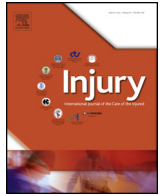




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Comparison of adverse events and postoperative mobilization following knee extensor mechanism rupture repair: A systematic review and network meta-analysis

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ABSTRACT

Background: Extensor mechanism rupture (EMR) of the knee is a rare but potentially debilitating injury that often occurs due to trauma. While a wide variety of surgical treatments have been reported, there is currently no consensus on the most successful treatment method. The timing of post-operative joint mobilization is also critical for successful recovery after EMR repair. Despite the traditional method of complete immobilization for 6 weeks, there is an increasing trend towards early post-operative knee mobilization. The purpose of this network meta-analysis was to compare adverse event rates and function outcomes between repair methods and between post-operative mobilization protocols.

Methods: MEDLINE, EMBASE, Web of Science, and Cochrane Central electronic databases were searched in August 2016 for observational studies involving repair of acute, traumatic EMRs. Data extraction included functional outcomes, adverse events, and additional surgeries. Cohort studies that were used in functional outcome analysis were assessed for risk of bias by the Newcastle-Ottawa Quality Assessment Scale (NOS).

Results: Twenty-three studies (709 patients) were included for adverse event analysis. There were no significant differences in adverse event or additional surgery rates between EMR repair methods. However, early mobilization produced significantly higher adverse event rates ($p = 0.02$) and total event rates ($p < 0.001$) than late mobilization, but the difference in additional surgery rates was not significant ($p = 0.06$). Six studies (85 patients) were included for functional outcome analysis. There were no significant differences in thigh girth atrophy or muscle strength compared to the contralateral leg between patients treated with transosseous drill holes and simple end-to-end sutures.

Conclusions: We performed the first network meta-analysis to date comparing treatment of EMRs. Our results support the current body of knowledge that there is no single superior repair method. Although there is an increasing trend towards early or immediate post-operative knee mobilization, we found that early mobilization is associated with significantly higher adverse event and total event rates compared to fixed immobilization for a minimum of 6 weeks, implicating an increased financial burden and decreased quality of life associated with early post-operative mobilization.

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Introduction

Rupture of the extensor mechanism of the knee is a rare but potentially debilitating injury, with incidences of 1.37/100,000 for quadriceps tendon rupture (QTR) and 0.68/100,000 for patellar tendon ruptures (PTR). PTR generally occurs in older individuals

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(mean age: 49 male, 69 female), while QTR is more common in younger patients (mean age: 51 male, 52 female) [1]. Extensor mechanism ruptures (EMRs) generally occur unilaterally due to trauma, but may occur bilaterally and spontaneously in the case of predisposing risk factors that cause pathological degeneration of the tendons [2–4]. Accurate diagnosis and early surgical treatment, rather than the surgical technique, are the most important factors for successful treatment of EMRs [5]. Delaying surgical repair may lead to tendon retraction and diminished tissue quality, which may negatively impact outcomes [5,6].

To date, there has been a wide variety of surgical techniques proposed for the treatment of EMRs, yet little consensus on the most successful method, despite several reviews published on the subject [3,5,7]. Transosseous patellar drill holes are considered the gold standard for treating ruptures near the patellar poles, whereas mid-tendon tears are more commonly treated with simple end-to-end sutures [7]. Recently, suture anchors have been proposed as an advantageous alternative to patellar drill holes. Suture anchors require smaller skin incisions and shorter operative time, but there is no consensus on whether they produce better outcomes than traditional methods [5]. As it is currently unclear which surgical method yields the best outcomes and fewest adverse events, patients and surgeons may benefit from a comparison of these techniques.

The timing of post-operative joint mobilization is also critical for successful recovery after EMR repair [8]. Traditionally, the knee is locked in full extension with a cylinder cast or brace for a minimum of 6 weeks post-operatively [9]. However, more recent studies have demonstrated a trend towards early or even immediate post-operative knee mobilization [10,11]. This is based on the notion that early rehabilitation and immediate joint mobilization following surgery is linked to decreased rates of knee stiffness, arthrofibrosis, and muscle atrophy [12]. However, definitive evidence favoring any one rehabilitation protocol is lacking.

Given that EMRs are relatively infrequent [1], studies to date have been mostly observational with small sample sizes, making it difficult to formulate evidence-based conclusions about surgical treatment and post-operative protocols. As such, the purpose of this network meta-analysis (NMA) was to pool data from multiple observational studies of acute, traumatic EMRs in order to provide a high-quality synthesis of data to drive clinical recommendations. We performed an NMA to answer three questions: first, which method of EMR repair is associated with the lowest risk of re-operation and adverse events; second, is there a difference in re-operation or adverse event rates following EMR repair between patients treated with prolonged immobilization compared to early mobilization; third, is there a difference in functional outcomes in patients with EMRs repaired with transosseous drill holes compared to simple sutures.

Materials and methods

We searched the Medline, Embase, Web of Science, and Cochrane Central electronic databases for observational studies involving treatment of EMRs in accordance with the Cochrane Collaboration and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [13]. The following search strategy was developed for Ovid Medline and was later adopted for other databases: (exp Quadriceps Muscle/OR exp Patellar Ligament/OR ((patell\$ OR quadriceps) adj1 (tendon\$ OR ligament\$)).ab,ti) OR extensor mechanism\$.ab,ti) AND (exp Rupture/OR (rupture\$ OR tear\$ OR disrupt\$ OR avulsion\$ OR dissociat\$).ab,ti) AND (exp Reconstructive Surgical Procedures/OR Suture Techniques/OR surgery.fs OR (surg\$ OR repair\$ OR

reconstruct\$ OR suture\$ OR drill hole\$).ab,ti) NOT (exp Animals/NOT exp Humans/).

Studies that met the following inclusion criteria were included for network meta-analysis: 1) surgical treatment of acute, traumatic EMRs, 2) availability in English language, 3) adult, human subjects, 4) a minimum of 10 patients included, 5) reported functional outcomes or adverse events. Studies that met the following exclusion criteria were omitted from network meta-analysis: 1) reviews, abstracts, editorial letters, or technical notes, 2) chronic ruptures, 3) pathological ruptures, 4) iatrogenic ruptures (e.g. following total knee arthroplasty), 5) partial tears (e.g. jumper's knee), 6) concurrent ligament injuries (e.g. anterior cruciate ligament), 6) studies that did not stratify outcomes by treatment method. Acute treatment was defined as repair within 2 weeks of injury, with chronic treatment defined as any repairs performed after 2 weeks [14]. Pathological ruptures were defined as spontaneous ruptures in patients with predisposing co-morbidities such as diabetes mellitus, gout, and rheumatoid arthritis [2].

Critical appraisal

For the studies that were included in functional outcome analysis, two independent reviewers assessed the risk of bias using the Newcastle-Ottawa Quality Assessment Scale (NOS) for Cohort Studies [15]. The studies that were included for adverse event analysis but did not meet the criteria for functional outcome analysis could not be assessed by this method because they lacked control groups.

Data extraction

A data extraction sheet was developed based on the Cochrane Consumers and Communication Review Group's data extraction template. All data was extracted by a single investigator and reviewed by another investigator to confirm accuracy and consistency. The following data were extracted: journal name, first author, year of publication, number of study participants, mean age, duration of follow-up (months), patients lost to follow-up (e.g. withdrawn, dropout), the type of tendon ruptures, and the type of control – i.e. contralateral knee or pretreatment measurement. The type of treatment and mobilization time were independent factors. Mobilization was defined as early if mobilization of the injured knee was initiated within 6 weeks after surgery or late if the injured knee was immobilized for at least 6 weeks post-operatively. Thigh girth atrophy and muscle strength compared to the contralateral leg were used for functional outcome assessment, while the rate of adverse events and additional surgeries were used for adverse event analysis. We did not attempt to obtain raw data or confirm synthesized data from investigators of the included studies.

The following adverse events were pooled in this study: Infection, re-rupture, fracture, wire breakage, patellar degeneration (measured by biopsy), and other surgical complications. The pooled additional surgery rate was reported to avoid double counting for cases that underwent additional surgery to treat an adverse event. Additional surgeries were counted with explicit mention of operations involving the affected joint. For example, Negrin et al. [2] reported five cases of infection with four instances of revision surgery in their PTR group, and seven cases of infection with three instances of revision surgery in their QTR group. It is unclear whether the patients with infection that did not receive revision underwent surgical debridement. Thus, to resolve this ambiguity without making assumptions, additional surgeries were only counted if an explicit mention was made.

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