Meta-Analysis

Clinical Outcome of Hamstring Autograft for Chronic Patellar Tendon Injury Reconstruction: A Meta-Analysis

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ABSTRACT

Introduction: Chronic patellar tendon injury is one of the most common overuse pathologies encountered in sports. In cases of chronic rupture, reconstruction using grafts becomes a necessary option to restore proper tendon length and restore knee function. Among the various graft options, hamstring autografts (hamstring tendon grafts) have emerged as a promising option for chronic patellar tendon reconstruction. This review aims to evaluate clinical outcome of hamstring autograft for chronic patellar tendon injury reconstruction.

Method: A systematic review - meta-analysis was conducted following the PRISMA guidelines. Relevant articles published from 2010-2025 were identified from PubMed, Google Scholar, and Cochrane. Pooled analysis of mean difference and 95% CI were initially conducted, followed by an evaluation of overall heterogeneity using Chi-Square and I^2 test.

Result: Four studies were included (65 patients with chronic patellar tendon injury). Meta-analysis showed the patellar tendon reconstruction using hamstring autograft was associated with significant improvements, by improving knee flexion (MD = –8.85^O, 95% CI = (–12.09) - (–5.61)), extension lag (MD = 17.03º, 95% CI = 16.61 - 17.46), and Insall-Salvati Index (MD = 0.31, 95% CI= 0.22 - 0.39).

Conclusion: Reconstruction of chronic patellar tendon injury using hamstring autografts provides significant improvements in clinical outcomes.

Keywords: Hamstring autograft, reconstruction, chronic patellar tendon injury

INTRODUCTION

Chronic patellar tendon injury is one of the most common overuse pathologies encountered in sports, particularly those involving jumping and repetitive changes in direction. The condition begins as tendinopathy, a degenerative condition characterized by microscopic tears and structural changes in the tendon due to excessive mechanical loading, and can gradually progress to significant pain and disability. Patellar tendinopathy has a high prevalence in athletes, making it the second most common knee injury after medial collateral ligament injuries.[1] The prevalence of this injury has been reported to be over 20% in basketball players and 12% showed signs of patellar tendinopathy upon ultrasonography.[2]

Systematic reviews have identified several risk factors, although the evidence is limited. Identified risk factors include body

weight, body mass index (BMI), thigh muscle flexibility (both quadriceps and hamstrings), and quadriceps muscle strength. In addition, gender also plays a role, with men being more likely to develop patellar tendinopathy than women, and age over 30 years may increase the risk due to structural changes in the tendon.[3] In severe cases, prolonged tendinopathy can lead to patellar tendon rupture, a rare but highly disabling injury that impairs the knee's extensor mechanism.[4] The knee's ability to straighten and flex depends heavily on the integrity of the patellar tendon, making it a crucial component of daily mobility and athletic performance.[5]

The management of chronic patellar tendon injuries involves a spectrum of approaches, ranging from conservative to surgical interventions. When tendinopathy leads to tendon rupture, surgical intervention is almost always indicated to restore the integrity of the knee extensor mechanism.[4] Early surgical repair yields better outcomes than delayed treatment, which requires more complex reconstructive procedures. In cases of chronic rupture, where there is tissue retraction and poor tendon quality, primary repair (direct suturing of the tendon ends) is often inadequate.[5] In these situations, reconstruction using grafts becomes a necessary option to restore proper tendon length and restore knee function.[6]

Various types of grafts can be used, including autografts (taken from the patient's own body), allografts (taken from a donor), or synthetic materials. Various surgical techniques have been developed, with the use of autologous grafts being one of the most common methods. Autologous grafts, derived from the patient's own tissue, offer the advantages of a minimal risk of immune rejection and the potential for better integration with surrounding tissue. Among the various graft options, hamstring autografts (hamstring tendon grafts) have emerged as a promising option for chronic patellar tendon reconstruction.[5] By synthesizing the latest evidence, this study aims to evaluate clinical outcome of hamstring autograft for chronic patellar tendon injury reconstruction.

METHOD
Article Review Process
The review process has been systematically carried out based on Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) protocol. The process consists of several steps, namely 1) determining the inclusion and exclusion criteria, 2) the literature search process, 3) screening and selection of literature results, 4) assessment of literature quality, 5) data extraction, 6) quantitative analysis.

Search strategy
Articles were identified from databases including PubMed, Google Scholar, and Cochrane. Researchers used a combination of keywords from Boolean operators, namely ("hamstring autograft" AND "chronic" AND "patella injury" OR "tendinopathy" AND "reconstruction" NOT "ACL").

Inclusion and exclusion criteria
The inclusion criteria for articles reviewed by researchers include: (1) English journals; (2) Published in 2010-2025 (3) Open-access. The exclusion criteria used by researchers include: (1) the topic of the article is not relevant to the study objectives; (2) The article is not a full text; (3) The article is the result of proceedings or conferences. Article eligibility checks were carried out based on the established PICO criteria (Table 1).

Table 1. PICO criteria

Population	Chronic Patella Tendon Injury
Intervention	Reconstruction using hamstring autograft
Comparison	Pre-operative condition
Outcome	Knee flexion, extension lag, Insall-Salvati index

Quality and risk of bias assessment

To ensure the quality of selected article, we conducted risk of bias assessment using ROBINS-1, a revised tool for the quality assessment of non-randomized study. This tool explicitly assesses the risk of bias associated with patient selection, index test, reference standard, and flow and timing. Overall, where studies had one or more domains in which there were some concerns or high concerns about the risk of bias, these studies were categorized as at high risk of bias. Differences were resolved by consensus.

Data collection

The final stage of this study was data extraction. The extracted data included the author's name and year of publication, the number and characteristics of participants, the type of intervention and its comparator, and the measurement of outcomes in both groups. Data were collected manually from selected articles, arranged in tables, then qualitative synthesis was carried out.

Statistical Analysis

All qualified article will undergo statistical analysis performed using Revman 5.4. Pooled analysis was reported using forest plots. Mean Difference (MD) and 95% Confidence Intervals (95% CI) were measured in the same way between trials. We tested for heterogeneity among included studies by the Chi-Square tests and quantified its extent by the I-Square test

RESULT

Characteristic of Included Study

In total, 580 records were identified in the initial database search (Google Scholar, PubMed, and the Cochrane Library). After primary screening, 48 articles were assessed, and 4 studies were ultimately included in this review (**Figure 1**).
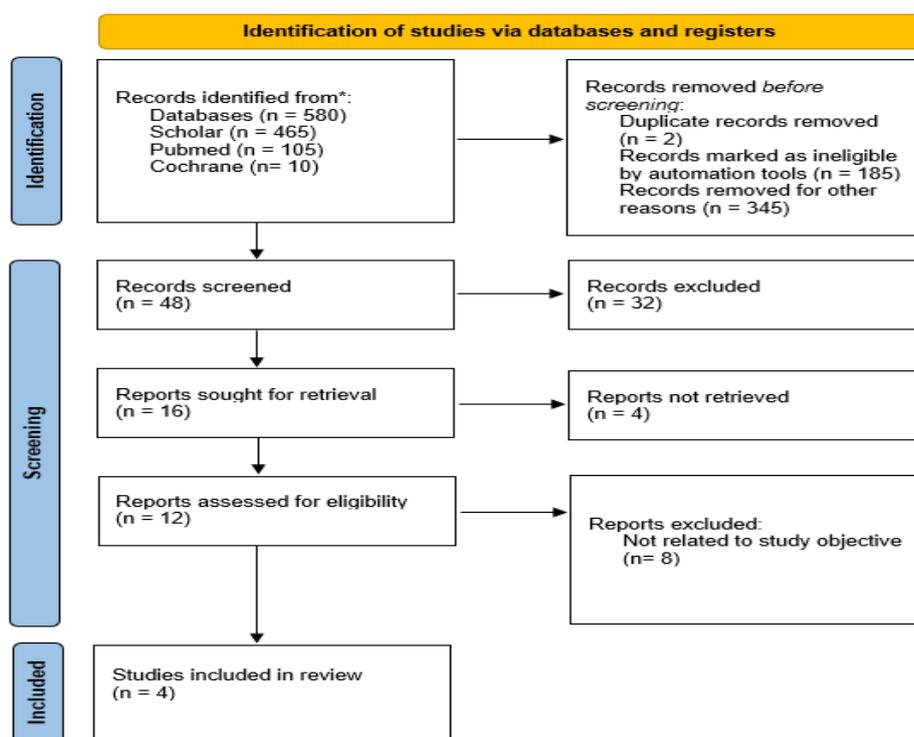

Figure 1. PRISMA flowchart of study selection

Risk of bias study

Risk of bias was assessed using the ROBINS-I tool across seven domains: confounding, patient selection, classification of intervention, deviation from intended intervention, missing data, outcome measurement, and selection of reported result. All of studies generally showed low risk of bias in classification of intervention, missing data, outcome measurement, and

selection of reported result domain. However, the confounding factor, patient selection, and deviation of intervention domains were moderate to serious risk of bias (**Figure 2**).

Figure 2. Risk of Bias

Baseline Characteristics of Study Participants

Across the four studies, 65 patients with chronic patella tendon injury were identified. The mean age of participants varied across studies. The majority of participants were male, while one study predominantly included female patients (66.7%). The duration of follow-up ranged between 54.9 ± 23.1 months to 6 ± 1.72 years. A history of previous patellar injury and knee reconstruction were various in studies. Baseline characteristics of participants are summarized in **Table 2**.

Table 2. Baseline Characteristics of Study Participants

Study [ID]	Sample size	Age (years)	Gender	Duration of follow up	Previous Patellar Injury	Previous knee reconstruction
Friedman, 2020[7]	11	46.6 ± 14.2	Male (73%)	54.9 ± 23.1 months	Yes (81.8%)	Yes (81.8%)
Maffulli, 2017[8]	19	46 ± 9.2	Male	5.8 ± 3.5 years	None	None
Spoliti, 2016[9]	9	68 ± 2.95	Female (66.67%)	4 ± 3 years	None	None
Valinatos, 2019[10]	13	58.2 ±11.45	Male (69.2%)	6 ± 1.72 years	Yes (15.3%)	Yes (15.3%)

A pooled analysis was performed to estimate the overall effect of each variable. The pooled analysis using a fixed-effect model demonstrated a significant overall mean difference of –8.85 (95% CI: –12.09 to –5.61; Z = 5.35, p < 0.00001). This result indicates that post-operative values were significantly improve knee flexion, compared to pre-operative measurements. However, heterogeneity among the studies was very high (Chi² = 58.45, df = 3, p < 0.00001; I² = 95%), suggesting substantial variability between studies. Individual studies reported mixed effects: Maffulli (2013) and Friedman (2020) showed large negative mean differences favoring the post-operative group, while Spoliti (2016) and Valianatos (2019) demonstrated positive or smaller effects.[7,8,9,10]

Study or Subgroup	Pre-operative Mean	SD	Total	Post-operative Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
Friedman, 2020	103.3	25.4	11	116.7	12.7	11	3.7%	-13.40 [-30.18, 3.38]
Maffulli 2013	110	9.2	19	132	5.26	19	46.3%	-22.00 [-26.77, -17.23]
Spoliti, 2016	105	6.61	9	100	8.41	9	21.5%	5.00 [-1.99, 11.99]
Valinatos, 2019	125	3.92	13	122.3	10.49	13	28.4%	2.70 [-3.39, 8.79]
Total (95% CI)			52			52	100.0%	-8.85 [-12.09, -5.61]

Heterogeneity: Chi² = 58.45, df = 3 (P < 0.00001); I² = 95%
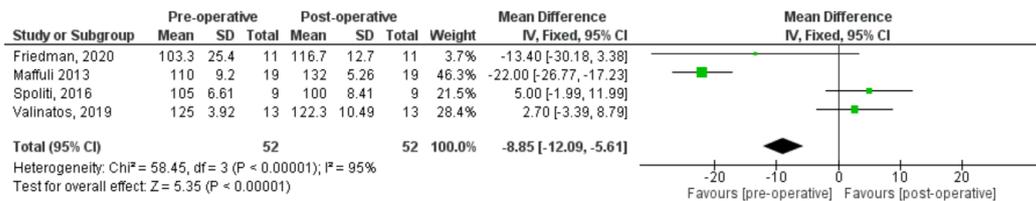Test for overall effect: Z = 5.35 (P < 0.00001)

Figure 3. Pooled Analysis of Knee flexion Mean Differences

The pooled analysis for evaluation of extension lag before and after reconstruction revealed a significant overall mean difference of 17.03 (95% CI: 16.61 to 17.46; Z = 78.23, p < 0.00001), indicating markedly improved outcomes after surgery compared with baseline. Despite this strong effect, heterogeneity among the included studies was high (Chi² = 14.31, df = 2, p = 0.0008; I² = 86%), reflecting considerable variability across study results.

Study or Subgroup	Pre-operative Mean	SD	Total	Post-operative Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
Friedman, 2020	47.5	27.1	11	0.33	1.8	11	0.1%	47.17 [31.12, 63.22]
Maffulli 2013	20	0.53	19	3	0.79	19	99.5%	17.00 [16.57, 17.43]
Spoliti, 2016	25	9.05	9	5	5	9	0.4%	20.00 [13.25, 26.75]
Total (95% CI)			39			39	100.0%	17.03 [16.61, 17.46]

Heterogeneity: Chi² = 14.31, df = 2 (P = 0.0008); I² = 86%
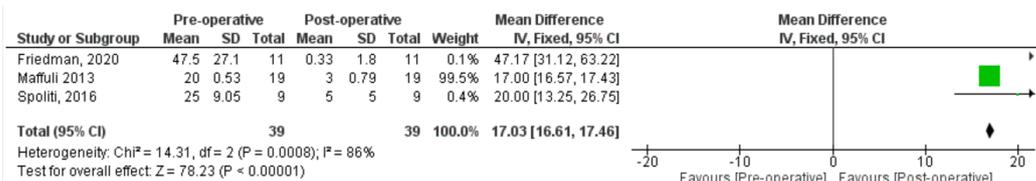Test for overall effect: Z = 78.23 (P < 0.00001)

Figure 4. Pooled Analysis of Extension lag Mean Differences

Application of hamstring autograft in patella injury reconstruction demonstrated a significant overall mean difference of 0.31 (95% CI: 0.22 to 0.39; Z = 6.72, p < 0.00001) in Insall-Salvati index, favoring post-operative improvement. Heterogeneity across the studies was negligible (Chi² = 0.80, df = 2, p = 0.67; I² = 0%), indicating consistent findings among the included trials. Individual studies (Maffulli 2013, Spoliti 2016, Valinatos 2019) all reported positive mean differences, with values ranging from 0.30 to 0.60, further supporting the benefit of surgical intervention.[8,9,10]
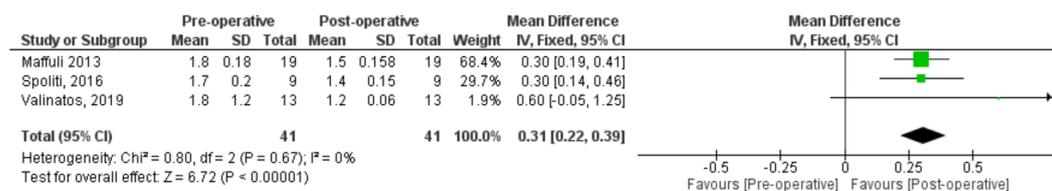
Study or Subgroup	Pre-operative Mean	SD	Total	Post-operative Mean	SD	Total	Weight	Mean Difference IV, Fixed, 95% CI
Maffulli 2013	1.8	0.18	19	1.5	0.158	19	68.4%	0.30 [0.19, 0.41]
Spoliti, 2016	1.7	0.2	9	1.4	0.15	9	29.7%	0.30 [0.14, 0.46]
Valinatos, 2019	1.8	1.2	13	1.2	0.06	13	1.9%	0.60 [-0.05, 1.25]
Total (95% CI)			41			41	100.0%	0.31 [0.22, 0.39]

Heterogeneity: Chi² = 0.80, df = 2 (P = 0.67); I² = 0%
Test for overall effect: Z = 6.72 (P < 0.00001)

Figure 5. Pooled Analysis of Insall-Salvati Index Mean Differences

DISCUSSION

We identified 4 studies evaluating clinical outcome of patella reconstruction using hamstring autograft for chronic patella injury. The present meta-analysis demonstrated that application of hamstring autograft was associated with significant improvements across multiple outcome measures, compared to pre-operative result. The pooled analysis of knee flexion showed a substantial overall reduction in scores post-operatively (MD –8.85, 95% CI (–12.09) – (–5.61)), although heterogeneity was extremely high (I^2 = 95%). This high degree of variability suggests that patient characteristics, surgical techniques, and follow-up durations differed considerably among the included studies, which may explain the inconsistency in effect size. Nevertheless, the overall direction of effect consistently favored post-operative outcomes.

Hamstring autograft for patella construction also showed improvement of extension lag, proved by positive pooled mean difference (MD 17.03°, 95% CI 16.61 to 17.46). However, heterogeneity remained high (I^2 = 86%), underscoring substantial variability across studies. This suggests that while patients generally benefit from surgical repair, the magnitude of improvement may depend on factors such as the chronicity of the rupture, and previous knee reconstruction. These findings emphasize the importance of contextualizing pooled results within the clinical heterogeneity of the included trials.

By contrast, the third pooled analysis demonstrated a smaller but highly consistent benefit in Insall-Salvati index (MD 0.31, 95% CI 0.22 to 0.39), with no observed heterogeneity (I^2 = 0%). This suggests that for certain standardized outcome measures, the effect of surgery is both significant and reproducible across different studies. The consistency observed in this outcome may reflect the use of validated clinical scores that capture functional recovery in a comparable manner, thus reducing variability in measurement across trials.

Taken together, the results indicate that surgical treatment yields significant functional and clinical improvements for patients, but the extent of these benefits varies depending on the outcome measure analyzed and the heterogeneity among studies. The high heterogeneity observed in two of the pooled analyses limits the certainty of the effect estimates and highlights the need for more standardized study designs, consistent outcome reporting, and larger multicenter trials.

The use of hamstring autografts in chronic patellar tendon reconstruction has gained attention in recent years. Relevant scientific evidence suggests that these grafts can be used to reconstruct ruptured patellar tendons, with semitendinosus and/or gracilis tendon grafts passed through bone tunnels in the patella and tibial tuberosity.[5] A systematic review of the clinical outcomes of various reconstruction techniques reported that the use of hamstring autografts resulted in a mean range of motion (ROM) of 1–128°, which was the highest ROM among all graft types reviewed. Functional scores such as the Lysholm score also showed significant improvement, with a mean postoperative score reaching 90.6. However, this review also noted several complications, including persistent knee pain and one case of reconstruction failure.[11]

It is important to note that most of the comparative literature comparing hamstring autografts with other grafts (such as patellar tendon grafts) focuses on anterior cruciate ligament (ACL) reconstruction, not patellar tendon reconstruction. These data from the ACL context provide indirect insights that valuable. In ACL reconstruction, hamstring autografts are associated with a lower risk of anterior knee pain and pain on kneeling compared with bone-patellar tendon (BPTB) grafts.[12] However, the same data also indicate that hamstring autografts have a higher risk of graft failure, especially in young athletes, compared with BPTB grafts. This difference indicates a trade-off

between donor site morbidity and postoperative stability.[13]

We acknowledge some limitations in our article. Limited amount of study may influence the pooled mean difference. Various patient characteristics and follow-up protocol in the studied population probably influenced the heterogeneity of the results. Future research should focus on identifying factors that contribute to the variability in outcomes, which will help refine patient selection and optimize surgical strategies.

CONCLUSION

This meta-analysis indicates that reconstruction of chronic patellar tendon injury using hamstring autografts provides significant improvements in clinical outcomes. Across the included studies, patients demonstrated substantial gains in post-operative knee flexion, extension lag, and Insall-Salvati Index compared with baseline. While some analyses revealed high heterogeneity, the overall effect directly favored surgical intervention. Taken together, these results support the use of hamstring autograft reconstruction as an effective option for restoring knee function in chronic patellar tendon ruptures.

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