Complications in Brief

Quadriceps and Patellar Tendon Tears

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Abstract Effective treatment of knee extensor mechanism disruptions requires prompt diagnosis and thoughtful decision-making with surgical and nonsurgical approaches. When surgery is chosen, excellent surgical technique can result in excellent outcomes. Complications and failures arise from missed or delayed diagnoses and from technical problems in the operating room. In particular, inappropriate surgical timing (especially late surgery), misplaced patellar drill holes, and failure to address concomitant injuries can result in complications seen when repairing a patellar or quadriceps tendon tear. We review the complications that can occur during treatment of these injuries (Table 1).

Avoiding Major Complications

To ensure a functional extensor mechanism, adequate ROM, appropriate knee stability, and prevention of patellofemoral joint degeneration, the surgeon must exhibit a high index of suspicion for any patient unable to perform

a straight leg raise after experiencing an eccentric load. With thorough physical examination and imaging (Figs. 1, 2), the major complication of missed or delayed diagnosis and treatment can be avoided. The adage “never miss an opportunity to aspirate a knee” is true here because the surgeon may be able to distinguish between painful swelling and an extensor mechanism injury with simple aspiration and injection of local anesthetic with reexamination [4]. Once the knee is properly anesthetized by the injection, the patient with an extensor mechanism disruption will be unable to perform a straight leg raise. By contrast, a patient with a painful effusion for other reasons (such as an acute meniscus tear) should be able to perform a straight leg raise. Additionally, the contents of the aspirated effusion may assist the surgeon in making the diagnosis.

For patients who are suitable surgical candidates with complete tendon tears, it is mandatory to try to achieve primary direct repair within the first several days after the injury [3, 7, 8, 10]. MR images should be reviewed by the treating surgeon and used to direct the preoperative plan [9]. By using MRI, the surgeon may delineate the location, extent, and nature of the injury. For example, the MR images may show a simple avulsion of the patellar tendon from the inferior pole of the patella. The surgeon then may plan for a simple repair using bone tunnels or anchors [3]. By contrast, MRI may show tearing in a different location or perhaps a more significant tendinous injury prompting the surgeon to plan use of a tendon augment and discuss this possibility with the patient preoperatively.

Special attention should be paid to the patient with diabetes as failure to recognize the effects of systemic illness like diabetes and inherent poor tissue quality may lead to delayed wound and tendon healing and compromised outcomes [4]. During fixation, it is important to

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Table 1. Errors and complications in the treatment of quadriceps and patellar tendon tears

Error/complication	Clinical effect	Prevention	Detection	Remedy
Judgment errors				
Missed diagnosis: patella tendon tear	Patient seen in the emergency room, presumed to have a patella dislocation; sent home; delay in treatment leads to chronic extensor mechanism disruption, which can cause disability and be more difficult to treat	Careful history and physical examination	(1) Physical examination Infrapatellar pain Infrapatellar gap Inability to maintain full active extension Unable to perform straight leg raise Gait abnormalities: stiff knee gait or exaggerated hip elevation for swing through circumduction (2) Radiographs Abnormal patella height (alta) (3) MRI/ultrasound	Education of physicians and ancillary staff; high index of suspicion; thorough history and physical examination
Missed diagnosis: quadriceps tendon tear	Very common, especially in obese patients; delay in treatment leading to chronic extensor mechanism disruption, which can cause disability and be more difficult to treat	Careful history and physical examination	(1) Physical examination Suprapatellar pain Suprapatellar gap Inability to maintain full active extension Gait abnormalities: stiff knee gait or exaggerated hip elevation for swing through circumduction (2) Radiographs Abnormal patella height (baja) (3) MRI/ultrasound	Education of physicians and ancillary staff; high index of suspicion; thorough history and physical examination
Missed diagnosis: intact retinaculum but torn quadriceps tendon	Patient able to perform weak straight leg raise as a result of intact retinaculum, but quadriceps tendon actually completely torn; lack of power leading to altered gait and joint kinematics, joint breakdown and potential subsequent traumatic injuries	(1) Careful physical examination: check for extensor lag (2) Aspirate blood from knee and inject with lidocaine; then reexamine (3) Additional imaging: MRI	(1) Palpable defect in soft tissues proximal to patella (2) MRI	Education of physicians and ancillary staff; high index of suspicion
Missed diagnosis: multiligament knee injury, failure to recognize extensor mechanism disruption	With severe traumatic knee injuries, clinicians may focus on ligament/bony injury and may miss extensor mechanism disruption, leading to incomplete care of injuries and significant disability	(1) Careful review of imaging, particularly sagittal views (2) Thorough physical examination	(1) Palpable defect in soft tissues proximal/distal to patella (2) MRI	Education of physicians and ancillary staff; high index of suspicion; thorough history and physical examination; careful review all imaging

Table 1. continued

Error/complication	Clinical effect	Prevention	Detection	Remedy
Delayed diagnosis: delayed surgery	Operating too late after injury; tendon becomes scarred down and retracted; may be difficult to perform primary repair; may require tissue grafting and multiple surgeries	Performing surgery as soon as possible, preferably within first week		Proper detection and early management; if noted too late, consider V-Y or Scuderi technique
Incorrect diagnosis: partial tendon tear	Tendon only partially disrupted (< 10 mm separation of the tendon from bone); will heal without surgery; in one study, nonsurgical management resulted in 93% success rate [5]	(1) MRI (2) Ultrasound (3) Physical examination	(1) Patient should be able to maintain full active extension (2) Radiographs: normal patellar height	This individual can be treated nonoperatively with immobilization until the tendon has healed
Incorrect diagnosis: retinaculum torn, but quadriceps tendon intact	As long as the tendon is intact, the retinaculum should heal nonoperatively	(1) Careful physical examination (2) Aspirate blood from knee and inject with lidocaine; then reexamine (3) Additional imaging: MRI or ultrasound		
Incorrect diagnosis: inability to extend knee or perform straight leg raise, but extensor mechanism is intact	Multiple reasons: (1) Femoral nerve palsy (2) Pain (3) Intraarticular pathology: locked knee (loose body, bucket handle meniscal tear, etc)	(1) Thorough history and careful physical examination (2) Additional imaging: MRI	Consider aspiration/injection of local anesthetic and reexamination	
Potential judgment errors				
Performing definitive surgery in open injury	Consider staged procedure if contaminated wound (1) Irrigation and debridement (2) Definitive fixation	Thorough history and careful physical examination		Single stage management of contaminated or chronically open injuries potentially leads to infection and repair failure
Failure to account for diabetes	Poor tissue quality that should be accounted for. Delayed wound and tendon healing	Thorough history and careful physical examination. Tight perioperative glycemic control	Laboratory studies. Patient's glycemic history Consultation with patient's primary care provider/internal medicine	Adequate diseased tendon debridement. Delayed postoperative motion to account for expected delayed healing
Technical errors				
Positioning and preparing	(1) Supine, bump under ipsilateral hip to internally rotate lower extremity (2) Consider full muscle paralysis to aid in reduction			

Table 1. continued

Error/complication	Clinical effect	Prevention	Detection	Remedy
Inadequate exposure	Generous midline incision needed to see extent of injury (retinacular injury) and define injury pattern (midsubstance tear versus avulsion from patella)			
Failure to identify correct injury pattern: patellar tendon	Three injury patterns based on location: (1) Avulsion (with/without bone) from inferior pole patella (2) Midsubstance rupture (3) Distal avulsion from tibial tubercle	(1) Preoperative imaging (2) Adequate exposure	(1) Preoperative imaging	Correctly identifying injury pattern will dictate fixation method
Failure to identify correct injury pattern: quadriceps tendon	Three injury patterns based on location: (1) Avulsion (with/without bone) from superior pole patella (2) Midsubstance rupture (3) Mixed	(1) Preoperative imaging (2) Adequate exposure	(1) Preoperative imaging	Correctly identifying injury pattern will dictate preoperative planning and fixation method
Failure to débride patella/quadriceps tendon stump	Failure to débride scar or devascularized tissue may predispose to failure of the repair and/or chronic weakness	Rongeur scar tissue from patella		Prepare bleeding bone bed: curette or burr a trough
Failure to débride/prepare patella bone bed	Failure to débride patella bone bed may predispose to poor healing	Rongeur scar tissue from patella		Prepare bleeding bone bed: curette or burr a trough
Tendon repair: inadequate tissue for repair of midsubstance ruptures	Can be challenging, especially with severely disrupted patella tendons			Consider augmentation with contralateral hamstring autograft or allograft; role for other biologics (dermal patches, etc)?
Tendon repair: appropriate tension for midsubstance ruptures	Can be challenging, especially with severely disrupted patella tendons			Lateral radiograph of contralateral leg can help determine appropriate tension
Transosseous tendon repair: divergent tunnels	Divergent tunnels lead to asymmetric reduction of tendon to bone; may lead to poor contact and therefore poor healing or maltracking			(1) Adequate exposure of entire patella (2) Parallel pin drill guide (3) Consider use of fluoroscopy
Transosseous tendon repair: tunnel penetration into articular surface	Iatrogenic articular cartilage injury			(1) Adequate exposure of entire patella (2) Parallel pin drill guide

Table 1. continued

Error/complication	Clinical effect	Prevention	Detection	Remedy
Transosseous tendon repair: drill breakage	Broken drill bit in tunnel			<ol style="list-style-type: none"> (1) Careful drilling technique (2) Do not attempt to change direction of drill hole once started drilling (3) Do not torque drill (4) Use stout drill bit
Transosseous tendon repair: anterior placement of tunnels	May lead to downward tilting of the patella and increase patellofemoral contact forces and pain			<ol style="list-style-type: none"> (1) Place drill holes in center of patella (with respect to AP) (2) If have to cheat, cheat toward articular surface
Transosseous tendon repair: overtightening repair	May lead to patella alta or baja			<ol style="list-style-type: none"> (1) Prepare opposite leg to assist with tensioning (2) Obtain intraoperative radiograph and compare with contralateral side
Transosseous tendon repair: undertightening repair	<ol style="list-style-type: none"> (1) May lead to patella alta or baja (2) Poor tendon to bone contact may interfere with healing 			<ol style="list-style-type: none"> (1) When tying knots, make sure to remove all the slack and that the tendon is pulled snugly into patella bone trough (2) Adequate retinacular repair
Transosseous tendon repair: prominent proximal suture knots	May lead to skin irritation			<ol style="list-style-type: none"> (1) Attempt to bury knots and cover with surrounding soft tissue
Suture anchor tendon repair	<p>Advantages:</p> <ol style="list-style-type: none"> (1) Less dissection (2) Decreased surgical time (3) More accurate suture placement (4) Low profile <p>Causes:</p> <ol style="list-style-type: none"> (1) Poorly placed anchors (2) Poor bone quality (3) Weak anchors 			<ol style="list-style-type: none"> (1) Anchors should be placed in center of patella [2] (2) Not to be used in osteoporotic bone (3) Two 5.0-mm corkscrew titanium anchors (equivalent pullout to transosseous tunnels) [1]

Table 1. continued

Error/complication	Clinical effect	Prevention	Detection	Remedy
Suture anchor tendon repair: proud anchors	Proud anchors will not allow the tendon edge to be pulled into the bone trough in the patella, possibly leading to a gap at the bone-tendon junction and poor healing			Anchors should be slightly countersunk to pull tendon firmly into bone trough in patella
Failure to repair retinacular tissue	May lead to increased stress on central repair			(1) Adequate exposure (2) Suture medial and lateral retinaculum
Additional complications				
Infection	(1) Open injury (2) Comorbidities Diabetes Smoking Chronic disease			(1) Irrigation and debridement (consider delayed repair) (2) Timely administration preoperative antibiotics (3) Tight glucose control (4) Smoking cessation
Wound complications	(1) Open injury (2) Comorbidities Diabetes Smoking Chronic disease (3) Prominent sutures			(1) Irrigation and débridement (consider delayed repair) (2) Timely administration preoperative antibiotics (3) Tight glucose control (4) Smoking cessation
Nerve injury	Extremely rare			
Rehabilitation complications				
Prolonged immobilization	Leads to stiffness and decreased ROM	Intraoperative assessment of maximum flexion before gapping between bone and tendon is observed		Early ROM (10–14 days): active flexion, passive extension to limits determined intraoperatively ROM bracing locked in extension
Inadequate immobilization	(1) Wound complications (2) Failure of repair			
Overly aggressive physical therapy	Need time for tendon-to-bone healing to occur			No forced flexion or active extension in first 6 weeks

Fig. 1A–B (A) A lateral radiograph of the knee shows patella alta (Blackburne-Peel ratio > 0.8) [7, 10] in a patient with an acutely ruptured patellar tendon. (B) A sagittal proton density MR image of the knee shows the acutely ruptured patellar tendon.

Fig. 2A–B (A) A sagittal proton density with fat suppression image shows rupture of the quadriceps tendon. A portion of the vastus intermedius tendon remains intact. (B) The sagittal proton density image shows rupture of the quadriceps tendon and vastus medialis oblique.

debride any diseased tendon and nonfunctional tendon back to a healthy edge to allow for the most optimal healing [4]. Here, it also is important to ensure a secure but not overtight repair. A tendon that has been advanced too much may lead to patella alta or baja depending on the tendon being repaired and subsequent alteration in patellofemoral joint mechanics in cartilage contact pressures [7]. These changes may result in rapid development of significant patellofemoral joint breakdown and early, painful arthritis [7]. Additionally, a generous midline incision will allow for appropriate exposure ensuring the surgeon's ability to repair all injured structures, including the retinaculum [6, 8]. Judicious use of fluoroscopy can

help surgeons detect and correct malpositioned bone tunnels or anchors. After the procedure, close followup with the patient is important for successful outcomes. The surgeon should monitor the patient's adherence to postoperative restrictions and therapy protocols, and follow the patient clinically until it is clear that the patient has recovered from the procedure.

Detecting and Treating of Major Complications

Thorough examination, advanced imaging, and a high index of suspicion should yield the appropriate diagnosis [4].

However, major complications including misdiagnosis, failed repair, or infection may still occur. Misdiagnosis and failed repair are easily detected as the patient will continue with extensor mechanism dysfunction and difficulty with ambulation. Patients also may report a repeat traumatic episode wherein the knee “gave way”. Delayed or failed repair may be the result of infection which may be detected by standard means such as laboratory studies and knee aspiration. When complications arise, the surgeon needs to diagnose them promptly and treat them effectively. Appropriate preoperative planning as discussed above can help avoid these issues. In the event of a misdiagnosis leading to delayed management or a failed repair, the surgeon may still be able to salvage a competent extensor mechanism. Although full discussion of this topic is outside the scope of this article, in brief, the surgeon may consider the use of semitendinosus/gracilis autografts or allografts as augments to revision repair. Additionally, techniques such as a V-Y advancement or quadriceps turndown have been described for treatment of failed or chronic, retracted quadriceps tendon ruptures [4, 7].

Summary

Adequate repair of the quadriceps and patellar tendons to the patella is essential for a functional extensor mechanism. Too often, these injuries are missed as a result of inadequate suspicion of injury or confusion with other potential knee injuries. A careful examination combined with imaging can detect these injuries, which should be repaired promptly if the patient is a suitable surgical candidate in

other respects to provide the most optimal outcomes. In the event of delayed presentation, retraction of the quadriceps tendon yields a challenging reconstruction problem often necessitating the use of allograft and advanced reconstruction techniques with less predictable results. Every effort should be made to avoid missing this diagnosis.

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