

# Comparison of clinical results after augmented versus direct surgical repair of acute Achilles tendon rupture

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**Summary.** *Background and aim of the work:* Achilles tendon rupture is frequent and can result in a disabling condition. The ideal method of management remains a matter of debate. We aimed to compare the clinical outcome of patients who underwent surgical repair of Achilles tendon rupture with Silfverskiöld augmentation technique with gastrocnemius fascia flap versus Krackow end-to-end stitching technique. *Methods:* We retrospectively studied all patients that were surgically treated for Achilles tendon rupture at our institution, between January 2000 and December 2015, using either Silfverskiöld or Krackow technique. We excluded all patients deceased or untraceable, and those refusing the follow up interview. Disability, Quality-of-Life and functional restriction were evaluated using the Achilles-Tendon-total-Rupture-Score (ATRS) and Foot-and-Ankle-Disability-Index (FADI); means were compared by the Mann-Whitney test and correlations by the Spearman coefficient. *Results:* A total of 90 patients were included, with a mean age of  $45.3 \pm 12.6$  years. The augmented repair group-A included 33 patients and the simple repair group-B 57 patients. Follow-up averaged 8 years (1 to 16). FADI was  $103.7 \pm 1.6$  for group-A versus  $100.3 \pm 15.6$  for group-B. ATRS was  $2.0 \pm 7.1$  and  $5.7 \pm 18.8$ , respectively. Differences were not significant. Age showed a low linear correlation with ATRS ( $R=0.41$ ) and FADI ( $R=-0.40$ ), indicating that clinical outcomes minimally tend to worsen in older patients. *Conclusions:* We didn't find significative differences in the clinical outcomes between the two groups of patients. Acute uncomplicated Achilles tendon ruptures can be successfully treated with a direct suture technique. Augmentation with a fascial flap should be reserved to chronic or neglected cases with severe tendinosis or tissue defect. ([www.actabiomedica.it](http://www.actabiomedica.it))

**Key words:** Achilles tendon rupture, Achilles tendon repair, open surgery, augmentation, functional outcome

## Introduction

Subcutaneous rupture of Achilles tendon is a frequent lesion, accounting for approximately 35% of all tendon tears and for about 1/3 of foot acute injuries (1). It is estimated that the incidence of this lesion is 18 per 100,000 in some regions, a considerable rise from

the 2 per 100,000 estimates in the 1980s (2). Rupture of the Achilles tendon commonly afflicts men in their fourth and fifth decades of life (2). The left tendon is more commonly ruptured than the right (2).

Despite the Achilles tendon is the thickest and strongest tendon of the human body, it is also vulnerable to injury, due to its limited blood supply and the

high tensions placed on it (2). All ruptures are due to indirect causes, in which either mechanical stress or intratendinous degeneration play a role (1).

Following tendon rupture, Activity of Daily Life (ADL) and Quality of Life (QoL) are compromised because of weakness, pain, swelling, stiffness and walking or running limitation. Disability can last for a long period or become permanent.

In recent years, there is a growing recognition in evaluating patients' satisfaction as a metric of quality care; this method of measuring results is important because it shows how a procedure can significantly impact on the patient's life. Conversely, several studies have shown that objective parameters do not necessarily correlate with the perception of a successful outcome by patients. Several authors reported a discrepancy between the objective and subjective assessments of outcome after orthopedic operations (3). The role of QoL is gaining more and more importance also in patients suffering Achilles tendon ruptures where immediately after the lesion, the patient is acutely and strongly limited in his usual activities. Even after surgical repair, when performed, a plaster cast or splint should be kept for several weeks, according to different rehabilitation protocols suggested in literature. This means that the patient is limited in ADL such as walking or going to work, and in recreational activities. This disability can lead to physical, social, psychological and economic consequences.

The ideal method of managing such injuries remains a matter of debate, with surgical and non-surgical treatment being the main alternatives. The goals of management of Achilles tendon ruptures are to minimize the morbidity of the injury, accelerate functional recovery and prevent complications (4).

During the past, surgical treatment has been considered as the first choice by many authors. Several studies have shown that the incidence of rerupture is higher in nonsurgically treated patients, but also that the incidence of different complications, such as adhesive scars, infection, problems with wound healing, sural nerve lesions, deep venous thrombosis, pulmonary embolism and death, is higher after surgery (2).

There is not consensus on the best method of surgical repair. Open and percutaneous techniques are both safe and effective in repairing the ruptured Achil-

les tendon and both have demonstrated to ensure good anatomical and clinical results. Medium-term results are substantially comparable (4).

The most frequent complication after open repair is wound healing, because the longitudinal incision, the one most widely used, is made on poorly vascularized skin (1).

Most of the surgical techniques consist in a direct end to end repair of the tendon, such as the bilateral enchained stitching described by Krackow (5). Other techniques rely on augmentation of the repair, such as the down-turned gastrocnemius fascia flap as described by Silfverskiöld (6).

## Objective

Authors aimed to evaluate functionality and quality of life in patients that had undergone open surgical repair of acute Achilles tendon ruptures, and compare the results achieved with the Silfverskiöld versus the Krackow technique.

## Materials and methods

A retrospective observational cohort study was carried out.

All patients who had undergone open surgical repair for acute Achilles tendon rupture at "Maggiore della Carità" Hospital in Novara (Italy) between January 2000 and December 2015, were retrieved from the hospital DataBase "AcceWeb" (Hi.Tech S.p.A. Software Engineering, Bagno a Ripoli - FI, Italy) matching the ICD-9-CM codes 727.67 for "atraumatic rupture of Achilles tendon", 83.64 for "tendon stitching/tenorrhaphy" and 83.88 for "plastic repair".

We included all patients that were operated using either the Silfverskiöld augmented technique (Group A) or the Krackow simple repair technique (Group B). The allocation into the two different groups depended only on a chronological parameter: the augmented technique was routinely used until 2008, while the simple technique was adopted later.

The postoperative protocol was different for the two surgical techniques:

- in Group A, weight bearing was not allowed for 8 weeks, using an over-knee pes equinus plaster cast for the first 5 weeks and a below-knee plaster cast with ankle flexed at 90° for the following 3 weeks;

- in Group B, weight bearing was not allowed with immobilization in a below-knee pes equinus plaster cast for 4 weeks; after this period, full weight bearing was allowed with the ankle immobilized in a locked static splint for 4 weeks and kinesis exercises were started to recover ankle movement and force.

Three months after surgery all patients could use normal shoes for walking, while sport activities were allowed after 6 months.

All the patients that were operated using different techniques, deceased or untreatable, and those refusing the follow up interview were excluded.

All the retrieved patients were interviewed at the time of this study by an independent observer, in order to evaluate residual disability and QoL in the two groups of patients, we used the Achilles tendon Total Rupture Score (ATRS) (7), and Foot and Ankle Disability Index (FADI) (8).

To compare the means of the investigated parameters we used the Mann-Whitney test. Correlation of age to total scores of FADI and ATRS was investigated using the Spearman correlation coefficient. The level of significance was set at  $p < 0.05$ .

## Results

We enrolled a total of 206 patients accepted at our institution for Achilles tendon rupture: 187 (90.8%) were males and 19 (9.2%) females.

41 patients were excluded because treated with alternative surgical techniques. Of the remaining 165 patients, 4 were deceased at the time of follow up and 71 (39 for group A and 32 for group B) were untreatable or refused the interview. Therefore, the drop out rate was 45.5% (75/165).

The resulting sample of 90 patients was considered for this study and included 33 patients (36.7%) of group A (M/F=32/1) and 57 patients (63.3%) of group B (M/F=54/3).

Patients' age at time of surgery averaged  $45.3 \pm 12.6$  years (range 21 to 81). The mean age was lower in

group A ( $43.1 \pm 9.9$ , range 29-76y) than in group B ( $46.7 \pm 13.9$ , range 21-81y),  $p$ -value  $> 0.05$ . Conversely, age at follow up was higher in group A ( $55.5 \pm 10.3$ , range 41-86y) than in group B ( $50.7 \pm 14.1$ , range 25-88y),  $p$ -value  $> 0.05$ .

The average follow-up time of the total sample was  $86.4 \pm 56.4$  months (range, 13 to 201). Patients of group A were evaluated at a mean follow up of  $147.6 \pm 37.8$  months (range, 89 to 201). Due to later adoption of the Krackow technique, average follow up for patients of group B was shorter:  $49.1 \pm 23.4$  months (range, 13 to 90).

No patients reported tendon rerupture or additional surgical procedures.

Clinical outcome at follow-up resulted in an average total FADI score of  $103.7 \pm 1.6$  for group A versus  $100.3 \pm 15.6$  for group B. Total ATRS score averaged  $2.0 \pm 7.1$  for group A vs  $5.7 \pm 18.8$  for group B. These differences were not statistically significant with a  $p$ -value  $> 0.05$ .

A comparison between the two groups for each item of FADI and ATRS was also carried out: results are reported in Tables 1 and 2, respectively. Average partial scores were slightly, but constantly, better in group A patients. However, a significant difference was detected only for three items of FADI and two items of ATRS.

Statistical analysis aimed to correlate age to clinical scores revealed a positive linear correlation for ATRS (Spearman's coefficient  $+0.4124$ ) and a negative linear correlation for FADI (Spearman's coefficient  $-0.4008$ ), thus indicating that clinical results decline with growing age of patients.

## Discussion

In the present study authors report the clinical results of two different surgical techniques that were adopted for acute Achilles tendon repair at a single Institution in two different consecutive periods, as in a "before-after" study. In particular, the Silfverskiöld augmented technique was used almost exclusively from 2000 until 2008, while after that period it was abandoned for opting in favor of the Krackow direct suture technique.

Two different factors hinder the comparison between the two groups of patients: the disparity in the

**Table 1.** Comparison of Silfverskiöld versus Krackow FADI scores, where zero represents the worst score and 104 the best for total and 0-4 the range for each item

		FADI (Foot and Ankle Disability Index)				
		Group A Silfverskiöld		Group B Krackow		p
	Condition/Difficulty within the past week	Mean	SD	Mean	SD	
1	Standing	4	0	3.89	0.56	p=0,1826
2	Walking on even ground	4	0	3.89	0.56	p=0,1826
3	Walking on even ground without shoes	4	0	3.89	0.56	p=0,1826
4	Walking up hills	4	0	3.86	0.61	p=0,1217
5	Walking down hills	4	0	3.86	0.61	P=0,1217
6	Going up stairs	4	0	3.81	0.64	<b>p=0,0370</b>
7	Going down stairs	4	0	3.79	0.65	<b>p=0,0251</b>
8	Walking on uneven ground	4	0	3.77	0.71	<b>p=0,0251</b>
9	Stepping up and down curves	4	0	3.88	0.57	p=0,1217
10	Squatting	4	0	3.82	0.63	p=0,0552
11	Sleeping	4	0	3.91	0.54	p=0,2792
12	Coming up to your toes	4	0	3.86	0.58	p=0,0818
13	Walking initially	4	0	3.86	0.58	p=0,0818
14	Walking 5 minutes or less	4	0	3.88	0.57	p=0,1217
15	Walking approximately 10 minutes	4	0	3.88	0.57	p=0,1217
16	Walking 15 minutes or greater	3.97	0.17	3.86	0.61	p=0,4167
17	Home responsibilities	3.97	0.17	3.86	0.61	p=0,6141
18	Activities of Daily Living	4	0	3.88	0.57	p=0,1217
19	Personal care	4	0	3.88	0.57	p=0,1217
20	Light to moderate work (standing, walking)	4	0	3.86	0.58	p=0,0818
21	Heavy work (push/pulling, climbing, carrying)	4	0	3.84	0.59	p=0,0551
22	Recreational activities	3.97	0.17	3.86	0.58	p=0,2911
23	General level of pain	3.91	0.29	3.86	0.58	p=0,9797
24	Pain at rest	3.97	0.17	3.88	0.57	p=0,4227
25	Pain during your normal activity	3.94	0.24	3.84	0.62	p=0,6199
26	Pain first thing in the morning	3.94	0.35	3.84	0.75	p=0,6142
<b>Total</b>	<b>Total</b>	<b>103.67</b>	<b>1.56</b>	<b>100.31</b>	<b>15.57</b>	<b>p=0,3818</b>

length of follow up and the high rate of dropouts, that greatly reduced the sample size and decreased the statistical power of the study.

Another limit of the study is represented by the fact that the ATRS and FADI scales have not been validated into Italian yet. Therefore, their use in the English original version proves to be inappropriate and limited when applied to Italian patients (9). To reduce the risk of error the two scales were translated

into Italian in order to obtain an univocal and standardized, even if not validated, version.

The average age of the sample of the study was 45 years, thus in accordance with literature data, reporting that Achilles tendon ruptures occur more frequently in the fourth and fifth decades of life (2).

There is not consensus on the opportunity to treat Achilles tendon ruptures surgically. Authors recommend conservative treatment only for elderly patients

**Table 2.** Comparison of Silfverskiöld versus Krackow ATRS scores, where zero means “any limitation” (best result), whereas 10 “maximum level of limitation” for each item, and 100 for total (worst result)

		ATRS (Achilles Tendon Total Rupture Score)				
		Group A Silfverskiöld		Group B Krackow		p
	Limitations/difficulties related to the injured Achilles tendon	Mean	SD	Mean	SD	
1	due to decreased <b>strength</b>	0.15	0.87	0.32	1.52	p=0,5840
2	due to <b>fatigue</b>	0.15	0.62	0.55	1.69	p=0,2699
3	due to <b>stiffness</b>	0.33	1.11	0.68	1.94	p=0,3197
4	due to <b>pain</b>	0.18	1.04	0.58	1.84	p=0,1252
5	in <b>ADL</b>	0	0	0.49	1.69	<b>p=0,0465</b>
6	in walking on <b>uneven surfaces</b>	0	0	0.57	1.93	<b>p=0,0465</b>
7	in <b>walking</b> quickly up the stairs or up a hill	0.06	0.35	0.51	1.88	p=0,2476
8	in <b>running</b>	0.36	1.02	0.65	2.04	p=0,8106
9	in <b>jumping</b>	0.36	1.02	0.62	2.09	p=0,8131
10	in <b>hard physical labor</b>	0.36	1.02	0.68	2.21	p=0,8215
<b>Total</b>	<b>Total</b>	<b>1.95</b>	<b>7.05</b>	<b>5.65</b>	<b>18.83</b>	<b>p=0,6828</b>

with very low functional demands. In this series of patients, no reruptures occurred, regardless the repair technique adopted. This observation should be taken into account in choosing treatment, considering that a higher risk of rerupture after conservative treatment is reported in literature (2).

In this study, both surgical repair techniques demonstrated to be effective in achieving good clinical results, with patients recovering a good quality of life with minimal residual disability. The recorded outcomes were slightly better after the augmented repair, even if a significant difference could be demonstrated only for few items of FADI and ATRS between the two groups owing to the low numerosity of the sample. The longer time span from surgery in the augmented repair group might justify the achievement of an optimal recovery, that requires several months, if not years, after injury, despite the older age at follow up.

Pajala and Leppilahti reported that at one year follow up Achilles tendon elongation occurred either after augmented or direct repair. Elongation correlated significantly with isokinetic peak torque deficits and isometric strength deficits in the simple repair group (10).

In a recent RCT (11), the same authors reported that in the long term (average follow up of 14 years)

the Silfverskiöld technique did not provide any detectable advantage over the Krackow technique. They observed that Achilles tendon ruptures resulted in a permanent calf muscle weakness, but its clinical relevance remains unclear (11).

Considering also that Krackow is technically less demanding than Silfverskiöld, we wonder when it's worthwhile to perform the augmentation flap with longer operating time and higher risk of wound complication (10).

It must be highlighted that tendon healing is greatly influenced by postoperative immobilization and rehabilitation protocol, too (12). In literature, several protocols can be found, with different rationales according to the repair technique performed. The protocols adopted in the two groups of patients of this study were not the same and this difference might have influenced the outcome. Further investigations should be carried out to clarify this important aspect.

The correlation of the clinical scores with patients' age indicates that older patients are weakly associated to worst outcomes; but, if patients' age at time of surgery was lower in group A than in group B, conversely, age at follow up was higher in group A than in group B.

## Conclusions

Surgical repair of acute Achilles tendon rupture allows to achieve good clinical outcomes with minimal residual disability and a low risk of complications.

The augmented repair technique does not seem to offer significant advantages over the direct repair technique, that is technically simpler. Augmentation should be reserved for chronic and neglected cases in patients with severe tendinosis or tissue defect.

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