

## ACL Reconstruction Using Semi T Endobutton Technique

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ACL injury is one of the commonest problems faced by any Arthroscopist. For many years Bone patellar tendon Bone graft was used successfully giving consistently good results to the extent that this graft source not only become established but also has become the gold standard against which any new graft source will be compared for years to come.

In recent years Semi tendinosus has gained widespread popularity as alternate graft source. The possibility of reconstructing the ACL with barely one finger breadth incision, using Semi T without violating the extensor apparatus and with minimum donor site morbidity is indeed irresistible.

The literature reports 25 advantages of Semi T over BPTB, and hence no wonder it is gaining popularity.

As surgeons we have to be committed to master newer techniques and deliver the best possible results to our patients. Unfortunately, there are instances where patients who have frank positive Lachman or Anterior drawer test are advised diagnostic Arthroscopy just to tell the patient that he has ACL rupture and requires ACL reconstruction at a later date.

### Diagnosis

**Clinical Features :** History is by far the most important factor in the diagnosis of ACL injuries. A history of fall with immediate swelling, inability to bear weight for several days, with or without history of aspiration or plaster or brace, with instability symptoms like giving way or history of falls, insecurity while walking, running or climbing stairs is

pathognomonic of ligament injury unless proved otherwise!

**The Dictum is :** Expect an ACL injury if there are instability symptoms irrespective of clinical and / or radiological / MRI findings. Please rule out other causes of giving way like quadriceps wasting, pain etc.

Objective clinical findings include positive Lachman test, Anterior Drawer test, and positive pivot shift test. These are far more important than MRI.

**A Word of Caution :** One must be gentle while doing the anterior drawer test because sometimes in the presence of gross instability, the knee may dislocate and give unbearable pain to the patient. At times, the knee may not reduce easily. A better alternative is Examination under anaesthesia in case of doubt especially in the acutely injured knee.

### Graft Choice

#### 1. Autograft : THE BEST CHOICE

Semi T/BPTB/Central third Quadriceps tendon

**2. Allograft :** Semi T/BPTB/Tendo Achilles/Tibialis anterior/Tibialis posterior. High failure rates, risk of rejection and disease transmission restrict their use

**3. Synthetic :** Gortex etc. Prosthetic failures, recurrent effusions, late infections, cost and high revision rates prohibit their use.

TABLE 1 PAGE 676 PART 1

### Advantages of Bone Patellar Tendon Bone (BPTB) Graft

1. It has stood the test of time.



2. All other graft sources are compared with BPTB.

3. May be required in revision ACL surgery if Semi T was used previously.

4. Useful when Semi T is inadvertently transected while harvesting

5. Easy to perform; good option for beginners.

6. Bone to bone healing at femoral as well as tibial end.

7. Rigid fixation with interference screws is possible with early mobilisation.

8. Can be done as open procedure.

#### **Advantages OT Semi T as Graft Source**

1. Minimal donor site morbidity.

2. No interference with the Extensor apparatus.

3. Hamstring graft is the strongest (4108 N) and the stiffest (807 N/mm).

4. Cross sectional area 53 sq.mm (BPTB 35 sq.mm).

5. No kneeling pain as in BPTB; minimal anterior knee pain.

6. No Patellofemoral pain; ( in BPTB incidence is 19 %).

7. No Quadriceps weakness (reported incidence in BPTB is as high as 65 %; Rosenberg reports 18% @ 6 months. With Central 3<sup>rd</sup> quad-20 %)

8. No Hamstring weakness occurs with Semi T ( hardly 3 % reported)

9. Semi T quadrupled is 280% of ACL strength; BPTB 10 mm only 120 %.

10. The two strands of Semi T behave as the AM & PL bands of normal ACL.

11. Semi T does not undergo initial necrosis since it is avascular hence no loss of strength occurs in the postoperative period.

12. No FFD reported with Semi T; With BPTB incidence reported is 24 %

13. Double socket technique to reproduce the anteromedial and the posterolateral bands of normal ACL is possible with Semi T; impossible with BPTB

14. Tunnel widening not seen frequently with Semi T.

15. Wind shield wiper effect is rarely seen

16. Can be done in acute cases without fear of arthrofibrosis

17. All endoscopic procedure; joint not invaded as in BPTB.

18. Soft tissue fixation equally effective; Endobutton better than interference screw.

19. No fear of posterior blow out as fixation is by endobutton outside the tunnel.

20. Tendon to bone healing is equally good; although slightly slower

21. Can be done in skeletally immature patients without violating the epiphyseal growth plate; BPTB is contraindicated

22. Semi T can be used where BPTB is contraindicated: small patellar tendon <25mm, previous patellofemoral disease, revision of failed BPTB, Augmentation

23. Complications of BPTB harvest like patella fracture, Patellar tendon rupture, patellar dislocation, patellar entrapment, patellar tendonitis and patella Baja etc. can be avoided by using Semi T.

24. Smaller incision: Better cosmesis, lesser pain.

25. Hamstrings are known to regenerate although not always completely; what else one could expect if the tendon which was used to reconstruct is back in it's place in few weeks there is no deficit created by the harvest.

Before ACL reconstruction it is imperative to do Examination under Anaesthesia and confirm the preop findings. One must make sure that one is not dealing with PCL injury before undertaking ACL reconstruction

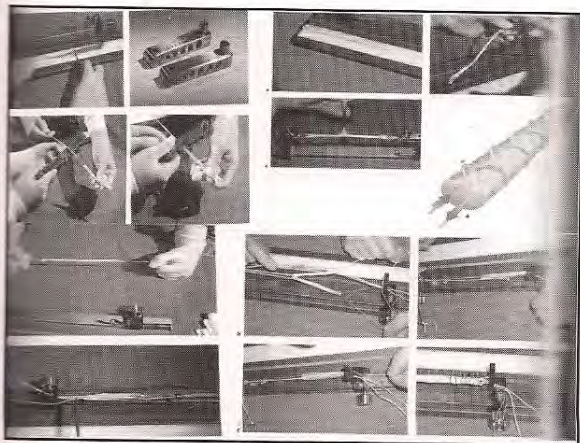
If one is confident clinically that the ACL is torn one can proceed with graft harvest first and hand



over the graft to the trained assistant on the back trolley for graft preparation to save time and then proceed with the arthroscopy; If the diagnosis is not certain one must first do diagnostic arthroscopy and then proceed with graft harvest etc.

**ACL Surgery can be Divided Conveniently into Following Steps :**

1. Graft Harvest.
2. Graft preparation.
3. Graft tensioning.
4. Graft sizing.
5. Arthroscopy & treatment of associated lesions like meniscal tears.
6. Notch preparation / Notchplasty.
7. Excision of old ACL Stump.
8. Tibial tunnel placement.
9. Femoral tunnel placement.
10. Endobutton preparation/ Endobutton CL.
11. Graft passage.
12. Impingement.
13. Cycling.
14. Isometry.
15. Graft fixation.



**Fig. 1 : Various Steps in Graft Preparation.**

**Graft Harvesting**

The incision is 3 fingerbreadths below the joint line. The biggest threat in doing Semi T is in the harvesting! If one does not carefully cut all the bands and release all adhesions one can easily transect the

Semi T halfway through and land up in a short graft. If Semi T length is short Gracilis can be harvested and both gracilis and Semi T used as doubled loops.

“One cannot assure the patient that he is undergoing Semi T ACL reconstruction until the Semi T is successfully harvested without transection!”

In short one must be prepared for such eventuality; hence the importance of BPTB. BPTB can be life saving in such scenario although other options like contra lateral hamstrings, central third quadriceps tendon also exist. Allograft or synthetic grafts may also be considered with their pros and cons in such situation.

**Pearls & Pitfalls**

1. Do not damage the infrapatellar branch of the saphenous nerve.
2. Be extremely careful in avoiding damage to the medial collateral ligament which lies directly underneath the pes anserinus insertion.
3. Release all bands and adhesions of the Semi T before using the tendon stripper; if released well the tendon will not retract and this is how we know it is ready to be harvested.
4. Preferably use closed tendon stripper.
5. Direct the stripper to the origin of Semi T i.e. the ischial tuberosity and for Gracilis towards the pubic symphysis from where it originates.
6. Never use force; in case of resistance, make sure there are no adhesions.

**Graft Preparation**

Minimum 22 cms of graft length is required for quadrupled Semi T. In case of shorter length the gracilis can be harvested. Overall aim should be to attain length of 75 mm of each strand at the minimum. Minimum 15 mm of graft must enter in either femoral and tibial tunnel.

Ideally 25 mm goes in femur, 25 m in tibia and intraarticular length is 25 mm thus constituting 75 mm overall length. Each strand must be sewn with No. 2 Ethibond (No. 5 if patient weighs more than 75 kgs) in Chinese trap fashion and tensioned equally.



### **Graft Tensioning**

The graft should be tensioned on the graft master board up to 10 lbs for 20 mins.

### **Graft Sizing**

After the graft is prepared it is cut into two halves and each half is doubled thus producing a quadrupled graft which is then measured for its diameter with the sizing tube.

### **Arthroscopy & Treatment of Associated Lesions**

Arthroscopic assessment of the entire joint must be undertaken. Associated lesions like meniscal tears must be treated by meniscectomy or meniscal repair at this stage BEFORE starting ACL reconstruction.

### **Notch Preparation / Notchplasty**

Cleaning the lateral femoral condyle of all soft tissues is important right up to the posterior most part or the over the top position. In general chronic ACL ruptures have stenotic notches and need generous notchplasties.

**Resident's Ridge :** A prominent ridge exists in all normal knees in the posterior notch which can be easily confused with the real posterior edge of the notch and wrong tunnel placement can be made if one is not wary of this. Make sure to probe the notch and ascertain that this does not occur.

'A' shaped notch must be widened. Under no circumstance impingement on the new ACL graft is permissible. At the end of ACL reconstruction one must move the joint and assess whether there is any impingement on the new graft especially in extension; in case of impingement the notch should be expanded taking care not to damage the graft.

### **Excision of Old ACL Stump**

Old ACL stumps when chronic become smooth and ballooned and look like bells the classical "*Bell Clapper*" effect. Of special mention is the partial rupture where arthroscopic diagnosis can not only be confusing but quite challenging as the ACL frequently looks normal especially when it is avulsed from the femoral insertion and gets attached lower down in the notch ; it may adhere to the PCL and

even impart some pseudo stability by virtue of its adhesions. Blunt dissection on the lateral femoral condyle easily peels off these adhesions but no excess force should be used while evaluating these difficult to diagnose femoral avulsions. Needless to say considerable experience is required to diagnose partial tears and particularly femoral avulsions. At times Anterior drawer under arthroscopic control may also be negative; and under these circumstances correlation of arthroscopic findings with clinical findings and instability symptoms may help in deciding whether to chop off the so called normal looking ACL and proceed with ACL reconstruction.

***BEWARE ! A sloppy and lax ACL may be the result of PCL rupture the so called "Sloppy ACL sign". In case of a lax normal looking ACL one must rule out PCL rupture before proceeding with reconstruction otherwise there is danger of reconstructing the Normal ligament !***

### **Tibial Tunnel Placement**

The single most important step is tunnel placement since. If the tunnels are not placed correctly they can affect the range of motion and also result in graft failure as a result of stretching or impingement. It is obvious ACL surgery requires understanding the technical details as much as the skills to execute the surgery. Each and every step is important and no technical flaw is permissible if a good result is desired. Therefore it's a demanding surgery. Not a single step in ACL surgery is forgiving which only highlights the need to master the technique thoroughly before even embarking to consider doing this magnificent surgery.

Commercial drill guides from Smith & Nephew etc are available for accurate placement of the tibial tunnel. Use of locally made drill guides is not recommended since the entire success of the procedure depends on isometry and correct tunnel placement.

### **The Landmarks for Tibial Tunnel Placement Include :**

1. The intersection of the posterior border of the anterior horn of the Lateral meniscus with the ACL stump.



2. The point must be 7 mm anterior to the Posterior cruciate ligament.

3. It should be in the centre of the native ACL stump.

4. The wire should point to the femoral insertion site / or the over the top site.

5. The wire should not impinge on the PCL or on the anterior notch.

6. The wire should be in the centre of the intercondylar eminence.

7. The wire should be inserted at 70 degrees to the tibial articular surface.

### **Femoral Tunnel Placement**

Once the tibial tunnel is placed the femoral aimer guide is passed through the tibial tunnel. Commercial femoral guides are available in the offset of 5, 7 mm to facilitate femoral tunnel placement without posterior blow out. If the graft diameter is 10 mm, 7 mm offset guide is taken to allow for radius of 5 mm and a posterior wall of 2 mm and the guide is placed at 11 O'clock position in the right knee (1 O'clock in left knee) A socket of 30 mm (20 mm for insert of graft and 10 mm for rotation of the endobutton) is drilled as per the graft diameter reading of the sizing tube e.g. 10 mm.

The tunnel is further drilled using 4.5 mm drill bit over the guide wire along the entire length across the lateral cortex.

Thereafter depth gauge is used to measure the total tunnel length e.g. 60 mm. This measurement is critical to the placement of the endobutton and no mistake is permissible as it will create problems in the locking of the endobutton or in the insertion length of the graft or both.

### **Pearls & Pitfalls**

1. The femoral tunnel length depends on the degree of knee flexion the higher the flexion the shorter the tunnel; hence for short stocky individuals, 90 degrees should be sufficient and for tall patients 70 to 80 degrees will give longer tunnel.

2. Take extreme care not to blow out the lateral cortex with the 10 mm drill as this will make

use of endobutton impossible. For the endobutton to lock the lateral cortex needs to be drilled with 4.5 mm drill bit.

3. In case of inadvertent lateral cortex blow out with large reamer the options for fixation are either:

(a) Special implant designed by Dr. Padmakar Shinde (patenting in process).

(b) Transfix.

(c) Soft tissue interference screws.

(d) Smith & Nephew designed "Extendobutton

(e) Suture post or suture disc on the lateral femoral cortex using open incision laterally.

(f) I am in the process of designing a fail proof implant for femoral fixation (patent awaited) which will not only address all the current problems but will be technically easy to perform, economical and stronger than the current implants.

### **Endobutton Preparation**

Hereafter No. 5 ethibond is used (Or 6mm mersilene tape) to create 3 loops from the endobutton to the graft of  $60 - 30 = 30$  mms for example for a tunnel length of 60 mm. Alternatively Endobutton CL (closed loop) from Smith & Nephew can be used.

### **Pearls & Pitfalls**

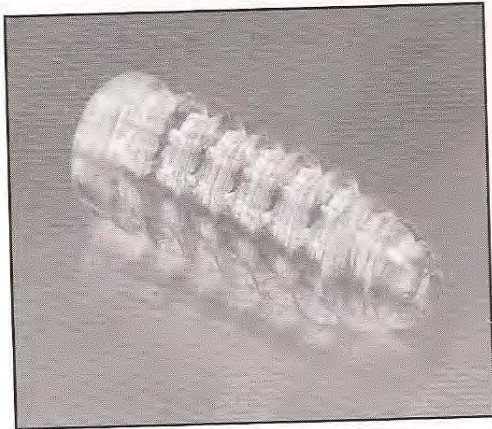
1. Accurate measurement of the femoral tunnel is critical for locking as well as correct insertion of the graft inside the femoral tunnel; If one wants 20 mm insertion additional 10 mm must be drilled for the endobutton to come out of the lateral femoral cortex to allow flipping and hence the locking

2. Alternate methods of fixation must be ready and kept at hand e.g. soft tissue interference screws or Transfix or suture post etc.

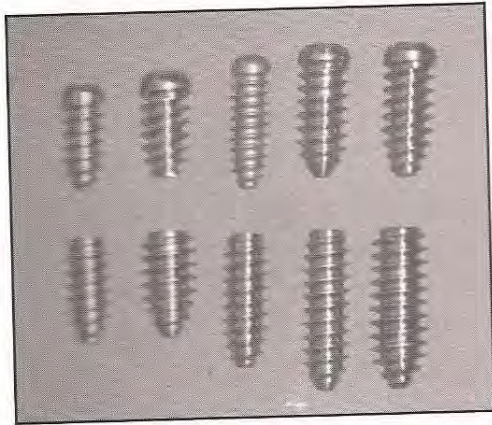
3. Locally made screws can be dangerous and can lacerate the graft.

*Figure on Next Page....*





**Fig. 2 : Bioabsorbable Screw.**



**Fig. 3 : Titanium Screw.**

### Graft Passage

A passing beath pin is used to pass the graft. No. 5 ethibond is used to pull the graft and no.2 graft is used to flip the endobutton after it is pulled out of the lateral femoral cortex. Once the graft is pulled out of the femoral cortex it is flipped using the no. 2 Ethibond sutures (trailing sutures).

Locking of the endobutton is confirmed by the "toggle test" whereby the pulling no.5 and no.2 trailing sutures can toggle the endobutton once it is pulled out of the lateral femoral cortex.

If the graft cannot be pulled out by pulling on the sutures at the tibial end of the graft; locking is confirmed.

### Impingement

Once the graft is locked on the femoral side, the scope is used to check for impingement of the graft against the anterior femoral notch; in case of

impingement, notchplasty is revised till complete clearance is obtained.

### Cycling

Once the button is locked and impingement is ruled out, the sutures at the tibial end are held firmly and the knee is moved from 0 to 90 degrees of flexion vigorously at least 20 times to remove the slack and the crimp in the graft before tibial fixation.

### Isometry

While cycling, axial movement (pistoning) of the sutures outside the tibial tunnel mouth is checked to make sure that the tunnel placement is optimal and isometric.

Upto 2 mm pistoning is acceptable; more than 2 mm pistoning indicates suboptimal tunnel placement and poor isometry which is destined for graft failure and / or restriction of knee motion and necessitates immediate revision of the tunnels which is a formidable procedure and requires experience in revision ACL surgery.

### Graft Fixation

The last step in ACL surgery is tibial fixation of the graft; The graft is fixed over a suture wheel or a suture post at 30 degrees of knee flexion with stress posterior drawer given by assistant in external tibial rotation.

In case of patients having hyperextension of the normal knee, the graft is tensioned and fixed at 0 degrees extension to prevent capturing of the knee. Thus ACL reconstruction surgery is a precision surgery and if technical details are observed predictable results is assured.

However, if technical details are not followed, results can be suboptimal and in cases where tunnel placement is faulty ACL surgery is destined to fail.

### Complication's

Can be divided into (1) Intraoperative and (2) Postoperative

(1) **Intraoperative Complications** : Can be further subdivided into :

(a) Graft Harvest.



- (b) Graft Fixation.
- (c) Tunnel Placement.
- (d) Tensioning.

**(a) Graft Harvest :**

**(i) Inadequate Graft Length or Width :**

Premature transection or amputation of Semi T is a dreaded complication and can best be avoided by carefully dividing all bands and adhesions. In case of short length the options are –

1. Harvest the Gracilis and use doubled loops.
2. Use contralateral hamstrings.
3. Use allografts.
4. Use BPTB or central third quadriceps tendon.
5. In case of less width use Gracilis and make 5 bundle graft to increase diameter.

It is better to inform patients before hand about such possibility.

**(ii) Medial Collateral Damage : DO NOT HARVEST THE MCL!** This is a devastating complication and one should best avoid it by not plunging the scalpel into the pes anserine as the MCL lies immediately underneath the pes. In case of damage it should be repaired.

**(iii) Saphenous Nerve Damage :** Place the leg in figure of 4 position to relieve tension on the nerve and hence injury.

Usually the paraesthesia recovers but in cases where there is local tenderness or reflex sympathetic dystrophy or neuralgia, local anaesthetic blockade, neuroleptic medication, topical anaesthetic patches, neurolysis or neurectomy should be done.

**(iv) Dropped Graft :** Grafts dropped on the floor inadvertently can be a frustrating experience. Use of such grafts by cleaning and immersing in Betadine carries a 30% risk of infection.

**(b) Graft Fixation :**

1. Femoral fixation: the various options for fixing the graft at the femoral end include the endobutton, Transfix, Soft tissue interference screws.

Care must be taken not to pull the trailing sutures too hard as there is danger of over flipping.

2. Tibial fixation must be done in extension if there is normal hyperextension on the opposite side.

**(c) Tunnel Placement :** Faulty tunnel placement leads to nonisometric graft placement and results in loss of movement and failure of the graft. Attention to technical details, the anatomic landmarks and correct instruments can avert this complication which is very difficult to correct and necessitates revision.

**(d) Tensioning :** Contra lateral normal knee must be examined for normal hyperextension which exists in many patients. In such patients the graft should be tensioned and tied at zero degrees extension to avoid capturing the knee.

In remaining patients, the ligament can be tensioned at 30 degree flexion.

**(2) Postoperative Complications :**

**1. Infection :** infection is a serious complication and can threaten the reconstruction as well as the joint if not treated aggressively. Early recognition is critical to salvage. In presence of high fever in the immediate postoperative period, high WBC counts, frank pus on aspiration or from the incision, one must start high antibiotics, send pus for culture and take the patient for Arthroscopic debridement. Thorough debridement, lavage and synovectomy can salvage the surgery. Post operatively, closed suction irrigation should be continued for 3 to 5 days and antibiotics should be given for 3 weeks. In case the infection cannot be controlled by these measures, the only option is to remove the graft, all implants, debride and keep drains till the infection settles. After 3 to 6 months when all signs of infections have disappeared and the Blood counts, CRP etc. is normal, Revision ACL reconstruction can be undertaken.

**2. Deep Vein Thrombosis :** Early mobilisation can prevent DVT.

**3. Arthrofibrosis :** Though rare one must avoid knee stiffness by early mobilisation and accelerated rehabilitation programme in all cases.



Cases with infection are at higher risk of developing stiffness due to slower Rehab programme and must be monitored closely.

**Arthrofibrosis**



**Fig. 4 : Arthrofibrosis Due to Lack of Postop. Physiotherapy.**

**Results**



**Fig. 5 : Double Socket ACL Reconstruction Using Semi T.**



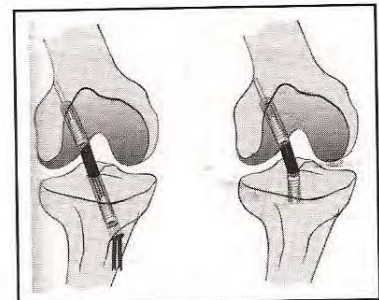
**Fig. 6 : ACL Recons. 6 Months Later Full Flexion No Instability.**



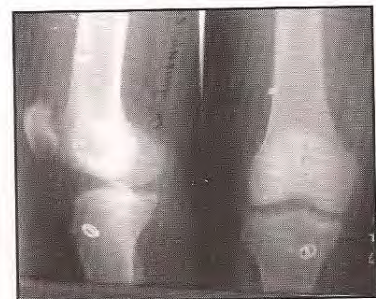
**Fig. 7 : ACL Recon 5th Postop Day.**



**Fig. 8 : ACL Recons. 5th Postop Day.**



**Fig. 27 : Soft Tissue Interference Screws.**



**Fig. 28 : X Ray of ACL Reconstruction Showing Endobutton Locked on Lateral Femoral Cortex.**



### **Accelerated Rehabilitation**

1. Early mobilisation: to achieve full flexion within 1 week of surgery
2. Nonweightbearing for one week in long leg knee brace. Some advocate immediate weightbearing with brace.
3. Muscle strengthening: closed kinetic chain exercises
4. Avoid active knee extension
5. Sports activities can be started after 6 months
6. In case of meniscal repair : knee brace immobilisation for 3 weeks

7. In case of microfracture: nonweightbearing for 3 weeks.

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