ACL

History

Injury mechanism

70% Non-contact

30% contact injuries

"Pop" in 40% of cases

Early swelling of the joint due to hemarthrosis in all cases

Mechanism

Hyperextension: Combined ACL and PCL

Dashboard: PCL

Hyperextension with varus and valgus: ACL [contact in soccer]

Sudden deceleration, abduction and external rotation [Non-contact]

Isolated or combined. Laxity in 0º is significant. It means, ACL is not isolated injury.

More common in young athlete more so in women

Lax joints

Valgus knee

Hormonal

Small notch

Examination

1. Instant Swelling: Immediately following injury
2. Lachman's test: Very sensitive [check under clinical examination of the knee]

   May be difficult to elicit in acute situation
3. Anterior Drawer test [foot in neutral]. More than 1 cm translation is significant

4. Pivot test is strongly suggestive of ACL deficiency. It is better appreciated under general anaesthesia

X ray

1. Segond's Fracture

   Chip fracture due to avulsion of the capsule on the lateral side of the tibial condyle.

   Seen in 10% of ACL rupture

   Common site is middle of lateral capsule

2. Chronic ACL

   Prominent intercondylar osteophytes

   Evidence of arthritis

MRI

Normal Parallel striations ''fanlike'' configuration
ACL smaller than PCL. PCL is J shaped
ACL fibers are normally oriented parallel to to Blumensaat's line, inclining about 55º from the tibial plateau

Torn ACL: Discontinuous usually in one sagittal view;

Increase signal in T2, "Laying down"

Angulation of PCL due to subluxation of tibia

Osseous bruise: Posterolateral tibia and anterolateral femoral

95% accurate

Arthrometry

KT 1000.

3mm differences with opposite side is significant

Natural history of non-operative treatment

1. Natural history of the ACL-injured patient remains controversial

Noyes: 1/3 : Pain and instability

1/3 : No symptoms in sports or ADL's.

1/3 : Fine with modification

Hawkins: 87% fair to poor results with non-op treatment in active patients.

14% returned to athletic activity

2. Untreated ACL in active patients

Progress to Osteoarthritis, rotary instability, Meniscal tear
Recurrent give way symptoms are well correlated with osteoarthritis

3. ACL reconstruction

Instability is controlled better
However, has not shown to decrease osteoarthritis

4. Need for requiring surgery is more in highly active patients

6. Increase incidence of Medial Meniscal tear in chronic situation.[cf. in acute ACL rupture, Lateral Meniscal tear is more common.]

Treatment
Physio

Hamstring exercises

Isometric quadriceps exercises

ROM exercises

Indications for surgery

I. **Activity level**

International Knee Documentation Committee [IKDC]

I	soccer base ball
II	Heavy manual or tennis or Ski
III	Light manual or non-cutting sports, jogging
IV	Sedentary

I and II ACL rupture always need surgical reconstruction

III and IV Brace or +/- surgery

2. **Age**

Older patient previously considered relatively contra-indicated. But recently results are as good as in young patient

3. **Children**

Conventional reconstruction surgery may damage the growth plates.
Activity restriction is impractical. Present trend is:

With skeletal age of 14 years	Reconstruction like adult
With <14 years	Transepiphyseal grafts and soft tissue tendons are used in younger patients [<14 years]

4. **Females:** factors may predispose failure

1. Female athlete
2. Lax joint
3. Narrow intercondylar notch
4. Torsional deformity

Historical Surgeries

1. **Primary repair:** Suggested by O Donogue in 1950 and Marshal: Bound to fail

2. **Primary repair with augmentation**

With lateral extra-articular reconstruction [Macintosh or Ellison: using ITB].
Long strip of Iliotibial band which remains attached to Tibia is passed under lateral collateral ligament and through the intermuscular septum and then suture back again

3. **Prosthetic Replacement**: 80% failure at 15 yrs. Wear debris related problem.

Contemporary Surgeries

1.Reconstruction of ACL using patellar tendon or hamstring using open or arthroscopic method

2. Allograft: Valid alternative to autograft

Freezing: do not weaken the graft [<25 rads]

Become vascular and viable with time

Rate of incorporation is slower than autograft

Timing

Earlier than 2 weeks: high chance of arthrofibrosis
Majority: within 2-6 weeks
Left too long: Secondary changes in the menisci and cartilage

Patellar Tendon Graft
Advantages

1. Easily available ad reliable
2. Graft strength: 2900 N
3. Rigid fixation of the graft is possible
4. Good preservation of stiffness

5. Early incorporation and ? return to sports in 3 months

Disadvantages

Ant Knee pain

Patellar tendonitis

Rupture of the patellar tendon

Increased joint stiffness

Late chondromalacia

Operative

Bone patella bone reconstruction

I. **Diagnostic Arthroscopy**

Antero-lateral portal for arthroscopy placement

Antero-medial portal for working portal.

Check menisci for tear [Medial meniscus in Chronic situation and lateral is common in acute]

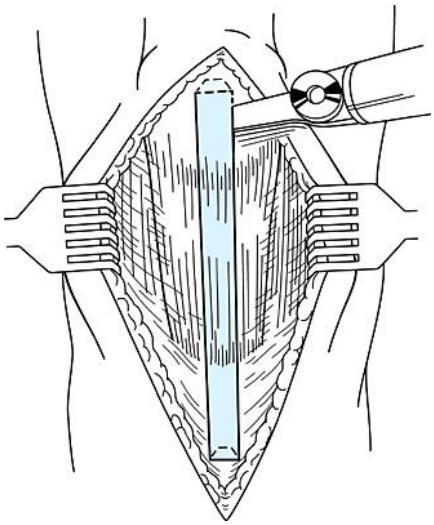
Repair big tears and nibble small tears.

II. **Graft Harvest**

Knee in 90º flexion

Incision: Tip of the patella to 2 cm below the tibial tubercle
Graft size: Mid 10 mm of the ligamentum patella and

25 mm of patella and tibial tuberosity
Oscillating saw 1 cm depth to create bone plugs
Check the size 10 mm cylinder



Graft: Nibble to achieve bullet end and take the soft tissue

Tension on the tendon

At each end 2 drill holes at 1 and 2 cm proximal to the end.

Ends are fixed with 5 Trichon

III. **Notch preparation**

Remove the remnants of ACL
The notchplasty : not always required [only when impingement of the graft in full extension]

IV. Femoral Preparation

Clear the soft tissue from the lateral wall of the notch.

Resident ridge: Avoid misinterpreting a vertical ridge two thirds posteriorly as the true posterior outlet.
H**ook a probe** over the posterior edge to confirm proper "over-the-top" positioning.

Femoral tunnel

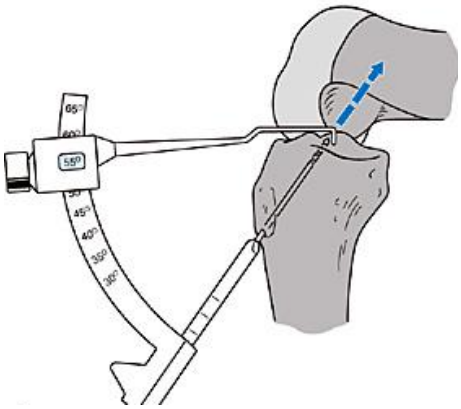
At the 1 o'clock position in the left knee and 11 o'clock position in the right knee
7 mm anterior to the posterior margin of the condyle
Pass a guide wire first with knee in full flexion
5 mm cannulated drill to come out through the lateral cortex. [Avoid cortical blow out]

When blow out: use endobutton.]
Ream with a 10-mm reamer 2.5 cm into the femur, creating an "endoscopic footprint."

V. **Tibial Tunnel**

Make a medially based rectangular periosteal flap just medial to the tibial tubercle

The tibial tunnel: 1.5 cm medial to the tubercle, 1 cm proximal to the pes Anserine
Tibial tunnel guide systems: 45º and should emerge at the site of ACL attachment



Several parameters to determine guide pin placement

1. ACL foot print: posterior 1/3rd of the foot print
2. Posterior edge of the anterior horn of the lateral meniscus
3. Just lateral to the medial tibial spine
4. Last, the guide pin should enter the joint **7 mm** anterior to the PCL

Once drill position is confirmed then use 10 mm cannulated drill. Remove loose bone and cartilage around the tunnel entrance with the shaver, and smooth posterior ridges of the tunnel

VI. **Femoral side fixation**

Pull the nylon loop of the graft through the tibial tunnel

"Push up" the graft through the tibial tunnel

Direct the graft through the femoral tunnel

7mm x 25 mm titanium fully threaded cannulated interference screw on the femoral side.

Face the cortical surface posterior and cancellous anterior

Divergence angle should be less than 20º

VII **Tibial side fixation**

Cortical side of the graft [cf. femoral side]

Flex the knee from 100° to complete extension or hyperextension.

Cycle the knee several times with tension placed on the graft.

Fix the tibia with guide wire lateral and fix with 9 or 10 mm x 25 interferential screw

Misplacement of the graft tunnels

Graft placement: More anterior in the tibia: Extension will be limited

More anterior in the femur: Flexion will be limited

VIII Post operative

Hinged knee brace locked at 20 of knee flexion [relaxes ACL]

Non weight bearing for one week

After 1 week, patients begin range of motion therapy

Progressively bear weight as tolerated.

After nearly full range of motion is achieved, patients start strength training, with the emphasis on closed kinetic chain exercises.

Close chain is preferred than open chain as it exerts less shear force Sports after 6 months

Special situation

1. Isolated ACL in Athlete	Reconstruct ACL
2. ACL with Medial collateral ligament	Reconstruct only ACL and ROM brace for MCL 6 weeks
3. ACL with Posterolateral instability	Repair PL corner + ACL reconstruction Staged or single sitting
4.ACL + PCL	Reconstruct both same or different sitting

Hamstring tendon

Advantages

1. Strong and can withstand 4100 N
2. Greater cross sectional area of tendon
3. Small incision
4. Low post operative morbidity
5. Less donor site morbidity

Disadvantages

1. Slower tendon to bone healing. Longer time to incorporate
2. Weakness of the hamstrings
3. Widening of the tunnels: windshield

1. Occupation: Job with kneeling avoid PTG [carpet layers, Tile layers]
2. Technical difficulties: Hamstring is easier than PTG
3. Compliance: Hamstring graft requires less supervision
4. Open growth plate: Hamstring tendon reconstruction is preferred
5. Time to return to sports: Quicker with Patellar tendon than Hamstring

Open or Arthroscopy: Clinically not much different

Steps

Graft harvest

Notchplasty

Femoral tunnel

Tibial tunnel: Posterior foot print of ACL or 7 mm anterior to PCL

Graft passage

Femoral fixation: 11 Right knee and 1 in the Left knee

Tibial fixation

Fixation: End button for Hamstring for femur

Interferential screw for tibia

Graft harvest

A longitudinal incision 3 fingerbreadths below the joint and 2 medial to the tuberosity

Incise the sartorial fascia overlying the borders of the gracilis and semitendinosis.

Do not divide MCL.

Identify the gracilis and semitendinosus tendons beneath the sartorial fascia.

Tendons: Detach or fixed to the tibia

Harvest the gracilis tendon first

The leg in a figure-4 position

Place traction on the gracilis sutures and palpate around the tendon for fascial slips

The gracilis is proximal to the semitendinosus, and the saphenous nerve crosses the gracilis at the posteromedial joint line.

A consistent semitendinosus fascial band arises 7 to 9 cm proximal to the tendon's tibial insertion and inserts into the medial gastrocnemius fascia.

This fascial band should be release before using the stripper

One should be able to harvest more than 24 cm of tendon

Strength of different grafts

	Ultimate tensile load[N]	Stiffness [N/mm]
ACL	2160	242
Doubled Semitendinosis-gracilis	4140	807
Bone patella tendon bone	2977	455
Bone patella tendon bone [Frozen]	2552	633
Bone patella tendon bone [Frozen]	1990	531

Anterior knee pain:

25% in Semitendinosis-gracilis

75% with Patella tendon graft at one year. Usually mild

Prospective study: ST-G Vs PTG: at one year

Both grafts showed 10% quad power loss

Hamstring showed 10% flexion in addition

Allograft

1. Viral infection: 1:600000

2. Deep freezing superior to freeze thawing

3. Gamma irradiation [2.5 mRAD]

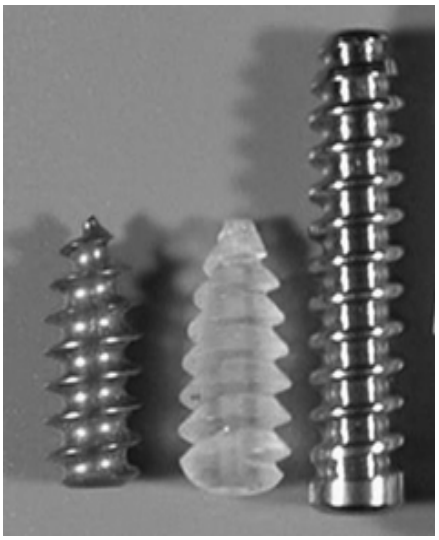
Indications

Used mainly for revision or when multiple grafts are required for complex instabilities

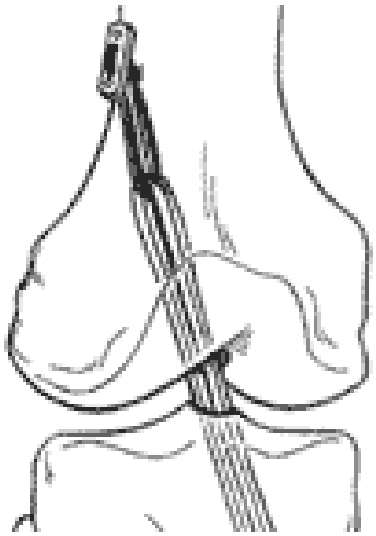
Multiple ligamentous injury

Fixation method

Interference screw



Endobutton



Various parameters

1. The length and diameter of the screw
2. Its divergence
3. The size of the bone block compared with that of the tunnel
4. The geometry of the bone block
5. The torque of insertion of the screw, 6. the BMD.

Pomeroy: the effect of interference fit on different lengths of bone plugs with interference screws and showed no difference in fixation with longer plugs.

Results

ACL reconstruction: 10 yrs

With menisci intact gives 87% good to excellent results

With Meniscetomy gives 63%

Randomised controlled trial of patellar tendon v hamstrings

Both groups 10% loss of quadriceps power.

Hamstring group 10% loss hamstring power at 1year

Special Circumstances

1.Medial OA with ACL deficiency

High tibial osteotomy is theoretically the best choice since, as well as offloading the medial compartment, this osteotomy tends to reduce the tibial slope and so lessens anterior directed stress on the proximal tibia.

The controversy is as to whether or not simultaneous ACL reconstruction should be performed.

2. **ACL in Children**

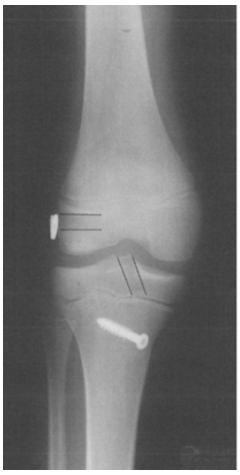
Incidence is rapidly increasing
High incidence of secondary meniscal injuries
High osteoarthritis when allowed high level athletic activities
Risk of surgery is sometimes of lower risk than repeated injury
Children older than 14 years can be treated like adults
Problem in immature children [Tanner I & II]

Options are

a. Activity modification
b. Brace
c. Extra-articular reconstruction
d. Total Transepiphyseal [present trend should be performed paediatric orthopaedic surgeon]

Problems: Growth plate damage, Compliance, Non-isometry

4. **Contemporary procedure is Transepiphyseal grafts**



Autogenous hamstring grafts: graft of choice

Contention: Centrally placed tunnel usually does not cause growth problem and if when it interferes it does not cause angular deformity

Replacement of the ACL is a technically demanding procedure
It can be performed in prepubescent patients with safety.

It should be attempted only by accomplished knee surgeons.

3. **Revision ACL [Graft rupture]**

Issues: malalignment of the tunnel
Graft: Hamstring or Contralateral knee graft or allograft

4. **Bucket handle tear of the meniscus with ACL tear**

Reported that the incidence of meniscal tear is over 50% [16-80%]

Early cases it is easy to repair meniscus in selected cases
Patterns:

Acute: Lateral [56%] and Medial [44%]
Chronic: Medial [70%] and Lateral [30%]

Present recommendation is staged procedures.
Meniscal repair or meniscectomy.
Once knee motion: a second-stage procedure for ACL reconstruction

5. Grade III chondromalacia with ACL
Hamstring reconstruction is preferred

Complications
1. Arthrofibrosis
Shelborne: Arthrofibrosis 4 types
I Extension loss <10º with normal flexion
II >10 º with normal flexion
III >10 º with loss of >25 º flexion loss
IV >10 º and >30 º with patella infera

Tunnels:

Femoral tunnel: 1-2 mm from the posterior intercondylar region at the 11'o' clock in the

Right and 1'0' clock for the Left Knee

Tibial tunnel: at the foot print of the native ACL.

If the graft is placed anterior to the ideal placement in the tibia it causes limitation of extension and if it is placed to anterior in the femur it causes limitation of the flexion.

2. **Fracture of Patella**:

Bone weakens following graft harvest

More in small patella in women

3. **Cyclop lesion:**

Limits extension.

Scar from retained ACL

4. **Graft fixation**:

Interference screws can be dangerous if used incorrectly

Should be inserted at correct angle

Graft must be taught when screw is inserted

5. **Ant Knee pain**:

More with Patellar tendon graft than in Hamstring transfer

[10% in recent study same in both surgery

6. Femur fracture

7. Rupture of the graft

8. Widening of the tunnel
High incidence of tunnel widening with greater incidence in hamstring group.
It is possible there is increase movement of the graft in the tunnel.
Cause: ? Bungee effect.
Tunnel widening is not due to method of fixation. [Clateworthy]

8. **Sterility of the graft**
When the graft dropped on the floor at the time of preparation the sterility is lost.
Sterilise the graft with 3 solution: 10% Povidone Iodine Or 4% Chlorhexidine

Or Triple antibiotic [Gent; Clind, Polymyxin]