



# High rates of return to play and work follow knee extensor tendon ruptures but low rate of return to pre-injury level of play

Jonathan D. Haskel<sup>1</sup> · Jordan W. Fried<sup>1</sup> · Eoghan T. Hurley<sup>1</sup>  · Edward S. Mojica<sup>1</sup> · Michael J. Alaia<sup>1</sup> · Eric J. Strauss<sup>1</sup> · Kirk A. Campbell<sup>1</sup>

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## Abstract

**Purpose** Extensor mechanism ruptures (EMR) of the knee are rare but debilitating injuries that always require surgery to restore knee function. The purpose of this study was to systematically review the literature to ascertain the rate of return to play following patellar or quadriceps tendon ruptures.

**Methods** A systematic literature search was conducted based on PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, using the EMBASE, MEDLINE, and Cochrane Library databases. Inclusion criteria consisted of clinical studies reporting on return to play after patellar or quadriceps tendon repair. Statistical analysis was performed with the use of SPSS.

**Results** Our review found 48 studies including 1135 cases meeting our inclusion criteria. There were 33 studies including 757 patellar tendon (PT) repairs, and 18 studies including 378 quadriceps tendon (QT) repairs. The overall rate of return to play for PT repairs was 88.9%, with 80.8% returning to the same level of play. The overall rate of return to play for QT repairs was 89.8%, with 70.0% returning to the same level of play. Among professional athletes, the overall rate of return to play after PT repair and QT repair was 76.9% and 70.9%, respectively. Following PT repair, 95.8% were able to return to work, and following QT repair, 95.9% were able to return to work.

**Conclusion** The overall rate of return to play was high following both PT and QT repairs. Moreover, a high percentage of those patients were able to return to their pre-operative level of sport with a low risk for re-rupture.

**Level of evidence** Level IV.

**Keywords** Quadriceps tendon rupture · Patellar tendon rupture · Return to sport · Systematic review

## Introduction

Extensor mechanism ruptures (EMR) of the knee are rare but debilitating injuries that often require surgery to restore knee function. Patellar tendon (PT) ruptures generally occur in individuals below the age of 40 years, while quadriceps tendon (QT) ruptures occur in older patients with systemic conditions such as obesity, gout, diabetes, chronic renal failure, or hyperparathyroidism [2, 9, 12]. Biomechanically, patellar and quadriceps tendon tears often occur in patients as a non-contact injury in which the quadriceps contracts while the knee is in a flexed position [22]. Risk factors for sustaining

QT ruptures include systemic processes such as obesity, gout, diabetes, chronic renal failure, hyperparathyroidism, or prolonged steroid intake [9, 10, 12, 17]. However, the primary cause of traumatic EMRs is repetitive micro trauma due to participation in strenuous sporting activities [11, 13, 21]. Expedient diagnosis and surgical management are critical to optimize outcome and restore knee function [6, 7, 15, 16].

The timing of post-operative mobilization is a critical component to recovery; however, there is no consensus on when to initiate knee mobilization, thus producing significant heterogeneity in the literature [6, 16, 19]. Traditionally, post-operative knees are kept immobilized in full extension for at least 6 weeks; however, more recent studies describe earlier mobilization protocols, which theoretically reduce complications, including knee stiffness, arthrofibrosis, and muscle atrophy [3, 8]. Moreover, the return-to-play

✉ Eoghan T. Hurley  
eoghanhurley@rcsi.ie

<sup>1</sup> New York University, New York, NY, USA

outcomes of surgical repair of the extensor mechanism are described primarily only in small case series. Amongst elite athletes, it is described that return-to-play for NBA [19] and NFL [14] players following operative repair of PT injuries is approximately 75% and 50%, respectively. However, these results should not be generalized to the general population, do not include QT repairs, and comprise a very limited sample of patients.

For those who treat extensor mechanism injuries, return-to-play data are important with respect to conveying prognostic information and for the management of performance expectations. However, no concise review of the literature is yet available regarding the rates and timing of return to play after surgical management of EMRs. The purpose of the current study was to systematically review the literature to ascertain the rate of return to play following operative management of PT or QT ruptures. The hypothesis was that surgical management of EMRs would result in high rates of return to play but that criteria for return to play would be scantily reported.

## Materials and methods

### Study selection

To compile the evidence related to return-to-play following repair of EMRs, a literature search was performed 2 authors by using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and reviewed the search results, with a senior author arbitrating on any disagreement. The title and abstract identified in the search were screened, and potentially eligible studies received a full-text review.

### Search strategy

The following search terms were used in MEDLINE, EMBASE, and The Cochrane Library, databases on February 2020 as the search algorithm: [(patella or patellar or quadriceps or quadriceps) and (tendon) and (rupture) and (repair or reconstruction or surgery or surgical or operative)]. No time limit was given to publication date.

### Eligibility criteria

The inclusion criteria were the following: (1) clinical study on patella or quadriceps tendon repair, (2) reports on return to play, (3) published in a peer-reviewed journal, and (4) published in English. The exclusion criteria were the following: (1) review studies, (2) cadaver studies, (3) biomechanical studies, and (4) abstract only.

### Data extraction/analysis

The relevant information regarding the study characteristics, including the study design, the level of evidence (LOE), the methodological quality of evidence (MQOE), population, clinical outcome measures, and the follow-up time points, were collected by two blinded reviewers using a predetermined data sheet, with the results compared by a third independent reviewer. The LOE was evaluated based on the guidelines by the Oxford Centre for Evidence-Based Medicine. The MQOE was evaluated using the MINORS criteria, a 16-point Likert scale for case series, and a 24-point Likert scale for comparative studies [23].

Clinical outcomes extracted analysed were: (1) overall rate return to play and return to previous levels including; (a) overall rate, (b) rate among professional athletes, (2) time of return to play, (3) Tegner score, (4) return to work, and (5) time of return to work.

### Statistics

Descriptive statistical analysis including weighted mean of various metrics was performed using SPSS (IBM Corp. Released 2013. IBM SPSS Statistics for Macintosh, Version 22.0. Armonk, NY: IBM Corp.).

## Results

The initial literature search resulted in 3,238 total studies. After removal of duplicates, the articles were screened for inclusion and exclusion criteria, and 2,243 unique studies were evaluated and full texts were assessed for eligibility.

### Study characteristics/patient demographics

Our review identified 48 studies including 1,135 patients meeting our inclusion criteria. (Fig. 1). Three studies reported on both PT and QT injuries; LOE III: 5, LOE IV; 43. There were 33 studies including 757 PT repairs, the majority of patients were male (88.6%), with a mean age of 32.7 years (14–56) and a mean follow-up of 40 months. There were 18 studies including 378 QT repairs, the majority of patients were male (90.8%), with a mean age of 52.3 years (28–66) and a mean follow-up of 49.1 months. The study characteristics and patient demographics are outlined in the appendix.

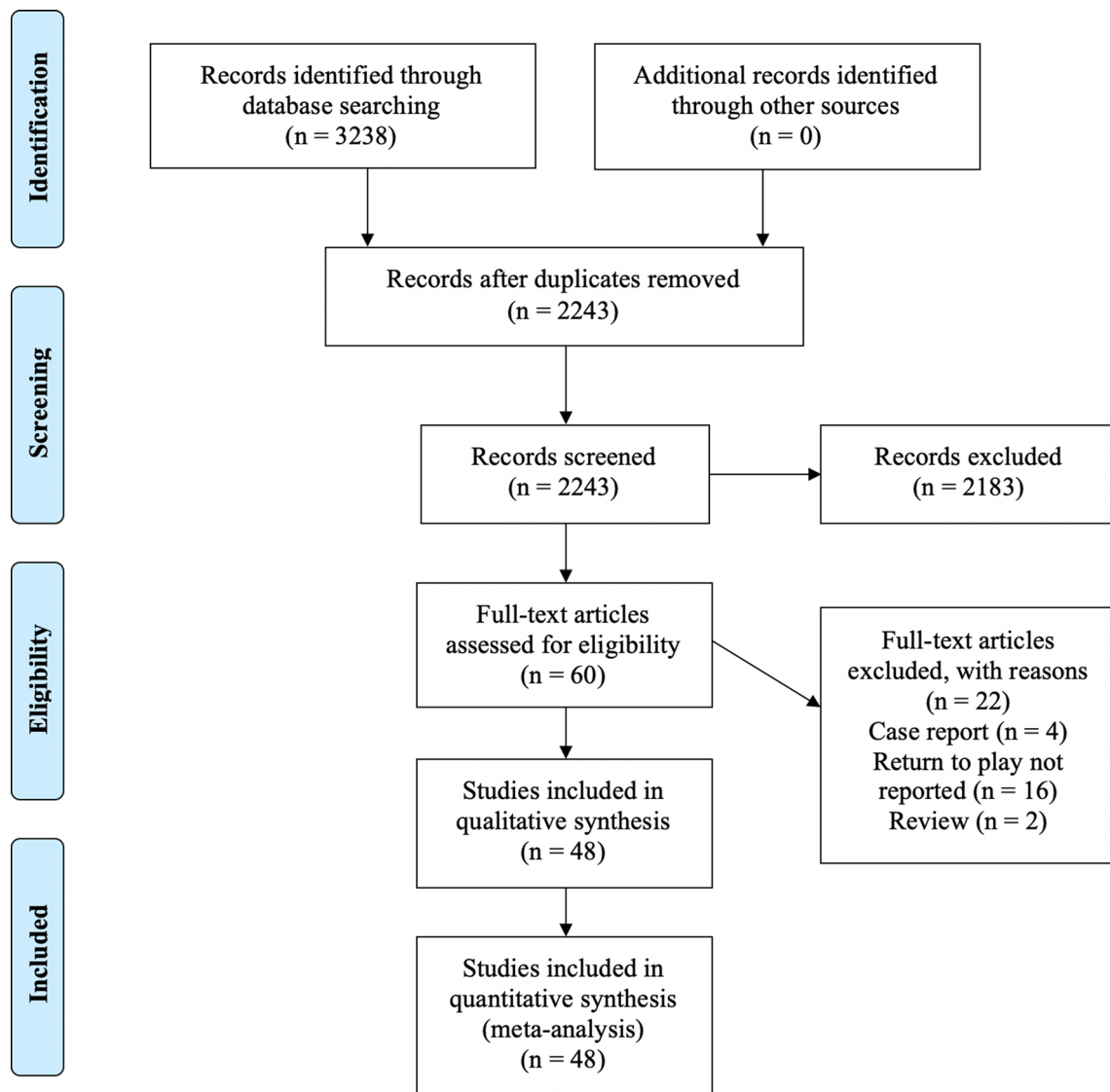


Fig. 1 PRISMA flow diagram

**Table 1** Return to play and work characteristics after operative patellar tendon management

	N (patients)	N (studies)	Outcome
RTP	504/567	22	88.9% (66.7%–100%)
RTP S/H	466/577	20	80.8% (0%–100%)
RTP pro	80/104	2	76.9% (57.7%–100%)
RTP time	145	8	9.6 mo (5.2–18)
Tegner	38	4	4.5 (1.7–7.1)
Re-rupture	2/633	30	0.3% (0%–4.3%)
RTW	136/142	11 studies	95.8% (70.5%–100%)
RTW time	N/R		

RTP return to play, S/H same/higher level, Pro professional athletes, RTW return to work

### Patellar tendon ruptures (Table 1)

The overall rate of RTP following PT ruptures was 88.9%, with 80.8% returning to the same level of sport. In professional athletes, the rate of return to play was 76.9%. The mean weighted time to return to play was 9.5 months. The mean weighted post-operative Tegner score was 4.5 (1.7–7.1). Among those working pre-operatively, 95.8% were able to return to work. There were only 2 (0.3%) re-ruptures.

### Quadriceps tendon ruptures (Table 2)

The overall rate of RTP following QT ruptures was 89.8%, with 70% returning to the same level of sport. In professional athletes, the rate of return to play was 70.9%. The mean

**Table 2** Return to play and work characteristics after operative quadriceps tendon management

QT	N (patients)	N (studies)	Outcome
RTP	115/128	9	89.8% (50%–100%)
RTP S/H	70/103	7	70% (9.1%–100%)
RTP pro	17/24	2	70.9% (50%–100%)
RTP time	55	5	4.6 mo (3.6–6)
Tegner	111	3	3.1 (2.7–3.8)
Re-rupture	10/378	18	2.6% (0%–9.1%)
RTW	165/172	8	95.9% (84.6%–100%)
RTW time	44	3	4.1 mo (3–8.9)

RTP return to play, S/H same/higher level, Pro professional athletes, RTW return to work

weighted time to return to play was 4.6 months. The mean weighted post-operative Tegner score was 3.1. Among those working pre-operatively, 95.9% were able to return to work at a mean of 4.1 months. There were 10 (2.6%) re-ruptures.

## Discussion

The most important finding from this study was a high and quantified rate and level of return to work following knee extensor mechanism rupture. Data from the current study demonstrated a high rate of return to play following both patella and quadriceps tendon repair in patients with extensor tendon mechanism injuries, with a low rate of post-operative treatment failure. The majority of patients were able to return to the same or higher level of play following PT repair and QT repair. However, despite the high overall rate of return to sport, a considerable number of patients were not able to return to their previous levels of play, particularly in professional American football players. While there is a trend towards older age in patients who are unable to return to play following QT repair compared to those who are able to return (28.6 years versus 25.7 years, respectively), this difference was not statistically significant [4].

The overall rate of return to play following PT repair was high, but the majority of patients returned to low level activity as evidenced by the Tegner activity score at the time of return to play. Nguyen et al. [18] conducted the largest series to date in the literature on outcomes following PT repair and examined the performance of professional athletes specifically. They found that 79 of 101 athletes returned to play (76.7%); however, significant variability exists depending on the specific sport, with return to play ranging from 100% in baseball players to 57.7% in American footballers. The outcomes are consistently encouraging in the overall athletic

population, with an overall 88.9% of patients returning to play, on average.

Moreover, the results demonstrate that only a very small percentage (0.3%) of patients who underwent PT repair experienced re-rupture. This is in contrast to a still small, but higher percentage of patients undergoing QT repair who experience re-rupture (2.6%). This difference may be attributed to patient-related factors. For example, compared to patients who sustain PT ruptures, those who sustain QT repairs are generally older, and more likely to have systemic conditions such as obesity, gout, diabetes, chronic renal failure, or hyperparathyroidism [9, 10, 12, 17]. These factors can contribute to poorer tissue quality and possibly confer a higher risk for re-rupture after repair.

The return to play following QT repair was high, but was associated with a very low mean Tegner score upon returning to play. As this is a condition that occurs at a lower frequency compared to PT disruption, there are significantly fewer studies in the literature for analysis. Boudissa et al. [5] evaluated the performance of the largest series in the literature to date, with 68 cases of quadriceps tendon repair. Of the 50 cases available for follow-up at 76 months, 97% of patients returned to work at the same level of function, but a low activity baseline with a Tegner score of 3.4 was noted. This is consistent with the results by O'Shea et al. [20], in which 95% of patients returned to their previous level of activity. In Garcia's analysis of 10 professional soccer players who underwent QT repair, all patients returned to play at a mean period of 3.8 months and returned to prior level of function. In contrast, Boublik et al. [4] analyzed the performance of 14 QT repairs in National Football League (NFL) athletes and found that only 50% (7/14) returned to play in regular-season games. This discrepancy in outcome is consistent with and analogous to Nguyen's large analysis of professional athletes who underwent PT repair, in which professional soccer players experienced a 95% return to play; whereas, the NFL players analyzed had the worst outcomes of all professional sports with a 57.7% return to play. However, this may be due to the high turnover of NFL athletes.

The analysis found a noticeable difference between PT and QT repairs with regard to time to return to play. The causes for this discrepancy are likely multifactorial and difficult to quantify. Patient demographic factors may play a role, as patients sustaining PT injuries are generally younger with a higher physical demand than those sustaining quadriceps tendon ruptures, who are often older and lower-demand, on average [1, 2, 9, 12, 25]. As such, it is reasonable to expect a longer recovery period for patients after undergoing PT repair compared to QT repair. While difficult to statistically compare the systematic performances of PT versus QT repair due to heterogeneity in the data and patient demographics between the two populations, there have been a small number of studies that have assessed the performance

of repairing both types of injuries [13, 24]. West et al. [24] compared the outcomes of 30 patients who underwent PT repair and 20 patients who underwent QT repair and found that all patients in both cohorts reached their pre-injury levels of activity after adequate recovery from surgery. However, no direct comparisons were made between PT and QT repairs. In the Kelly et al. [13] study, two of three patients returned to play following QT repair, and nine of 10 returned following PT repair, supporting the trend towards comparable outcomes after repair of both forms of extensor mechanism injury.

Despite the generally high rate of return to sports, the review of the literature revealed that not everybody can return to their pre-injury level [19]. This is an often overlooked but very important point when counselling patients, and often their parents, especially for high-demand populations such as American football players, where up to 50% of patients are expected to not return to their pre-injury level of sport.

This study had potential limitations and biases, and given the nature of a systematic review, included the limitations of the analyzed literature as well. A number of the included studies represented level IV evidence, which may include a component of selection bias. In addition, due to the heterogeneity in data reporting between studies, we were unable to analyze multiple factors (demographic information, patient-reported outcomes scores) as potential risk factors for preventing return to play. Another limitation is variability of the surgical techniques and postoperative rehabilitation protocols used in the various studies. Return to play may be influenced by the individual's sport and level of play, thus the heterogeneity in activities included in the studies likely impairs the generalizability of these results to all sports. Finally, not all studies define return to sport, and moreover, there is variability in studies' definitions of return to sport.

Although limited by these constraints, this systematic review provides important data on return to play following EMR repairs. To expand on this review, future large prospective studies may be able to use this as a foundation to create a stronger framework in more accurately determining the time to return to play following an individual's extensor mechanism repair surgery. The value of this study is to provide both clinicians and athletes with important information regarding return to play following patellar and quadriceps tendon repairs, and to potentially set expectations early in the process.

## Conclusion

The overall rate of return to play was high following both PT and QT repairs. Moreover, a relatively high percentage of those patients were able to return to their pre-operative level of sport with a low risk for re-rupture.

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## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** Ethical approval was not required as this was a systematic review of the literature.

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