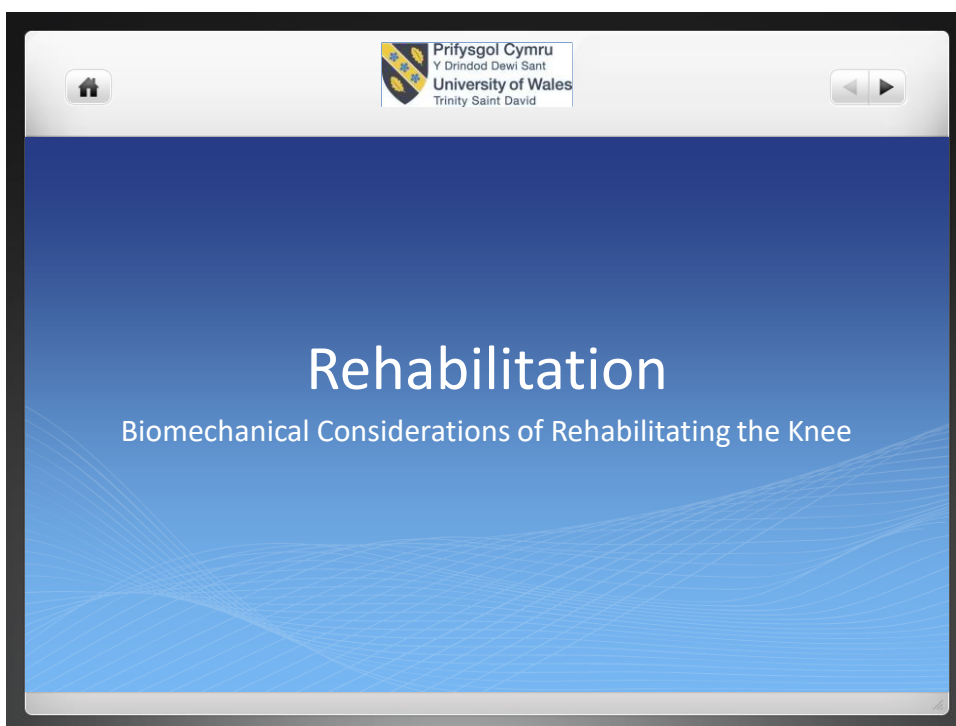




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Early & Intermediate Rehabilitation

Flexibility & ROM

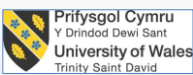
- Active
 - 15-30sec
 - 4-5 reps
- Passive
 - 15-30sec
 - 4-5 reps
- Prolonged
 - Up to 20mins
 - 3min if FWB

Proprioception

Maintain CV Fitness

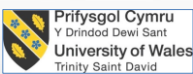
M. Endurance & Strength

- Isometric
 - 200 Intervals in P+ free range
 - 5-6 sec hold (ease on & off)
 - 10 reps
 - 10 sec rest per rep
- Concentric & Eccentric
 - Strength Endurance
 - Up to 3 sets 25 reps
 - 30sec recovery per set
 - <67% 1RM
 - Strength
 - 2-6 sets
 - 6 reps
 - 85% + 1RM
 - 2-5min recovery

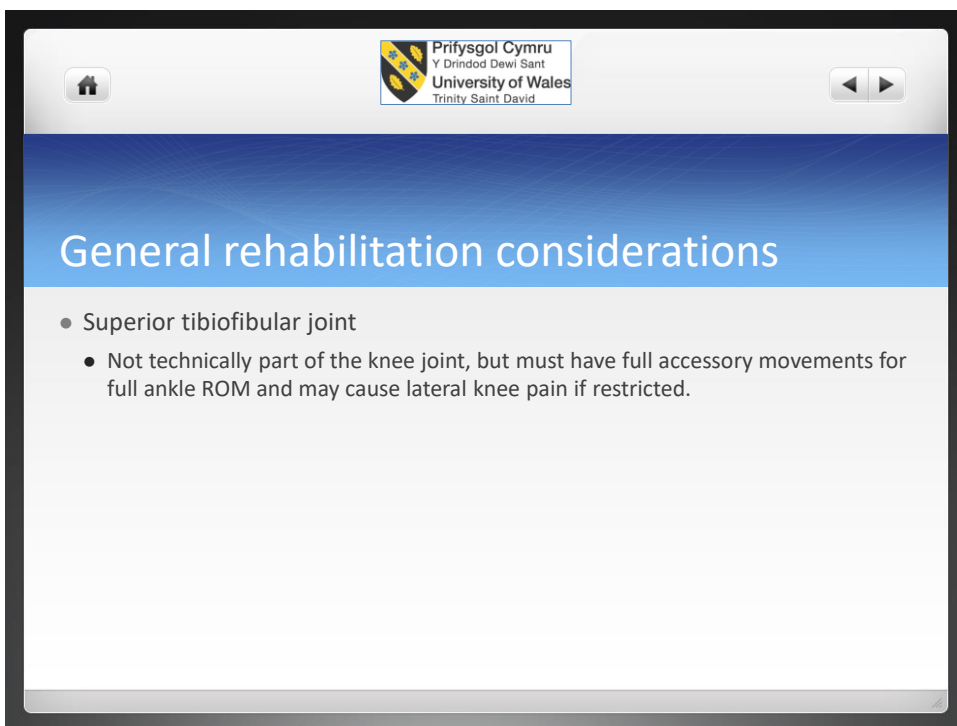

General Rehabilitation Considerations

- Tibiofemoral Joint
 - ▣ Concave tibial plateau & convex femur
 - ▣ During movement the concave tibia moves on the convex femur in the same direction as the physiological movement
 - ▣ i.e. Posterior glide = flexion
 - ▣ Anterior glide = extension
 - ▣ Largest joint in body
 - ▣ Capsular pattern that restricts in flexion rather than extension
 - ▣ Loose packed position is 20-30° flexion
 - ▣ Closed packed position is full extension with lateral tibial rotation


General rehabilitation considerations

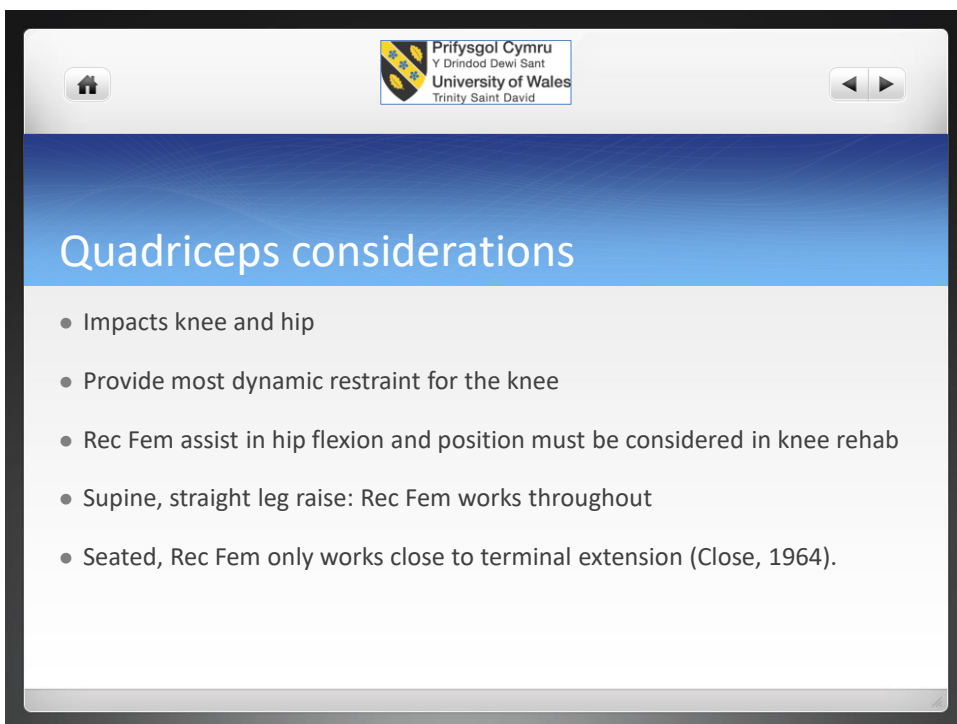
- Tibiofemoral joint
 - ▣ Mensici absorb 50-60% compressive knee forces
 - ▣ At 90° KF primary force is applied through the posterior aspect of the knee and mensici absorbing 85% of total knee compressive forces
- Patellafemoral joint
 - ▣ Loose packed position = KE
 - ▣ Close packed position = KF
 - ▣ Bony stability = femoral sulcus
 - ▣ Ligamentous stability = PF & PT joint
 - ▣ Active restraints from quadriceps, then indirectly from pes anserine & biceps femoris as they control tibial rotation



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General rehabilitation considerations

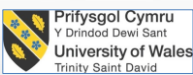
- Superior tibiofibular joint
 - Not technically part of the knee joint, but must have full accessory movements for full ankle ROM and may cause lateral knee pain if restricted.



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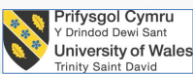
Quadriceps considerations

- Impacts knee and hip
- Provide most dynamic restraint for the knee
- Rec Fem assist in hip flexion and position must be considered in knee rehab
- Supine, straight leg raise: Rec Fem works throughout
- Seated, Rec Fem only works close to terminal extension (Close, 1964).


Hamstring Considerations

- ☐ Hamstrings flex knee, extend hip and cause tibial rotation
- ☐ Biceps femoris: lateral tibial rotation
- ☐ Semi mem and tend: medial tibial rotation
- ☐ Secondary dynamic restraint to anterior tibial translation thus assisting ACL
- ☐ In ACL deficient knees , hamstrings must be trained to be prominent stabilisers
- ☐ Rehab of isolated hamstring injuries must include all roles; KF, HE, and tibial rotation
- ☐ Eccentric exercises are important here


Biomechanical considerations

- What is the relationship between patellafemoral and tibiofemoral joints?
 - When the knee extends the patella glides superiorly.
 - When the knee flexes the patella glides inferiorly
 - Total movement is 5-7cm
 - Patella must move freely for full tibiofemoral movement to be possible



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Biomechanical Considerations

- Normal alignment:
 - Patella's inferior pole is at knee's joint line and rests on supratrochlear fat pad
 - If patella lies superior to this: patella alta
 - Patella tendon injuries including grafts for ACL reconstruction may cause patella alta
 - Patella lies inferiorly to this: patella baja
 - Quadriceps ruptures
- Either position restricts full ROM



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Biomechanical Considerations

- Compressive forces are applied to posterior patella, as patella makes contact with femoral groove (Sulcus)
- These compressive forces can reach 10 x BW during training activities (Brownstein et al 1988)

Biomechanical Considerations

□ CKC

■ Greatest compressive forces @ 60-90o

■ Least joint irritation @ 0-30o and 90o +

■ Walking – compressive forces ½ body weight

■ Stair Climbing – 3 x BW

■ Squatting – 7 x BW

■ Least stressful = 0 -30o

■ Most stressful = 60-90o

□ OKC

■ Joint stress lowest at 90o

■ Joint stress greatest at 0o (Ext)

■ Least irritating position @ 60-90o

■ Dependent on joint position

- Knee ext with ankle weight peak compressive force @ 35-40o
- Isokinetic machine 90o KF peak compressive force @ 90o and decreases as Ext

■ Isokinetic exercises – 5 x BW

■ Most stressful 0-30o

■ Least stressful 60-90o

Biomechanical Considerations

	CKC	OKC
Least stressful:	0-30o	60-90o
Most stressful:	60-90o	0-30o
Safe to work at:	0-40o	50o +

•There is no contact between two articulating surfaces 0-20°

•So safe to strengthen 0-10°

•But 0-20° may also be tolerated for strengthening work



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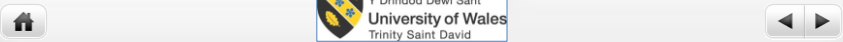


Q-Angle

- ❑ Angle formed by a line from the ASIS to the middle patella, and a line from the middle patella to the tibial tubercle
- ❑ Normal measurement 10°
- ❑ Gender differences range 12-15°
- ❑ Changes weight bearing to non-weight bearing (tibial rotation)
- ❑ Q-angle thought to be key to patellafemoral alignment and symptoms
- ❑ Now not so much (Livingston, 1998)
- ❑ Probably more about lower extremity alignment (?)



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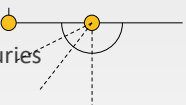
Common problems/considerations

- Extensor Lag
 - Full passive motion present but active extension poor
 - Terminal extension difficult for weakened quads
- VMO atrophy/insufficiency
 - VMO; patella medial stabilizer
 - Last 15° of extension require 2x the force as other ranges of knee extension
 - VMO does not exert any more effort than any other quadriceps muscle during terminal extension (Lieb and Parry, 1971)
 - Muscle fibre atrophy is more prominent in the VMO but reason unknown?





Common problems/considerations Open and Closed Kinetic Chains

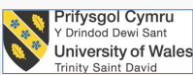


- Debate, especially for ACL injuries
- **Open Kinetic Chain**
 - Greatest anterior displacement (ACL) occurs at 30°
 - Less anterior shear force applied 60-90° knee flexion
 - Greatest ACL force applied near terminal extension 0-40° flexion
 - 30° best position for quads strengthening but worst for ACL strain
- **Closed Kinetic Chain**
 - Least amount of anterior force on ACL occurs at 60° during CKC exercises
 - Joint compression forces may be responsible for reduced shear forces and anterior translation during CKC
 - CKC less stressful on ACL
 - But CKC exercises that move beyond 50° flexion increase patellofemoral joint stress
 - CKC more stressful for patients with patellofemoral pain



Common problems/considerations

- **Shear Stress**
 - Tibiofemoral shear stress
 - Peak shear at 28-14° flexion
 - External force applied to distal component of leg increases shear than proximally applied force
 - Slow speed produce greater torque, increases anterior tibial displacement and ACL strain
 - Isokinetic exercise (typically open chain) do not use until later stages due to significant shear stress

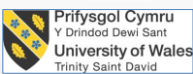




Common problems/considerations

- Braces
 - Prophylactic (prevent or reduce severity of injury)
 - Rehabilitative (restricts ROM)
 - Functional (improves stability)
- Used for ACL
 - Braces provide anterior stability during low-stress loads BUT not shown to stabilise adequately during functional athletic loads
 - Do provide some Proprioceptive benefit
 - Subjective? Sense of stability

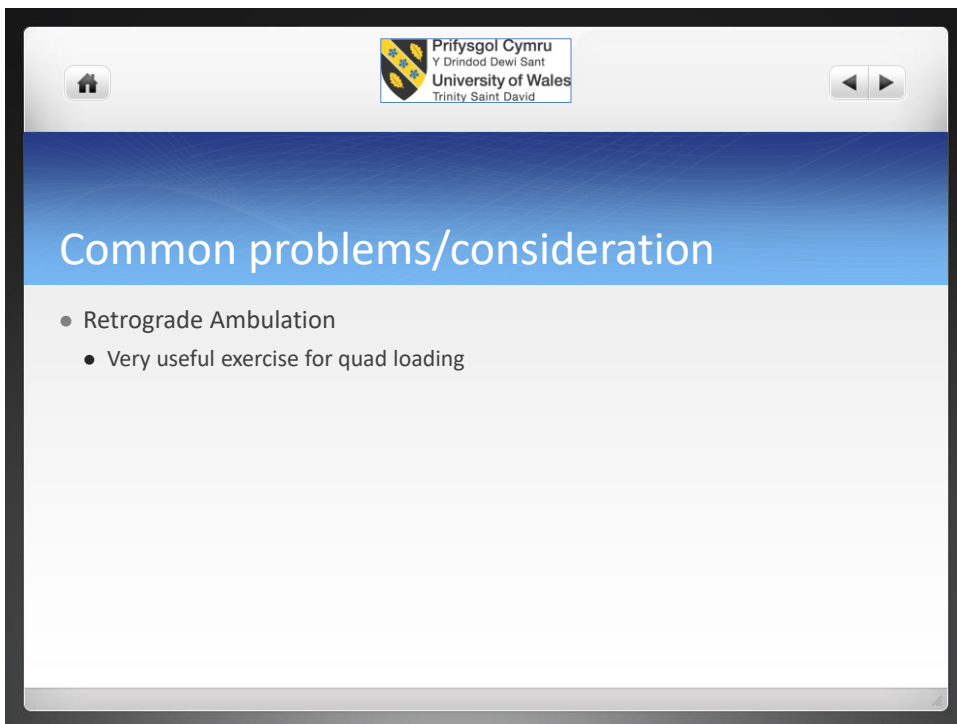







Common problems/consideration

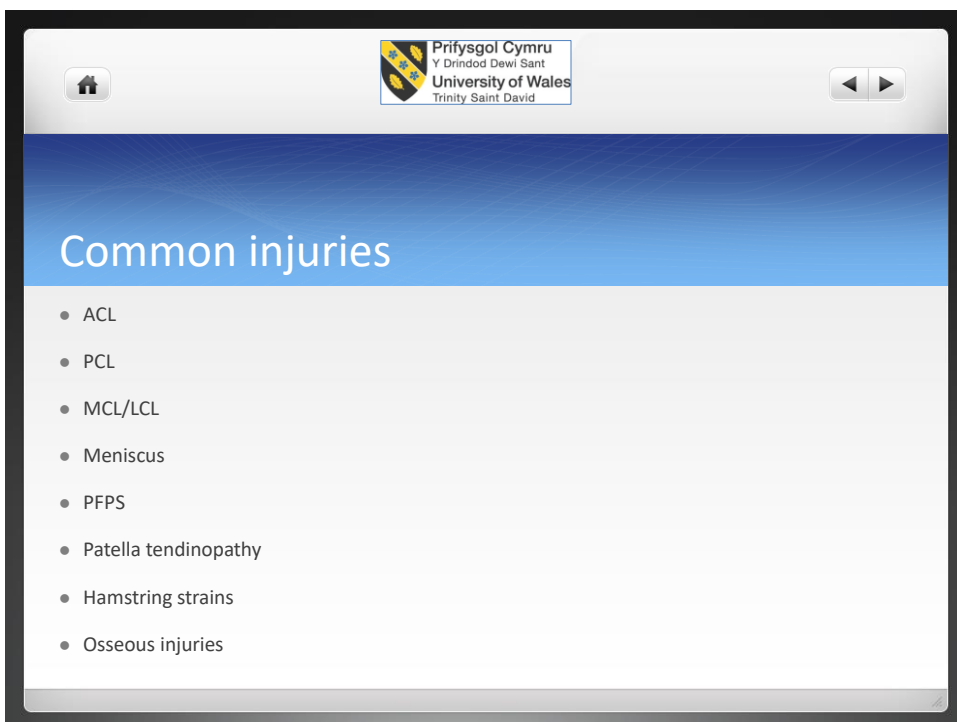
- Fatigue and knee stability?
 - Fatigue reduces knee Proprioceptive function (Lattanzio et al 1997)
 - Agility requires Proprioceptive feedback for proper execution
 - Organisation of Agility: introduce it early in the exercise session before fatigue occurs



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Common problems/consideration

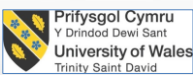
- Retrograde Ambulation
 - Very useful exercise for quad loading



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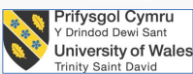
Common injuries

- ACL
- PCL
- MCL/LCL
- Meniscus
- PFPS
- Patella tendinopathy
- Hamstring strains
- Osseous injuries


ACL

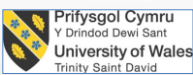
- ☐ Tolerate 1730 N before failure (Markolf et al 1990)
- ☐ Maximum stress at 90° flex or full extension
- ☐ Grade III surgical repair
- ☐ Graft from either patellar tendon or medial hamstring tendon (semi Tend)
- ☐ Which one is best?
- ☐ Patella graft uses bone blocks (less healing tx)
 - ☐ Immediate WB, 2-3days post op Ther Ex, RTS 3-6mo)
- ☐ Hamstring graft do not advocate running until 6mo
 - ☐ Fixation is not bone to bone, tenuous attachment site, greater risk of failure; conservative


ACL Rehab

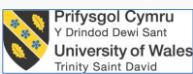
Accelerated v Conservative

- ☐ Histologically: ACL graft necrosis and remodelling once transplanted
- ☐ Initially avascular, revascularises in 8-10 weeks – completed in 16wk
- ☐ 4-8 wk for proliferation of graft cells completion
- ☐ Can take 8 wks for graft to firmly attach to bone (risk of rupture)
- ☐ Maturation and remodelling take up to 26wk
- ☐ Does not ever regain normal tensile strength
- ☐ Rx depends on type of graft, fixation used, type of surgery, surgeons preferences for rehab & other injuries!



Accelerated ACL rehab

Time	Rehab
0 day -wk 1	Crutch walking Weight bearing to tolerance with full knee ext 2d post op passive knee ext exercises, active hip incl SLR, ankle ROM exercises to begin End of wk 1: GOAL 90o flex with full extension
Week 2-3	AROM knee exercises, patella mobs and STM Walking w/o crutches (may use brace) CKC introduced end of 2 nd wk (mini squats, cycle etc) Hamstring concentric , toe raises also included Flexion 105o
Wk 3-6	Cross train, stepper (<10cm) leg press through 60o flex Stork stand 115o flex, full ext (may develop capsular tightness)
Wk 8-12	Jogging, running to sprinting Agility, Plyometric and sport specific (non-contact) if 80% strength
5-6 mo	Sports specific functional work



Conservative ACL rehab

Timings	Goals
wk 1	Stretching Hams, Gastroc, ITB, Quads Locked brace worn locked to max 15o ext (full ext prevented)
wk 1-2	Strengthen quads concentrically CV only upper body or unilateral cycle NWB-FWB in first 2wk
wk6	Full WB with normal gait Add other exercises e.g Ham curls, hip exercises, cycle ergs, leg press (10o) ROM add calisthenics e.g. Mini squats , toe raises , AROM flexion should be 90o; full Ext not achieved
Wk 9-10	Treadmill walking, stepper, ski machines
6mo	Jogging
8– 12mo	sports specific and RTS





Non-operative ACL (Grade II-III)

Emphasis on hamstring as secondary stabiliser

Timings	Goals
0-3wk	PWB-FWB Wk 2+ AROM and strength exercises (CKC) with brace
3-6wk	Brace restricted ROM 15-90o @ wk 3 progress to 0-90o @ wk 5 Wk 3/4: exercises with brace removed (CKC)
Wk 6	AROM extension should be 0o step ups and treadmill walking
Wk 8-10	Jogging, progress to run & sprint then agility, Plyometrics and functional activities
Wk 12+	RTS?





PCL Injuries (Grade III)

- Not frequently surgically repaired
- Only reconstruct if unstable or other structures are affected
- Reconstructions using semi-tend, patellar tendon (mid 1/3rd) or medial gastroc



PCL mechanics: Guidelines

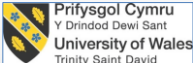
- ☐ PCL stressed differently
- ☐ Progressive increase in shear stress in resisted OKC flexion exercises (ext – flex)
- ☐ Amount of shear stress ?
- ☐ PCL shear stress high @ 85-100°
- ☐ PCL shear stress low @ full ext (ACL high)
- ☐ In CKC greatest shear stress @ 70-100°
- ☐ OKC extension no more than 60° flex
- ☐ Avoid OKC resisted flexion until PCL adequately healed
- ☐ CKC exercises in similar range 0-60°



PCL rehab

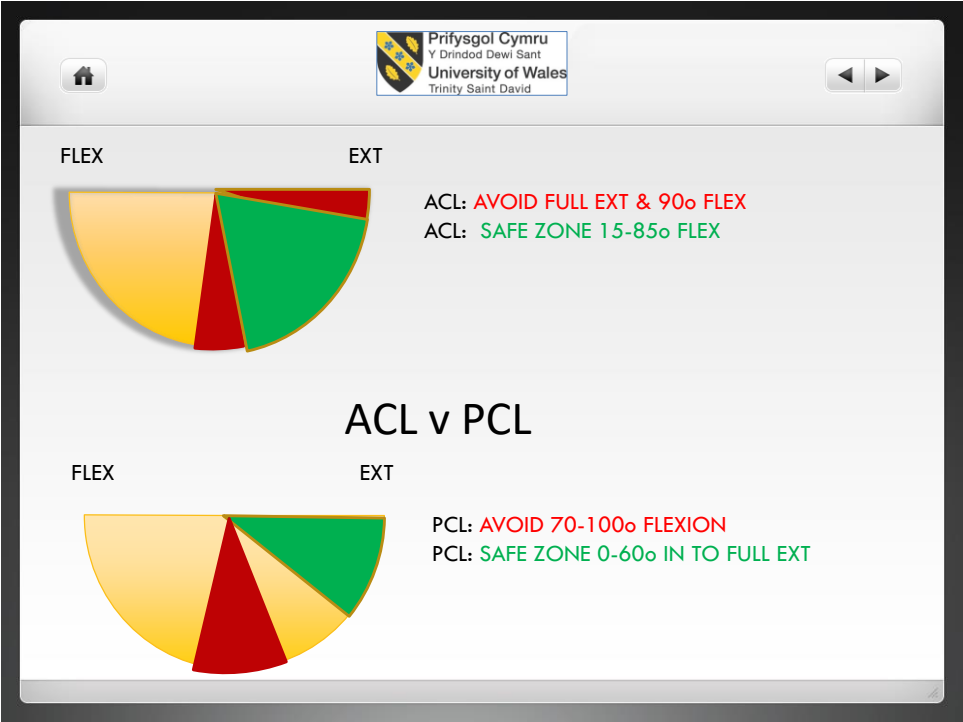
- Should not be unstable (unless walking down hill: anterior femoral displacement)
- Goal 1: manage inflammation & restore ROM
- Goal 2: restore strength, control & normal function

	
PCL Rehab	
Do's	Don'ts
ROM including active knee extension Passive flexion	AVOID active hamstring (produce post tibial translation) AVOID strong Gastroc contractions beyond 30o Knee Flexion (translational stress increases PCL stress)
OKC extension exercises ONLY up to 60o Flex	Avoid resisted exercise in 85-100o flex Resisted CKC avoid 70-100o Resisted OKC avoid 60o to extension
Use crutches until FWB	
Do strengthen hamstring s using CKC exercises OKC only for hamstrings over the hip with knee extended	Continue with Quad exercises if Patellafemoral pain presents : modify o of motion and joint angles
Use weight transfer exercises if Pt is apprehensive of FWB	

	
PCL rehab goals (non-surgical)	
Time	Goal
Week 3	CKC FWB exercises such as wall squats, step-ups
Week 6	Treadmill walking progress to jogging, running, Increased weights (strength) Agility Plyometrics
Wk 9-12	Functional and specific activities Full return to sport

PCL rehab goals (Surgery)

Time	Goals (Do's)	Don'ts
0-4wk	Immobilisation brace worn locked in full 0o extension (PWB) Brace removed for PROM exercises only Brace kept on for isometric and concentric quad exercises Hip add & Abd against resistance (around thigh) can be used By end of week 3 Pt should be FWB with brace (Proprioception)	Caution over resting position (posterior sag) Avoid hip extension and knee flexion exercises in first 3 weeks
6-8wk	Brace still worn until wk8 but removed during AROM exercises	Caution over resting position (posterior sag)
Wk 8	If Pt has full PROM & normal gait then hip extension with knee extension against resistance can be used, stationary bike with toe clips used (reduced hamstring activity)	
Wk 6-10	Mild resisted hamstring curls , treadmill walking , step machine, pool activities. Continue lower limb conditioning	RTS expected 6-12mo





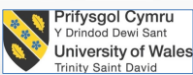
Collateral Ligament Sprains

- MCL
 - More frequent
 - Rarely surgically repaired
 - Except if instability from MCL & ACL
 - Even then, may only repair ACL
- LCL & MCL management is similar



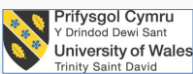
Collateral Ligament Sprains

Timings	Goals
0-3/6 wk	Brace in conjunction with early Ther Ex Brace set to 0-90o flex to control lig stress but allow movement Crutches also used to facilitate PWB-FWB in brace (no crutches after wk4) Brace removed for AROM, isometrics, and hip and ankle exercises
After 105° flexion	Use stationary cycle
Wk 4+	When FWB begin Proprioception OKC & CKC exercises for Quads and Hams ? Patellafemoral P+ Progress as per ACL injuries
Full motion not achieved at wk 5-6	Joint mobs & prolonged stretches
RTS	3-4 wk ranging to 2-3mo

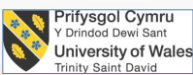

Meniscal Injuries

- ☐ Recent changes to rehab and surgery for meniscal injuries
- ☐ No longer Arthrotomies (complete removal)
- ☐ Now arthroscopic procedures for removal of torn segment, repair and allograft replacements
- ☐ Meniscal repair preferable to meniscectomy BUT rehab is longer (4-6mo v 4-6wk)
- ☐ Isolated meniscal injuries do not cause instability ? ACL and MM for instability
- ☐ Isolated tears tend to be degenerative
- ☐ Lateral repairs have a greater success than medial : due to less movement and smaller attachment to knee

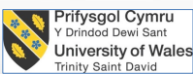

Meniscal Injuries

- Surgical repair
 - NWB & Restricted ROM for 6-8wks
- MM & ACL
 - Dilemma: ACL best results is delayed until post inflammation & if accelerated Rehab: immediate PWB to FWB and full ROM
- Programmes can be Accelerated repair , Conservative repair, Meniscectomy or allograft/autograft transplant rehabilitation


Conservative rehab

Timings	Goals
0-6/8wk	Crutches with NWB for 6-8wk Toe-touch weight bearing (sometimes) permitted after 2wk Rehab brace also used to keep knee in flexed position for 6wk Pt can start trunk, hip and ankle exercises
6/8wk +	Patella mobs, tibiofemoral mobs (post brace (6wk) AROM & progressive strengthening can begin post brace (6wk)
4-6mo	Pivoting,, acceleration and deceleration activities can start

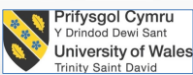




Accelerated rehab

Timings	Goal
ASAP	Weight bear (P+ free) . Pt may need crutches
Wk 1	ROM exercises during first post-operative week
Wk 2	Quad isometric and concentric
Wk2-3	Pt should walk normally w/o crutches
Wk2-4	CKC (inc stationary cycle, mini squats, treadmill walking)
Wk 6-8	Isokinetics
80% strength	Running, lateral and pivoting movements Progressions same as ACL RTS 10-12wk post op

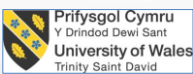
Menisectomy rehab	
Timings	Goals
Immediately post op	Crutch walking Weight bearing to tolerance Quad isometric and concentric
2-3d post op	Pt should walk without assistance with a few days post op •Proprioceptive OKC & CKC used •Minisquat, wall squat, step-ups, step-downs, standing terminal extensions, stationary cycle, Theraband, free weights May need weight transfer activities if apprehensive ROM, ankle mobility, hip exercises
Wk 2	Lunges, stepper, cross trainer,
Wk 3-5	Jogging progress to running, Isokinetic, agility, plyometric, functional exercises added when pt has control strength and proprioception
Wk 6-8	RTS

Autograft transplantation	
• Rare !	
Timings	Goals
0-6wk	NWB progress to PWB ROM used immediately post op: with flexion limited to 90o Brace worn to maintain full extension Ther Ex to maintain full knee ext, minimise quad atrophy
6wk +	Walking w/o brace CKC exercises from full Ext to 60o OKC exercises to 90o Flex Strength progressions
8-10mo	RTS

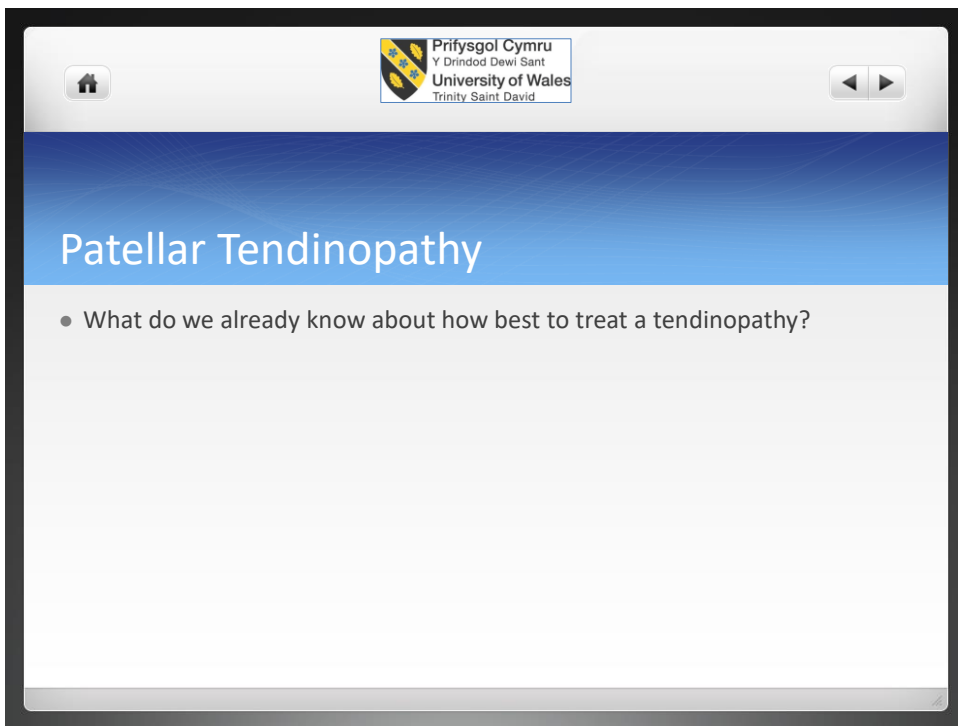

Patellafemoral Injuries Dislocations & Subluxations

- What do we know about the causes of lateral sublux?
- Crutches but WB to tolerance
- Immobiliser brace progress to functional (patella) brace
- All exercises should be pain free
- Average recovery time period is 4-10wk (recurrent to first time dislocations)


Patellofemoral Pain Syndrome

- Causes
 - ▣ Direct trauma
 - ▣ Tightness in ITB, hamstrings, gastroc
 - ▣ Weakness in VMO,
 - ▣ Imbalance of VMO v VL
 - ▣ Excessive pronation
 - ▣ Increased Q-angle
 - ▣ Knee hyperextension
 - ▣ Patellar alignment
- Rehab implications?

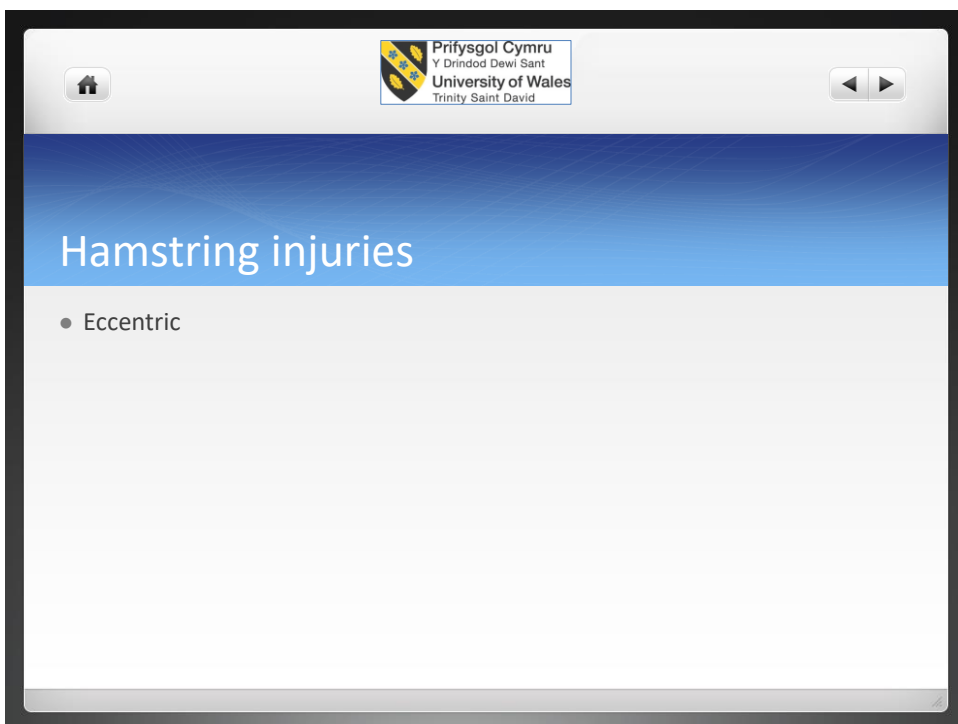


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Patellar Tendinopathy

- What do we already know about how best to treat a tendinopathy?



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Hamstring injuries

- Eccentric



Osseous Injuries

- Tibial plateau fractures
 - NWB 6-8wk
 - Displaced require ORIF (Open Reduction and Internal Fixation)
- Chondral fractures & articular cartilage defects
 - Can develop in to localised joint degeneration



Conclusion

□ Common injury rehabilitation ■ ACL ■ accelerated, ■ Conservative ■ Non-surgical ■ PCL ■ Non-surgical ■ Post-operative ■ General guidelines	■ Collateral ligament sprains ■ Meniscal injuries ■ Conservative ■ Accelerated ■ Meniscectomy ■ Autograft transplant ■ Patellafemoral jt ■ Patellar dislocations ■ PFPS ■ Patella tendinitis ■ Osseous injuries
--	---





Knee rehabilitation goals

- General
 - Remove swelling (inhibits MM activity)
 - Restore quad/VMO strength (extensor lag)
 - Control the knee through the foot and the hip
 - Restore proprioception
 - Restore normal gait
- Tibiofemoral Considerations
 - Protect the menisci
 - In KE, menisci absorb 50-60% total joint compressive forces.
 - Increases to 85% at 90o KF
 - CKC v OKC

	CKC	OKC
Greatest Compressive forces	60-90o	0-30o
Lowest Compressive forces	0-30 & <90o	60-90o





Knee rehabilitation goals

- Patellofemoral Joint
 - Loose Packed = KE
 - Close packed position = KF
 - Patella glides superiorly in KE, inferiorly in KF and should translate approx 5-7cm
- Articular contact
 - begins at 10-20° KF
 - At 30o = 2cm² contact
 - At 45o = maximum contact area
 - At 90o = 6cm² contact but increased force (6.5 x BW)

PFJ Activities:
Walk and cycle = ½ x BW
Stair ascent = 3.3 x BW
Stair Descent = 5 x BW

Squat & Jog = 7 x BW
Deep Squat = 20 x BW