Patella Fracture and Extensor Mechanism Injuries

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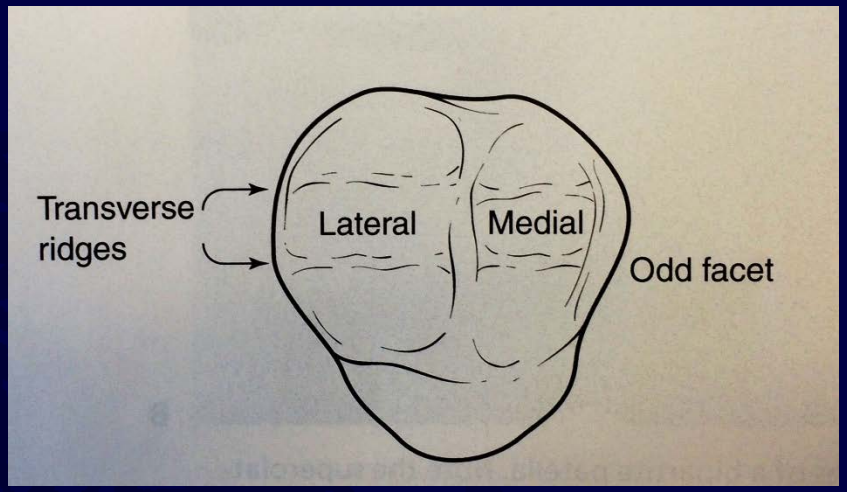
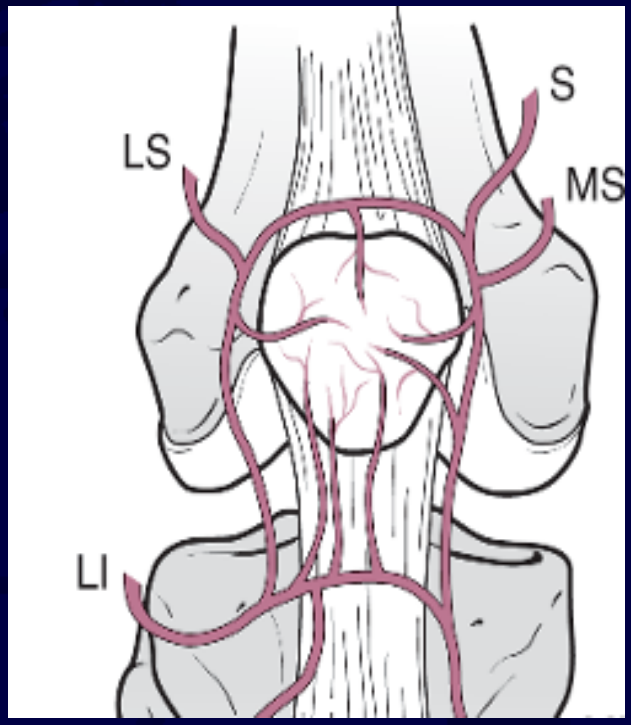
Anatomy



- Patella
  - Largest sesamoid bone
  - Triangular shape (apex distal)
  - Distal pole - patellar tendon origin
  - Proximal pole – quadriceps insertion
  - Proximal ¾ covered with articular cartilage
  - Medial/lateral facets: Lateral is typically larger

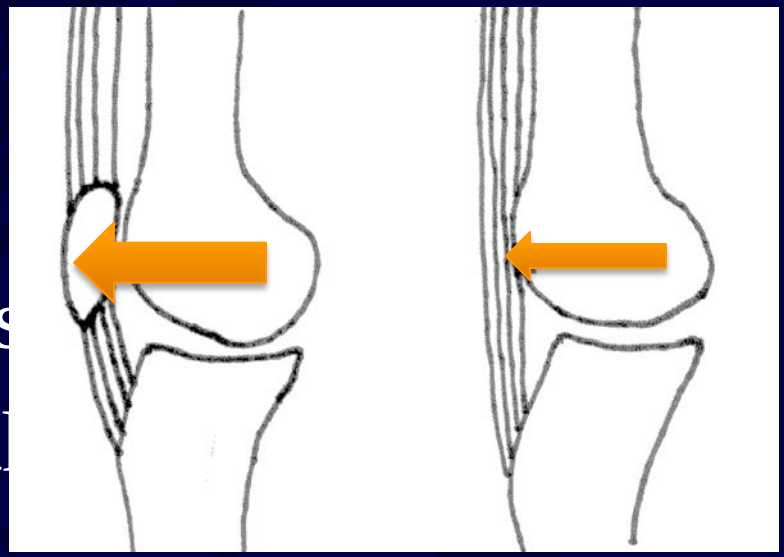
Anatomy

- Arterial Blood Supply
  - Extraoseous anastomotic ring of vessels
  - Central superior geniculate
  - Medial and lateral inferior / superior geniculate
  - Inferior recurrent tibial
- Main portion of blood supply from anterior body and inferior pole



Biomechanics

- Patella increases extensor power by 30 % (full extension)
- Small surface contact areas
- Contact pressures high with knee flexion



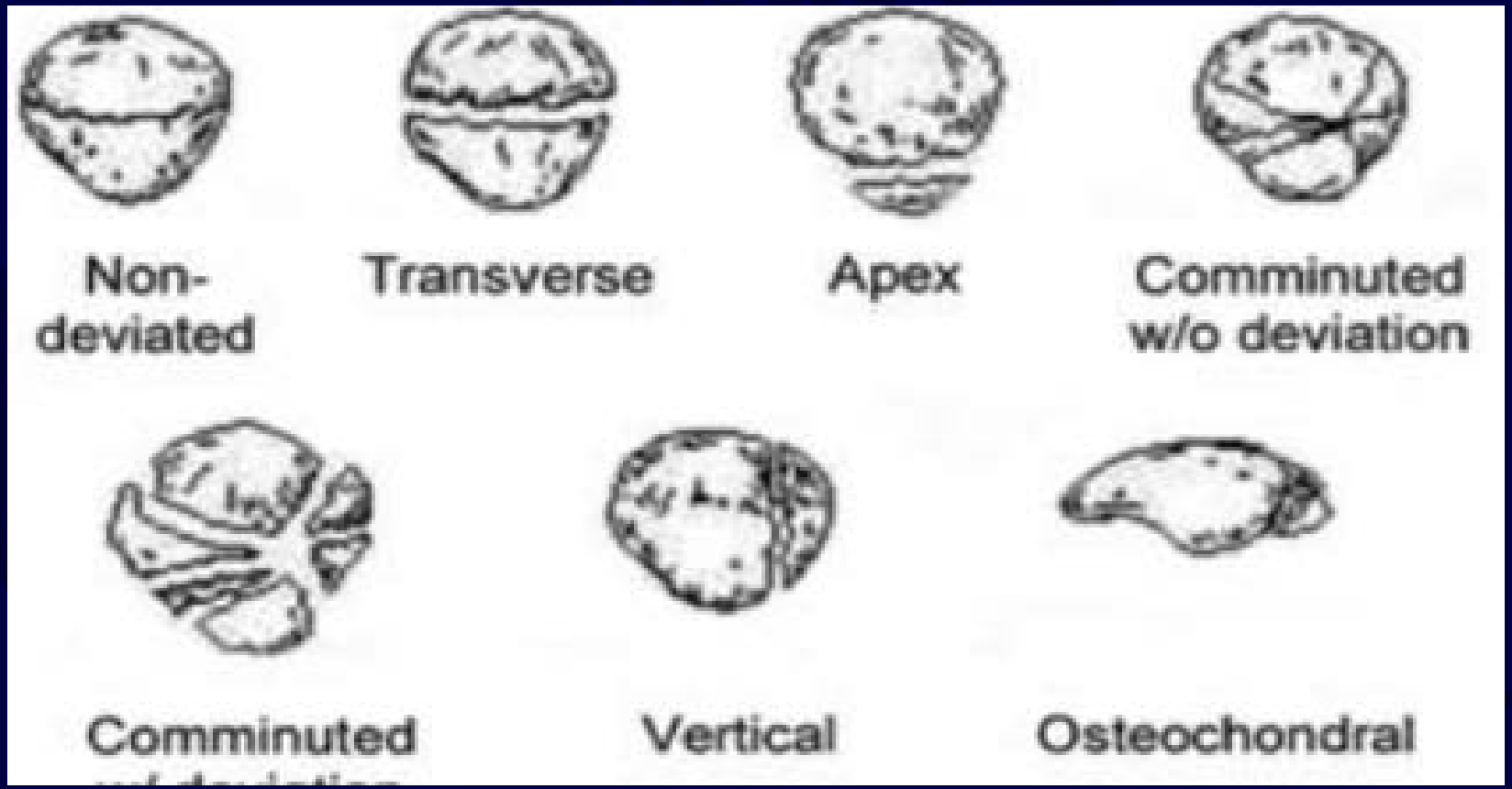
Mechanism of Injury

- Direct anterior blow
  - Typically with knee flexed
  - Failure in compression
  - Often comminuted
  - Extensor mechanism may be intact
- Indirect mechanism
  - Forceful extensor mechanism contraction that exceeds patellar tensile strength
  - 2 part transverse fracture

Diagnosis

- History
- Palpation
- Effusion
- Inability to extend knee
  - Ability to extend knee does not rule out fracture
- X-ray (lateral view most helpful)

Classification



Treatment

- Goals
  - Maintain biomechanical/functional integrity
  - Restoration of articular congruity
- Treatment options
  - Non operative
  - ORIF
  - Partial/complete patellectomy

Non-operative Treatment

- Minimal articular displacement
- Intact extensor retinaculum
- Long leg / cylinder cast in extension
  - Typically 4-6 weeks

Operative Treatment

- Anterior tension band wiring
- Circumferential wiring (comminuted fractures)
- Lag screw fixation
- Combination of lag screws and tension band wiring

Standard Midline Approach

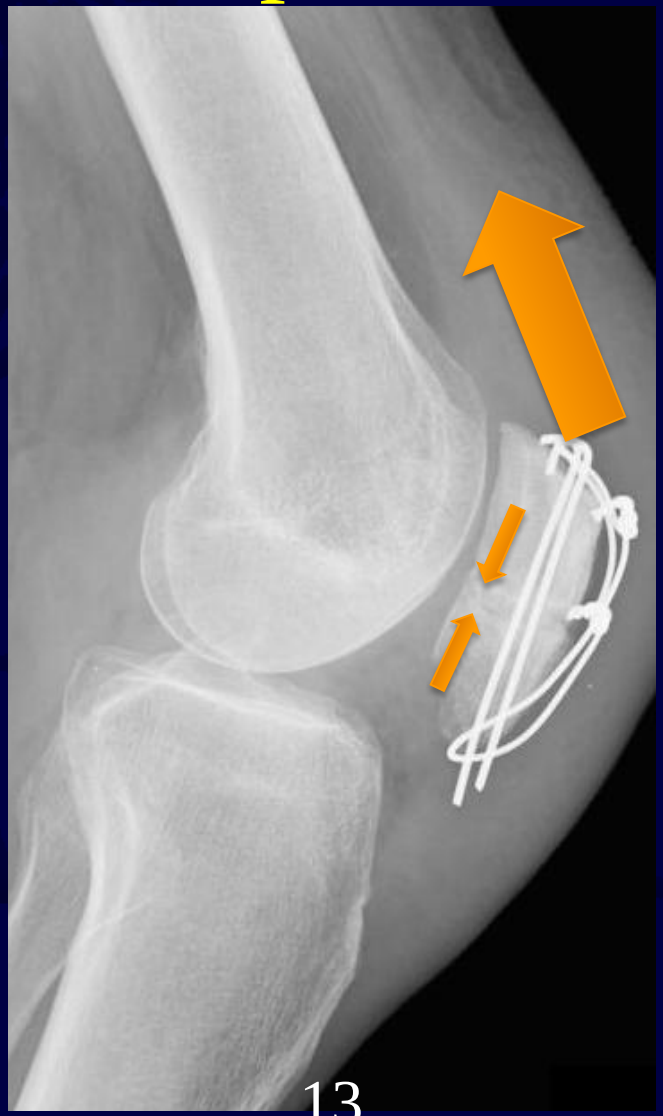
- Dissect medial and lateral to expose and repair torn retinaculum
- Dissect 2 mm of periosteum from edge of fracture
- Reduction is judged based on anterior cortex
  - May not be reliable if there is comminution or coronal injury of subchondral surface

Extensile medial parapatellar approach

- Indicated for comminuted fractures
- Evert patella
- Allows direct visualization of articular surface

Tension Band Biomechanical Principle

- Distractive forces of quadriceps contracture produces compression along articular surface



Biomechanical Evaluation

- Compared 3 methods of transverse patella fixation in 18 cadaveric specimens
  - Modified anterior tension band wiring
  - Two lag screws
  - Cannulated screws and tension band
- Cannulated lag screw with tension band wiring stronger than routine anterior tension band
- Less articular surface displacement with lag screws

Carpenter JE, et al. Biomechanical evaluation of current patella fracture fixation techniques. J Orthop Trauma. 1997 Jul;11(5):351-6.

Treatment

- Partial Patellectomy
  - One large fragment
  - Other fragments comminuted

Partial Patellectomy

- Retrospective study of 40 patients
- Average f/u 8.4 years
- Isokinetic quad strength 85 % of unaffected side
- Active ROM 94 % of unaffected side
- 78 % good or excellent

Saltzman CL, et al. Results of treatment of displaced patellar fractures by partial patellectomy. J Bone Joint Surg Am. 1990 Oct;72(9):1279-85

Partial Patellectomy

- Only variable to affect outcome was initial fracture configuration
- No threshold size for remaining patellar fragment

Saltzman CL, et al. Results of treatment of displaced patellar fractures by partial patellectomy. J Bone Joint Surg Am. 1990 Oct;72(9):1279-85

Complete Patellectomy

- Avoid if possible
  - Only in cases of unsalvageable fractures/failed ORIF that can not be salvaged
  - Low patient satisfaction (6 – 25 %)
  - Extensor strength reduced by 50 %
  - Loss of motion average 18 degrees

Complications

- Retrospective review of 51 patella fractures treated with tension band wiring and early motion
  - 22 % (11) Displacement > 2 mm
  - Technical errors in 5 cases
  - Patient noncompliance in 8 cases

Smith ST, et al. Early complications in the operative treatment of patella fractures. J Orthop Trauma. 1997 Apr;11(3):183-7

Surgical Tactic

Position: Supine. Consider bump under ipsilateral hip. Fluoroscopy from contralateral side.

Table: Radiolucent table or radiolucent extension.

Consider foregoing tourniquet use as may tether quadriceps and interfere with reduction.

Implants: 1.6 mm K-wires or 4.0-mm cannulated screws. 18-guage wire. Mini-fragment screws/plates for comminuted fractures.

Large Weber tenaculum for reduction.

Post-op Management

- Multiple protocols exist
  - Early motion is preferred
  - Initial range of motion based on intra-operative evaluation that does not put fixation/repair at risk
  - Systematically increase knee motion in a controlled fashion
  - Weight bearing with knee in extension
    - Drop lock hinged knee brace
    - Cylinder cast if patient not dependable

Outcomes

- At Mean follow up 6.5 years after ORIF for patella fracture
  - Incidence of implant removal: 52%
  - Implant related pain: 38%
  - 20% of patients with extensor lag >5 degrees
  - 53% with decreased Range of motion
    - Terminal flexion more affected than extension
  - 30% decreased strength compared to un-injured extremity

Outcomes

- Most patients score worse on patient related outcome tools when compared to population norms.
  - SF-36: Differences in physical component score only
  - KOOS: Differences exist for all subscales

LeBrun CT, Langford JR, Sagi HC. Functional Outcomes After Operatively Treated Patella Fractures. J Orthop Trauma. 2012 Jul;26(7):422-6.

Extensor Mechanism Injuries

- Anatomy
  - Extensor Mechanism comprises the quadriceps tendon, patella and patellar tendons
  - Quadriceps Tendon
    - Trilaminar organization
      - Superficial: Rectus Femoris
      - Intermediate: Medialis/lateralis
      - Deep: Vastus Intermedius

Leib F, Perry J. Quadriceps function. J Bone Joint Surg Am.1968;50-A:1535-1548

Extensor Mechanism Injuries

- Anatomy
  - Patellar Retinaculum and IT band
    - Secondary Extensors
- Patellar Tendon
  - Continuation of the central fibers of the rectus femoris tendon

Extensor Mechanism Injuries

- Mechanism of Injury
  - Forceful quadriceps contraction/load with knee in flexed position
  - Fall from height, motor vehicle accident
  - Be aware that lower energy mechanism may exist with elderly/medical co-morbidities.

Extensor Mechanism Injuries

- Diagnosis
  - History
    - Prodromal symptoms
    - History of systemic disease (i.e. renal disease)
    - History steroid use
    - Pain with associated tearing/popping sensation
    - Inability to bear weight except with knee completely extended.

Extensor Mechanism Injuries

- Physical Exam
  - Tenderness over quadriceps/patellar tendon
  - Palpable defects
  - Inability to actively extend knee or maintain extension.
    - May still be possible with intact retinaculum

Extensor Mechanism Injuries

- Radiographic
  - Insall ratio
  - Patellar tendon : Patella
  - > 1.2 is abnormal
- Inferior pole of patella typically projects to Blumensaat's line

Extensor Mechanism Injuries

- Other Modalities
  - Ultrasound
  - MRI useful for
    - Neglected tears- Degree of retraction/Status of tissue available for repair
    - Partial Injuries- Determine amount of extensor mechanism remaining in continuity.

Extensor Mechanism Injuries

- Treatment
  - Goals: Restore active knee extension

- Treatment Options
  - Non operative
  - Operative
    - Repair
    - Reconstruction

Extensor Mechanism Injuries

- Non Operative Management
  - Indications
    - Unacceptable medical risk
    - Functionally intact extensor mechanism
      - i.e. Partial disruptions
  - Contraindications
    - Associated overlying soft tissue injury/open injury
    - Significant extensor lag/loss of active knee extension

Extensor Mechanism Injuries

- Non Operative Management
  - Poor long term results due to gait dysfunction
  - Stiff-knee gait, circumduction
  - Knee buckling
  - Difficulty with stairs

Extensor Mechanism Injuries

- Operative Treatment
  - Indications
    - Loss of extensor mechanism function in patient with acceptable medical risk
- Options-Acute
  - Primary Repair
    - Multiple techniques described

Extensor Mechanism Injuries

- Techniques
  - End to end suture
  - Suture/Drill holes
  - Suture Anchor
  - Suture with turndown flap

Primary Quadriceps repair utilizing suture-transosseous tunnel technique

Surgical Tactic

- Suture-Transosseous tunnel technique
  - Position: Supine
  - Implants/Instruments: 2.0 mm drill, Suture passer, Heavy nonabsorbable suture
  - Technique:
    - Anterior incision. Full thickness flaps to allow visualization of medial/lateral retinaculum.
    - Suture placed in distal quadriceps utilizing krackow or other locking type suture configuration. Two sutures, leaving four free “tails” distally.
    - Three transosseous tunnels drilled in either antegrade or retrograde fashion through patella.
    - Previously placed sutures shuttled through tunnels and tied distally at inferior pole of patella

Biomechanical Evaluation

- Transosseous tunnels and suture anchor repair of extensor mechanism injuries have been shown to be roughly equivalent

Hart ND, et al. Quadriceps tendon rupture: a biomechanical comparison of transosseous equivalent double-row suture anchor versus transosseous tunnel repair. J Knee Surg. 2012 Sep;25(4):335-9

Lighthar WA, et al. Suture anchor versus suture through tunnel fixation for quadriceps tendon rupture: a biomechanical study. Orthopedics. 2008 May;31(5):441

Chronic Extensor Mechanism Injuries

- Autograft/allograft reconstruction or augmentation
  - Poor tissue/>3 cm gap present
- V-Y turndown Flap
  - Helpful when <3 cm gap is present

Extensor Mechanism Injuries

- Outcomes
  - Acute Quadriceps tendon
    - Generally 80-100% good to excellent results (10-18)
  - Acute Patellar Tendon Repair
    - 70-100% Good to Excellent results
    - Chronic Repair
    - Expect 10-20 degrees of extensor lag with active extension

Ramsey RH, Muller GE. Quadriceps tendon rupture: A diagnostic trap. Clin Orthop. 1970;70:161-164

Surgical Tactic

Position: Supine. Consider bump under ipsilateral hip.

Consider foregoing tourniquet use as may tether quadriceps and interfere with mobilization of the quadriceps, particularly for chronic disruptions.

Repair: Primary repair with heavy non-absorbable suture. Consider suture anchor for distal patellar tendon avulsion. Consider augmentation with heavy non-absorbable suture/tape in cerclage fashion.

For quadriceps tear consider turn down flap with smaller gaps. Allograft/Autograft reconstruction may be necessary for larger gaps. Be prepared to do both when dealing with chronic tears. Chronic patellar tendon disruption more likely to require reconstruction as soft tissue mobilization more limited.

Extensor Mechanism Injuries

- Post Operative Management
  - Immobilize in extension during initial post operative period
    - Longer for chronic/tenuous repairs
  - Weight bearing with knee in extension
    - Brace/Cast
  - Systematically increase knee motion
  - Active knee extension /strengthening is high risk

Extensor Mechanism Injuries

- Complications
  - Infection
  - Knee stiffness
  - Loss of terminal extension
    - Typically <10 degrees

Summary

- Operative treatment indicated for most patients with loss of extensor mechanism and acceptable medical risk
- Goal is congruent articular surface with stable fixation to permit early range of motion
- Critically evaluate repair in the operating room to guide allowable initial knee flexion

Summary

- Allow early weight bearing with knee braced in extension
- Communicate post operative rehabilitation plan clearly to patients and therapists
- Counsel patients regarding: weakness, extensor lag, and implant irritation

- For questions or comments, please send to ota@ota.org