

Reconstruction of neglected achilles tendon ruptures with gastrocnemius flaps: excellent results in long-term follow-up

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Abstract

Objective Repair of the neglected achilles tendon ruptures can be challenging due to retraction of tendon stumps. Different repair and augmentation techniques were described. This study aims to investigate long-term results of neglected achilles tendon rupture repair with gastrocnemius flaps.

Patients and methods Between 1995 and 2005, 21 neglected achilles tendon rupture reconstructions were performed with using gastrocnemius fascial flaps. Mean age was 32.1 years. Mean period between rupture and operation was 8.4 weeks. Ankle range of motion, calf circumference, heel raise test, Visual Analog Scale (VAS), American Orthopedic Foot and Ankle Society (AOFAS) hindfoot and Foot and Ankle Disability Index (FADI) scores were checked.

Results The average gap length was 6.4 cm. Mean follow-up was 145.3 months. Median dorsiflexion/plantar flexion values for operated and uneffected sides were 18°/30° and 19°/30°, respectively. The mean values for AOFAS and FADI scores were 98.5 points and 98.9 %, respectively. VAS score was 0 point for all patients. With the numbers available, no significant difference could be detected in terms of ankle range of motion, calf circumference measures

and dynamometric analysis. Mean time for return to daily activities was 11.1 (8–16) weeks after surgery. Prerupture activity level was achieved 14.1 months postoperatively. All patients were able to perform heel raise test.

Conclusion Repair of neglected achilles tendon ruptures with gastrocnemius flaps has satisfactory long-term results.

Keywords Achilles tendon · Gastrocnemius flap · Neglected · Reconstruction · Rupture

Introduction

The Achilles is the most frequently ruptured tendon in human body [1]. The incidence of rupture is increasing and acute ruptures can be misdiagnosed. Results of acute repair are excellent but in chronic cases primary repair of tendon would become impossible due to the increased gap between stumps [2, 3].

Several techniques were described for the surgical treatment of neglected Achilles ruptures. Primary repair after tendon mobilization/advancement or reconstruction with gastrocnemius fascia, flexor hallucis longus (FHL), plantaris, peroneus brevis tendons or allografts can be preferred [2, 4–10]. This study aims to present long-term functional results of the repair of neglected achilles tendon ruptures with two gastrocnemius turn-down flaps. We investigated if the operated side could achieve the level of the uneffected side or not functionally and by dynamometric measures.

Patients and methods

Between 1995 and 2010, total of 46 patients were operated for neglected achilles tendon rupture. Among these, 21 patients who were treated by using two gastrocnemius

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fascial flaps and have at least 10 year follow-up were included. Patients who had acute ruptures, less than 10 years of follow-up and who were treated with different reconstruction techniques were excluded. The demographic data and details of procedures were investigated retrospectively from patients' records. The patients were invited for last control and clinical evaluation was performed. All patients in this study were male and they were performing sports recreationally. The diagnosis was made by clinical examination. They had no other comorbidity. The mechanism of injury was ankle sprain in two patients, fall in one patient and sports trauma in the remainders. The causes of neglect was misdiagnosis in 17 and late presentation in 4 patients. Mean age of patients at the time of operation was 32.1 (range 17–45) years. Mean period between rupture and operation was 8.4 (range 4–48) weeks.

Patients were evaluated clinically by comparing two ankles' range of motions, circumference of calves and heel raising tests during follow-ups. The calf circumference was measured at the widest point. The strength of the plantar flexion of the effected side was compared with the unaffected side. A Cybex NORM[®] isokinetic dynamometer device (Cybex International Inc., Medway, MA, USA) was used to measure the peak torque values and range of motion in last control. The patients were seated in the adjustable chair of the system with the position of 60° of hip and 45° of knee flexion. The leg was elevated by a support arm under the knee. The positions of the joints were confirmed by goniometric measures. The patients' ankles were placed on the foot-plate and the feet were secured with straps. The ankle center of rotation was aligned with the rotational axis of the dynamometer. The evaluations were performed at different velocities as 30°/s and 120°/s for 20 repeats. Peak torque values (N-m) were recorded for each angular velocity. Visual Analog Scale (VAS), American Orthopedic Foot and Ankle Society (AOFAS) hindfoot score [11] and Foot and Ankle Disability Index (FADI) were checked at last interview [12]. This study has local Institutional Review Board approval and all subjects had given informed consent.

SPSS 15 (SPSS INC., Chicago, IL, USA) was used for statistical analysis. The distributions of the variables were checked with the Kolmogorov–Smirnov test. For normally distributed data, the independent samples *T* test was used in order to compare mean values. The Mann–Whitney *U* test was used in order to compare the differences between the median values of non-normally distributed data. The *p* value less than 0.05 was accepted as statistically significant.

Surgical technique

Under general or spinal anesthesia the patient was placed in prone position. A tourniquet was applied at the level of the

thigh. A longitudinal skin incision that is slightly medial to the midline was made between middle one-third of the calf and calcaneus. The skin flaps were freed from underlying fascia while protecting the sural nerve. After the incision of the paratenon, stumps of the ruptured tendon and gastrocnemius aponeurosis were exposed (Fig. 1). The scar tissues within the tendon gap were removed and tendon ends were excised up to the healthy tissues. When the ankle was at neutral position, the gap between stumps was measured in to determine flap lengths. Two peripheral fascial flaps with 1 cm wide and appropriate length were prepared (Fig. 2). The proximal ends of the flaps were cut from the proximal aponeurosis but two centimeters of the flaps were intact distally. The average length of gaps was 6.4 (range 4–10) cm. The flaps were turned down and rotated 180° to face the smooth surfaces outward to prevent adhesions. The flaps were sutured to each other side to side and to the distal stump with No: 1 Prolene sutures (Ethicon, Edinburgh, United Kingdom) when the ankle is at neutral position. The anastomosis of the flaps to the distal stump was performed by using modified Kessler technique (Fig. 3). The donor area and paratenon with closed side to side with 2.0 Vicryl sutures (Ethicon, Edinburgh, United Kingdom). After closure of the incision, an above-knee cast was applied with the ankle at neutral position and knee at 30° flexion for 3 weeks and it was replaced with a below-knee one for another 3 weeks. Patients were discharged the day after surgery. The thromboprophylaxis was performed by using 40 mg enoxaparin sodium for 1 week. Mobilization was allowed by using two crutches without weight-bearing. After 6 weeks cast was removed; range of motion and strengthening programs were started. Weight-bearing was allowed as the patient tolerated without crutches.

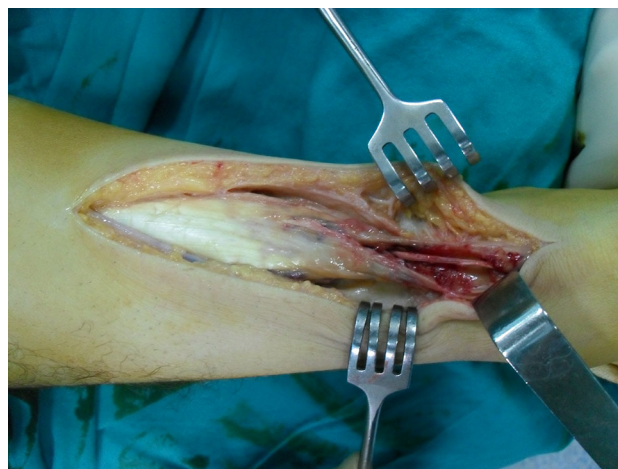


Fig. 1 The gap between stumps was evaluated after debridement of the fibrous tissues in neutral ankle position

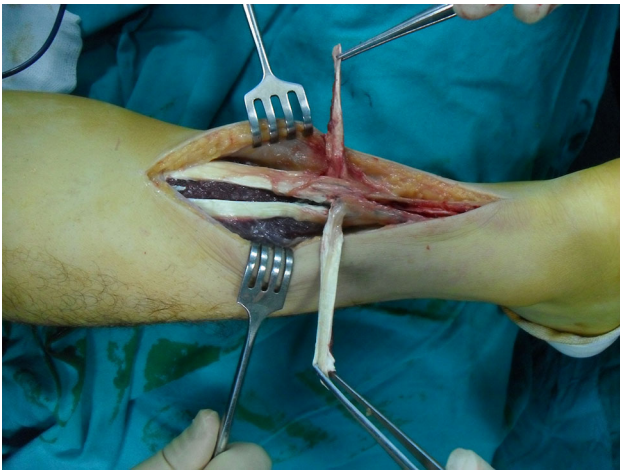


Fig. 2 Two gastrocnemius fascial flaps. Last 2 cm of the flaps were kept intact

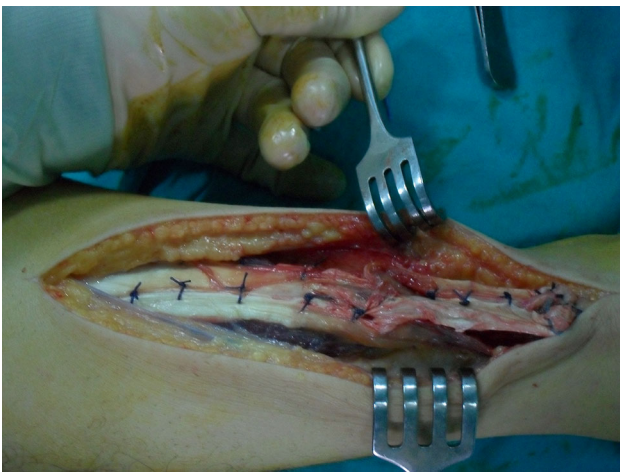


Fig. 3 View of the reconstruction before the closure of the tendon sheath

Results

Mean follow-up was 145.3 (range 121–181) months. No complication was observed in early postoperative period except the one with superficial soft tissue infection which was treated with oral antibiotherapy. No rerupture was reported at the last follow-up. The mean calf circumference values of the operated and non-operated sides were 36.2 (range 30–40) cm and 37.2 (range 32–41) cm, respectively. The difference between two sides was not significant ($p = 0.291$). Median ankle dorsiflexion was 19 (range 15–20) degrees for non-operated and 18 (range 10–20) degrees for operated sides. These values were 30 (range 20–40) degrees for both operated and non-operated sides in terms of plantar flexion. With the numbers available, no significant difference could be detected regarding ankle

plantar flexion and dorsiflexion ($p > 0.05$) (Table 1). Mean time for return to daily activities was 11.1 (range 8–16) weeks after surgery. All patients were able to perform double and single leg heel raise tests and they returned to their prerupture activities with a mean of 14.1 (range 9–20) months after surgery (Fig. 4). All patients emphasized the fear of rerupture for delay in return to sport.

In dynamometric analysis, the median plantar flexion peak torque values for 30°/s and 120°/s velocities were 82 (range 70–142) Nm and 42 (range 39–69) Nm in operated side; 96 (range 70–145) Nm and 43 (range 40–75) Nm in non-operated side, respectively. Median peak force deficiencies were 6.0 (range 0–21) % for 30°/s and 4.8 (range 0–12.5) % for 120°/s. The median dorsiflexion peak torque values for 30°/s were 51 (range 45–60) Nm in operated and 55 (range 44–67) Nm in non-operated side. These values were 39 Nm bilaterally (range 35–54 Nm in operated side and 31–55 Nm in non-operated side) regarding 120°/s velocity. Median peak force deficiencies were 5.7 (range 0–13.8) % for 30°/s and 2.6 (range 0–12.2) % for 120°/s. With the numbers available, no significant difference could be detected in terms of dynamometric evaluations ($p > 0.05$) (Tables 2, 3, 4).

The mean values for AOFAS and FADI scores were 98.5 (range 90–100) points and 98.9 (range 96.2–100) %, respectively. VAS score was 0 point for all patients.

Discussion

Achilles tendon ruptures are common injuries especially in middle-aged people [1]. The diagnosis is made by physical examination. Palpation of a gap on tendon, inability to perform ankle plantar flexion and Thompson test can be useful for diagnosis [2]. In chronic cases calf atrophy, weakness or difficulty during walking, swelling and sometimes pain can be observed. Magnetic Resonance Imaging (MRI) can be used in suspected cases or partial ruptures and may be useful for estimation of the gap [4]. According to the literature, 10–25 % of achilles tendon ruptures were missed [10, 13–16]. In our series, the causes of delay were misdiagnosis in 17 and late presentation in 6 patients. In misdiagnosed patients, the

Table 1 Median values for ankle range of motion in operated and unaffected sides

	Operated side	Unaffected side	<i>p</i> value
Plantar flexion (°)	30 (20–40)	30 (20–40)	0.595
Dorsiflexion (°)	18 (10–20)	19 (15–20)	0.623

Fig. 4 All patients were able to perform heel raise test



Table 2 Median peak torque values of operated and non-operated sides in dynamometric evaluation

Angular velocity	Plantar flexion peak torque (Nm)		Peak torque deficiency (%)	<i>p</i> value	Dorsiflexion peak torque (Nm)		Peak torque deficiency (%)	<i>p</i> value
	Operated side	Unaffected side			Operated side	Unaffected side		
30°/s	82 (70–142)	96 (70–145)	6.0 (0–21)	0.113	51 (45–60)	55 (44–67)	5.7 (–6–13)	0.098
120°/s	42 (39–69)	43 (40–75)	4.8 (0–12.5)	0.06	39 (35–54)	39 (31–55)	2.6 (–8–12.2)	0.47

first evaluations were performed by general practitioner or non-orthopaedic specialist and the conditions had been accepted as ankle sprain in all.

Time limit for chronic rupture was generally accepted as 4 weeks [17]. Management of chronic achilles tendon ruptures can be either surgical or non-surgical. Non-surgical treatment should be considered for patients with several risk factors (e.g., cardiovascular diseases) or patients with sedentary life. Christensen accepted the inability to perform single leg heel raise as an indication for surgical treatment and analyzed 57 achilles tendon ruptures treated either conservatively or surgically. The author concluded that with both techniques functional improvement and pain relief were achieved but in non-operative group these may take more time [18]. Mean period between rupture and operation was 8.4 (range 4–48) weeks in our series and all patients were treated surgically.

Various techniques were described for surgical treatment of chronic achilles tendon ruptures. Porter et al. claimed that gaps less than 3 cm in length after debridement could be treated with primary repair [19]. Gaps between 3 and 5 cm can be treated with V–Y advancement [20]. The average length of gaps was 6.4 cm in our series and we preferred reconstruction instead of advancement or primary repair. There are several techniques for reconstruction of the neglected Achilles tendon. Besides fascia lata; tibialis posterior, peroneal, plantaris, flexor digitorum longus, and flexor hallucis longus tendons, bone-patellar tendon autografts and artificial grafts can be used [17, 20–29]. Recently, Maffuli et al. reported minimal invasive transfer of the peroneus brevis tendon. Authors performed tenodesis of the peroneus brevis tendon to the calcaneus in 17 patients and reported excellent results in six patients, good results in ten patients and fair results in one patient according to Boyden classification system [21].

Table 3 Range of motion and calf circumference measurements

Patient no	Age (years)	Dorsiflexion (°)		Plantar flexion (°)		Calf circumference (cm)	
		Operated side	Non-operated side	Operated side	Non-operated side	Operated side	Non-operated side
1	41	15	10	30	20	30	32
2	32	16	16	35	35	40	41
3	27	17	17	35	35	39	40
4	35	18	18	30	30	37	38
5	17	20	20	30	30	38	39
6	45	20	19	25	25	40	40
7	34	20	20	30	30	33	34
8	26	18	18	35	35	35	36
9	36	19	17	30	27	38	39
10	19	19	18	30	30	35	36
11	32	20	17	35	35	37	38
12	36	16	19	35	33	40	41
13	36	18	16	35	33	39	41
14	37	15	15	25	25	33	34
15	31	19	20	25	25	34	34
16	25	20	20	30	30	36	37
17	30	20	19	25	25	31	33
18	36	20	20	25	28	39	39
19	27	20	20	20	20	34	35
20	35	17	20	25	25	35	36
21	38	19	17	25	23	38	38

Lui treated a 10 years neglected Achilles rupture by overlapping the interposed scar at the rupture site. The author reported good results and improvement of preoperative symptoms, even the calf atrophy [3]. In addition to two fascial flaps, single central fascial flap can also be preferred. No difference was detected between different turnaround flap techniques [4].

According to the literature, all achilles reconstruction techniques have good results but there is no comparative study [2, 3, 5, 17, 21]. Despite good clinical outcomes, reconstruction with other tendons or autolog tissues means sacrifice of another healthy tissue. In addition this may cause impairment of another function of the body. On the other hand, the papers related with artificial materials are almost all case reports or small series. Besides, we could not find long-term results of those materials. In our series we preferred two gastrocnemius fascial flaps in order to reconstruct the ruptured tendon. According to the dynamometric analysis there was no significant difference between effected and uneffected sides in terms of plantar flexion peak torque values. Wegrzyn et al. reconstructed Achilles tendon with FHL tendon. Authors reported good results but they detected significant difference between effected and uneffected sides in plantar flexion peak torque

[22]. Maffulli et al. reported significant difference between operated and uneffected sides after reconstruction with peroneus brevis tendon, in terms of both plantar flexion and eversion strength of the foot [21]. On the other hand El Shazly et al. reconstructed chronic achilles ruptures by using free hamstring tendon autograft and reported excellent results. Authors claimed that the difference between involved and uninvolved sides was insignificant (less than 10 %) in terms of average ankle plantar flexion and dorsiflexion peak torque values [29].

Although mean time for return to daily activities was 11.1 weeks, patients were able to perform sports at the preoperative level with a mean of 14.1 months postoperatively. Also there was a wide range (9–20 months) about this issue. Maffulli et al. reported that all patients had returned to their preinjury level at a mean of 6.8 months but at final review ten of 13 patients were able to perform sports at the same level [21]. Brumann et al. reviewed the rehabilitation protocols for achilles repair after acute ruptures and reported the mean times for return to sports between 2 and 9 months [30]. Our results were too much higher than these numbers but our study group consisted only chronic ruptures. The cause of delay was determined as fear of rerupture. All patients in this study were

Table 4 Dynamometric results

Patient no	Peak torque values (Nm) (Plantar flexion – operated side)		Peak torque values (Nm) (Plantar flexion – non-operated side)		Peak force deficiency (Flexion) (%)		Peak torque values (Nm) (Dorsiflexion – operated side)		Peak torque values (Nm) (Dorsiflexion – non-operated side)		Peak force deficiency (Dorsiflexion) (%)	
	30°	120°	30°	120°	30°	120°	30°	120°	30°	120°	30°	120°
	1	70	39	70	40	0	2.5	45	31	44	35	2.2
2	142	69	145	75	2.1	8	60	54	67	55	10.4	1.8
3	80	56	86	57	7	1.8	55	36	57	37	3.5	2.7
4	78	43	83	43	6	0	49	39	49	38	0	2.6
5	90	41	95	43	5.6	4.7	50	42	46	44	8	4.5
6	108	51	110	53	1.8	3.8	57	44	61	46	6.6	4.3
7	119	51	122	56	2.5	8.9	56	41	60	41	6.6	0
8	110	50	118	53	6.8	5.7	51	38	56	38	8.9	0
9	88	41	104	42	15.4	2.4	50	39	58	37	13.8	5.1
10	70	42	84	42	6	0	53	40	53	42	0	4.8
11	82	40	84	42	2.4	4.8	48	36	50	41	4	12.2
12	90	39	111	41	18.9	4.9	47	37	52	37	9.6	0
13	83	40	105	45	21	11.1	51	39	53	41	3.7	4.9
14	101	42	105	46	3.8	8.7	52	40	55	40	5.5	0
15	106	39	117	42	9.4	7.1	58	41	60	41	3.3	0
16	79	39	100	44	21	11.3	55	40	57	39	3.5	2.5
17	80	45	96	49	16.7	8.1	53	38	58	39	8.6	2.6
18	71	42	75	48	5.3	12.5	50	38	53	40	5.7	5
19	71	41	72	41	1.4	0	50	37	47	37	6	0
20	74	41	81	41	8.6	0	48	36	51	37	5.9	2.7
21	77	42	80	42	3.8	0	58	36	56	36	3.4	0

performing sports recreationally and people may prefer to quit sports instead of risk of rerupture. The other explanation for delay would be ineffective postoperative rehabilitation. Our data about postoperative protocols were limited and this is a limitation of this study.

Postoperative immobilization was performed with above-knee cast for first 3 weeks. It was replaced with a below-knee cast for additional 3 weeks. Because the origin of the gastrocnemius muscle is femoral condyles, immobilization of the knee joint had been preferred formerly. The lengths of the fascial flaps were determined according to the defective area in order to prevent tension in the anastomosis site. Therefore, the ankles were positioned in neutral position. We quit this regimen for last few years. We prefer below-knee cast anymore. After 2 weeks we remove the cast and use immobilizing boot for 4 weeks. Passive ROM exercises are advised avoiding excessive dorsiflexion during this period. Similar protocols were reported in the literature. The positioning of the ankle can vary neutral to slight plantar flexion depends on the tension in the repair area [17, 20, 21].

Our study has some other limitations such as its retrospective design, low number of patients and lack of control groups. But when we check the literature, to our knowledge there is no such a comparative study about different techniques for chronic ruptures and multicentric studies are needed in order to get such a big cohort.

In conclusion, reconstruction of neglected achilles tendon ruptures by Lindholm technique has excellent results. There is no need to sacrifice other healthy tissues and the operated side could have similar results as unaffected side in terms of functional and dynamometric measures in long-term follow-ups.

Compliance with ethical standards

Conflict of interest None.

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