Interhospital Rehabilitation Meeting

Sport Medicine:
Athletes with Anterior Cruciate Ligament Reconstruction

Kowloon Hospital Department of Rehabilitation

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Introduction

- The knee joint is the central weight-bearing joint of the lower limb, where various types of injuries and disorders are caused by sports.
- There are approximately 250,000 ACL injuries in a given year in USA.
- Anterior cruciate ligament (ACL) injury is the most frequently known sport injury, where healing mechanisms hardly work.
- Many cases of this injury require surgical treatment due to remaining instabilities that greatly trouble athletes in their sports activities.

Introduction

- The goal of the treatment of knee injuries in athletes is the restoration of maximum function while preventing recurrent injury.
- A successful plan requires making the correct diagnosis and initiating appropriate treatment, with a staged approach to rehabilitation.

Case 1

- Male, 36 years old, fireman
- Right-hander, Captain of badminton team of university
- Got non-contact sport injury while playing badminton match 12 years ago
- Jump in air with landing off-balance on right leg
- Sprain right knee with external rotation and valgus stress at partially flexed knee
- Got “pop” sound and acute knee swelling
- Presented to private O&T with persistent right knee pain
- No pre-operation and post-operation physiotherapy training
- Got partial medial meniscectomy and ACL reconstruction with patellar tendon graft, 2 months after injury
- Current problem:
  - knee pain over medial joint line in recent two years, especially while squatting, climbing up and down stair and increase knee pain after fitness training.
- P/E: 10-20% right quadriceps wasting, crepitus in moving knee joint

Case 2

- Male, 30 years old, teaching soccer and tennis in university
- Right-hander
- Got non-contact sport injury while playing soccer match 6 years ago
- Sprained right knee while “cutting”
- Moved right leg forcefully into a valgus position with the knee extended and the tibia rotated
- Presented to O&T with “giving way”
- Poor compliance to pre-operation and post-operation physiotherapy training because he was occupied by his long working hours
- Persistent ~10-20% right quadriceps wasting before operation.
- Got ACL reconstruction with patellar tendon graft, 3 months after injury
- Current problem:
  - Persistent anterior knee pain, especially while climbing up stair and after sport
  - Experience knee instability in playing soccer
- P/E: 10% right quadriceps wasting

Case 3

- Male, 33 years old, officer
- Left-hander
- Enjoy tennis and basketball competition
- Got non-contact sport injury while playing basketball 5 years ago
- Jump in air with landing off-balance on left leg
- Sprain left knee with external rotation and valgus stress at partially flexed knee
- Got “pop” sound
- Presented to O&T with persistent left knee swelling and pain
- Limited pre-operation physiotherapy training because of persistent left knee swelling and pain
- Persistent ~10-20% left quadriceps wasting before operation
- Got ACL reconstruction with patellar tendon graft, 4 months after injury
- Current problem:
  - Anterior knee pain after strenuous activities
- P/E: 10% left quadriceps wasting

Anterior cruciate ligament

- The primary function of the ACL is to control anterior translation of the tibia.
- It also is a secondary restraint to tibial rotation as well as varus or valgus stress.
- The ACL is made up of two bundles: an anteromedial (AM) bundle that is tight in flexion and a posterolateral (PL) bundle that is tight in extension.

ACL Injury

- Aside from direct trauma, nearly all ACL tears occur from non-contact athletic injuries.
- It can result from landing off-balance or "cutting" (ie, planting the foot while changing direction).
- High risk sports: soccer, basketball, football, tennis, volleyball and alpine skiing.
- ACL injuries are becoming more common as greater numbers of children and adolescents participate in community sports programs and more girls participate in collision sports, such as basketball and soccer.

ACL Injury - Mechanism

- The typical mechanism for a non-contact ACL injury involves a running or jumping athlete who suddenly decelerates and changes direction (eg, cutting) or pivots in a way that involves rotation or lateral bending (ie, valgus stress) of the knee.

ACL Injury - Mechanism

- The incidence of non-contact anterior cruciate ligament (ACL) injuries is much higher in woman's sport (soccer, handball, basketball and gymnastics) especially those in the second decade of life, with a 5:1 gender ratio.
- Proposed explanations:
  - –Quadriceps-dominant deceleration
  - –Increased valgus knee angulation with pivoting or deceleration

Quadriceps-dominant

- Quadriceps dominance refers to the muscle group used preferentially to prevent anterior tibial translation during deceleration.
- Biomechanical studies have found that in female athletes the quadriceps group generally contracts first during deceleration, while in men the hamstring group generally contracts first.
- The quadriceps muscles are less effective at preventing anterior tibial translation, thereby increasing the stress placed on the ACL.

Quadriceps-dominant

- Studies also suggest that women generally have weaker hamstrings and greater strength imbalances between the two muscle groups, which creates knee instability.
- Such findings suggest an important role for injury prevention training designed to correct relative muscle weakness and imbalance.

Increased valgus knee angulation

- Increased valgus angulation of the knee (ie, knee bent inward) during sudden changes in direction substantially increases the stress placed on the ACL.
- Biomechanical studies have found that female athletes are more likely to place their knees in positions of increased valgus angulation when changing direction during a sporting event.
- Training to correct faulty biomechanics may limit tendency to ACL injury.

ACL and other injuries

- ACL injuries often are accompanied by other injuries, particularly involving the medial collateral ligament and menisci.
- One-half to two-thirds of acute ACL injuries are accompanied by meniscal injury.
  - 40 % of these meniscal injuries require surgery.
- 50 % of patients with acute ACL injuries have collateral ligament injuries, and 10 to 16 % incur chondral injuries or patellar dislocation.
- Approximately one-third of patients report that they heard or felt a pop inside the knee.
- Acute hemarthrosis often is present.

Physical Examination

- The anterior drawer test, Lachman maneuver, and pivot shift test are used to evaluate the integrity of the ACL.
- It is also important to evaluate the other knee structures that can sustain injury in conjunction with the ACL.

Physical Examination

- The KT-1000 knee ligament arthrometer is a device that provides an objective measurement of anterior-posterior translation and is often used in studies evaluating ACL tears.
- This machine is seldom used in clinical practice because physical examination is generally reliable.

Imaging

- Plain radiographs are often performed following traumatic knee injuries to rule out fractures, but cannot be used to diagnose ACL tears.
- MRI is both highly sensitive and specific in the diagnosis of complete ACL rupture.
- But MRI is less accurate in differentiating complete tears from partial tears, and in detecting chronic tears.

Arthroscopy

- Diagnostic studies using arthroscopy as the gold standard describe sensitivities as high as 92 to 100% and specificities as high as 95 to 100%.

Initial Rehabilitation

- Phase One
  - Aim: control pain, prevent further injury and promote tissue healing
  - RICE (Rest, Ice, Compression, Elevation)
  - Adequate analgesic
  - Maintain quadriceps strength
    - by performing pain-free isometric quadriceps contractions, called “quad sets”.

Initial Rehabilitation

- Phase Two
  - Hamstring strengthening and neuromuscular control are emphasized to reduce the likelihood of anterior translation of the tibia on the femur.
  - Whereas the normal ratio of hamstring:quadriceps strength is 2:3, the goal for the ACL-injured knee is 1:1.

Initial Rehabilitation

- Gastrocnemius strengthening also is emphasized.
  - Soleus and gastrocnemius muscle loading decreases anterior tibial translation in anterior cruciate ligament intact and deficient knees; Paul S et al; The Journal of Knee Surgery; Jul 2003; 16,3.
- Its strength is increased by performing weight bearing toe-raises with the knees in full extension.
- These exercises initially are performed using body weight alone, and then with additional weights supported on the shoulders.

Operative or nonoperative

- Most active, younger patients and high-level athletes opt for surgical reconstruction.
- The decision to have surgery is based upon several factors, including age, level of activity, functional demands, the presence of associated injuries to the meniscus or other ligaments, and significant knee instability.

Operative or nonoperative

- Although rigorous studies are lacking, the ACL-deficient knee may place patients at increased risk for further injury (eg, meniscal tear), chronic pain, and decreased level of activity.
- However, surveillance studies suggest degenerative osteoarthritis may occur regardless of the treatment approach.
  - The long-term consequence of anterior cruciate ligament and meniscus injuries: osteoarthritis. Lohmander LS et al, Am J Sports Med. 2007 Oct;35(10):1756-69.
- According to one prospective, 15 years, cohort study of 100 consecutive patients with ACL rupture, osteoarthritis develops infrequently among those managed without ACL reconstruction, provided menisectomy is not performed.
  - Neuman, P, et al. Prevalence of Tibiofemoral Osteoarthritis 15 Years After Nonoperative Treatment of Anterior Cruciate Ligament Injury: A Prospective Cohort Study. Am J Sports Med 2008; 36:1717.

Graft selection

- Two autograft choices continue to predominate:
  - the bone-patellar tendon-bone autograft
  - the quadruple-strand hamstring autograft consisting of the semitendinosus and gracilis tendons.
- While the bone-patellar tendon-bone autograft has long been considered the gold standard, use of the hamstring graft continues to increase in popularity and is the graft of choice for many surgeons now.

Patella tendon graft

- All of our 3 cases used patella tendon graft.
- The theoretical advantages of the patellar graft include **increased initial strength and stiffness** compared with the normal ACL and potential bone-to-bone healing in the femoral and tibial tunnels made during surgery, which promotes **earlier graft fixation**.
  - Graft selection in anterior cruciate ligament reconstruction. Miller SL; Gladstone JN. Orthop Clin North Am. 2002 Oct;33(4):675-83.
- In practice, most young patients active in high-demand sports receive patellar tendon autograft reconstructions because of their strength and relatively rapid healing.

Patella tendon graft

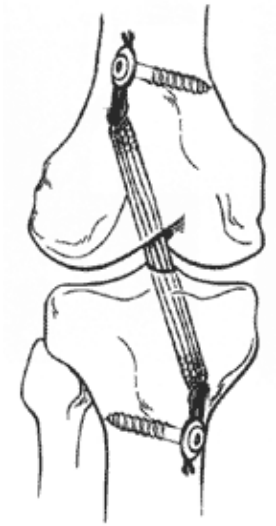
- However, systematic reviews and studies have documented patellar tendon grafts increased:
  - **Anterior knee pain**
    - Hamstring tendon autograft better than bone patellar-tendon bone autograft in ACL reconstruction: a cumulative meta-analysis and clinically relevant sensitivity analysis applied to a previously published analysis. Poolman RW et al. Acta Orthop. 2007 Jun;78(3):350-4.
  - **Development of osteoarthritis**
    - Sajovic M et al. A prospective, randomized comparison of semitendinosus and gracilis tendon versus patellar tendon autografts for anterior cruciate ligament reconstruction: five-year follow-up. Am J Sports Med. 2006;34:1933-40.
    - Keays SL et al. A 6-year follow-up of the effect of graft site on strength, stability, range of motion, function, and joint degeneration after anterior cruciate ligament reconstruction: patellar tendon versus semitendinosus and gracilis tendon graft. Am J Sports Med. 2007;35:729-39
    - A 10-year comparison of anterior cruciate ligament reconstructions with hamstring tendon and patellar tendon autograft: a controlled, prospective trial. Pinczewski LA et al. Am J Sports Med. 2007 Apr;35(4):564-74.
  - **Quadriceps deficits**
    - de Jong SN et al, Functional assessment and muscle strength before and after reconstruction of chronic anterior cruciate ligament lesions. Arthroscopy. 2007;23:21-8,28.e1-3.

Hamstring graft

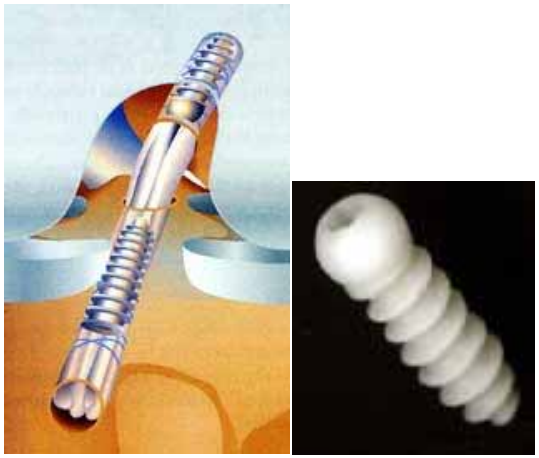
- Use of the hamstring tendon eliminates patellar tendon morbidity, primarily anterior knee pain.
- A systematic review found that hamstring donor site pain usually resolved by three months, while hamstring strength returned to normal by 12 months.
  - Hamstring tendon autograft better than bone patellar-tendon bone autograft in ACL reconstruction: a cumulative meta-analysis and clinically relevant sensitivity analysis applied to a previously published analysis. Poolman RW; Farrokhyar F; Bhandari M . Acta Orthop. 2007 Jun;78(3):350-4.
  - Graft site morbidity with autogenous semitendinosus and gracilis tendons. Yasuda K; Tsujino J; Ohkoshi Y; Tanabe Y; Kaneda K. Am J Sports Med. 1995 Nov-Dec;23(6):706-14.

Hamstring graft

- A potential disadvantage of hamstring grafts is that initial fixation may be slower and not as strong as patellar tendon graft.
- But initial hamstring tendon graft strength may be equal to that of patellar tendon grafts if such techniques as the endo-button are used, further research is needed to confirm this.



In the past, fixation of the hamstring tendons was performed by placing large sutures in the ends of the graft and tying these around a screw post outside of the bone tunnels.



Interference screws with special blunt threads designed not to cut the hamstring tendons are now able to fix the tendon within the bone tunnel similar to the patellar tendon bone fixation.

Another new modification for hamstring femoral end fixation is the Closed Loop Endobutton.

Single bundle vs Double bundle

- It is well known that ACL has both anteromedial and posterolateral bundles.
- Traditional reconstructions primarily restore the anteromedial bundle only.
  - In our 3 cases, all of them received single bundle ACL reconstruction.
- Proponents of double-bundle reconstruction suggest that a more anatomic reconstruction will result in improved outcomes.

Single bundle vs Double bundle

- Biomechanically, this theory has been confirmed with laboratory studies that have shown a synergistic interaction between the two bundles against anterior tibial translation and rotational forces.
- Clinical studies, however, have had more varied results.
- Longer follow-up is necessary to identify benefits and potential complications.

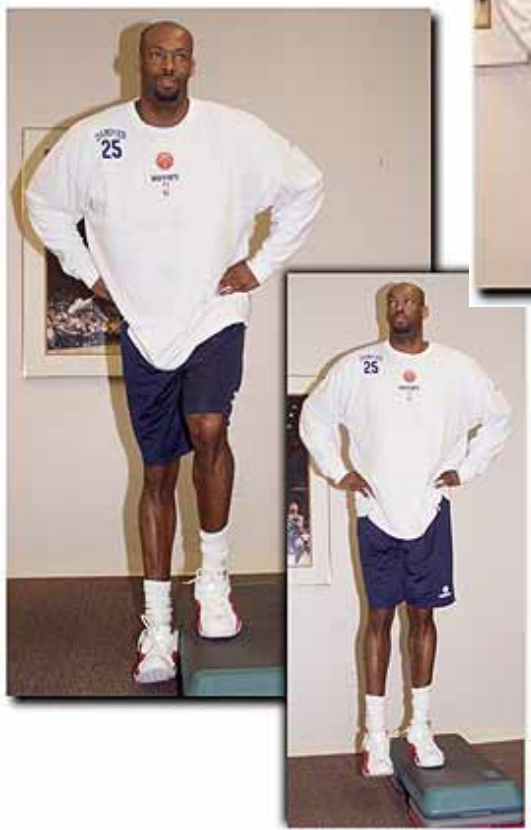
Post OT-Rehab

- Post ACL reconstruction rehabilitation programs should involve:
  - Pain management and decreasing swelling
  - Early quadriceps activation
  - Range of motion exercises with the aim for full knee extension
  - Early closed-chain kinetic exercises, with quadriceps strengthening
  - Neuromuscular training to ensure knee joint stability.

Post OT-Rehab

- Educate patient to do active knee extension exercise and start quadriceps training in home.

Lateral Step Up



Wall Sits

Ball on the Wall Squat

Post–OT Quadriceps strengthening

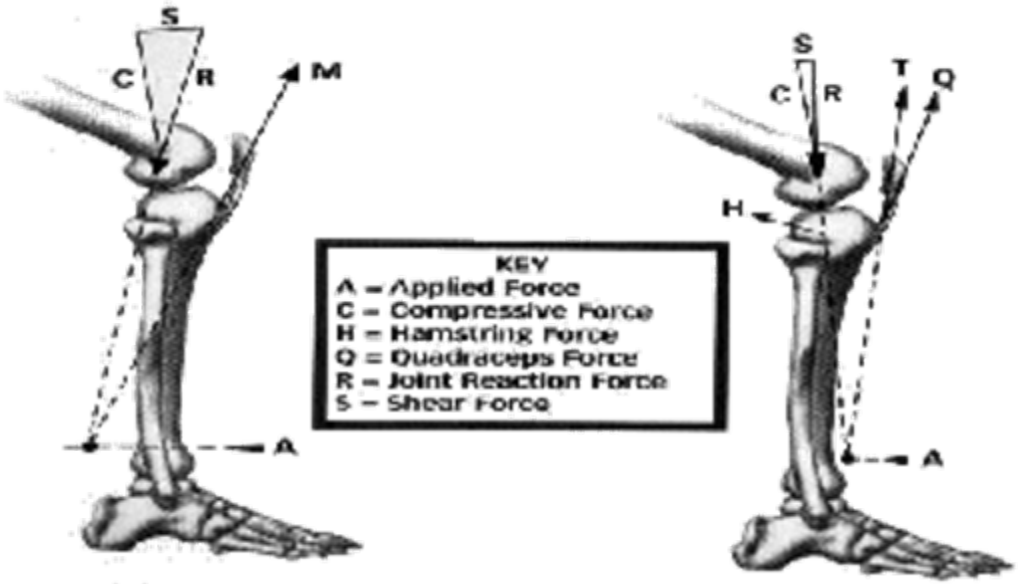
- Closed kinetic chain exercises (CKCE) to strengthen the hamstring and quadriceps are effective in the initial rehabilitation of the reconstructed ACL.
- CKCE require that the foot be planted and remain in a fixed position throughout the exercise (eg, squat, leg press).

Post–OT Quadriceps strengthening

- Open Kinetic Chain Exercises (OKCE) are performed typically were the foot is free to move with non-weight bearing, e.g. straight leg raises and knee extension.
- If there is any weight applied it is applied to the distal portion of the limb.
- OKCE concentrates on a strong quadriceps contraction, which will strengthen the quadriceps and restore quadriceps power output.
- But OKCE produces a great amount of shear force on ACL while CKCE produces a minimal amount of shear force.

Post–OT Quadriceps strengthening

- This is because, in OKCE, the lower leg shifting anteriorly which places a significant amount of stress on the ACL.
- When the knee is extended with CKCE, there is a co-contraction of the quadriceps and hamstrings. This reduces shear force placed on the knee by stabilizing the knee joint.



Post–OT Quadriceps strengthening

- As rehabilitation progresses, open chain exercises could be added.
- We could use isokinetic equipment (Cybex) to test the strength and try to make the exercise safe.
- It solve the problems of both isotonics and variable resistance by using accommodating resistance at a set velocity.
- Patient perform the exercise at a specific velocity, and no matter how much force your muscle produces, the isokinetic machine matches that force.
- If the patient are rehabilitating an injury and can't produce much force, the machine will only give patient what he can take.
- You can practice different velocities (speeds) to closely mimic the speeds of normal or sports activities.
- Unfortunately, isokinetic machines are very expensive and require someone who is trained to operate them.

Advantages of Isokinetic training:

- High speed training
- Safety
- Work in painfree range
- Submaximal exercise
- Neuromuscular control

Post–OT Neuromuscular training

- Exercises to enhance balance and proprioception should be incorporated into post-operative rehabilitation.

Post OT-Rehab

- Different muscle groups may have relatively greater weakness postoperatively depending upon the site of the autograft.
- Greater care must be taken with hamstring graft patients to avoid pulling out of the graft from its non-osseous fixation point.
  - This essentially means avoiding positions or activities which overly stress the graft, such as **uncontrolled knee hyperextension** (forced over straightening), **valgus stresses on a flexed knee** (stresses on the inside of the knee, taking the knee into 'knock knee' position) and **unrestrained anterior tibial translation** (forward movement of the shin bone), most commonly from the pull of the quadriceps during open kinetic chain knee extension activities.

REHABILITATION

- Patients who opt for non-operative management also benefit from these exercises and should participate in a comprehensive rehabilitation program following injury.
- The patient should be re-assessed at 3–4 months.
- If there is recurrent instability or patient unease then delayed surgery can be an option.

Post OT-Brace

- Use of a brace after surgery is based on surgeon and patient preference.
- A systematic review of bracing following ACL reconstruction, which included 12 randomized controlled trials, found no evidence of improved outcome or reduced risk of subsequent injury among patients using a brace.
  - Bracing after ACL reconstruction: a systematic review. Wright RW; Fetzer GB. Clin Orthop Relat Res. 2007 Feb;455:162-8.

PREVENTION

- Most trainers support the use of neuromuscular and proprioceptive training in ACL injury prevention programs for all athletes that participate in high-risk sports.

Study in Prevention program

- A meta-analysis of prospective trials (n=6) found that the overall risk of ACL injury was reduced in female athletes that participated in neuromuscular training programs.
  - Hewett TE et al. Am J Sports Med. 2006 Mar;34(3):490-8.
- The reviewers noted the following:
  - All four programs that incorporated high-intensity jumping plyometric exercises reduced injury rates.
  - All three programs that included biomechanical analysis and provided direct feedback to the athletes about proper position and movement reduced injury rates.
  - Programs that incorporated strength training reduced injury rates, although strength training alone did not.
  - Balance training alone is unlikely to reduce injury rates, although it may enhance other prevention techniques.
  - Athletes must participate in prevention training at least two times per week for a minimum of six consecutive weeks to show benefit.

Study in Prevention program

- Individual studies involving athletes in a number of high-risk sports (eg, basketball, soccer, skiing) have demonstrated decreased rates of ACL tear among athletes who participate in well-designed prevention programs.
- Different prevention programs incorporate specific drills that more closely approximate the demands of particular sports, and may hold advantages for athletes involve in these sports.

Author, Journal	Setting	Intervention	Results
Mandelbaum BR Am J Sports Med. 2005 Jul;33(7):1003-10	1041 female youth soccer players vs 1905 control	consisted of education, stretching, strengthening, plyometrics, and sports-specific agility drills designed to replace the traditional warm-up.	During the first season, there was an 88% decrease in ACL injury in the enrolled subjects compared to the control group. In 2nd year, there was a 74% reduction in ACL tears in the intervention group compared to the age- and skill-matched controls.
Myklebust G Clin J Sport Med. 2003 Mar;13(2):71-8	942 female handball players	A five-phase program (duration, 15 min) with three different balance exercises focusing on neuromuscular control and planting/landing skills was developed	29 ACL injuries during the control season, 23 injuries during the first intervention season 17 injuries during the second intervention season
Caraffa A; Knee Surg Sports Traumatol Arthrosc. 1996;4(1):19-21.	600 soccer players in 40 teams	gradually increasing proprioceptive training on four different types of wobble-boards during three soccer seasons.	found an incidence of 1.15 ACL injuries per team per year in the control group and 0.15 injuries per team per year in the proprioceptively trained group.
Ettlinger CF Am J Sports Med. 1995 Sep-Oct;23(5):531-7.	staff from 20 ski areas vs 22 ski areas staff	involving viewing videotaped scenes where knee injuries occurred	A total of 179 serious knee sprains were evaluated. Serious knee sprains declined by 62% among trained patrollers and instructors compared with the two previous seasons, but no decline occurred in the control group.

Prevention program

- The Prevent injury and Enhance Performance (PEP) program, which was designed to reduce ACL tears in female soccer players, is a well known neuromuscular training regimens.
- It requires about ten minutes to perform, consisting of a warm-up followed by several strength, agility, plyometric, biomechanic, and flexibility exercises.
- The goal is to increase lower extremity and core muscle fitness and to improve neuromuscular function such that athletes avoid positions that increase their susceptibility to ACL injury.
  - Two prospective nonrandomized controlled trials have found significant reductions in ACL injury rates among members of soccer teams assigned to perform the PEP program before each training session instead of their usual warm-up.
    - Gilchrist J. Am J Sports Med. 2008 Aug;36(8):1476-83.
    - Mandelbaum. J Sports Med. 2005 Jul;33(7):1003-10. Epub 2005 May 11.

Prevention program

- FIFA (Fédération Internationale de Football Association), the governing body of international soccer, includes a program for ACL injury prevention on its website.
  - "The 11" injury prevention program
    - http://www.fifa.com/aboutfifa/developing/medical/the11/index.html
    - was developed by FIFA's medical research centre (F-MARC) to help reduce the risk of injury in football players aged 14 years and over.
    - 10 exercises focus on core stabilisation, eccentric training of thigh muscles, proprioceptive training, dynamic stabilisation and plyometrics with straight leg alignment.
    - The programme requires no technical equipment other than a ball, and can be completed in 10-15 minutes.
  - "Health and Fitness for Female Football Player"
    - http://www.fifa.com/mm/document/afdeveloping/medical/ffb_gesamt_e_20035.pdf

Prevention program

- The Sportsmetrics™ training program includes a large number of volleyball athletes and includes jumping and plyometric training to increase strength and to inculcate safer landing positions.
  - http://www.sportsmetrics.net
  - The effect of neuromuscular training on the incidence of knee injury in female athletes. A prospective study. Hewett TE; Lindenfeld TN; Riccobene JV; Noyes FR. Am J Sports Med. 1999 Nov-Dec;27(6):699-706.

Prevention program

- A program developed by the Vermont Safety Research group, based in part on video analysis, teaches downhill skiers to avoid certain high-risk positions and movements.
  - http://www.vermontskisafety.com
  - A method to help reduce the risk of serious knee sprains incurred in alpine skiing. Ettlinger CF; Johnson RJ; Shealy JE. Am J Sports Med. 1995 Sep-Oct;23(5):531-7.

Prevention: Extrinsic supports

- Several randomized and observational studies suggest that prophylactic knee bracing does not prevent ACL tears, and one observational study suggests that such bracing may increase morbidity.
  - Bracing after ACL reconstruction: a systematic review. Wright RW et al. Clin Orthop Relat Res. 2007 Feb;455:162-8.
  - Prophylactic knee bracing in college football. Rovere GD et al; Am J Sports Med. 1987 Mar-Apr;15(2):111-6.
  - The efficacy of a prophylactic knee brace to reduce knee injuries in football. A prospective, randomized study at West Point. Sitler M et al. Am J Sports Med. 1990 May-Jun;18(3):310-5.

Prevention: Extrinsic supports

- A small laboratory study suggests medially posted orthotics may reduce the risk of valgus knee angulation, and thereby ACL injury, but further research is needed before this intervention can be recommended.
  - Knee valgus during drop jumps in National Collegiate Athletic Association Division I female athletes: the effect of a medial post. Joseph M; Tiberio D; Baird JL; Trojian TH; Anderson JM; Kraemer WJ; Maresh CM. Am J Sports Med. 2008 Feb;36(2):285-9. Epub 2007 Oct 31.
  - Knee and ankle 3-dimensional kinematics were measured using high-speed motion capture in 10 National Collegiate Athletic Association Division I female athletes during a drop-jump landing with and without a medial post.
  - Significant differences were found for all measures in the posted condition.
  - A medial post decreased knee valgus at initial contact (1.24 degrees , $P < .01$) and maximum angle (1.21 degrees , $P < .01$).

Follow Up Cases

- All of our 3 cases did not have adequate pre and post operation rehabilitation and neuromuscular training.
- In daily practice, there are limiting factors in training of the injured athletes, e.g. persistent knee pain or swelling, lack of knowledge and resources.

Follow Up Case 1

- Firearm
- Had right ACL reconstruction and partial medial meniscectomy 12 years ago
- Persistent right knee pain over medial joint line, esp. after physical training
- Consulted private O&T, told ACL graft intact after P/E
- Showed degenerative changes over medial aspect of right knee joint in private X-ray
- Given PRN Celebrex (not tolerated Voltaren)
- Given intra-articular hyaluronans - Hyalgan® with some improvement.

Intra-articular hyaluronans

- Sodium hyaluronate is a polysaccharide which is distributed widely in the extracellular matrix of connective tissue in man (vitreous and aqueous humor of the eye, synovial fluid, skin, and umbilical cord).
- Hyalgan®: Inject 20 mg (2 mL) once weekly for 5 weeks ($426/dose)

Intra-articular hyaluronans

- A year 2003 meta-analysis pooled the results of 22 trials of hyaluronan injections versus intra-articular placebo injections and concluded that hyaluronan injections were superior to the intraarticular saline injections but had a relatively small effect.
  - Intra-articular hyaluronic acid in treatment of knee osteoarthritis: a meta-analysis. Lo GH; LaValley M; McAlindon T; Felson DT. JAMA 2003 Dec 17;290(23):3115-21.

Intra-articular hyaluronans

- A year 2005 meta-analysis assessed hyaluronan and placebo noted a statistically significant advantage for hyaluronan in rest pain between two and six weeks.
- Patients who received the intervention also experienced a reduction in pain during movement.
  - the mean difference on a 100-mm visual analogue scale was -3.8 mm (95% confidence interval [CI] -9.1 to 1.4 mm) after 2-6 weeks, -4.3 mm (95% CI -7.6 to -0.9 mm) after 10-14 weeks and -7.1 mm (95% CI -11.8 to -2.4 mm) after 22-30 weeks.
    - Intra-articular hyaluronic acid for the treatment of osteoarthritis of the knee: systematic review and meta-analysis. Arrich J; Piribauer F; Mad P; Schmid D; Klaushofer K; Mullner M. CMAJ 2005 Apr 12;172(8):1039-43.

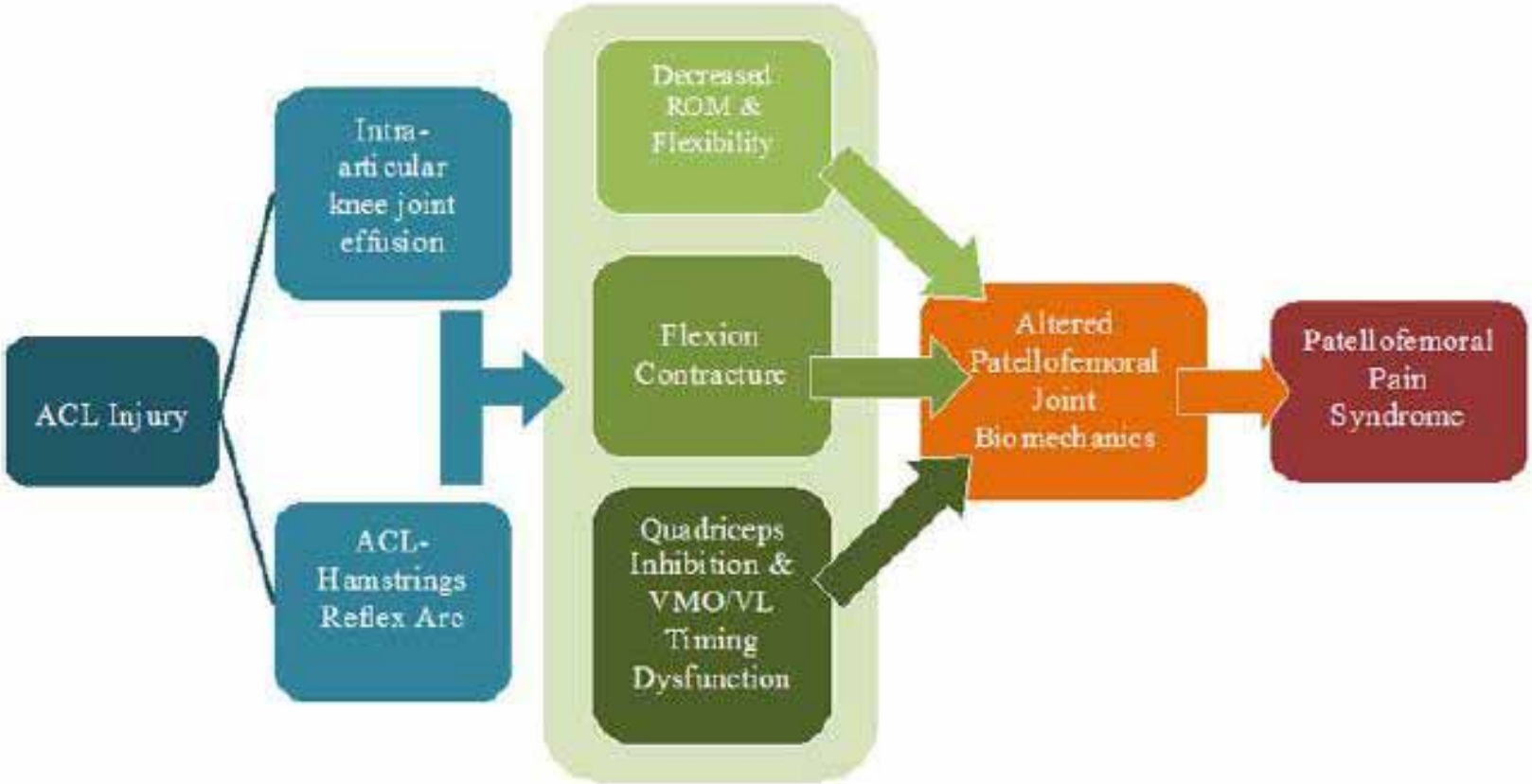
Adverse effects

- Post-injection flare, presented as increased pain, swelling, and inflammatory joint effusion, is a side effect of hyaluronan joint injection that is seen in 1.5 to 5% of injected knees.
- Some of these flares may produce pain, swelling, and joint fluid leukocytosis, which may suggest septic arthritis.
  - Pullman-Mooar et al. Are there distinctive inflammatory flares of synovitis after hylan GF intra-articular injections? Arthritis Rheum 1999; 42(Suppl 9):S295.

Follow Up Case 2

- Sport teacher
- Got ACL reconstruction 6 years ago
- Persistent anterior knee pain, especially while climbing up stair and after sport
- No improvement by using knee sleeve
- Mild knee instability in “cutting”
- Consulted physiotherapist in university
- Told ACL graft intact by doing P/E
- Suggested to try knee taping for realignment
- Got minimal improvement, and had mild skin irritation in prolong taping during sport.

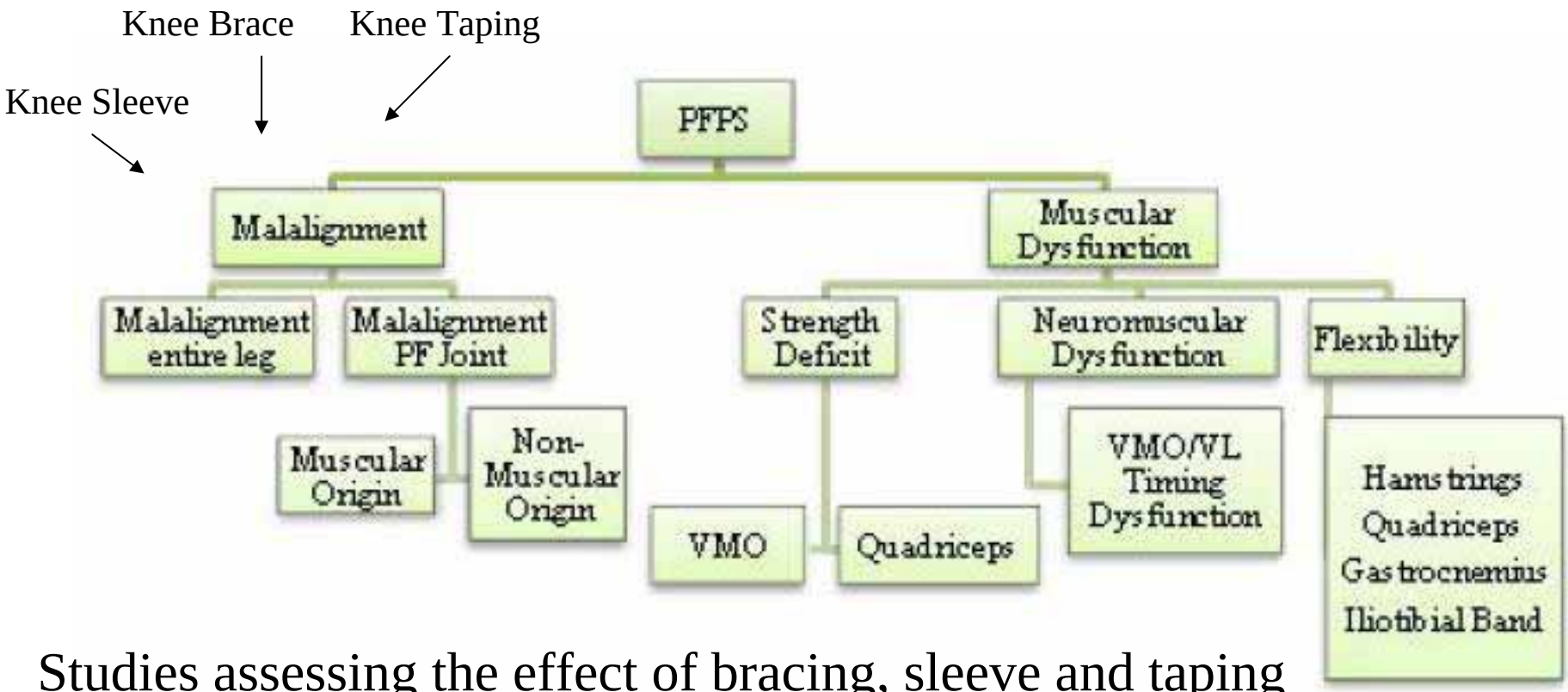
Patellofemoral Pain Syndrome



VMO = vastus medialis oblique; VL = vastus lateralis.

Patellofemoral pain syndrome

Clinical classification of PFPS. *VMO = vastus medialis oblique; VL = vastus lateralis.*



Studies assessing the effect of bracing, sleeve and taping on patellofemoral pain syndrome are inconclusive.

Correct Malalignment

- A systematic review of physical interventions for patellofemoral pain syndrome.
    - Crossley K et al. Clin J Sport Med 2001 Apr;11(2):103-10.
  - 16 studies were reviewed and none of these fulfilled all of the requirements for a randomized, controlled trial.
  - Significant reductions in PFPS symptoms were found with a corrective foot orthosis and a progressive resistance brace, but there is no evidence to support the use of patellofemoral orthoses, acupuncture, low-level laser, chiropractic patellar mobilization, or patellar taping.
  - Overall the physiotherapy interventions had significant beneficial effects but these interventions were not compared with a placebo control.
  - There is inconclusive evidence to support the superiority of one physiotherapy intervention compared with others.

Correct Malalignment

- Although the foundation of treatment for PFPS remains exercise and strengthening, if a patient cannot participate fully in rehabilitation exercises due to pain or does not make progress, it is reasonable to try taping or patellofemoral bracing.

Follow Up Case 3

- Enjoy tennis and basketball competition
- Got left ACL reconstruction 5 years ago in HA
- No neuromuscular rehabilitation
- Persistent left anterior knee pain after strenuous activities even using knee sleeve.
- Closed case from O&T SOPD 2 years after OT
- Pain control by ice therapy after exercise and self purchase Celebrex.
- Sprained left knee six months ago in tennis match, already using knee sleeve
- Got persistent left medial knee joint pain
- Consulted O&T again with P/E showed ACL graft intact.
- MRI knee: intact ACL graft.
- Advised resting by O&T and pain subsided after 8 weeks of resting.

Follow Up Case 3

- Apart from neuromuscular training to prevent further injury, what else could be done?
  - He tried Kinesio Taping with some improvement in anterior knee pain.

Kinesio Taping

- The concept of Kinesio Taping was developed by Dr. Kenzo Kase in 1973.
- This taping technique facilitates the body natural healing process to allow support and stability to muscles and joints without compromising the body's range of motion.
- In contrast, traditional athletic tape is designed to restrict and support the movement of the injured body part so as to protect the area from further damage.

Kinesio Concepts

- There are two ways to apply: unstretched or stretched.
- UNSTRETCHED: In this case, we stretch the skin of the affected area before application of the tape.
- This is done by stretching the muscles and joints in the affected area.
- After application, the taped skin will form convolutions when the skin and muscles contract back to their normal position.
- When the skin is lifted by this technique, subcutaneous flow of blood and lymphatic fluid is increased.

Kinesio Concepts

- On the other hand, if joints or ligaments are injured, the tape should be STRETCHED before application to the skin.
- The damaged joints or ligaments are incapable of functioning normally and rely on the stretched tape for correction.
- To ensure that the muscles have free range of motion, elastic tapes with an elasticity of 130-140% of its original length are recommended for Kinesio® Taping.
- This specific elasticity also will not allow an over stretch of the muscles themselves.
- It may look like conventional athletic tape, but Kinesio® Tape is fundamentally different from traditional athletic tapes.

Kinesio Concepts

- Kinesio® Taping alleviates pain and facilitates lymphatic drainage by microscopically lifting the skin.
- The taped portion forms convolutions in the skin, thus increasing interstitial space.
- The result is that pressure and irritation are taken off the neural and sensory receptors, alleviating pain.
- Pressure is gradually taken off the lymphatic system, allowing it to channel more freely.

Four major functions and effect:
-Normalize muscle function
-Improve lymphatic and blood flow
-Reduce pain
-Correct join malalignment and improve proprioception

Application for patella pain

- 1. Sit down with leg extended. Place the base of first “Y” tape at the front of the thigh.
- 2. Bend the knee to 90° and wrap tails around the kneecap with very little or no stretch.
- 3. Place base of second “Y” strip slightly below the knee, and wrap tails around the kneecap with very little or no stretch.

Kinesio taping in ACL Repair

- Only one small study with 2 subjects.
  - Effects of Kinesio Taping® on Muscle Strength after ACL-Repair
    - Heather M et al.University of New Mexico Murray (2000). Journal of Orthopedic and Sports Physical Therapy, 30, 1.
  - Compare the effects of Kinesio Taping® versus athletic tape on muscle strength in the quadriceps femoris, hamstring and anterior tibialis muscles of the lower extremity in individuals with recent ACL reconstruction.

Results: Kinesio Vs Athletic Tape

- In both subjects, under the Kinesio® Tape condition, there was a significant improvement in the active joint range of motion, no difference was noted in extensor lag between the no tape and the athletic tape conditions.
- EMG measurements revealed similar results that the Kinesio® Tape condition shown an immediate increase of approximately 1½ times in amplitude compared to no tap or athletics tape condition.
- In addition, each subject commented that they felt the muscle contraction was stronger when Kinesio® Tape was applied compared to either no tape or with athletic tape.

Limitations

- It is not known as this time if the effects demonstrated in this study are mediated by skin mechanoreceptors.
- Nor is it known if the enhanced muscular contraction noted shortly after application of Kinesio® Tape would be sustained after a prolonged period.
- These and other questions need to be addressed in further research efforts.

Summary

- Knee injury is common in athlete and could cause serious consequence.
- Although ACL reconstruction is done, early degeneration in the knee is still common.
- Injury prevention is most important for athlete and neuromuscular training should be emphasized.
- Rehabilitation in sport medicine and sport injury should be further promoted in Hong Kong.

The End