence of the peroneal tendon dislocation was found [53]. Steinböck and Pinsger treated 13 ankles of 12 patients with the same technique and reported no recurrences at a followup of 1.8 to 13.5 years [65]. In 1968, Leitz [36] performed an osteotomy of the fibular insertion of the FCL, transposed both peroneal tendons, and reattached the FCL insertion with Kirschner wires. He did not report any clinical results [56]. In 1975, Sarmiento and Wolf first described the division of both peroneal tendons, their transposition behind the intact FCL, and the final suture of the tendons in a case report [60]. Martens et al. [38] used this technique in 11 ankles in nine patients with a mean followup of 30.5 months. In one patient, the procedure was performed following failed plantaris tenoplasty. They reported no recurrences [38]. In 1984, Pöll and Duijfjes [54] mobilized a small bone block at the calcaneal

insertion of the FCL, transposed the peroneal tendons behind the FCL, reinserted the bone block in its bed, and fixed it with a small screw or vitallium nail. They treated 10 ankles in nine patients with a followup of 6 months to 8.5 years (mean, 4 years) and observed no patient with redislocation of the peroneal tendons [54]. Ferroudji et al. [17] treated 19 patients with the same technique. Their study is limited by a short followup of 2 to 24 months but reported the only recurrence following a rerouting procedure. Wang et al. [72] modified this technique elevating the calcaneal insertion of the FCL via interposition of a bone block from the calcaneus to avoid irritation of the transposed peroneal tendons. The authors reported no recurrent dislocation of the peroneal tendons at 2 to 5 years followup. Thus the only patient with recurrent peroneal tendon dislocation following a rerouting procedure has been reported among 83 patients described in the English and German literature (Medline from 1960 to 01/2009).

ROM of the hindfoot increased in all ankles in our study although three of our six patients showed a mild restriction of hindfoot mobility compared to the unaffected side (Tables 3, 4). In the literature, restriction of supination as well as of extension and flexion of the ankle were rarely found following a rerouting procedure (Table 5) [17, 38, 53, 54, 65, 72]. While we expected that one tendon in a space intended for two tendons would lead to less limitation of hindfoot ROM in contrast to the classic rerouting operation, we could not confirm that expectation. At the same time, we used our technique in revision surgery, so our results may not be directly comparable to those following primary surgery reported in the literature. In our patients, who were additionally suffering from a hindfoot valgus deformity, we found the space beneath the calcaneus and the FCL narrowed, which may have led to impingement if both tendons would have been transposed.

Despite the division and suture of the FCL, we observed no clinical decrease of hindfoot stability. Rather, hindfoot stability increased in more than half of our patients. This may be explained by a contracture of the scars of the weak ligament in patients suffering from hypermobility syndrome. Pöll and Duijfjes reported lateral ankle stability increased in one and unchanged in nine of 10 patients [54]. Martens et al. [38], Platzgummer [53], and Steinböck and Pinger [65] found no evidence for hindfoot instability following surgery. Instability of the ankle following transposition of one or both tendons behind the FCL has not yet been described (Table 5).

We observed an increase in the AOFAS ankle-hindfoot scale at 1 year followup (Table 2). Wang et al. also reported improvement of the AOFAS ankle-hindfoot scale in all 17 patients at 2 to 5 years followup [72]. All our patients showed a general laxity of joints. This may be explained by the fact that all our patients are women, who constitutionally have a higher laxity of their joints than men. In addition, hypermobile patients have a high incidence of hindfoot valgus and constitutionally, mostly bilateral and asymptomatic, peroneal tendon subluxation [35, 39, 47, 54, 75]. The high rate of hypermobile patients in our series indicates that laxity of joints and weakness of the soft tissues may be predisposing factors for recurrence after operative treatment. Multiple reasons exist for symptomatic dislocation of the peroneal tendons such as hypermobility syndrome, anatomical variants, and trauma. We believe good outcomes can be achieved with different operative procedures in most of these patients but in special anatomical and constitutional situations, one of these procedures may be stronger than others. Therefore it is important to know the pathoanatomy as well as the different procedures to have the opportunity to use them if needed to avoid recurrence [69].

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