

Do intra-articular knee injuries detected by preoperative MRI affect the clinical management of extensor mechanism ruptures?

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Abstract

Objectives: We sought to determine the prevalence of intra-articular findings at the time of extensor mechanism injury that required subsequent surgical intervention.

Design: Retrospective cohort study.

Setting: Level 1 academic trauma center.

Patients/participants: Sixty-seven knees in 66 nonconsecutive patients (mean age 53.6 years, 95.6% male) with extensor mechanism injury and preoperative magnetic resonance imaging (MRI) before undergoing open primary surgical repair.

Main outcome measurements: Patellar or quadriceps tendon rupture, high or low injury energy level, and age above or below 45 years were used to stratify patients. The primary outcome was additional surgery for intra-articular injury. Demographics, comorbidities, mechanism and location of injury, and internal derangements based on MRI findings were also collected.

Results: Fifty-one knees (76.1%) had quadriceps tendon injury, 13 knees (19.4%) had patellar tendon injury, and 3 knees (4.6%) had both. Thirty-four knees (50.7%) had intra-articular pathology and 3 (4.5%) required additional surgery, including 1 knee (7.7%) with patellar tendon injury and 2 knees (3.9%) with quadriceps tendon injury. Patellar tendon injuries were more commonly associated with cruciate ligament injury ($P < .01$) and occurred in younger patients ($P < .001$) than quadriceps tendon injury.

Conclusions: 50.7% of cases with extensor mechanism injury had intra-articular pathology but only 4.5% required additional surgery. The results of our study suggest that preoperative MRI is unlikely to be of significant clinical utility in most extensor mechanism injuries but should be considered in cases of patellar tendon rupture in younger patients where the incidence of concomitant cruciate ligament injury is higher.

Level of evidence: Diagnostic Level III.

Keywords: extensor mechanism rupture, MRI, patellar tendon, quadriceps tendon

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1. Introduction

Extensor mechanism injuries of the knee most commonly occur in male patients over the age of 40.^[1] The incidence of quadriceps and patellar tendon ruptures are 1.3% and 0.6%, respectively,^[2] and usually occur as a result of an indirect trauma during eccentric loading of the extensor mechanism,^[3] frequently in the setting of an underlying tendinopathy.^[4,5] Systemic risk factors for extensor tendon ruptures include gout, diabetes mellitus, renal failure, endocrine disorders, and fluoroquinolone use.^[6–8] Nonoperative treatment of these injuries can lead to gait dysfunction and significant morbidity.^[9] Timely surgical intervention is indicated for high-grade partial and complete quadriceps and patellar tendon ruptures in order to prevent tendon retraction, improve extensor mechanism strength, knee range of motion, and patient satisfaction.^[10]

Many surgeons will diagnose extensor mechanism injuries based on physical exam alone and forego advanced imaging, such as magnetic resonance imaging (MRI). While extensor mechanism injuries have traditionally been diagnosed and managed without advanced preoperative imaging, previous studies have shown that up to 30% of patients with extensor mechanism rupture have clinically significant concomitant intra-articular injuries, such as ACL or meniscal injuries.^[11–19] Failure to

recognize these intra-articular injuries at the time of initial diagnosis can potentially affect long-term outcomes after extensor mechanism repairs. Despite a relatively high prevalence of concomitant intra-articular pathology, the need for subsequent surgical repair of those intra-articular findings remains unknown. Given the controversy in preoperative advanced imaging workup of extensor injuries and paucity of literature related to this topic, we sought to determine the frequency of intra-articular findings identified at the time of initial injury that required additional subsequent surgical intervention.

2. Materials and methods

This single-institution retrospective study was performed in compliance with Health Insurance Portability and Accountability Act (HIPAA) regulations, with the approval of our Institutional Review Board, and a waiver of informed consent.

2.1. Study group

Patients were identified who underwent either open quadriceps tendon or patellar tendon repair at our institution between July 2009 and July 2018. Inclusion criteria for the study group included patients of age 18 years or older, history of quadriceps or patellar tendon rupture with open surgical repair, and a preoperative MRI scan within 6 months prior to surgery. Exclusion criteria omitted patients younger than 18 years of age, history of previous extensor tendon debridement or repair, history of concurrent patella fracture fixation, history of medial patellofemoral reconstruction or other extensor mechanism reconstruction, and those who had traumatic arthrotomies or extensor tendon ruptures after a total knee replacement. The study group consisted of 66 unique patients, including 67 knees with one bilateral case, which represented 16.1% of the 411 patients undergoing primary operative repair of extensor tendon injuries at our institution during this time period. Comparisons were made between patellar tendon injury and quadriceps tendon injury groups, initial injury energy level, and between those aged 45 years or older and those under 45 years.

Patient age, gender, body mass index (BMI), and comorbidities were collated, including history of diabetes, obesity, autoimmune disorder, and nicotine use. Knee injury laterality, mechanism of knee injury, location of extensor mechanism injury, and types of internal derangement based on MRI findings were collected. The locations of extensor mechanism injury included: proximal, mid-substance or distal quadriceps tendon and/or proximal, mid-substance or distal patellar tendon. The recorded types of internal derangement included: anterior cruciate ligament (ACL) tear, posterior cruciate ligament (PCL) tear, medial collateral ligament (MCL) tear, lateral collateral ligament (LCL) tear, medial, and lateral meniscal injuries, cartilage damage in the medial, lateral and/or patellofemoral compartments, joint effusion present, intra-articular body present, fracture, and bone contusion.

2.2. MRI examination

An MRI examination was performed on the 67 knees of the 66 patients in the study group using 1.5T and 3T MR scanners. MRIs were ordered either at the surgeon's preference in the context of injury mechanism and clinical presentation, or by a different care provider who was not the operating surgeon, for example in the emergent or urgent care setting. Knee MRI is routinely performed at 3T for orthopedic services at our

institution, however due to scheduling availability, claustrophobia, patient body habitus, or 3T incompatible implanted devices a patient may receive a 1.5T MRI. All MRI examinations consisted of routine sequences and planes for our institution, including an axial frequency selective fat-suppressed T2-weighted fast spin-echo sequence, a coronal proton density-weighted fast spin-echo sequence, a coronal frequency selective fat-suppressed proton density-weighted fast spin-echo sequence, a sagittal proton density weighted fast spin-echo sequence, and a sagittal frequency selective fat-suppressed T2-weighted fast spin-echo sequence. The clinical interpretations of the MRI examinations were used for our analysis.

2.3. Surgical technique

Direct repair of either the patellar or quadriceps tendon was performed by utilizing an anterior longitudinal incision directly over the palpable tendon defect. Frayed edges of the tendon were trimmed to healthy tissue. Next, nonabsorbable sutures were placed in a Krackow configuration to secure the ruptured tendon into the patella with either drill tunnels or anchors.^[20] Operative notes were reviewed to determine additional procedures performed at the time of the primary patellar or quadriceps tendon repair. Postoperatively, patients were placed into a hinged knee brace locked in extension and participated in physical therapy. Patients were made weight bearing as tolerated on the operative extremity while locked in extension. After 6 weeks, rehabilitation focused on range of motion and strengthening exercises. Patients were allowed to return to activities as tolerated once they exhibited normal range of motion, full quadriceps strength, and good proprioceptive function. All patients' charts were reviewed to record subsequent surgeries after primary extensor tendon repair with an average follow up of 8.0 (0.5–36) months.

2.4. Statistical analysis

Data were summarized via means and frequencies. Comparisons between quadriceps tendon and patellar tendon groups were based on various demographic variables and MRI findings via two-sample *t*-tests or chi-square tests. We performed a sensitivity analysis by removing the patient with bilateral injuries and found results were not affected. Analysis was conducted in R for statistical computing version 3.53.^[21] Statistical significance was set at a *P*-value < .05.

3. Results

The study cohort consisted of 67 knees in 66 patients with one bilateral case. The mean (SD) age of the cohort was 53.6 (13.1) years. There were 64 (95.6%) male knees in the cohort. There were 51 cases (76.1%) with quadriceps tendon rupture, 13 cases (19.4%) with patellar tendon rupture, and three (4.5%) with both. One patient had a subsequent extensor mechanism rupture on the contralateral limb within 6 months of the initial injury. Table 1 summarizes the demographics, comorbidities, and injury mechanism by extensor injury location. Patients with quadriceps tendon injury were significantly older than patients with patellar tendon injury (57.6 vs 37.5 years of age, *P* < .001). There was no difference between quadriceps and patellar tendon ruptures with regard to gender, BMI, studied comorbidities or injury mechanisms. As for the location of extensor injury noted on MRI, of the isolated quadriceps tendon tears, 35 were proximal tears, zero

Table 1
Demographic, comorbidity, and injury mechanism by extensor mechanism rupture type.

	Any extensor injury	Patellar tendon injury	Quadriceps tendon injury	<i>P</i> *
Number of cases	67 [†]	13	51	
Age in years (SD)	53.6 (13.1)	36.5 (8.7)	57.6 (10.4)	<.001
Gender-male	64 (95.6%)	12 (92.3%)	49 (96.1%)	.500
BMI (SD)	31.0 (4.5)	29.7 (4.3)	31.4 (4.7)	.243
Diabetes	38 (56.7%)	2 (15.4%)	6 (11.8%)	.660
Autoimmune disease	5 (7.5%)	0 (0%)	4 (7.8%)	.574
Nicotine use	6 (9.0%)	1 (7.7%)	5 (9.8%)	1.000
Indirect trauma	36 (53.7%)	7 (53.8%)	28 (57.1%)	1.000
High energy level	16 (24.0%)	5 (38.5%)	10 (20.0%)	.270

BMI = body mass index in kg/m², SD = standard deviation.

* Comparison between patellar and quadriceps tendon injury groups.

† Three cases had both quadriceps and patellar tendon injury.

were mid-substance tears, and 16 were distal tears. Of the isolated patellar tendon ruptures, three involved the proximal origin, 10 were mid-substance tears, and zero were distal tears.

At preoperative MRI, 34 cases (50.7%) with extensor mechanism injury revealed intra-articular pathology. Table 2 summarizes the concomitant intra-articular pathology by extensor injury location. The most common associated intra-articular finding with quadriceps tendon ruptures were medial and lateral meniscal tears. While several MCL and LCL injuries were seen, there were no concomitant ACL or PCL injuries in this group. Four patients (7.8%) in the quadriceps tendon injury group required additional surgery, one had an MCL repair, one had an arthroscopy with patellar chondroplasty, and two required manipulation under anesthesia with debridement and lateral and medial extensor releases. The patient who had the subsequent MCL repair eventually went on to require total knee arthroplasty. In the patellar tendon injury group, meniscal injuries, ACL, PCL, MCL and LCL injuries were identified as concomitant injuries. Two patients (15.4%) in the patellar tendon injury group required additional surgery. One patient underwent subsequent ACL reconstruction after the initial extensor repair. One patient required heterotopic ossification removal and manipulation and debridement. Notably, three patients (75%) with ACL injuries in the patellar tendon rupture

group elected to not have ACL reconstruction by the end date of this study.

Comparing cases of quadriceps and patellar tendon injury, summarized in Table 2, cases with patellar tendon rupture had a significantly higher likelihood of additional intra-articular injuries to the ACL ($P=.001$), PCL ($P=.007$), and MCL ($P=.024$). Figure 1 provides an example of concomitant intra-articular injury. Fracture ($P=.027$) and bony contusion ($P=.024$) were also significantly higher in those with patellar tendon injuries compared to quadriceps tendon injuries, despite no significant difference in the energy level of the injury ($P=.270$). Conversely, patients with quadriceps tendon injuries had significantly higher likelihood of cartilage damage in the patellofemoral joint ($P=.002$) and in the medial compartment ($P=.001$). An age stratified analysis, summarized in Table 3, found that patients younger than 45 years of age were more likely to sustain a patellar tendon rupture ($P<.001$), and have bone fracture ($P<.050$) or contusion ($P<.040$), while those older than 45 had a significantly higher likelihood of a quadriceps tendon rupture ($P<.001$). There was no statistically significant difference in the need for additional surgery between quadriceps and patellar tendon injuries. Table 4 stratifies the injuries by the energy level of the inciting trauma. There was no statistically significant difference in the incidence of any additional intra-

Table 2
MRI findings by extensor mechanism rupture type.

	Any extensor injury	Patellar tendon injury	Quadriceps tendon injury	<i>P</i> *
Number of cases	67 [†]	13	51	
Medial meniscus injury	28 (41.8%)	5 (38.5%)	21 (41.2%)	1.000
Lateral meniscus injury	11 (16.4%)	3 (23.1%)	7 (13.7%)	.411
ACL injury	4 (6.1%)	4 (30.8%)	0 (0%)	.001
PCL injury	3 (4.5%)	3 (23.1%)	0 (0%)	.007
MCL injury	4 (6.1%)	3 (23.1%)	1 (2.0%)	.024
LCL injury	4 (6.1%)	2 (15.4%)	2 (3.9%)	.181
Patellofemoral cartilage damage	37 (55.2%)	2 (15.4%)	32 (62.7%)	.006
Medial cartilage damage	29 (43.3%)	0 (0%)	26 (51.0%)	.002
Lateral cartilage damage	19 (28.4)	1 (7.7%)	15 (29.4%)	.157
Intra-articular body	3 (4.5%)	1 (7.7%)	1 (2.0%)	.368
Fracture	7 (10.4%)	4 (30.8%)	3 (5.9%)	.027
Bone contusion	4 (6.1%)	3 (23.1%)	1 (2.0%)	.024
Additional surgery	7 (10.4%)	2 (15.4%)	4 (7.8%)	.593
Additional surgery minus MUA [‡]	3 (4.5%)	1 (7.7%)	2 (3.9%)	.630

ACL = anterior cruciate ligament, LCL = lateral collateral ligament, MCL = medial collateral ligament, PCL = posterior cruciate ligament, SD = standard deviation.

* Comparison between patellar and quadriceps tendon injury groups.

† Three cases had both quadriceps and patellar tendon injury.

‡ Manipulation under anesthesia.

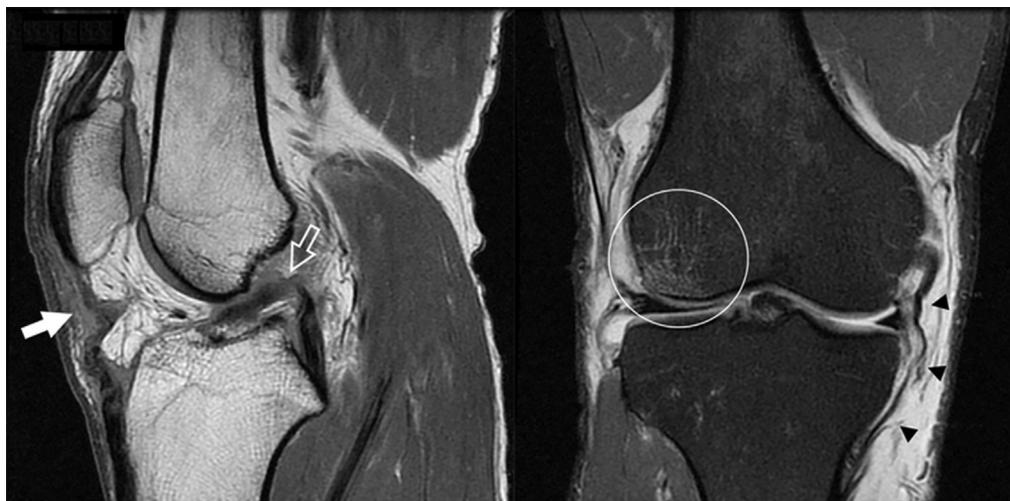


Figure 1. Sagittal proton density-weighted (A) and coronal fat suppressed proton density-weighted (B) MR images of the knee of a 42-year-old male with a patellar tendon rupture (arrow), a complete ACL rupture (empty arrow), MCL rupture (arrowheads) and medial femoral condyle contusion (circle).

articular injuries when compared by energy level of the initial injury.

Of note, four patients required subsequent operative manipulation and debridement for postoperative flexion contractures after extensor mechanism repair; one (7.7%) from the patellar tendon group, two (3.9%) from the quadriceps tendon group, and the one patient with both patellar and quadriceps tendon injuries. Preoperative internal derangements in these cases were dissimilar. One had a medial meniscal tear, one had partial grade patellofemoral cartilage damage, one had partial and full thickness patellofemoral, medial, and lateral cartilage damage, and one had no additional findings. These cases were not included in our analysis of internal derangement at the time of extensor mechanism injury requiring additional surgery (Table 2).

4. Discussion

In this retrospective review of extensor mechanism repair after injury we sought to determine whether preoperative MRI imaging is warranted to detect actionable pathology outside of the extensor mechanism disruption. We found that 50.7% of

cases with extensor mechanism injury had intra-articular pathology but only 4.5% required additional surgery related to the intra-articular pathology found at the time of initial injury, with the additional surgery occurring at an average of 15.3 (±6.4) months after the initial extensor repair. While previous studies have evaluated the presence of intra-articular pathology in the setting of patellar or quadriceps tendon rupture, ours is the first study to the best of our knowledge to evaluate the frequency that these findings require subsequent surgery. The results of our study suggest that even if concomitant pathology is identified prior to extensor mechanism repair, very few patients will require surgery to address those additional injuries.

Extensor mechanism injury can be diagnosed based on physical exam when there is a high index of clinical suspicion.^[9] The classic clinical exam findings include pain at the knee, a palpable defect of the involved tendon, lack of knee extension strength, and extensor lag.^[9,22] If there is a clear diagnosis for an extensor mechanism injury of the knee by physical exam, many

Table 3
Associated injuries by age group.

	Age < 45 years	Age ≥ 45 years	P
Number of cases	16	51	
Medial meniscus injury	3 (18.8%)	25 (49.0%)	.064
Lateral meniscus injury	3 (18.8%)	8 (15.7%)	.716
ACL injury	4 (25.0%)	0 (0.0%)	.002
PCL injury	3 (18.8%)	0 (0.0%)	.012
MCL injury	3 (18.8%)	0 (0.0%)	.040
LCL injury	2 (12.5%)	2 (3.9%)	.239
Patellofemoral cartilage damage	4 (25.0%)	33 (64.7%)	.012
Medial cartilage damage	1 (6.2%)	28 (54.9%)	.002
Lateral cartilage damage	2 (12.5%)	17 (33.3%)	.126
Intra-articular body	1 (6.2%)	2 (3.9%)	.565
Fracture	4 (25.0%)	3 (5.9%)	.050
Bone contusion	3 (18.8%)	1 (2.0%)	.040

ACL = anterior cruciate ligament, LCL = lateral collateral ligament, MCL = medial collateral ligament, PCL = posterior cruciate ligament.

Table 4
Additional injuries by energy level.

	Low energy	High energy	P
Number of cases	50	16	
Medial meniscus	19 (38.0%)	8 (50.0%)	.577
Lateral meniscus	8 (16.0%)	3 (18.8%)	1.000
ACL	2 (4.0%)	2 (12.5%)	.245
PCL	2 (4.0%)	1 (6.2%)	1.000
MCL	2 (4.0%)	2 (12.5%)	.245
LCL	3 (6.0%)	1 (6.2%)	1.000
Patellofemoral OA*	29 (58.0%)	7 (43.8%)	.479
Medial OA	21 (42.0%)	7 (43.8%)	1.000
Lateral OA	15 (30.0%)	4 (25.0%)	1.000
Intra-articular body	2 (4.0%)	1 (6.2%)	1.000
Fracture	3 (6.0%)	3 (18.8%)	.148
Contusion	2 (4.0%)	2 (12.5%)	.245
Additional surgery	4 (8.0%)	3 (18.8%)	.347
Additional surgery minus MUA†	2 (4.0%)	1 (6.2%)	1.000

ACL = anterior cruciate ligament, LCL = lateral collateral ligament, MCL = medial collateral ligament, PCL = posterior cruciate ligament.

* Osteoarthritis.

† Manipulation under anesthesia.

clinicians will perform surgery without obtaining advanced imaging preoperatively. At our institution, over 80% of all extensor tendon repairs that took place between 2009 and 2018 did not have a preoperative MRI, a reflection of surgeon practice at the time. However, the diagnostic failure rate of physical exam has been reported as high as 50%.^[4,23–25] Ultrasound and MRI are both proven tools to confidently diagnose patellar and quadriceps tendon rupture. Preoperative MRI has the additional benefit of identifying any concomitant intra-articular knee injuries, which are not evaluated by ultrasound and might not be suspected by physical examination. Given high enough clinical suspicion, a surgeon could alternatively utilize surgical inspection or diagnostic arthroscopy at the time of extensor repair to identify concomitant intra-articular injury, however, the cost of additional arthroscopic surgery is potentially much higher than a preoperative MRI, and therefore cost considerations favor preoperative MRI evaluation over intraoperative diagnostic arthroscopy. In practice, another compelling reason for obtaining a preoperative MRI or ultrasound is that a patient may be seen in the emergent or urgent care setting, evaluated, and indicated for surgery by a different care provider than the treating surgeon. In this case, an MRI would provide an objective measure of the true extent of the patient's injury that can be utilized when the patient is handed off from diagnosing physician to treating surgeon. While these additional injuries may not be addressed at the time of patellar or quadriceps tendon repair, understanding the underlying integrity of the knee allows the surgeon to appropriately counsel patients, plan for a secondary surgery if needed, and modify postextensor tendon repair rehabilitation as concomitant injuries may be additional sources of pain, reduced range of motion and decreased stability of the knee during rehabilitation.

We found that extensor mechanism injuries were associated with internal derangements in over 50% of MRI studies, with patellar tendon injuries more frequently associated with cruciate ligament injuries. Yet only three (4.5%) patients in our series elected to have additional surgery to manage these secondary findings. Previous literature has noted the importance of MRI in diagnosing concomitant ACL and patellar tendon ruptures as an ACL tear can be missed in the clinical exam of a knee with a concurrent patellar tendon rupture.^[26] Though this is a rare combination, it is important to identify a torn ACL as this may inform future surgical planning or postoperative rehabilitation protocols if the patient does not opt to have the ACL treated. We found in our cohort that only 25% of concomitant ACL injuries went on to get an ACL reconstruction.

There have been several prior investigations of extensor mechanism injuries and concomitant intra-articular injuries that have found similar high prevalence of concomitant intra-articular pathology,^[11–19] though our findings indicate a higher prevalence than previously reported. McKinney et al retrospectively studied 64 patients (31 quadriceps tendon and 33 patellar tendon repairs) with preoperative MRI scans.^[17] They found that 30% of patellar tendon ruptures sustained associated injuries, including 18% ACL rupture, 18% medial meniscus injury, 12% lateral meniscus, 12% fracture, 6% osteochondral lesion, and 3% MCL injuries. McKinney et al also showed that of those with quadriceps tendon ruptures, 10% had concomitant knee injuries, including 3.3% ACL rupture, 3.3% medial meniscus tear, and 3.3% lateral meniscus tear.^[17] In our study, we found that of those cases with extensor mechanism ruptures 50.7% had concomitant pathology, but only 4.5% of these patients required additional surgery. Patients with cruciate ligament injuries were more likely to require additional surgery, while patients with

meniscal injuries were not. This is likely due to the frequency of pre-existing asymptomatic intra-articular findings, especially in older patients.^[27–29] Boden et al showed that there was a 13% MRI prevalence of meniscal tear in asymptomatic individuals younger than 45 years compared to 36% prevalence in individuals older than 45 years.^[27] Zanetti et al studied MRI imaging on 100 patients (mean age 42.7 years) with suspected meniscal pathology.^[29] When comparing the symptomatic knee with the asymptomatic knee, the authors found that 57% of symptomatic knees had meniscal tears versus 36% of asymptomatic knees. Of the subgroup of symptomatic patients with MRI-confirmed meniscal tears, there was a 63% prevalence of having a contralateral asymptomatic meniscal tear. Our analysis showed a 49.0% prevalence of medial meniscal tear in patients older than age 45 with extensor mechanism injury, while those younger than 45 had only an 18.8% prevalence, though this was not statistically significant ($P=.064$).

Our study group included seven patients with associated fractures (four associated with patellar tendon injury and three associated with quadriceps tendon injury), with fractures and bone contusions occurring more frequently with patellar tendon injury and in younger patients. Five of these were avulsion fractures that were managed at the time of tendon repair. One patient had a nondisplaced fracture of the fibular tip without lateral collateral ligament complex instability, which did not require fixation. The last patient had an osteochondral impaction fracture of the lateral terminal sulcus that did not require treatment. We did not have any Hoffa fractures (a coronal plane fracture of the femoral condyle) in our cohort. Hoffa fractures are an increasingly recognized phenomenon among extensor mechanism injury patients.^[30–35] These fractures are often missed as they may be difficult to view on initial radiographic imaging. Proper diagnosis and fixation are critical to the management of Hoffa fractures as they are commonly associated with nonunion, arthrofibrosis, and osteoarthritis.^[32,34]

In our study cohort, quadriceps injuries occurred in predominately older male patients compared to patellar tendon injuries. Several studies have similarly shown that quadriceps tendon injuries are more common in patients older than 40 years, while patellar injuries are more common in patients younger than 40 years.^[10] Tejwani et al studied 94 patients (99 knees) with extensor mechanism injuries treated surgically and found patients with quadriceps tendon ruptures were older (57.5 years) compared to patients with patellar tendon ruptures (41.9 years).^[7] Garner et al retrospectively studied the demographic characteristics of 726 patients with extensor mechanism injuries at the knee, and also found quadriceps tendon ruptures occurred in older patients (61 years) when compared to patellar tendon injuries (39.5 years).^[1]

The physiological mechanism for why quadriceps tendon ruptures affect older individuals is twofold. First, patients sustaining quadriceps tendon ruptures likely have underlying tendinopathy and are susceptible to injury from lower energy mechanisms. Kannus et al compared 82 quadriceps tendons that underwent previous spontaneous ruptures with 40 control quadriceps tendons.^[5] They found that 100% of spontaneous quadriceps tendon ruptures had underlying tendinopathy compared to only 35% of control quadriceps tendons. Second, patellar tendon ruptures occur in higher energy injuries and require more force before rupture. According to Huberti et al, the patellar tendon experiences the greatest amount of forces at 60 degrees of flexion.^[3] With increased knee flexion, the patellofemoral contact shifts proximally and the extensor mechanism

force ratio is less than 1.0, thus creating a mechanical advantage for the patellar tendon. Zernicke et al estimated on kinematic analysis that the patella can withstand 17.5 times one's body weight during knee flexion before rupture.^[36]

Our study had several limitations. First, the retrospective nature of this study encompassed surgeon preference, dictating whether a preoperative MRI was obtained prior to surgical extensor mechanism repair. Only 16.1% of all open repairs of extensor tendon ruptures had preoperative MRI during the study period. This reflects the practice of many surgeons in diagnosing and treating extensor tendon ruptures based on clinical exam and radiographic images alone, without obtaining advanced imaging, and also raises the possibility that the included cases were more clinically challenging and may therefore have been more likely to have additional internal derangement. The practice of obtaining preoperative MRI has changed over time in this cohort, with increasing frequency over time. Second, our study cohort represents a small sample size with a limited number of preoperative MRI studies, which may have affected our ability to determine significant associations with comorbidities and extensor tendon injuries. Finally, this study included surgeries performed by 14 surgeons, who all followed the same surgical technique as outlined above, however some technical variations could exist.

5. Conclusion

50.7% of cases with extensor mechanism injury had intra-articular pathology but only 4.5% required additional surgery. The results of our study suggest that preoperative MRI is unlikely to be of significant clinical utility in most extensor mechanism injuries but should be considered in cases of patellar tendon rupture in younger patients where the incidence of concomitant cruciate ligament injury is higher.

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