



Proximal-Distal Extensor Mechanism Realignment Rehabilitation Protocol*

This rehabilitation protocol is designed for patients who undergo an isolated proximal-distal extensor mechanism realignment procedure*. Excluded are patients who also undergo major concomitant operative procedures including ligament reconstruction.

The protocol is divided into 6 phases according to postoperative weeks (for instance, Phase I = Postoperative Weeks 1-2). Each phase has several categories including:

- *General observation* of the patient's condition (weight bearing, pain, hemarthrosis, muscle control)
- *Evaluation* of specific variables with *goals* identified for each
- Treatment and exercise program, according to *frequency* and *duration*
- *Rehabilitation goals* which must be achieved to enter into the next phase

The **overall goals** of the reconstruction and rehabilitation are to:

- Control joint pain, swelling, hemarthrosis (minimal or none)
- Regain normal knee flexion and extension
- Regain a normal gait pattern and neuromuscular stability for ambulation
- Regain normal quadriceps, hamstring lower extremity muscle strength
- Regain normal proprioception, balance, and coordination for desired activities
- Achieve optimal functional outcome based on orthopaedic and patient goals

The supervised rehabilitation program is supplemented with a *home self-management program* which the patient performs on a daily basis. The therapist must evaluate the patient thoroughly to implement the enclosed protocol and should see the patient in the clinic for therapeutic procedures and modality treatments which are required for rehabilitation. The majority of this protocol can be accomplished at home provided patient cooperation and follow through are present. The approximate number of rehabilitation visits required for each phase are provided. Additional supervision may be required if a complication develops.

Important postoperative signs to monitor include:

- Swelling of the knee joint or soft tissues
- Abnormal pain response
- Abnormal gait pattern with or without assistive device
- Insufficient flexion or extension motions, limited patellar mobility
- Weakness (strength/control) of the lower extremity, especially the quads/hamstrings
- Insufficient lower extremity flexibility
- Early increased medial patellar instability (greater than 50% width)

*The surgical technique utilizes internal fixation of the distal tibial tubercle osteotomy which allows early motion and weightbearing to the operated leg. Specific details include an Elmslie-Trillat tibial tubercle medial displacement with a bony buttress proximally (tibial tubercle 8 mm thick, abutts against osteotomy site), distal periosteum tibial tubercle left intact, and cancellous screw internal fixation. The proximal advancement involves prevention against overtightening, with full ROM demonstrated after suture placement. This allows for early postoperative function and prevents loss of the surgical correction.

The patient is placed into one of four **sports activity** and **occupational activity categories** based on the following scales. It is expected that patients who follow this protocol desire to return to sports activity levels I or II, or very heavy/heavy occupations.

1. Cincinnati Knee Rating System Sports Activity Scale

(check one)

- Level I - jumping, hard pivoting, cutting sports (basketball, volleyball, football, gymnastics, soccer)
- Level II - running, twisting, turning (tennis, racquetball, handball, ice/field hockey, skiing, wrestling)
- Level III - light recreational sports (bicycling, swimming - no running, twisting, jumping)
- Level IV - no sports, activities of daily living only

2. Cincinnati Knee Rating System Occupational Rating Scale

Factor 1 sitting	Factor 2 standing/ walking	Factor 3 walking on uneven ground	Factor 4 squatting	Factor 5 climbing	Factor 6 lifting/ carrying	Factor 7 pounds carried
0 <input type="checkbox"/> 8-10 hrs/day	0 <input type="checkbox"/> 0 hrs/day	0 <input type="checkbox"/> 0 hrs/day	0 <input type="checkbox"/> 0 times/day	0 <input type="checkbox"/> 0 times/day	0 <input type="checkbox"/> 0 times/day	0 <input type="checkbox"/> 0-5 lbs
1 <input type="checkbox"/> 6-7 hrs/day	2 <input type="checkbox"/> 1 hrs/day	2 <input type="checkbox"/> 1 hrs/day	1 <input type="checkbox"/> 1-5 times/day	2 <input type="checkbox"/> 1 flight 2 times/day	1 <input type="checkbox"/> 1-5 times/day	1 <input type="checkbox"/> 6-10 lbs
2 <input type="checkbox"/> 4-5 hrs/day	4 <input type="checkbox"/> 2-3 hrs/day	4 <input type="checkbox"/> 2-3 hrs/day	2 <input type="checkbox"/> 6-10 times/day	4 <input type="checkbox"/> 3 flights 2 times/day	2 <input type="checkbox"/> 6-10 times/day	2 <input type="checkbox"/> 11-20 lbs
3 <input type="checkbox"/> 2-3 hrs/day	6 <input type="checkbox"/> 4-5 hrs/day	6 <input type="checkbox"/> 4-5 hrs/day	3 <input type="checkbox"/> 11-15 times/day	6 <input type="checkbox"/> 10 flights/ ladders	3 <input type="checkbox"/> 11-15 times/day	3 <input type="checkbox"/> 21-25 lbs
4 <input type="checkbox"/> 1 hrs/day	8 <input type="checkbox"/> 6-7 hrs/day	8 <input type="checkbox"/> 6-7 hrs/day	4 <input type="checkbox"/> 16-20 times/day	8 <input type="checkbox"/> ladders with weight 2-3 days/week	4 <input type="checkbox"/> 16-20 times/day	4 <input type="checkbox"/> 26-30 lbs
5 <input type="checkbox"/> 0 hrs/day	10 <input type="checkbox"/> 8-10 hrs/day	10 <input type="checkbox"/> 8-10 hrs/day	5 <input type="checkbox"/> > 20 times/day	8 <input type="checkbox"/> ladders daily with weight	5 <input type="checkbox"/> > 20 times/day	5 <input type="checkbox"/> > 20 lbs

_____ points x 2 = _____ total points

Occupation Rating

Total Points

- Disabled 0
- Very light 1-20
- Light 21-40
- Moderate 41-60
- Heavy 61-80
- Very heavy > 80

Physical Therapy Visit Timeline*

Phase	Weeks Postoperative	Minimum # Visits	Maximum # Visits
1	1-2	2	4
2	3-4	2	4
3	5-6	1	2
4	7-8	1	2
5	9-12	1	2
6	13-26	4	7
Total		11	21

*Physician Notification

The physician will be notified if the patient (1) fails to meet the expected goals for each phase of the protocol, (2) has a persistent joint effusion, (3) develops a chronic pain syndrome, (4) demonstrates quadriceps shutdown or severe insufficiency, (5) has difficulty with ambulation, or (6) has a limitation of knee motion or patellar mobility.

These problems could result in a modification of this protocol and necessitate further visits to the physical therapist.

Discharge Criteria (If goals for sports and occupation place patient into different categories, use category with highest functional demand criteria. For symptoms, use Symptom Rating Form found on next page.)

*Sports Activity Level I or Heavy/Very Heavy Occupational Rating**

No pain, swelling, giving-way with level 10 on Symptom Rating Form

KT-2000 < 3 mm (I-N, 134 N, total A/P)

Biodex strength testing: quadriceps & hamstrings strength \geq 85% of opposite limb

Function testing: 2 hop tests, limb symmetry \geq 85%

*Sports Activity Level II or Moderate Occupational Rating**

No pain, swelling, giving-way with level 8 on Symptom Rating Form

KT-2000 < 3 mm (I-N, 134 N, total A/P)

Biodex strength testing: quadriceps & hamstrings strength \geq 80% of opposite limb

Function testing: 2 hop tests, limb symmetry \geq 85%

Sports Activity Level III or Light Occupational Rating

No pain, swelling, giving-way with level 6 on Symptom Rating Form

KT-2000 3-5 mm (I-N, 134 N, total A/P)

Biodex strength testing: quadriceps & hamstrings strength \geq 70% of opposite limb

Function testing: 2 hop tests, limb symmetry \geq 75%

Sports Activity Level IV (ADL) or Very light Occupational Rating

No pain, swelling, giving-way with level 4 on Symptom Rating Form

KT-2000 3-5 mm (I-N, 134 N, total A/P)

Biodex strength testing: quadriceps & hamstrings strength < 70% of opposite limb

Function testing: 2 hop tests, limb symmetry < 75%

*patients desiring to return to sports or strenuous work activities may require 4-6 more physical therapy visits during postoperative weeks 25-52 for advanced neuromuscular, strength, and activity-specific training to prevent reinjury.

Cincinnati Knee Rating System Symptom Rating Form

Scale	Description
10	Normal knee, able to do strenuous work/sports with jumping, hard pivoting
8	Able to do moderate work/sports with running, turning and twisting; symptoms with strenuous work/sports
6	Able to do light work/sports with no running, twisting or jumping; symptoms with moderate work/sports
4	Able to do activities of daily living alone; symptoms with light work/sports
2	Moderate symptoms (frequent, limiting) with activities of daily living
0	Severe symptoms (constant, not relieved) with activities of daily living

1. PAIN (circle one)

10 — 8 — 6 — 4 — 2 — 0

2. SWELLING (circle one)

10 — 8 — 6 — 4 — 2 — 0

3. PARTIAL GIVING-WAY (circle one) (partial knee collapse, no fall to the ground)

10 — 8 — 6 — 4 — 2 — 0

4. FULL GIVING-WAY (circle one) (knee collapse occurs with actual falling to the ground)

10 — 8 — 6 — 4 — 2 — 0

Return to Activities Warning

Return to strenuous activities after proximal-distal extensor mechanism realignment carries the definite risk of a overuse injury or the potential of compounding prior articular cartilage changes. These risks cannot always be scientifically assessed. Patients are warned to return to athletic activities carefully and to avoid any activity in which symptoms of pain, swelling, or a feeling of instability are present. Return to strenuous activities are only allowed in patients that have normal articular cartilage in the patellofemoral joint. Those with abnormal cartilage changes are encouraged to return to only light recreational activities.

References

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- Noyes FR, Moor LA, and Barber SD: The assessment of work-related activities and limitations in knee disorders. Am J Sports Med 19: 178-188, 1991.
- Noyes FR, Mangine RE, and Barber SD: The early treatment of motion complications following anterior cruciate ligament reconstruction. Clin Orthop Rel Res 277: 217-228, 1992.
- Barber SD, Noyes FR, Mangine RE, McCloskey JW, and Hartman W: Quantitative assessment of functional limitations in normal and anterior cruciate ligament-deficient knees. Clin Orthop Rel Res 255: 204-214, 1990.
- Noyes FR, Barber SD, and Mangine RE: Abnormal lower limb symmetry determined by function hop tests after anterior cruciate ligament rupture. Am J Sports Med 19: 513-518, 1991.



Cincinnati SportsMedicine and Orthopaedic Center Rehabilitation Protocol Summary for Proximal-Distal Extensor Mechanism Realignment

	Postoperative Weeks			Postop Months	
	1-4	5-8	9-12	4-6	7-12
Brace: Bledsoe postoperative Patellar (optional, symptoms)	X	X	X	X	X
Range of motion minimum goals: 0°-90° 0°-110° 0°-135°	X X	X			
Weight bearing: 1/4 body weight Full	X X				
Patella mobilization	X	X			
Modalities: Electrical muscle stimulation (EMS) Biofeedback Pain/edema management (cryotherapy)	X X X	X X X			
Stretching: Hamstring, gastroc-soleus, iliotibial band, quadriceps	X	X	X	X	X
Strengthening: Quad isometrics, straight leg raises, Active knee extension Closed-chain: gait retraining, toe raises, wall sits, mini-squats Knee flexion hamstring curls (90°) Knee extension quads (90°-30°) Hip abduction-adduction, multi-hip Leg press (70°-10°)	X X X X X	X X X X X X X	 X X X X X	 X X X X	 X X X X
Balance/proprioceptive training: Weight-shifting, mini-trampoline, BAPS, KAT, plyometrics	X	X	X	X	X
Conditioning: UBE Bike (stationary) Water walking Swimming (kicking) Walking Ski machine	X	X X X X	 X X X	 X X X X	 X X X X
Running: straight			X*	X	X
Cutting: lateral carioca, figure 8's			X*	X	X
Full sports			X*	X	X

*only for patients with normal articular cartilage in the patellofemoral joint

BAPS = Biomechanical Ankle Platform System (Camp, Jackson, MI), KAT = Kinesthetic Awareness Trainer (Breg, Inc., Vista, CA), UBE = upper body ergometer.

Cincinnati SportsMedicine and Orthopaedic Center Rehab Protocol: EM Realignment
Phase 1. Weeks 1-2 (Visits: 2-4)

General Observation	<ul style="list-style-type: none"> ■ Toe-touch to 25% weight bearing when: <ul style="list-style-type: none"> - Pain controlled - Hemarthrosis controlled - Voluntary quadriceps contraction achieved 	
Evaluation	<ul style="list-style-type: none"> ■ Pain ■ Hemarthrosis ■ Patellar mobility ■ ROM minimum ■ Quadriceps contraction & patella migration ■ Soft tissue contracture 	<p align="center">Goals</p> Controlled Mild Good 0°-90° Good None
<p>Frequency 3-4 x/day 10 minutes</p> <p>3 x/day 15 minutes</p> <p>3 x/day 5 minutes</p> <p>As required</p>	<p>Range of motion ROM (0°-90°) Patella mobilization Ankle pumps (plantar flexion with resistance band) Hamstring, gastroc-soleus stretches</p> <p>Strengthening Active quadriceps isometrics Active hip adductor isometrics Knee extension (active-assisted)</p> <p>Balance training Weight shift side/side and forward/back Cup walking with crutches</p> <p>Modalities Electrical muscle stimulation Biofeedback Cryotherapy</p>	<p align="center">Duration</p> 5 reps x 30 secs 1 set x 10 reps 1 set x 10 reps 3 sets x 10 reps 5 sets x 10 reps 20 minutes 10 minutes 20 minutes
Goals	<ul style="list-style-type: none"> ■ ROM 0°-90° ■ Adequate quadriceps contraction ■ Control inflammation, effusion 	

Cincinnati SportsMedicine and Orthopaedic Center Rehab Protocol: EM Realignment
Phase 2. Weeks 3-4 (Visits: 2-4)

General Observation	<ul style="list-style-type: none"> ■ Full weight bearing when: <ul style="list-style-type: none"> - Pain controlled - Hemarthrosis controlled - Voluntary quadriceps contraction achieved 	
Evaluation	<ul style="list-style-type: none"> ■ Pain ■ Effusion ■ Patellar mobility ■ ROM minimum ■ Quadriceps contraction & patella migration ■ Soft tissue contracture 	<p align="center">Goals</p> Controlled Mild Good 0°-110° Good None
<p>Frequency 3-4 x/day 10 minutes</p> <p>2-3 x/day 20 minutes</p> <p>3 x/day 5 minutes</p> <p>2 x/day 10 minutes</p> <p>As required</p>	<p>Range of motion ROM (passive, 0°-110°) Patella mobilization Ankle pumps (plantar flexion with resistance band) Hamstring, gastroc-soleus stretches</p> <p>Strengthening Isometric training: multi-angle (0°, 60°) Active hip adductor isometrics Straight leg raises (flexion, extension, adduction) Active knee extension Calf raises Closed-chain <ul style="list-style-type: none"> - Wall sits - Mini-squats (0°-30°) Knee extension (PRE, 90°-30°, patellofemoral precautions) Hamstring curls (0°-90°)</p> <p>Balance training Weight shift side/side and forward/back Balance board, 2-legged Cup walking</p> <p>Aerobic conditioning UBE</p> <p>Modalities Electrical muscle stimulation Biofeedback Cryotherapy</p>	<p align="center">Duration</p> 5 reps x 30 secs 1 set x 10 reps 1 set x 10 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps to fatigue 3 sets x 20 reps 3 sets x 10 reps 3 sets x 10 reps 5 sets x 10 reps 20 minutes 10 minutes 20 minutes
Goals	<ul style="list-style-type: none"> ■ ROM 0°-110° ■ Muscle control ■ Control inflammation, effusion ■ Full weight bearing 	

Cincinnati SportsMedicine and Orthopaedic Center Rehab Protocol: EM Realignment
Phase 3. Weeks 5-6 (Visits: 1-2)

General Observation	<ul style="list-style-type: none"> ■ Full weight bearing when: - Pain controlled without narcotics - Hemarthrosis controlled - ROM 0°-135° - Muscle control throughout ROM 	
Evaluation	<ul style="list-style-type: none"> ■ Pain ■ Effusion ■ Patellar mobility ■ ROM ■ Muscle control ■ Inflammatory response 	<p align="center">Goals</p> <p>Mild/No RSD Minimal Good 0°-135° 3/5 None</p>
<p>Frequency</p> <p>3 x/day 10 minutes</p> <p>2 x/day 20 minutes</p> <p>3 x/day 5 minutes</p> <p>2 x/day 10 minutes</p> <p>As required</p>	<p>Range of motion</p> <p>ROM (passive, 0°-135°) Patella mobilization Hamstring, gastroc-soleus stretches</p> <p>Strengthening</p> <p>Straight leg raises (ankle weight, not to exceed 10% of body weight) Isometric training: multi-angle (90°, 60°, 30°) Closed-chain</p> <ul style="list-style-type: none"> - Toe raises - Mini-squats (0°-30°) - Wall sits <p>Knee extension (patellofemoral precautions) Hamstring curls (0°-90°) Multi-hip machine (flexion, extension, abduction, adduction) Leg press (70°-10°)</p> <p>Balance Training</p> <p>Balance board/2-legged</p> <p>Aerobic conditioning UBE</p> <p>Modalities</p> <p>Electrical muscle stimulation Biofeedback Cryotherapy</p>	<p align="center">Duration</p> <p>5 reps x 30 secs</p> <p>3 sets x 10 reps 2 sets x 10 reps</p> <p>3 sets x 20 reps 3 sets x 20 reps to fatigue x 3</p> <p>3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps</p> <p>5 sets x 10 reps</p> <p>20 minutes 10 minutes 20 minutes</p>
Goals	<ul style="list-style-type: none"> ■ ROM 0°-135° ■ Control inflammation, effusion ■ Muscle control ■ Early recognition complications (motion loss, RSD, patellofemoral changes) ■ Full weight bearing 	

Cincinnati SportsMedicine and Orthopaedic Center Rehab Protocol: EM Realignment
Phase 4. Weeks 7-8 (Visits: 1-2)

General Observation	<ul style="list-style-type: none"> ■ Full weight bearing when: - Pain controlled - Hemarthrosis controlled - ROM 0°-135° - Voluntary quad contraction achieved 	
Evaluation	<ul style="list-style-type: none"> ■ Pain ■ Effusion ■ Patellar mobility ■ ROM ■ Muscle control ■ Inflammatory response 	<p align="center">Goals</p> <p>Mild/No RSD Minimal Good 0°-135° 4/5 None</p>
<p>Frequency</p> <p>2 x/day 10 minutes</p> <p>2 x/day 20 minutes</p> <p>3 x/day 5 minutes</p> <p>1-2 x/day 15 minutes</p> <p>As required</p>	<p>Range of motion ROM (0°-135°) Patella mobilization Hamstring, gastroc-soleus stretches</p> <p>Strengthening Straight leg raises (flexion, extension, adduction) Straight leg raises, rubber tubing Hamstring curls (0°-90°) Knee extension with resistance (90°-30°) Leg press (70°-10°) Closed-chain - Toe raises - Wall sits - Mini-squats (rubber tubing, 0°-30°) Multi-hip machine (flexion, extension, abduction, adduction)</p> <p>Balance training Balance board/2-legged</p> <p>Aerobic conditioning UBE Water walking Walking Ski machine (short stride, level, low resistance)</p> <p>Modalities Electrical muscle stimulation Biofeedback Cryotherapy</p>	<p align="center">Duration</p> <p>5 reps x 30 secs</p> <p>3 sets x 10 reps 3 sets x 30 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps</p> <p>3 sets x 20 reps to fatigue x 3 3 sets x 20 reps 3 sets x 10 reps</p> <p>20 minutes 10 minutes 20 minutes</p>
Goals	<ul style="list-style-type: none"> ■ Full weight bearing ■ Muscle control ■ Control inflammation, effusion ■ ROM 0°-135° 	

Cincinnati SportsMedicine and Orthopaedic Center Rehab Protocol: EM Realignment
Phase 5. Weeks 9-12 (Visits: 1-2)

General Observation	<ul style="list-style-type: none"> ■ Full weight bearing when: <ul style="list-style-type: none"> - Pain, effusion controlled - Muscle control throughout ROM ■ ROM 0°-135° 	
Evaluation	<ul style="list-style-type: none"> ■ Pain ■ Manual muscle test Hamstrings, quadriceps, hip abductors/adductors/flexors/extensors ■ Swelling ■ Patellar mobility ■ Crepitus ■ Gait 	<p align="center">Goals</p> <p>Minimal/No RSD 4/5</p> <p>Minimal Good None/slight Symmetrical</p>
Frequency		Duration
2 x/day 10 minutes	<p>Range of motion Hamstring, gastroc-soleus, quad, ITB stretches</p>	5 reps x 30 secs
2 x/day 20 minutes	<p>Strengthening Straight leg raises Straight leg raises, rubber tubing Hamstring curls (0°-90°) Knee extension with resistance (90°-30°) Leg press (70°-10°) Closed-chain <ul style="list-style-type: none"> - Wall sits - Mini-squats (rubber tubing, 0°-40°) - Lateral step-ups (2-4" block) Multi-hip machine (flexion, extension, abduction, adduction)</p>	3 sets x 10 reps 3 sets x 30 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps to fatigue x 3 3 sets x 20 reps 3 sets x 10 reps 3 sets x 10 reps
3 x/day 5 minutes	<p>Balance training Balance board/2 legged Single leg stance</p>	
1 x/day 15-20 minutes	<p>Aerobic conditioning (patellofemoral precautions) Water walking Swimming (straight leg kicking) Walking Ski machine (short stride, level, low resistance)</p>	
3 x/week 10 minutes	<p>Running program* (30% deficit isometric test) Jog Walk Backward run</p>	1/4 mile 1/8 mile 20 yards
3 x/week	<p>Cutting program* (20% deficit isometric test) Lateral, carioca, figure 8's</p>	20 yards
3 x/week	<p>Functional training* (10-15% deficit isometric test) Plyometric training – box hops, level, double-leg Sport specific drills</p>	15 secs, 4-6 sets
Goals	<ul style="list-style-type: none"> ■ Increase strength and endurance ■ ROM 0°-135° 	

*exclude patients with >2A lesions patellofemoral joint

Cincinnati SportsMedicine and Orthopaedic Center Rehab Protocol: EM Realignment
Phase 6. Weeks 13-26 (Visits: 4-7)

General Observation	<ul style="list-style-type: none"> ■ No effusion, painless ROM, joint stability ■ Performs activities of daily living, can walk 20 minutes without pain 	
Evaluation	<ul style="list-style-type: none"> ■ Isometric test (% difference quads, hams) ■ Swelling ■ Patellar mobility ■ Crepitus ■ Single-leg function tests (hop distance, timed hop, % inv/uninv) 	<p align="center">Goals</p> <p>10-15 None Good None/slight 85</p>
Frequency		Duration
2 x/day 10 minutes	Range of motion Hamstring, gastroc-soleus, quad, ITB stretches	5 reps x 30 secs
1 x/day 20-30 minutes	Strengthening Straight leg raises, rubber tubing (high speed) Hamstring curls (active, 0°-90°) Knee extension with resistance (90°-30°) Leg press (70°-10°) Multi-hip machine (flexion, extension, abduction, adduction) Closed-chain: Mini-squats (rubber tubing, 0°-40°)	3 sets x 30 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 10 reps 3 sets x 20 reps
1-3 x/day 5 minutes	Balance training Balance board/2 legged Single leg stance	
3 x/week 20 minutes	Aerobic conditioning (patellofemoral precautions) Stationary bicycling Water walking Swimming (kicking) Walking Ski machine (short stride, level, low resistance)	
3 x/week 15-20 minutes	Running program* (30% deficit isometric test) Jog Walk Backward run	1/4 mile 1/8 mile 20 yards
3 x/week	Cutting program* (20% deficit isometric test) Lateral, carioca, figure 8's	20 yards
3 x/week	Functional training* (10-15% deficit isometric test) Plyometric training – box hops, level, double-leg Sport specific drills	15 secs, 4-6 sets
Goals	<ul style="list-style-type: none"> ■ Increase function ■ Maintain strength and endurance ■ Return to previous activity level 	

*exclude patients with >2A lesions patellofemoral joint