REVIEW

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Efficacy of Surgical Management *versus* Conservative Management to Decrease the Incidence of Re-Rupture in Adult Patients with Achilles Tendon Rupture: A Systematic Review and Meta-Analysis

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SUMMARY

Purpose. To determine whether surgical management is more effective than conservative management in reducing the incidence of re rupture in adult patients with Achilles' tendon rupture.

Materials and methods. A systematic review and meta-analysis was conducted, including ten clinical trials that compared surgical management *versus* conservative management. Data were extracted and analyzed to compare the efficacy of both approaches in the incidence of re-rupture of the Achilles tendon and secondary outcomes: short- and long-term functional outcome, presence of chronic pain, and adverse effects (deep vein thrombosis and pulmonary embolism).

Results. The incidence of re rupture in the surgical management group was 65% lower than in the conservative management group (RR 0.35; 95%CI 0.20-0.62). As for short-term functional outcome, there were no statistically significant results (MD 1.22; 95%CI -1.62 to 4.05). The mean long-term functional outcome in the surgical management group was 0.72 standard deviations higher (MD 0.72; 95%CI 0.37-1.08). The probability of developing chronic pain in the surgical management group is 68% higher than in the conservative management group (RR 1.68; 95%CI 1.09-2.59). The probability of developing pulmonary embolism and developing deep vein thrombosis did not have statistically significant results (RR 2.75; 95%CI 0.31-24.75) (RR 0.71; 95%CI 0.23-2.23).

Conclusions. Surgical management is more effective in reducing the incidence of Achilles tendon re-rupture, presents a lower long-term functional result. However, increase the probability of presenting chronic pain compared with conservative management.

KEY WORDS

Achilles' tendon re rupture; Achilles' tendon rupture; adults; conservative management; surgical management.

INTRODUCTION

Achilles tendon rupture is defined as a break in continuity that partially or totally compromises its structure and that can occur at any anatomical level located between the musculo-tendinous junction and the insertion of the tendon at the level of the calcaneus, but the majority of ruptures occur where the blood supply to the gastrocnemius and soleus muscle is poor, *i.e.* 2 to 6 cm above the point of insertion (1-3). This pathology is attributed to the increase in the elderly and obese population, as well as the increase in sports activities among middle-aged individuals, showing a peak of increase between 30-39 years of age, suffering the risk of breaking

when running, jumping, accelerating or decelerating. suddenly, even after normal activity such as walking. This incidence of rupture ranges from 11 to 37 per 100,000 people, it may be higher in some regions and in terms of gender, it is distributed predominantly in the male sex, reporting a male-female ratio of 2:1 to 12:1 (2-5).

The management of an Achilles tendon rupture remains controversial, as the risks and benefits of conservative management *versus* surgical management continue to be debated, which will depend on the surgeon and patient preference, with the goal of restoring a tension relationship: normal length, optimizing strength and function (1). Patients who demand some sport or demanding work could opt for surgical repair where one of the advantages over conservative management is the lower risk of re-rupture. The prognosis is really satisfactory, with patients able to resume activities after approximately six months (6, 7).

Regarding conservative management, it is mainly directed at older adult patients who cannot participate in early mobilization or accelerated functional rehabilitation, non-athlete patients and patients related to degenerative diseases. This group may choose to be treated with splints facing the tendon ends to promote healing, which is done for 6 to 8 weeks using a short leg cast. However, these patients managed without surgery should be informed of the high risk of tendon re-rupture (3, 8, 9).

Re-ruptures of the Achilles tendon are a challenging problem, as they generally appear four to six weeks after treatment, with retraction and degeneration of the tendon occurring and the space between the ruptured ends eventually filling with fibrotic scar tissue (10-12). This complication is related to inadequate intraoperative management of acute injuries. The existence of previous scars makes the approach and primary closure difficult, especially in cases of complex and bulky reconstructions that cause excessive tension on the skin, increasing the risk of dehiscence (13).

In terms of incidence, they have become more common as the frequency of acute Achilles tendon injuries has increased, and they are associated with considerable functional morbidity. Compared with acute injuries, re-ruptures are associated with a higher rate of postoperative infection and longer recovery, which will result in impaired Achilles tendon function and a marked degree of disability (11, 14, 15).

When a patient has a re-rupture, the pain and swelling have often subsided, and active, albeit weak, plantarflexion may be possible by action of the tibialis posterior, flexor hallucis longus, and flexor hallucis longus muscles. toes and peroneal. These residual functions can make it difficult to confirm the correct diagnosis by clinical examination alone. A high index of suspicion is required, and a series of tests and special investigations can help establish the exact diagnosis (14).

Most surgeons opt for augmentation techniques to prevent further ruptures: gastrocnemius aponeurosis free flap, semitendinosus free graft, tendon transfers and, finally, allografts where end-to-end repair is possible if the gap is < 2.5 cm (8, 11). In the same way, studies recommend that in Achilles tendon re-ruptures between 6 and 8 cm, the V-Y descent tendon plasty, and the massive tendon-bone graft in larger ones, are good alternatives. of treatment, achieving an adequate reconstruction, which allows early rehabilitation and recovery with satisfactory functional results (13).

The rest of the complications vary according to different factors such as the severity of the injury, the age and comorbidities of the patient, but mainly due to the treatment used. In addition to the high incidence of re-rupture with conservative management, it is important to mention the possibility of muscle atrophy, loss of ankle mobility, deep vein thrombosis, and chronic disability. Likewise, there are around 15.1% of complications, of which wound dehiscence, tendon exposure, surgical site infection and sural neuromas are associated with surgical management (3, 8, 9).

Finally, this systematic review and meta-analysis tries to determine if surgical management is more effective than conservative management in reducing the incidence of re-rupture in adult patients with Achilles tendon rupture. Likewise, to evaluate the functional result in the short and long term through the use of scores in adult patients with Achilles tendon rupture undergoing surgical management and conservative management; to identify the presence of chronic pain and compare the presence of adverse events (pulmonary embolism and deep vein thrombosis) in adult patients with Achilles tendon rupture undergoing surgical management and conservative management.

MATERIALS AND METHODS

A systematic review study was carried out based on previous studies that evaluated the efficacy of surgical management *versus* conservative management, evaluating the incidence of re-rupture in adult patients with Achilles tendon rupture. The efficacy of both treatments was evaluated through randomized clinical trials and relative risks based on: Achilles tendon re-rupture, functional outcome, chronic pain, and adverse effects (pulmonary embolism, deep vein thrombosis).

Inclusion criteria

All those studies of the type randomized clinical trials were included, where all those articles that included patients with Achilles tendon rupture, the intervention group to surgical management and the comparison group to conservative management were considered as population. Primary outcomes to Achilles tendon re-rupture were considered, while secondary outcomes to short- and long-term functional outcome through different SCORES, chronic pain, and adverse effects (pulmonary embolism, deep vein thrombosis).

Exclusion criteria

Observational, cross-sectional, descriptive and case report studies, studies in the pediatric population, studies that have not been completed or whose results have not been published.

Search method

An electronic search for related articles was performed, which were obtained from medical literature databases such as PubMed/Medline, Web of Science, Cochrane Library, Embase, Scopus, and Ovid/Medline. The search strategy included keywords ("Conservative" OR "Not surgical") AND ("Surgical Treatment" OR "Conventional Open Surgery") AND ("Acute Achilles' Tendon Rupture" OR "Achilles Tendon re rupture") AND ("Randomized Clinical Trial") AND ("Adult patients").

Procedure

The selected articles were stored in the Rayyan software to form a database and the citation of the bibliographic references. The next step was carried out among the members of the team, which consisted in making a comparison of the results, in case of finding differences, an additional author will intervene to discuss and reach an agreement. Using the Microsoft Excel 2021 software, the data that was related to the studies was recorded depending on the intervening variables. The systematic review was reported following the PRISMA 2020 recommendations.

Assessment of heterogeneity

Heterogeneity between each study was ascertained using the I^2 statistic, where values between 0-30% will be considered as low heterogeneity, 30-60% as moderate heterogeneity and values > 60% as high or significant heterogeneity.

Data extraction and management

For this step, a form created in the Cochrane Collaboration Revman 5.4.1 software was used. Data were extracted individually from studies that met the inclusion criteria.

Measures of effect

For dichotomous data, the relative risks with their respective confidence intervals were calculated. Continuous data were analyzed considering their arithmetic mean and standard deviation. A fixed effects model using the Mantel-Haenzel method was considered for analysis. The effect of the intervention is also presented by mean differences (MD), Odds ratios (OR), relative risk (RR) and/or Hazard Ratios (HR). These three components will have a 95% confidence interval.

Data synthesis

It was carried out by random effects, detecting the heterogeneity of the studies through the Chi^2 test and the I^2 statistic, likewise the variability between the studies will be evaluated with the Tau2 test. When outcomes are reported in median and interquartile range (IQR), these units will be converted to mean and standard deviation (SD) for data analysis capability. For which, the following formula was used: $x = (a + 2m + b)/4$, using the median values as the "m" value, and the P25 and P75 as "a" and "b" respectively.

RESULTS

Article selection

A total of 2,452 articles were identified in the following databases: PubMed, Web of Science, Scopus, Cochrane, Ovid Medline, and Embase, which were stored in the Rayyan tool. 315 duplicate articles were eliminated during the identification phase. After the elimination of duplicates, 2,137 articles were examined individually by two members of the team, then conflicts were resolved and an agreement was reached between the three members of the group, leaving a total of 28 articles to be analyzed in full text, of which 4 items failed to be recovered. Of the rest, 14 articles were excluded due to type of erroneous design, lack of results, erroneous variable or erroneous main outcome, leaving 10 randomized clinical trial type articles, from which relevant data and results could be extracted, so that this project can be carried out (**figure 1**).

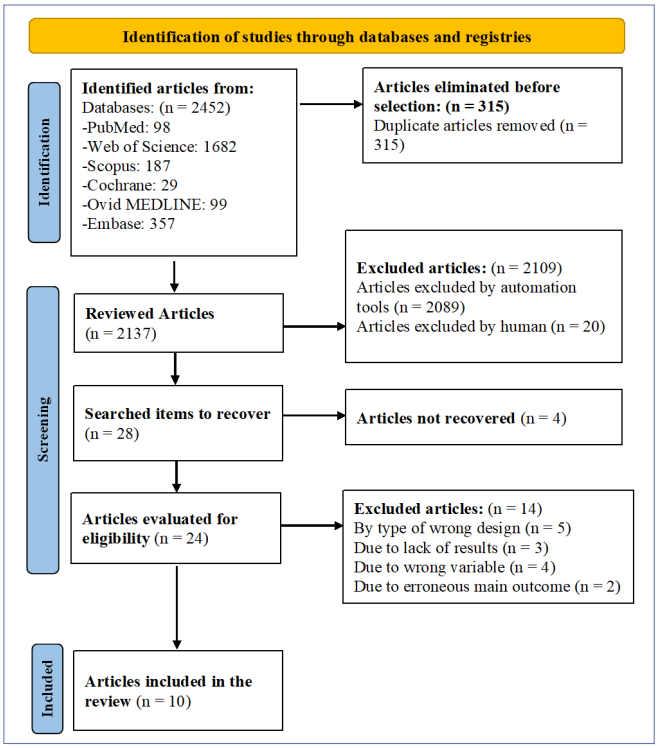

Figure 1. PRISMA 2020 flow diagram.

Characteristics of the included articles

Data was extracted and stored in a qualitative and a quantitative table. The qualitative table was prepared taking into account the author, country where the study was conducted, year of publication of the study, total number of patients included, mean age, distribution by sex, and number of patients undergoing each type of management. Likewise, a quantitative table was made including data such as the number of patients who presented re-rupture for each type of management, frequencies in each of the groups according to scores in relation to the short and long-term functional result, number of patients who presented chronic pain and number of patients who presented adverse effects (pulmonary embolism and deep vein thrombosis) (**tables I-VII**).

Table I. Characteristics of the included studies, baseline characteristics of the included population.

	Author	Country	Year	Sample	Sex		Mean age	Number of patients under CM	Number of patients under SM
					M	F			
1	Stale	UK	2022	526	135	391	39.6	178	348
2	Maempel	UK	2020	64	-	-	57.6	31	33
3	Fischer	Germany	2020	90	9	81	41.3	30	60
4	Manent	Spain	2019	34	3	31	41.2	11	23
5	Koslol	Austria	2022	18	18	0	52.2	9	9
6	Mihailo	Serbian	2020	80	25	55	44.2	30	50
7	Olsson	Sweden	2013	100	14	86	39.7	51	49
8	Willits	Canada	2010	144	26	118	40.4	72	72
9	Metz	Netherlands	2008	83	17	66	40.5	41	42
10	Miller	UK	2005	172	34	138	45.2	32	140

*CM: Conservative management; SM: Surgical management.

Table II. Re-rupture.

	Author	Year	CM		SM	
			Events	Total	Events	Total
1	Stale *et al.*	2022	11	178	2	348
2	Maempel *et al.*	2020	4	31	2	33
3	Fischer *et al.*	2020	2	30	2	60
6	Mihailo *et al.*	2020	1	30	1	50
7	Olsson *et al.*	2013	5	51	1	49
8	Willits *et al.*	2010	1	72	2	72
9	Metz *et al.*	2008	5	41	3	42
10	Miller *et al.*	2005	3	32	6	140

CM: Conservative management; SM: Surgical management.

Table III. Short-term functional result.

		ATRS					
		CM			SM		
	Author	Mean	SD	Total	Mean	DS	Total
2	Maempel	95	5.46	31	94	4.03	33
4	Manent	80	8.64	11	65	5.78	23
5	Koslol	78.7	8.60	9	88.2	4.79	9
6	Mihailo	87.5	1.72	30	89.1	6.58	50
7	Olsson	73	19	51	75	23	49

AFAOS							
	Author	CM			SM		
		Mean	SD	Total	Mean	SD	Total
4	Manent	78	8.67	11	85	11.53	23
6	Mihailo	83.6	3.60	30	90.2	2.45	50
7	Olsson	70	19	51	70	24	49
LEPPILAHTI Score							
	Author	CM			SM		
		Mean	SD	Total	Mean	SD	Total
8	Willits	76.3	9.12	72	78.5	6.29	72
SF 36							
	Author	CM			SM		
		Mean	SD	Total	Mean	SD	Total
2	Maempel	97.1	1.60	31	96.6	0.84	33

CM: Conservative management; SM: Surgical management; SD: Standard Deviation; ATRS: Achilles tendon total rupture score; AFAOS: American Orthopedics foot and ankle score; SF-36: 36 item short form survey.

Table IV. Long-term functional result.

ATRS							
	Author	CM			SM		
		Mean	SD	Total	Mean	SD	Total
4	Manent	100	11.51	11	77.5	14.42	23
7	Olsson	90	23	51	89	20	49
AFAOS							
	Author	CM			SM		
		Mean	SD	Total	Mean	SD	Total
3	Fischer	94.9	2.82	30	96.7	2.81	60
4	Manent	100	8.62	11	92	12.96	23
7	Olsson	90	21	51	90	20	49
LEPPILAHTI							
	Author	CM			SM		
		Mean	SD	Total	Mean	SD	Total
8	Willits	82.2	7.10	72	82.6	6.41	72
SF 36							
	Author	CM			SM		
		Mean	SD	Total	Mean	SD	Total
2	Maempel	99.3	1.02	31	100	0.35	33

CM: Conservative management; SM: Surgical management; SD: Standard Deviation; ATRS: Achilles tendon total rupture score; AFAOS: American Orthopedics foot and ankle score; SF-36: 36 item short form survey.

Table V. Adverse event: chronic pain.

	Author	Year	CM		SM	
			Events	Total	Total	Events
1	Stale *et al.*	2022	1	178	9	348
2	Maempel *et al.*	2020	10	31	16	33
3	Fischer *et al.*	2020	3	30	0	60
4	Manent *et al.*	2019	1	11	2	23
6	Mihailo *et al.*	2020	4	30	5	50
7	Olsson *et al.*	2013	2	51	13	49
8	Willits *et al.*	2010	1	72	0	72
9	Metz *et al.*	2008	0	41	1	42
10	Miller *et al.*	2005	1	32	14	140

CM: Conservative management; SM: Surgical management.

Table VI. Adverse event: pulmonary embolism.

	Author	Year	CM		SM	
			Events	Total	Events	Total
1	Stale *et al.*	2022	0	178	2	348
8	Willits *et al.*	2010	0	72	1	72

CM: Conservative management; SM: Surgical management.

Table VII. Adverse event: deep vein thrombosis.

	Author	Year	MC		MQ	
			Events	Total	Events	Total
1	Stale *et al.*	2022	1	178	3	348
2	Maempel *et al.*	2020	2	31	0	33
3	Fischer *et al.*	2020	0	30	1	60
8	Willits *et al.*	2010	1	72	1	72
9	Metz *et al.*	2008	1	41	0	42

CM: Conservative management; SM: Surgical management.

Risk of bias of included articles

Overall bias for randomized clinical trial studies was graded as low risk of bias. Individually, seven studies were categorized as low risk, two within some concerns category, and one within the high-risk category, specifically in the domain of randomization process (**figure 2**).

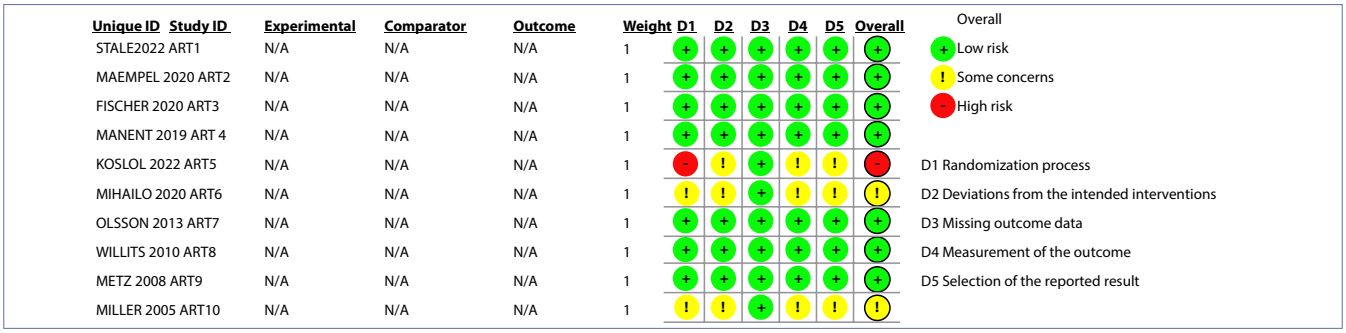

Figure 2. Study bias from clinical trials included in the study

Statistical fragility

A systematic review of comparative studies on Achilles tendon rupture management found that the average number of outcome reversals needed to alter the significance of a given study was 2.90, indicating potential fragility in the statistical stability of studies comparing operative *versus* nonoperative management for Achilles tendon rupture. So, we evaluate additionally the sample size and enrollment, the baseline characteristics, the primary and secondary outcomes, sensitivity analyses, safety and time frame. The Fragility Index (FI) and Fragility Quotient (FQ) were calculated for various studies, revealing insights into the robustness of their findings. Stale *et al.* demonstrated a robust result with an FI of 10, indicating that a substantial number of events would need to change for the results to lose statistical significance. Maempel *et al.* (29) showed moderate robustness with an FI of 3 and an FQ of 75%, suggesting a moderate margin of safety. Fischer *et al.* (30) exhibited low robustness (FI: 0.33, FQ: 1.39%), indicating sensitivity to a small number of events. Manent *et al.* had a somewhat robust result (FI: 1.33, FQ: 11.95%), vulnerable to a moderate number of changes (18). Koslol *et al.* had no robustness (FI: 0, FQ: 0%), indicating high sensitivity to observed events. Mihailo *et al.* displayed moderate robustness (FI: 2, FQ: 4%), with a reasonable margin of safety. Olsson *et al.* (33) and Willits *et al.* (34) both demonstrated moderate robustness, with FIs of 3 and 2.5, and FQs of 6% and 3.47%, respectively. Metz *et al.* (35) showed moderately robust findings (FI: 4, FQ: 9.64%), suggesting a reasonable margin of safety. Miller *et al.* (36) displayed moderate robustness (FI: 1, FQ: 3.95%). These indices provide valuable insights for assessing the reliability of study outcomes, considering the impact of potential changes in observed events on the statistical significance of the results (**table VIII**).

Table VIII. Certainty of the evidence (GRADE).

Surgical Management Compared to Conservative Management in Achilles Tendon Rupture					
Outcomes	**Number of participants (studies)**	**Certainty of the evidence (GRADE)**	**Relative effect (95%CI)**	**Anticipated Absolute Effects**	
				Risk with CM	The risk difference with SM
Re-rupture	1259 (8 ECAs)	⊕⊕⊕⊕ High[b,c]	RR 0.35 (0.20 a 0.62)	69 per 1,000	45 less per 1,000 (55 less to 26 less)
Short-term functional result	718 (6 ECAs)	⊕◯◯◯ Very low[d,e]	-	The mean short-term functional outcome was 0	0 (0 to 0)
Long-term functional outcome	566 (5 ECAs)	⊕◯◯◯ Very low[b,c,d]	-	The mean long-term functional outcome was 0	0 (0 to 0)
Chronic pain	1293 (9 RCTs)	⊕⊕⊕⊕ High[b,c]	RR 1.68 (1.09 to 2.59)	48 per 1,000	33 more per 1,000 (4 more to 77 more)
Pulmonary Embolism	670 (2 RCTs)	⊕⊕⊕⊕ High[e,f]	RR 2.75 (0.31 to 24.75)	0 per 1,000	0 less per 1,000 (0 less to 0 less)
Deep venous thrombosis	907 (5 RCTs)	⊕⊕⊕⊕ High[a,e]	RR 0.71 (0.23 to 2.23)	14 per 1,000	4 less per 1,000 (11 less to 17 more)

Patient or population: Achilles tendon rupture. **Setting: intervention:** Surgical management. **Comparison:** Conservative management.

GRADE Working Group grades of evidence: High certainty: We are very confident that the true effect is close to that of the estimate of effect. Moderate certainty: We are moderately confident in the effect estimate: the true effect is likely to be close to the effect estimate, but there is a possibility that it is substantially different. Low certainty: Our confidence in the effect estimate is limited: the actual effect may be substantially different from the effect estimate. Very low certainty: We have very little confidence in the estimate of effect. The actual effect is likely to be substantially different from the estimate of effect.

The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% confidence interval). CI: confidence interval; RR: Risk ratio. to: Homogeneity ($I^2 = 0\%$; < 40%); [a,e]Wide confidence interval and the possibility of the point estimate crossing; [b]Significant sample size (n = 126); [c]Result of the significant statistical test (Test for overall effect $p < 0.10$); [d]Statistical heterogeneity between studies ($I^2 > 40\%$) and result of the statistical test not significant (Test for overall effect ($p > 0.10$); [f]Wide confidence interval.

Primary outcome

Incidence of Achilles tendon re-rupture

This is the main result of the study, where eight studies presented data available to develop the meta-analysis. The results of the total synthesis of the eight studies show an RR of 0.35 with a 95%CI of 0.20-0.62, that is, that the patients who underwent CM had a 65% lower incidence of re-rupture than those who underwent MC; therefore, the results are in favor of the intervention. In addition, they presented a low I^2 heterogeneity of 0% (**figure 3**).

Secondary results

Short-term functional outcome

Four scales were used to measure this outcome, the ATRS, AFAOS, LEPPILAHTI, and SF36 scales. Based on the mean and the standard deviation obtained from the data, a mean difference (MD) of 1.22 was obtained with a 95% CI of -1.62 to 4.05, that is, when comparing the results of the four scales, no found some significant difference, as well as a high I^2 heterogeneity of 93%. The first subgroup included five studies that measured short-term functional outcome using the ATRS scale, the results were an MD of -0.72 with 95%CI of -5.99 to 4.54 and I^2 heterogeneity of 90%. The second subgroup included three studies using the AFAOS scale, the results were an MD of 6.19 with a 95%CI of 3.90-8.48 and an I^2 heterogeneity of 12%. The third subgroup included a study using the LEPPILAHTI scale, the results were an MD of 2.20 with a 95% CI of -0.36 to 4.76. Finally, the fourth subgroup included a study using the SF36 scale, where the results were an MD of -0.50 with a 95%CI of -1.13 to 0.13 (**figure 4**).

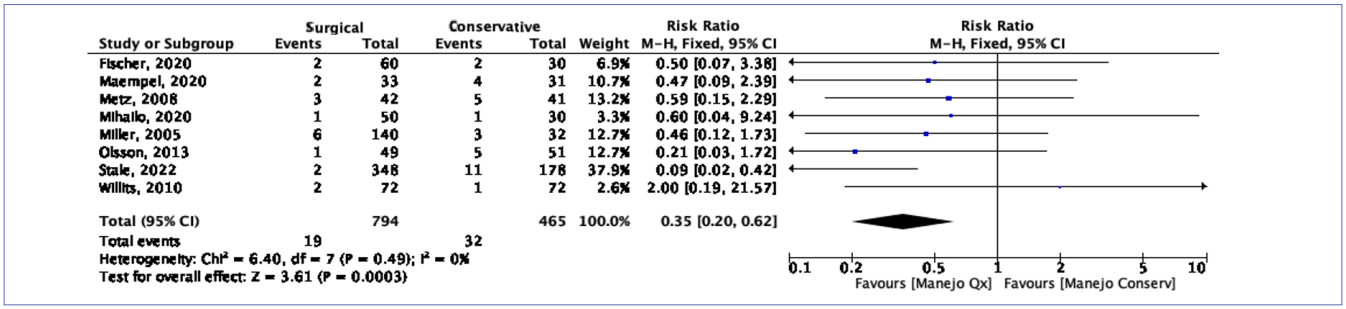

Figure 3. Forest plot re-rupture.

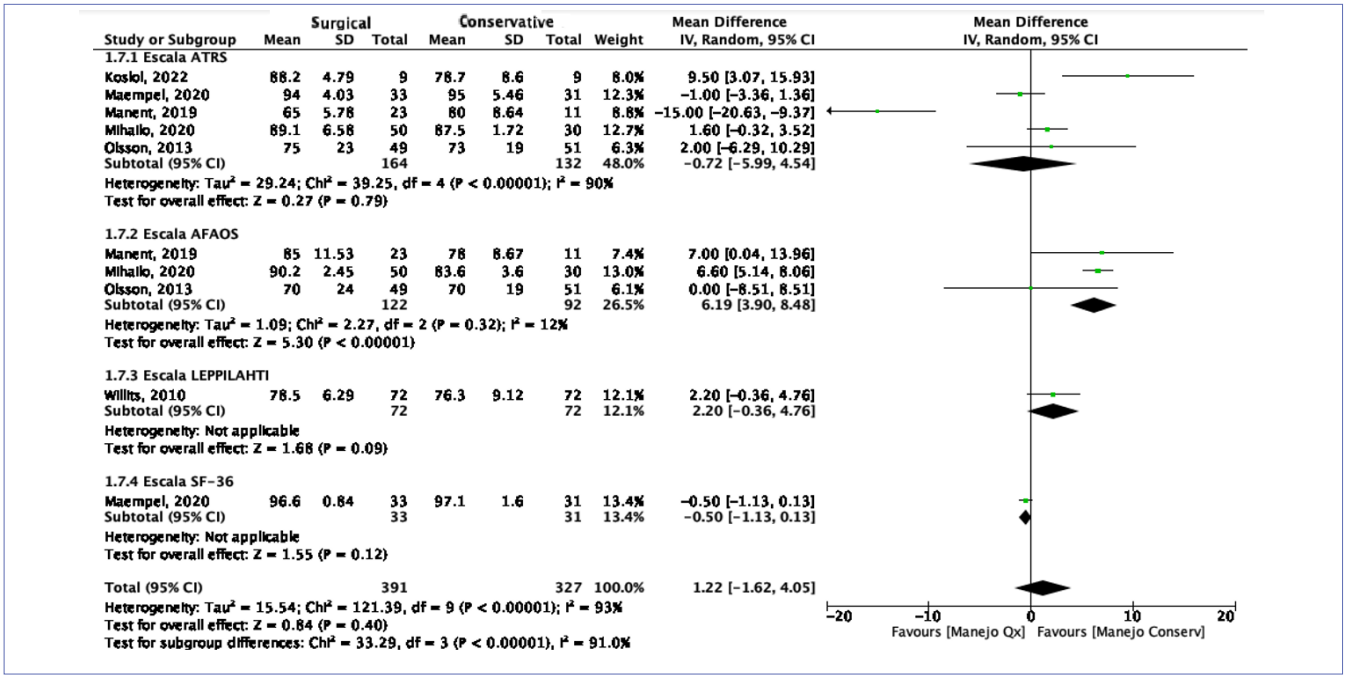

Figure 4. Forest plot short-term functional outcome.

Long-term functional outcome

The total synthesis of the studies gave us a mean difference of 0.72 with a 95%CI of 0.37-1.08, that is, the mean long-term functional outcome in patients undergoing MQ was 0.72 standard deviations more compared to the group of patients who underwent CM. In addition, they resulted in a high I2 heterogeneity of 82%. The first subgroup included three studies that measured long-term functional outcome using the ATRS scale, the results were an MD of -11.06 with 95%CI of -17.21 to 4.90 and I^2 heterogeneity of 91%. The second subgroup included three studies using the AFAOS scale, the results were an MD of 1.50 with a 95%CI of 0.29-2.70 and an I^2 heterogeneity of 71%. The third subgroup included a study using the LEPPILAHTI scale, the results were an MD of 0.40 with a 95%CI of -1.81 to 2.61. And the fourth subgroup included a study using the SF36 scale, where the results were an MD of 0.70 with a 95%CI of 0.32-1.08 (**figure 5**).

Presence of chronic pain

Nine studies were included for this variable, where the results of the total synthesis of the studies show an RR of 1.68 with a 95%CI of 1.09-2.59, that is, the probability of presenting chronic pain in the group subjected to MQ is 68% higher than that of the group subjected to CM, the results being in favor of the control. In addition, it presents a low I^2 heterogeneity of 36% (**figure 6**).

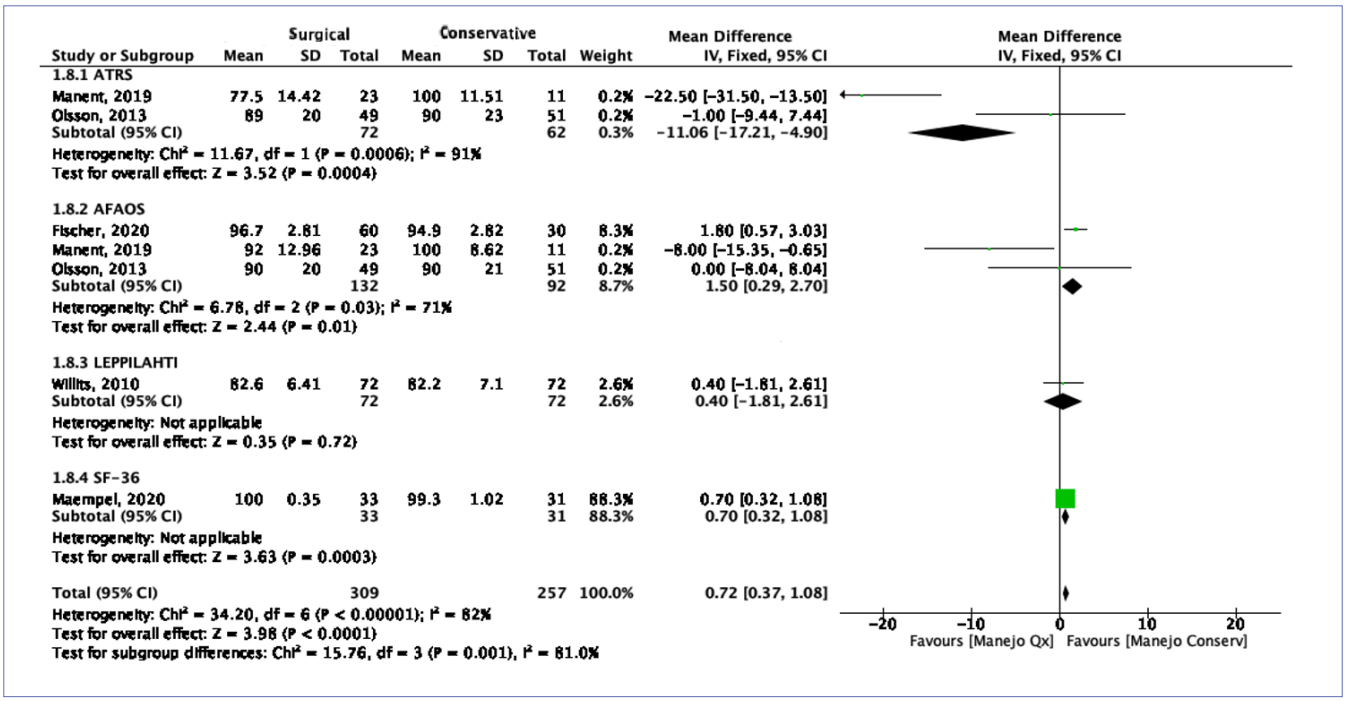

Figure 5. Forest plot long-term functional outcome.

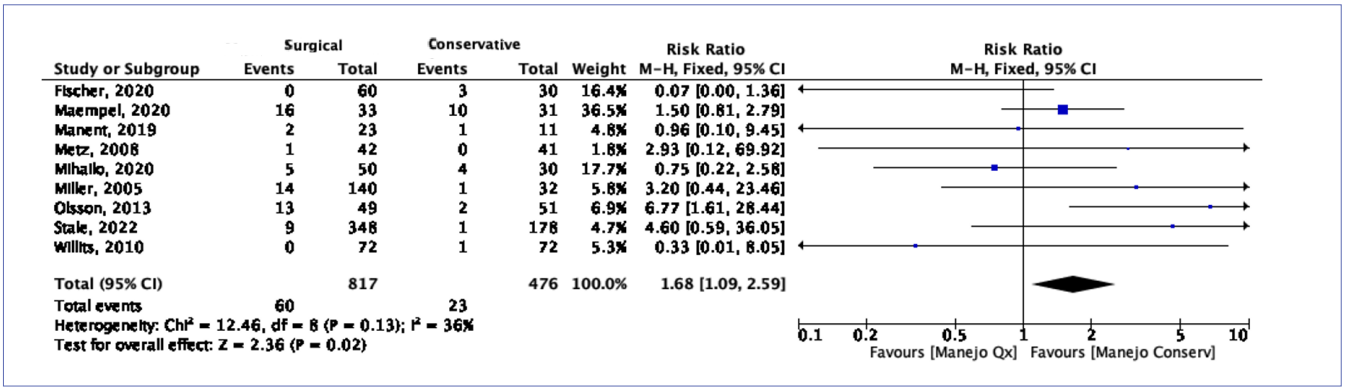

Figure 6. Forest plot chronic pain.

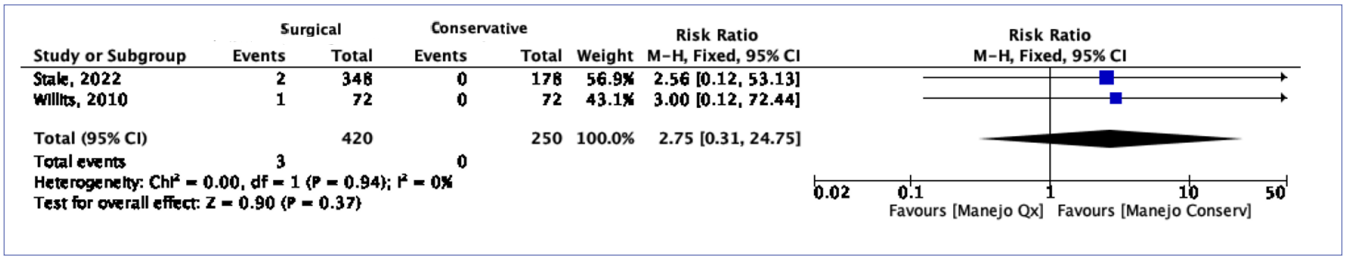

Figure 7. Forest plot pulmonary embolism.

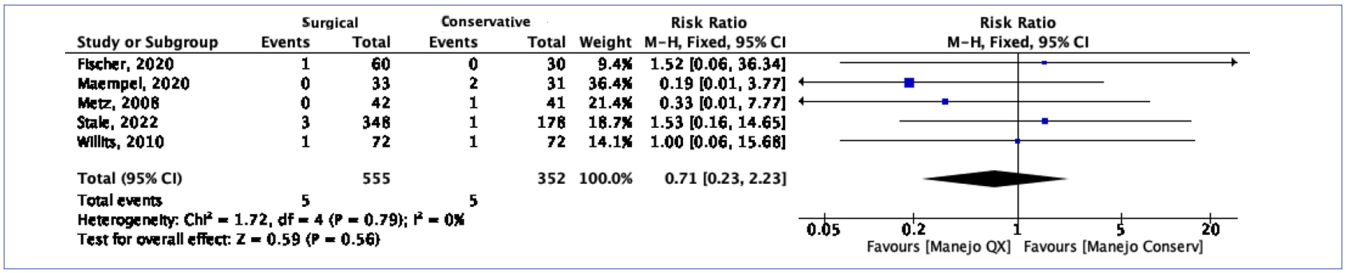

Figure 8. Forest plot deep vein thrombosis.

Presence of adverse effects

Pulmonary embolism

Two studies were included for this variable, where the results of the total synthesis of articles show an RR of 2.75 with a 95%CI of 0.3124.75, non-statistically significant results, in addition to a low I^2 heterogeneity of 0% (**figure 7**).

Deep vein thrombosis

Five studies were included for this variable, where the results of the total synthesis of articles show an RR of 0.71 with a 95%CI of 0.23-2.23, non-statistically significant results, in addition to a low I^2 heterogeneity of 0% (**figure 8**).

DISCUSSION

Acute Achilles tendon ruptures can be treated with surgical management or conservative management. However, the optimal intervention for acute Achilles tendon rupture remains controversial.

The following systematic review, as well as the following meta-analyses, compared the effectiveness of conservative management (MC) *versus* surgical management (MQ) in the incidence of Achilles tendon re-rupture, in addition to other important variables such as short- and long-term functional outcome term according to the use of scores, presence of chronic pain and presence of adverse effects such as pulmonary embolism and deep vein thrombosis.

The main result was the incidence of re-rupture of the Achilles tendon, where eight RCTs were included that when comparing MC with MQ, the result was favorable for MQ with a 65% lower incidence of re-rupture than those subjected to MC; therefore, the results are in favor of the intervention. (RR 0.35; 95%CI 0.20-0.62). A similar result was obtained in the meta-analysis by Ochen *et al.*, where a 57% lower recurrence rate was reported in MQ compared to MC (RR 0.43; 95%CI 0.31-0.60; I^2: 22%) (37). Likewise, we found another study by Deng *et al.*, where they included eight RCTs involving 762 patients in the meta-analysis. Overall, a new rupture occurred in 14 of 381 patients who underwent CM (3.7%) and in 37 of 377 patients who underwent MC (9.8%). The combined results showed that the total rate of re-rupture was significantly lower in the MQ than in the MC (RR 0.38; 95%CI 0.21-0.68) (38).

Another way to evaluate the efficacy is by measuring the functional result of the patient through different types of scores with high reliability, validity and sensitivity, it is an essential index to determine the best treatment. In this meta-analysis we decided to assess the short-term and long-term functional outcome. Regarding the short-term evaluation, no significant difference was reported between the groups (MD: 1.22; 95%CI -1.62 to 4.05). However, regarding the evaluation of long-term functionality, our analysis showed an MD of 0.72 (95% CI 0.37-1.08), that is, that the mean long-term functional result in patients undergoing MQ was 0.72 deviations. more standard compared to the group of patients undergoing CM. It can be compared with the results obtained from the meta-analysis by Soroceanu *et al.*, which used four studies that reported functional results, expressed with the use of different scores (Musculoskeletal Functional Assessment Instrument (MFAI), Lower Leg and Ankle Functional Index (FIL), Leppilahti and modified Leppilahti) in each study. Fixed effect analysis showed that

the standardized mean difference did not differ significantly between the two groups (39). Another study that supports our results is that of She *et al*., where they also found no significant difference between the MQ and MC regarding the ATRS assessment (3 studies, 207 participants, RR 4.27; 95%CI -0.24 to -8.77) (40). However, the aforementioned studies do not evaluate in the short and long term, so they use a different range of recovery time when applying the scores, and this could lead to a possible bias since it does not allow a correct standardization of the variable.

Within the multiple complications observed in both procedures, it was decided to include the chronic pain variable, since it was present in nine of the ten included studies; our meta-analysis concluded that the probability of presenting chronic pain in the group undergoing CM is 68% more than that of the group undergoing CM, the results being in favor of control (RR 1.68; 95%CI 1.09-2.59). However, again the study by Ochen *et al*., concludes that the incidence of complications was 4.9% after MC compared to 1.6% after MC (risk difference of 3.3%), specifically 3 individuals out of 469 (0.03%) in the MQ group and 2 individuals out of 475 (0.02%) in the MC group (29). The aforementioned study is an example of the various meta-analyses found where the pain variable is found within the set of complications; however, it is not evaluated separately; more studies would be needed to evaluate the variable independently from the rest of the complications to get a more reliable conclusion.

For the pulmonary embolism variable, two studies were included, where the results of the total synthesis of articles show non-statistically significant results (RR 2.75; 95%CI 0.31-24.75). Unfortunately, the data found in various studies did not allow us to differentiate between pulmonary embolism and other complications.

Five studies were included to evaluate the incidence of deep vein thrombosis (DVT); however, we did not find statistically significant results (RR:0.71 95%CI 0.23-2.23). According to the results of Keating *et al*., DVT, as confirmed by Doppler ultrasound, did not occur in any of the 39 patients in the MQ, however, they reported a higher incidence of DVT in the MC group, presenting this complication in 2 patients of 41 (5%); despite this, it was not statistically significant (41). On the other hand, in the study by Nilsson-Helander *et al*., in which an evaluation of all patients in both management groups is also carried out through Doppler ultrasound, shows that it is a common complication in both managements, since it appeared in 34% of cases after Achilles tendon rupture (34). In addition, this study adds the use of a routine thrombus prophylaxis protocol. This is important to highlight, since most of the analyzed studies are ambiguous when describing complications other than re-ruptures: they do not usually specify the use or not of thrombus prophylaxis. Finally, this shows us that DVT is a frequent complication in this pathology, so we must pay adequate attention to it.

One of the limitations to be highlighted is the high heterogeneity obtained in the functional outcome variable (42), which could be explained by the difference in the number of patients included in each group in the different articles; therefore, these results should be taken with caution.

Likewise, more research is required on the treatment of Achilles tendon rupture. For example, more RCTs are needed to compare percutaneous repair with MC to determine the difference in complications between the two management modalities, since, in some studies found, some groups of CM underwent open surgery and others percutaneous surgery. , generating a possible risk of bias.

Finally, since not all complications are major, some patients and surgeons may find the increased rate of other complications after MQ an acceptable trade-off for the reduced rate of re-rupture. This information should be part of the informed consent discussion when CM is being considered, likewise, another area for future research would be the study of criteria that allow physicians to select patients who would be suitable for MC.

CONCLUSIONS

Surgical management is more effective in reducing the incidence of Achilles tendon re-rupture than conservative management. Surgical management presents a lower long-term functional result than conservative management. Surgical management reveals a greater probability of presenting chronic pain than conservative management.

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DATA AVAILABILITY

All the data used in this research are available at the referenced sources.

CONTRIBUTIONS

GC-F, CA-J: conceptualization, formal analysis, research, methodology, resources, software, validation, visualization, writing – original draft. ZC-C: methodology, validation, conceptualization, final redaction, writing – original draft, writing – review & editing.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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