

**ARTHROSCOPIC ANTERIOR CRUCIATE LIGAMENT
RECONSTRUCTION USING BONE-PATELLAR
TENDON-BONE AUTOGRAFT AND FOUR STRAND
HAMSTRING TENDON AUTOGRAFT:
A COMPARATIVE ANALYSIS**

A DISSERTATION SUBMITTED TO
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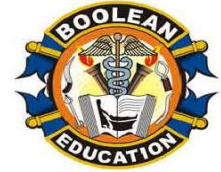


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INTRODUCTION

Anterior cruciate ligament is an intra-articular, extrasynovial structure present in the central complex of knee joint. It functions in concert with all other anatomical structures in the knee joint to control and limit motion and to maintain both static and dynamic equilibrium. It is commonly injured in athletic activities specially contact sports and motor vehicle accidents. Ligament disruption occurs without a fall or direct contact where deceleration along with valgus external rotation or hyper extension force comes into play.

The aim of surgical treatment is to restore knee stability, thereby allowing the patient to return to his original physical activity levels. Selection of appropriate graft in ACL reconstruction is important as allogenic tissue and prosthetic ligaments have shown discouraging results due to short half life and decreased mechanical strength in contrast to autologous grafts which include bone patellar tendon bone, hamstrings (semitendinosus-gracilis), quadriceps bone, Achilles tendon and iliotibial band.

The choice of graft and its fixation plays a key role in ACL reconstruction . An ideal graft would be one that provides as much strength as native anterior cruciate ligament, allows for secure fixation, has minimal harvest site morbidity, enables unrestricted rehabilitation and restores normal knee biomechanics and kinematics.

The midthird bone- patellar tendon- bone and multiple stranded hamstring tendons(semitendinosus-gracilis) are the most frequently used autografts today^{7,19,22,30}. The bone-patellar tendon- bone autograft is considered to be the "gold standard" because of the bone- to- bone healing that allows for an early and accelerated rehabilitation with documented good and excellent long- term results^{24,25,27,30}.

The hamstring tendon grafts have increased in popularity as an alternative to the bone-patellar tendon-bone graft¹⁰. Advantages of hamstring over patellar

tendon are reduced donor site morbidity associated with fewer kneeling problems and muscular deficits and less anterior knee pain in the long-term follow-up^{1,10,11,29}. On the contrary, **Yunes et al**³⁰ reported significantly poorer static knee stability after hamstring tendon ACL reconstruction compared with patellar tendon graft.

The present study is designed to compare BPTB and hamstring tendon autografts for arthroscopic ACL reconstruction with interference screw fixation for both grafts on tibial side and tranfix screw on femoral side in hamstrings and transference screw in BPTB graft in clinical outcome study with 12 months follow-up.

AIMS AND OBJECTIVES

- To combine and evaluate the best available evidences for choice between bone-patellar tendon- bone and hamstring tendon grafts for use in anterior cruciate ligament reconstruction.
- To assess the effectiveness of the bone-patellar tendon-bone graft compared to hamstring tendon graft as used in the treatment of anterior cruciate ligament injuries of the knee.

MATERIALS AND METHODS

This study was conducted at Primus Hospital, New Delhi during a period of twelve months from April 2009 to March 2010.

Patients presenting with unilateral knee complaints in the Orthopaedic out patient department of Primus Hospital, New Delhi were evaluated by a thorough general and local clinical examination of the knee. Uninjured knees of normal subjects in supine position were taken as reference. The following specific tests were performed for diagnosing ACL deficiency:

- 1) Lachman test
- 2) Anterior drawer test
- 3) Lateral pivot shift maneuver

Injuries to the associated structures were assessed by performing the following clinical tests:

- 1) Valgus/ Varus stress test(for collateral ligaments)
- 2) McMurray's test(for menisci)
- 3) Posterior drawer test(for posterior cruciate ligament)
- 4) Reverse pivot shift test (for posterolateral complex)

Routine skiagrams of the affected knee were taken in standing position in antero-posterior and lateral views. MRI of the knee was done in cases with equivocal clinical findings.

CRITERIA FOR SELECTION

- 1) Clinical / radiological / arthroscopic evidence of ACL deficiency which is symptomatic even after conservative therapy of adequate duration.

- 2) Young and middle aged, active, motivated patients with future interest in professional / recreational sports or who are involved in vigorous activities,unwilling to change their active life style.
- 3) A normal contralateral knee.
- 4) The acute inflammatory phase of the injury has subsided and full range of motion and good quadriceps strength has been regained with no extensor lag(usually after 4-6 weeks of injury).

CRITERIA FOR EXCLUSION

- 1) Bilateral anterior cruciate ligament deficiency.
- 2) Multiple ligament injury of the knee.
- 3) Elderly patients especially with pre-existing osteo-arthritis.
- 4) Presence of fractures around the knee(tibial plateau, patella, femoral condyles).
- 5) Patients with sedentary life style, not keen on pursuing sports in future, and having minimal disability.

An informed consent was taken from the selected patients after explaining the procedure, its outcome, complications and the prolonged rehabilitation protocol to be followed subsequently.

PREOPERATIVE PERIOD

After pre-anaesthetic check-up, a single dose of a third generation cephalosporin (ceftriaxone; 1 gm) and aminoglycoside (amikacin; 500mg) was administered intravenously about half an hour prior to procedure.

PROCEDURE

After giving adequate anaesthesia (spinal/ spinal and epidural/ general), the patient was placed in supine position. The affected knee was correctly

identified and a high pneumatic tourniquet applied. Using a sterile esmarch bandage the limb was exsanguinated, and the tourniquet inflated.

GRAFT HARVEST

HAMSTRING GRAFT

- A longitudinal skin incision of about 4 cm was given, centered approximately 4 cm medial and just distal to the tibial tubercle or about three finger width below the medial joint line.
- Semitendinosus tendon was hooked under Pes Anserinus fascia.
- Deep fascial bands were dissected.
- Open -end stripper was passed over the tendon one by one and advanced carefully in line with it giving firm, steady but gentle pressure and simultaneously applying counter- traction using the previously placed suture. Gracilis usually had a more muscular appearance after harvesting.
- Graft was harvested.

GRAFT PREPARATION

- Grafts were placed on *graft master board*.
- They were stripped off their residual muscle fibers proximally using the blunt end of scalpel blade.
- They were placed together and using a number 5 ethibond suture a running baseball stitch was placed in both tendons in a *Chinese finger trap configuration*.
- The tendons were looped (using an umbilical tape around the stitched tendons) and passed through various holes in the graft sizer.
- *Prestressing of the graft* was done manually.

BONE- PATELLAR TENDON- BONE GRAFT

- A 6 cm medial parapatellar incision was given with knee in 90 degrees of flexion, starting at the inferior pole of the patella and extending distally medial to the tibial tuberosity.
- Patella and tendon was exposed by subcutaneous dissection. A straight midline incision was given through the peritenon.
- A 10mm wide graft or one third of the tendon was harvested, whichever was smaller, from the central portion of the tendon, extending distally from the palpable inferior tip of the patella.
- After harvesting the graft it was contoured with rongeurs so that it fits through the 10mm trial.
- 25mm long tibial graft was freed with curved osteotome.

ARTHROSCOPY

- Arthroscope was introduced and knee was examined systematically in the 'W' sequence, starting from the suprapatellar pouch, then the patellofemoral joint, medial gutter, medial meniscus, intercondylar notch, lateral meniscus and lateral gutter after making high anterolateral portal.
- Once all the pathologies were recorded a second anteromedial portal (working portal) was made at the inferior pole of patella, 1cm medial to patellar tendon. All associated pathologies were dealt with appropriately like partial meniscectomy for a meniscal tear that was unstable to probing, chondral defect shaving and removal of loose bodies.

NOTCH PREPARATION

- A torn ACL was usually visualized as failing to extend to its normal femoral attachment (empty lateral wall sign).

- The remaining ACL tissue was removed using the basket forceps and a 5.5 mm aggressive plus resector.

TUNNEL PLACEMENT

HAMSTRING GRAFT

TIBIAL TUNNEL

- The acufex tibial guide was introduced into the joint through the anteromedial portal after setting the inclination of the zig at 55 degrees.
- The aimer was placed on the center of the tibial foot print which lies about 7 mm anterior to the PCL in the midpoint and just medial to the posterior edge of the anterior horn of lateral meniscus.
- The sleeve was inserted into the guide upto the tibial cortex(through the incision used for graft harvesting) at about 2cm medial to the tibial tubercle and 4 cm below the joint line. A guide pin was drilled into the joint through the sleeve.
- The tunnel was then reamed with a cannulated headed reamer placed over the guide pin, starting from 8mm size upto the size determined by graft sizer.

FEMORAL TUNNEL

- Femoral offset guide was introduced into the joint through the tibial tunnel and engaged into "over the top" position with the knee in 90° flexion. The guide was aimed at 2 o'clock position in the left knee and 10 o'clock in the right knee.
- An appropriate sized offset guide was used so as to leave about 2mm of posterior cortical wall after drilling the femoral tunnel (7mm size for 10mm reamed tunnel).
- The guide pin was then drilled through the intercondylar region and lateral femoral cortex to emerge out of the anterolateral aspect of the thigh.

- An appropriate sized cannulated calibrated reamer was threaded over the pin and femoral tunnel reamed upto the 40mm mark on the calibrated reamer. The sharp edges of the femoral tunnel were smoothed by shaver and debris removed.

BONE- PATELLAR TENDON- BONE GRAFT

TIBIAL TUNNEL

- Proper length and direction of the tunnel required a starting point approximately 1cm proximal to the pes anserinus and about 1.5 cm medial to the tibial tuberosity. Four consistent land marks were used to locate the center of the tibial tunnel.
- In the antero-posterior plane, pin is placed approximately 7 mm anterior to the PCL and about 2 to 3mm anterior to the peak of the medial spine just posterior to the center of the ACL footprint.
- Guide is placed at 55 to 60 degrees to the tibial plateau surface to obtain sufficient tunnel length and an angle that allows the graft angle to approximate that of the original.
- Using the guide, wire was advanced approximately 20 mm into the knee while observing through the arthroscope.
- Tunnel was reamed first with 8-mm reamer and then with 10-mm reamer.

FEMORAL TUNNEL

- With the knee flexed approximately 90 degrees, femoral pilot hole was confirmed with an Arthrex 7 mm offset femoral guide passed through the tibial tunnel. The starting point was at 10-o'clock position on the right knee and 2 o'clock on the left knee.
- A long guide wire was advanced through the guide to the chosen

physiometric point on the posterolateral portion of the femoral condyle.

- 10 mm endoscope reamer was passed over the previously placed wire.

GRAFT PLACEMENT AND FIXATION

HAMSTRING GRAFT

- The size specific tunnel (marking) hook was mounted on the C-ring of the femoral guide and inserted through the tibial tunnel into the femoral socket.
- The guide pin sleeve was advanced to mark the skin over the lateral femoral condyle and about 1 cm longitudinal incision was given in the skin and iliotibial band.
- The guide pin sleeve was placed against the lateral femoral cortex and a 3 mm guide pin was drilled through it, in a direction slightly posterolateral to anteromedial in the coronal plane coming out through the medial skin.
- The guide pin was then drilled back and forth a few times to loosen it for its easy removal subsequently. The outer cortex of the lateral femoral condyle was drilled over the guide-pin, upto a depth of 7 mm using a cortical reamer with a depth stop.
- The fine wire loop of the nitinol wire was then placed into the slot on the lateral end of the guide pin and the guide pin was pulled through the condyles .
- The tunnel hook was then withdrawn out pulling the loop of wire down through the femur and out of the tibial tunnel.
- The hook was then disengaged from the wire loop and the prepared tendon graft was loaded at its middle on to the wire loop.
- The graft was passed through the tibial tunnel and up into the femoral socket.

- The TransFix implant(3mm x 50mm) was placed on its impactor and slid over the guide wire into the lateral femoral condyle and under the grafts at the end of the femoral tunnel, taking care that it is slid easily.
- As the lateral threaded head contacted the femoral cortex, the implant was hammered with the impactor till its head was flush with the cortex.
- The graft was then placed under tension and knee was cycled several times to remove "creep" from the graft construct.
- The knee was then placed in about 20-30 degrees of flexion, an appropriate sized headless Titanium screw (usually same size of the diameter of tibial tunnel) was inserted into the tibial tunnel until it was buried just below the cortex. If fixation was found to be inadequate, a staple was used in addition, just distal to the tibial tunnel.

BONE- PATELLAR TENDON- BONE GRAFT

- Eyelet guide wire was used to pass the patellar bone plug guide suture through the femoral tunnel and then out through the lateral thigh.
- With the suture, graft was pulled up into the knee and a probe was used to help guide the graft up into the femoral tunnel with the cancellous portion of the graft pointing anteriorly.
- For graft fixation a cannulated screw with non- cutting threads was passed through the medial portal or central patellar portal. Knee was flexed to about 110 degrees.
- Screw was advanced into the tunnel, placing head even with the bone plug. Tension was held on the graft for approximately 3 minutes while cycling the knee to allow for collagen fiber stress relaxation. Graft was secured with appropriate size screw.

CLOSURE

HAMSTRING GRAFT

- The sartorial fascia and subcutaneous tissue was stitched with an interrupted 2.0 vicryl suture and skin was closed with interrupted silk sutures.
- The portal sites were usually left open for drainage.
- A sterile dressing was applied. After applying a pressure bandage, tourniquet deflated and tourniquet time noted. Knee was subsequently placed in a brace locked in extension.

BONE- PATELLAR TENDON- BONE GRAFT

- Patellar tendon was loosely approximated with simple interrupted absorbable sutures through the anterior portion of the fiber of the tendon.
- Bone saved from contouring the bone plug was placed into the patellar defect and peritenon was closed.
- Sutures were removed from the thigh and from tibial bone plug. Periosteal flap was closed back over the tunnel. Wound was closed in two layers.

POSTOPERATIVE CARE

Patient was encouraged to lie supine with foot end elevated for 24 hours, as spinal anaesthesia was given during procedure. He was encouraged to use ice packs to reduce the swelling. Round the clock analgesia (initially i.v., later oral) was administered to assist in physiotherapy. Wound inspection was done on 3rd postoperative day. Only if the wound was healthy and patient's compliance for physiotherapy was assured, the patient was discharged on oral antibiotics. Sutures were removed on 14th postoperative day.

REHABILITATION

Rehabilitation programme was divided into 4 phases with following goals:

1) Immediate phase (0-2 weeks)

- Control of pain and swelling with rest, cryotherapy, NSAIDs and compression bandage.
- Recovery of full range of motion with active flexion and passive/ self assisted extension, especially in the last 45°.
- Isometric quadriceps and hamstring exercises with ankle pumps.
- Re-establishment of normal gait by walking with crutches and knee brace.

2) Early phase (2-5 weeks)

- Full range of motion, active extension from 0-45 , 60-65% quadriceps strength.
- Begin agility drills and proprioception activities by 5th week.
- Brace-free, normal gait pattern without crutches.

3) Middle phase (5-12 weeks)

- Critical period, as revascularization occurs during this time.
- Full active range of motion, 70-75% isokinetic quadriceps strength, start athletic activity (swimming, bike).

4) Late phase (3-6 months)

- 80-85% isokinetic quadriceps activity by 4 months when return to non-contact sports is advised.
- 90% isokinetic quadriceps activity by 6 months when full return to sports(including contact sports) is allowed.

All knees were examined before surgery, in the operating room immediately after the Procedure, and at two, four, six and twelve months and following things were noted:-

- Ability to bear weight (graded as full, partial, or impossible)
- Difficulty with squatting or flexing the knees greater than or equal to 90 degrees (assessed as no problem, slight difficulty, or unable to squat)
- Presence or absence of anterior knee pain was documented.
- 2000 IKDC (International Knee Documentation Committee) Subjective Knee Evaluation Form and 2000 IKDC Knee Examination form was recorded preoperatively and at the twelve month follow- up interval.

OUTCOME AND ANALYSIS OF DATA

After completing the study, observations were tabulated and were analysed, qualitatively as well as quantitatively, using proper statistical methods.

- Demographic and clinical data between two groups were compared.
- Intergroup comparison was analysed by K- Independent sample t test.
- Intragroup comparison was analysed by Paired t - test.
- In all tests P value :
 - > 0.05 - Non-significant
 - < 0.05 - Significant
 - < 0.01 - Highly significant
 - < 0.001 - Very highly significant (P value 0.000 => P value < 0.001)

DISTRIBUTION OF PATIENTS

Table no. I shows distribution of patients in different groups according to the type of graft chosen for reconstruction.

TABLE NO. 1

S.No.	Group	No. of patients	Type of Graft
1	A	15	Bone-Patellar- Tendon- Bone Graft
2	B	15	Four Stranded Semitendinosus-Gracilis Graft

RECORDING OF THE PARAMETERS

Table No. 2: shows recording time of various parameters for group A and B.

TABLE NO. 2

RECORDING TIME	DESCRIPTION
T0	Pre- operative (base line value)
T1	Post- operative 2 months
T2	Post- operative 4 months
T3	Post- operative 6 months
T4	Post- operative 12 months

DEMOGRAPHIC CHARACTERS

AGE DISTRIBUTION

TABLE NO. 3

S. no	Age group	Group A	Group B	Total
1	20-30	07	09	16
2	31-40	07	03	10
3	41-50	01	03	04
Total		15	15	30

SEX DISTRIBUTION

TABLE NO. 4

S.no	Group	No. of patients	Sex	
			Male	Female
1	A	15	13	2
2	B	15	12	3

DURATION SINCE INJURY

TABLE NO. 5

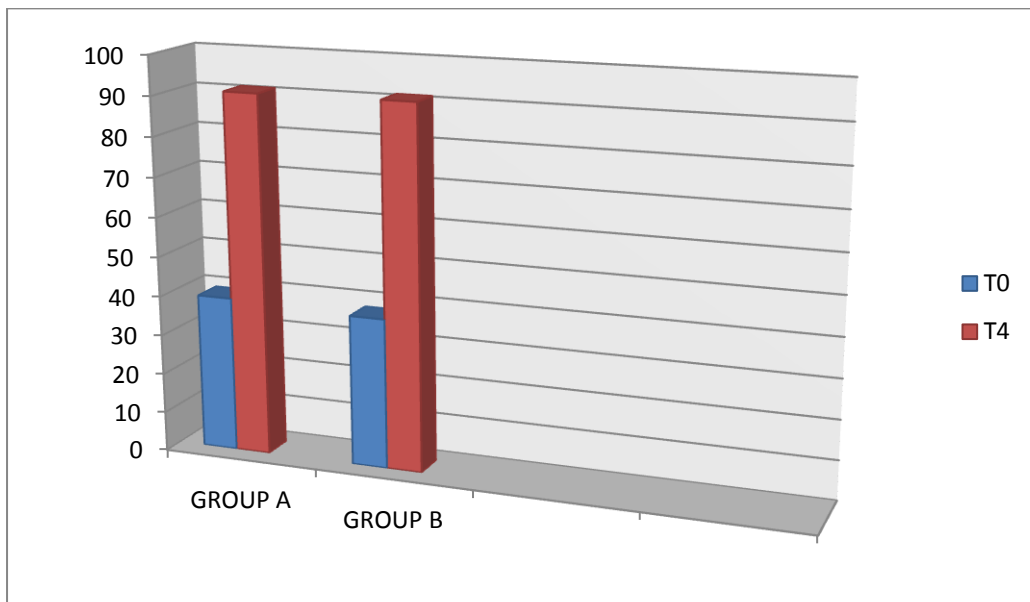
S.NO.	Group	Duration since injury (range)	Mean +/-S.D
1	A	2-12 months	4.666+7-2.845
2	B	2-7 months	4.466+7- 1.505

MEAN SCORE OF SUBJECTIVE IKDC EVALUATION IN TWO GROUPS

TABLE NO. 6

Recording time	Group A		Group B	
	Mean	+/-S.D	Mean	+/-S.D
T0	39.299	17.89	37.950	11.21
T4	91.012	2.91	91.323	2.22

Table 6 for group A and group B shows increase in subjective IKDC evaluation at 12 months.



STATISTICAL ANALYSIS OF MEAN SCORE OF SUBJECTIVE IKDC EVALUATION

TABLE NO. 7

Recording time	Group A		Group B	
	P value	Significance	P value	Significance
TO-T4	0.000	VHS	0.000	VHS

Table 7 for group A and group B shows statistically very highly significant (P value< 0.001) improvement in subjective IKDC evaluation at 12 month as compared to base line value.

INTER GROUP STATISTICAL COMPARISON OF MEAN SCORE OF SUBJECTIVE IKDC EVALUATION

TABLE NO. 8

Recording time	Group A	Vs	Group B
	P value		Significance
TO	0.806		NS
T4	0.407		NS

Table No.8 shows statistically non significant (P value>0.05) difference in subjective IKDC evaluation for group A as compared to group B at relevant recording time.

**MEAN SCORE OF GROUP GRADE FOR OBJECTIVE IKDC EVALUATION
IN TWO GROUPS**

TABLE NO. 9

Recording time	Group A		Group B	
	Mean	+/-S.D	Mean	+/-S.D
TO	3.600	0.507	3.333	0.487
T4	1.333	0.467	1.266	0.457

Graded as:

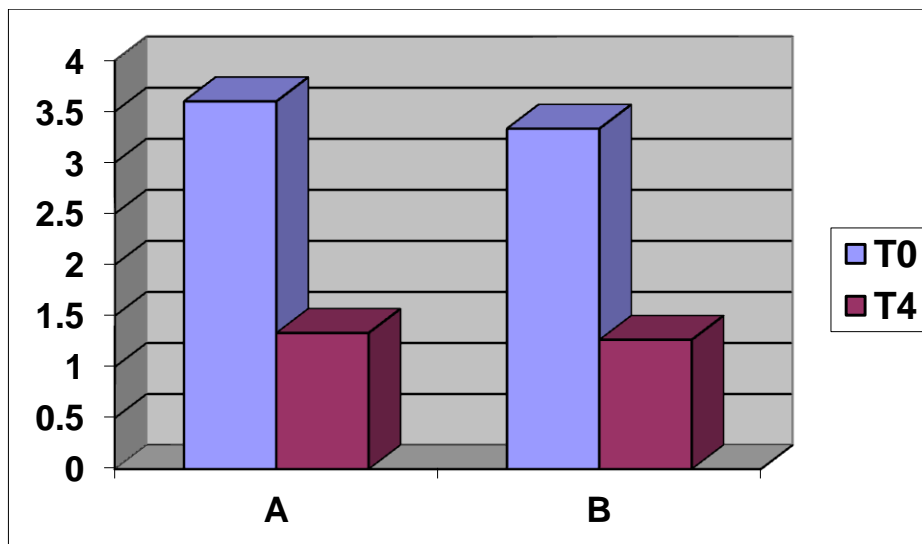
Normal (A) 1

Nearly normal (B)..... 2

Abnormal (C)..... 3

Severely abnormal (D)..... 4

Table No. 9 for group A and group B shows improvement in objective IKDC knee evaluation at 12 month.



**Figure 2
MEAN OF GROUP GRADE FOR OBJECTIVE IKDC
[TABLE NO. 9]**

**STATISTICAL ANALYSIS OF MEAN SCORE OF GROUP GRADE FOR
OBJECTIVE IKDC EVALUATION IN TWO GROUPS AND THEIR
COMPARISON WITH BASE LINE VALUE**

TABLE NO. 10

Recording time	Group A		Group B	
	P value	Significance	P value	Significance
TO-T4	0.000	VHS	0.000	VHS

Table No. 10 for group A and group B shows statistically very highly significant (P value< 0.001) improvement in objective IKDC knee evaluation at 12 month as compared to base line value.

**INTER GROUP STATISTICAL COMPARISON OF THE MEAN SCORE OF
GROUP GRADE FOR OBJECTIVE IKDC EVALUATION AT RELEVANT
RECORDING TIME**

TABLE NO. 11

Recording time	Group A	Vs	Group B
	P value		Significance
T0	0.153		NS
T4	0.702		NS

Table no. 11 shows statistically non significant (P value>0.05) difference in objective IKDC knee evaluation for group A as compared to group B at any relevant recording time.

MEAN SCORE OF EVALUATION OF EFFUSION IN TWO GROUPS

TABLE 12 (A) - I

Recording lime	Group A		Group B	
	Mean	+/-S.D	Mean	+/-S.D
T0	1 .266	0.457	1.200	0.414
T4	1.000	0.000	1.000	0.000

Graded as:

Normal (A)..... 1

Nearly normal (B)..... 2

Abnormal (C)..... 3

Severely abnormal (D).....4

Table No. 12(A)-I shows that the effusion pre-operatively was normal to near normal in both the groups and became normal at 12 months, thereby reflecting no significant difference pre and post-operatively and also when compared between the two groups.

**MEAN SCORE OF PASSIVE MOTION DEFICIT EVALUATION IN TWO
GROUPS AT RELEVANT RECORDING TIMES**

TABLE NO. 12(B)-I

Recording time		Group A		Group B	
		Mean	+/-S.D	Mean	+/-S.D
T0	Ext	1.333	0.351	1.200	0.414
	Flex	1.266	0.457	1.400	0.414
T4	Ext	1.266	0.457	1.066	0.258
	Flex	1.066	0.258	1.266	0.457

Graded as:

Normal (A).....1

Nearly normal (B).....2

Abnormal(C).....3

Severely abnormal (D).....4

Table No. 12(B)-I for group A and group B showed nearly no passive motion deficit pre-operatively and at 12 months.

**STATISTICAL ANALYSIS OF MEAN SCORE OF PASSIVE MOTION
DEFICIT IN TWO GROUPS AND THEIR COMPARISON WITH THE
BASELINE VALUE TABLE NO. 12 (B) - II**

Recording time		Group A		Group B	
		P value	Significance	P value	Significance
T0-T4	Ext	0.164	NS	0.164	XS
	Flex	0.082	NS	0.164	NS

Table 12(B)-II for group A and group B showed statistically non-significant (P value>0.05) passive motion deficit at 12 month as compared to base line value.

**INTERGROUP STATISTICAL COMPARISON OF MEAN SCORE OF
PASSIVE MOTION DEFICIT EVALUATION
TABLE NO. 12 (B) – III**

Recording time		Group A	Vs	Group B
		P value		Significance
T0	Ext	0.638		NS
	Hex	0.456		NS
T4	Ext	0.164		NS
	Flex	0.082		NS

Table No. 12(B)-III shows statistically non significant (P value>0.05) difference in passive motion deficit for group A as compared to group B at any relevant recording time.

MEAN SCORE OF LIGAMENT EXAMINATION IN TWO GROUPS

TABLE NO. 12(C) - I

Recording time		Group A		Group B	
		Mean	+/-S.D	Mean	+/-S.D
T0	Lach	3.600	0.507	3.533	0.516
	AP25	3.600	0.507	3.533	0.516
	AP70	3.600	0.507	3.533	0.516
	MJO	1.133	0.351	1.200	0.414
	LJO	1.066	0.258	1.200	0.414
	ERT30	1.333	0.487	1.200	0.414
	ERT90	1.533	0.516	1.200	0.414
	PST	3.600	0.507	3.533	0.516
T4	Lach	1.333	0.487	1.266	0.457
	AP25	1.333	0.487	1.266	0.457
	AP70	1.333	0.487	1.266	0.457
	MJO	1.133	0.351	1.200	0.414
	LJO	1.066	0.258	1.200	0.414
	ERT30	1.333	0.487	1.200	0.414
	ERT90	1.466	0.516	1.200	0.414
	PST	1.333	0.487	1.266	0.457

Graded as:

Normal (A).....1

Nearly normal (B).....2

Abnormal(C).....3

Severely abnormal (D).....4

Table No.12(C)-I for group A and group B showed improvement in Lachman test, AP translation at 25 degrees, AP translation at 70 degrees and pivot shift test at 12 month, whereas no improvement was seen in medial joint opening, lateral joint opening, external rotation test at 30 degrees and external rotation test at 70 degrees.

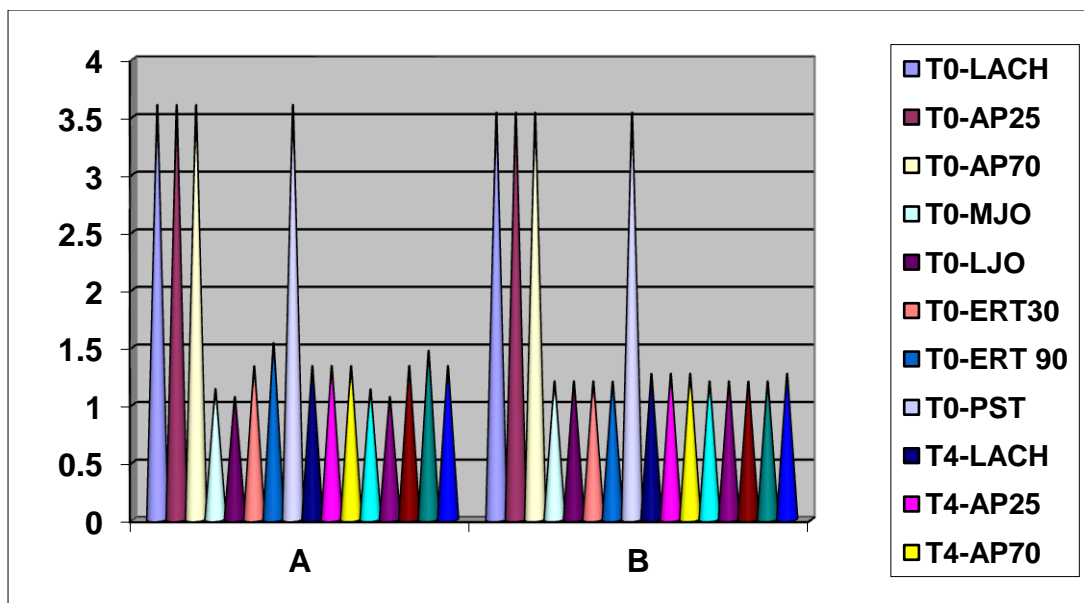


Figure 3: MEAN OF LIGAMENT EXAMINATION
TABLE NO. 12(C)-I

STATISTICAL ANALYSIS OF MEAN SCORE OF LIGAMENT EXAMINATION IN TWO GROUPS AND THEIR COMPARISON WITH BASE LINE VALUE TABLE NO. 12(C) - II

Recording time		Group A		Group B	
		P value	Significance	P value	Significance
TO-T4	Lach	0.000	VHS	0.000	VHS
	AP25	0.000	VHS	0.000	VHS
	AP70	0.000	VHS	0.000	VHS
	MJO	0.678	NS	0.678	NS
	LJO	0.080	NS	0.080	NS
	ERT30	0.414	NS	0.414	NS
	ERT90	0.334	NS	0.334	NS
	PST	0.000	VHS	0.000	VHS

Table 12(C)-II for group A and group B showed statistically very highly significant (P value<0.001) improvement in Lachman test, AP translation at 25 and 70 degrees, and pivot shift test at 12 months as compared to base line value. Statistically non significant changes were observed in medial joint opening, lateral joint opening and external rotation test at 30 and 70 degrees at 12 months as compared to base line value.

**INTERGROUP STATISTICAL COMPARISON OF MEAN SCORE OF
LIGAMENT EXAMINATION**

TABLE NO. 12 (C) - III

Recording time		Group A	Vs	Group B
		P value		Significance
TO	Lach	0.723		NS
	AP25	0.723		NS
	AP70	0.723		NS
	MJO	0.638		NS
	LJO	0.300		NS
	ERT30	0.426		NS
	ERT90	0.061		NS
	PST	0.723		NS
T4	Lach	0.702		NS
	AP25	0.702		NS
	AP70	0.702		NS
	MJO	0.638		NS
	LJO	0.300		NS
	ERT30	0.426		NS
	ERT90	0.130		NS
	PST	0.702		NS

Table No.12(C)-III shows statistically non significant (P value>0.05) difference in ligament examination for group A as compared to group B at any relevant recording time.

MEAN SCORE OF COMPARTMENT FINDINGS IN TWO GROUPS

TABLE NO. 12 (D) - I

Recording time		Group A		Group B	
		Mean	+/-S.D	Mean	+/-S.D
TO	Ant	1.066	0.258	1.333	0.351
	Med	1.200	0.414	1.266	0.457
	Lat	1.000	0.000	1.133	0.351
T4	Ant	1.066	0.258	1.333	0.351
	Med	1.200	0.414	1.266	0.457
	Lat	1.000	0.000	1.133	0.351

Graded as:

Normal (A)..... 1

Nearly normal (B)..... 2

Abnormal (C)..... 3

Severely abnormal (D).....4

Table No.12(D)-I shows normal to near normal compartment findings preoperatively and at 12 months in both the groups, thereby revealing no statistical significance pre and post-operatively and also between the two groups.

MEAN SCORE OF HARVEST SITE PATHOLOGY IN TWO GROUPS

TABLE 12 (E) – I

Recording in	Group A		Group B	
	Mean	+/-S.D	Mean	+/-S.D
T0	0.000	0.00	0.000	0.00
T4	0.400	0.507	0.000	0.00

Graded as:

Normal (A)..... 1

Nearly normal (B)..... 2

Abnormal(C)..... 3

Severely abnormal (D)..... 4

Table no 12 (E)-I for group A showed occurrence of harvest site pathology at 12 month. Harvest site pathology was not seen in group A pre-operatively and in group B at any relevant recording time .

STATISTICAL ANALYSIS OF MEAN SCORE OF HARVEST SITE PATHOLOGY IN TWO GROUPS AND THEIR COMPARISON WITH BASELINE VALUE

TABLE NO. 12 (E) - II

Recording time	Group A		Group B	
	P value	Significance	P value	Significance
TO-T4	0.008	HS	NS	NS

Table No.12(E)-II for group A shows statistically highly significant (P value< 0.01) occurrence of harvest site pathology as compared to base line value at 12 month. For group B, harvest site pathology was not observed at any relevant recording time.

**INTERGROUP STATISTICAL COMPARISON OF MEAN SCORE OF
HARVEST SITE PATHOLOGY**

TABLE NO. 12 (E) - III

Recording time	Group A	Vs	Group B
	P value	Significance	
T0	NS	NS	
T4	0.008	HS	

Table No.12(E)-III shows statistically highly significant (P value<0.01) occurrence of harvest site pathology at 12 months in group A as compared to group B.

MEAN SCORE OF X-RAY FINDINGS IN TWO GROUPS

TABLE NO. 12 (F) – I

Recording time		Group A		Group B	
		Mean	+/-S.D	Mean	+/-S.D
T0	MJS	1.133	0.351	1.266	0.457
	LJS	1.000	0.000	1.066	0.258
	PF	1.200	0.414	1.266	0.457
	AJS	1.000	0.000	1.000	0.000
	PJS	1.000	0.000	1.000	0.000
T4	MJS	1.133	0.351	1.266	0.457
	LJS	1.000	0.000	1.066	0.258
	PF	1.200	0.414	1.266	0.457
	AJS	1.000	0.000	1.000	0.000
	PJS	1.000	0.000	1.000	0.000

Graded as:

Normal (A)..... 1

Nearly normal (B)..... 2

Abnormal(C)..... 3

Severely abnormal (D)... 4

Table No. 12(F)-I shows normal to near normal X-ray findings in both the groups preoperatively and at 12 months, thereby revealing no statistical significance between pre and post-operative findings and also between the two groups.

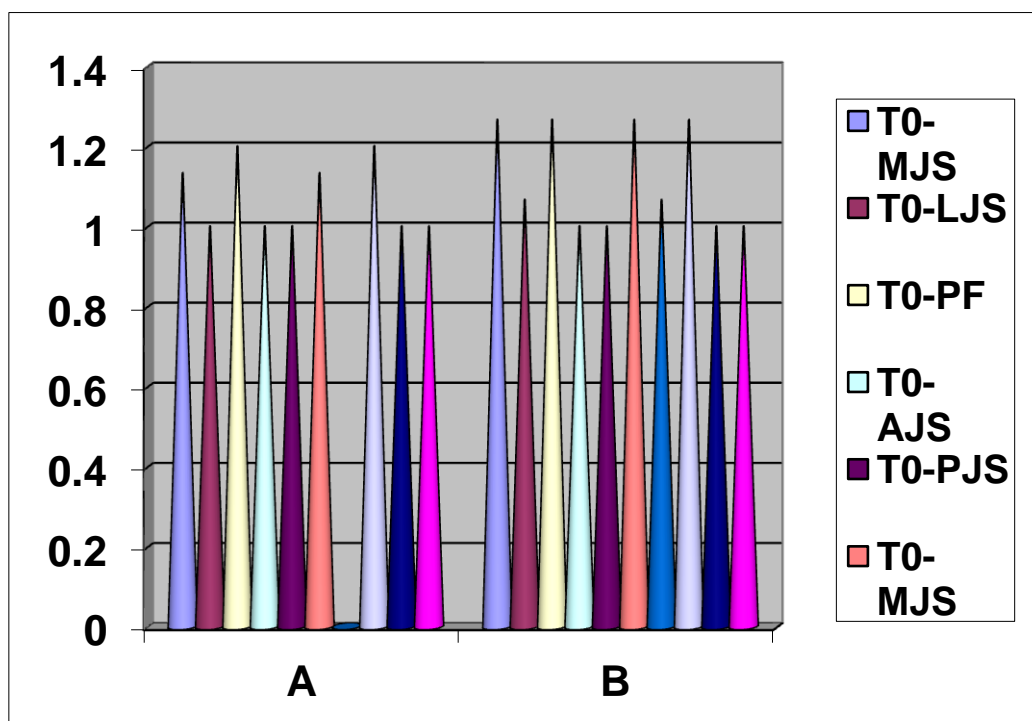


Figure 4: MEAN OF X-RAY FINDING

TABLE NO. 12(F)-I

MEAN SCORE OF FUNCTIONAL TEST IN TWO GROUPS

TABLE NO. 12 (G) - I

Recording time	Group A		Group B	
	Mean	+/-S.D	Mean	+/-S.D
T0	3.600	0.507	3.333	0.487
T4	1.333	0.487	1.266	0.457

Table No. 12 (G) - I for group A and group B shows improvement in Functional Testing at 12 month.

**STATISTICAL ANALYSIS OF THE MEAN SCORE OF FUNCTIONAL TEST
IN TWO GROUPS AND THEIR COMPARISON WITH BASE LINE VALUE**

TABLE NO. 12(G)-II

Recording time	Group A		Group B	
	P value	Significance	P value	Significance
TO-T4	0.000	VHS	0.000	VHS

Table No. 12 (G) - II for group A and group B shows statistically very highly significant (Pvalue< 0.001) improvement in Functional Testing at 12 month as compared to base line value.

**INTERGROUP STATISTICAL COMPARISON OF MEAN SCORE OF
FUNCTIONAL TEST**

TABLE NO. 12 (G) - III

Recording time	Group A	Vs	Group B
	P value		Significance
TO	0.153		NS
T4	0.702		NS

Table No. 12 (G) - III shows statistically non significant (P value>0.05) difference in Functional Testing for group A as compared to group B at any relevant recording time.

DISCUSSION

ACL injury is a common occurrence these days due to increased participation in sports and a high incidence of accidental trauma. ACL deficiency causes progressive deterioration of knee function and stability in due course of time, especially in active individuals. Surgical reconstruction plays an important role here as it helps to restore normal joint kinematics and function, thereby eliminating knee instability. But the choice of graft (BPTB or Hamstring) still remains a controversial issue. Therefore, we undertook this study to subjectively and objectively compare the results of ACL reconstruction using BPTB and Hamstring Tendon grafts.

Mean age group of patients was 30.33 yrs (range 21-41 yrs) and 31.46 yrs (range 22-46 yrs) in group A and B respectively, similar to that in the study conducted by **Wagner M et al**²⁶. **Daniel et al**¹² found the incidence of ACL injury in 15-44 years age group to be greater than twice the general population. 2 patients in group A and 3 in group B out of a total of 15 patients in each group were females. Similar variation in sex predisposition was shown in various studies^{4,18}.

A mean delay in surgery of 4.66 months (range 2-12 months) since the time of injury in group A and 4.46 months (range 2-7 months) in group B was observed.

INTRAGROUP COMPARISON

I Group A (Bone-patellar tendon-bone graft)

II Group B (Four stranded Semitendinosus-gracilis graft)

❖ **Subjective IKDC knee evaluation:** At 12 months postoperative evaluation, statistically very highly significant improvement was seen in subjective knee evaluation score as compared to baseline preoperative assessment in both the groups. Postoperative stable knee reduced the

apprehension and allowed patients to perform original level of physical activities^{2,3,5,8,9,13,14,15,16,20,26,28}.

- ❖ **Objective IKDC grade:** At 12 months postoperative evaluation, statistically very highly significant improvement was seen in objective IKDC evaluation score as compared to baseline preoperative assessment in both the groups. **Beynonn BO et al⁹, Wagner M et al²⁶ and Aglietti P et al²** have showed similar results. Stability imparted due to ACL reconstruction led to favourable outcome of objective IKDC evaluation^{2,5,9,13,17,26}.
- ❖ **Effusion:** It was very minimal or nearly absent both pre and post operatively in both the groups thereby reflecting no significant difference in the two values.
- ❖ **Passive motion deficit:** At 12 month postoperative evaluation, both groups showed statistically nonsignificant change in passive motion deficit for flexion and extension as compared to preoperative baseline evaluation. Adequate preoperative and postoperative physiotherapy resulted in good range of passive knee flexion and extension^{1,3,5,6,13,14,17,20,21,28}.
- ❖ **Ligament examination:** At 12 months postoperative evaluation, statistically very highly significant changes were seen in Lachman test, AP translation at 25 and 70 degrees flexed knee and Pivot shift test, as compared to baseline values in both the groups. **Beynonn BD et al⁹** reported similar results in their study. ACL is primarily an anteroposterior stabilizer of knee and acts as secondary stabilizer for movements in coronal plane and rotations^{3,6,14,16,21,23}.
- ❖ **Compartment findings:** At 12 month postoperative evaluation, statistically nonsignificant change was observed in both the groups in clinical compartment findings as compared to preoperative baseline evaluation. Various studies show increased occurrence of

patellofemoral crepitations, especially on long term follow-up^{6,14,16,21,23}.

- ❖ **Harvest site pathology.** At 12 months postoperative evaluation, there was statistically very highly significant occurrence of harvest site pathology in group A as compared to base line preoperative evaluation. Similar results were found in various studies^{1,10,11,13,17,21,29}.
- ❖ **X-ray findings:** There were no findings on x-ray pre and postoperatively thereby revealing no significant difference in any of the two groups.
- ❖ **Functional test:** At 12 months postoperative evaluation, both groups showed statistically very highly significant improvement in functional testing as compared to baseline preoperative assessment, also observed by **Wagner M et al**²⁶.

INTERGROUP COMPARISON

- ❖ **Subjective IKDC knee evaluation:** In comparing group A with group B, preoperative and month postoperative evaluation showed statistically nonsignificant change, similar to the observations made by **Aglietti P et al**². **Feller JA and Webster KE**¹⁶ and **Wagner M et al**²⁶ in their study reported significantly better results for subjective knee evaluation in hamstring group whereas **Eriksson K et al**¹⁴ and **Aglietti P et al**³ reported better results in BPTB group. In our study, we found that the patient satisfaction level was same irrespective of the type of graft used.
- ❖ **Objective IKDC grade:** Although anterior cruciate ligament reconstruction using either of grafts showed significant improvement in IKDC knee evaluation, none of the grafts showed superiority with respect to the other.
- ❖ **Effusion:** In comparing the two groups, pre and postoperative evaluation showed statistically no significant change. In our study

mean delay in ACL reconstruction from the time of injury was more than 4 months, by which time knee swelling subsided significantly.

- ❖ **Passive motion deficit:** In comparing group A and B, pre and postoperative evaluation showed statistically no significant change. Various studies have shown passive extension loss more commonly in BPTB group^{3,14,16,21} while few have shown flexion loss to be more common in hamstring group^{3,14,16,21}. **Shaieb et al**²³ in their study did not find any significant extension or flexion loss using either kind of graft. In our study, patients were put on intensive knee mobilization exercises along with quadriceps and hamstring strengthening regime in preoperative period. Moreover, intraoperatively it was made sure that the graft was not impinging in femoral notch during extension. This resulted in achieving preoperative level of flexion and extension by patients in either group.
- ❖ **Ligament examination:** In comparing both the groups, pre and postoperative evaluation showed statistically no significant change. **Wagner M et al**²⁶ in their study reported significantly less positive pivot-shift examination results in hamstring group. Various studies reported that either of the graft is equally good with respect to improvement in postoperative Lachman test^{14,21,23}, as observed by us. **Eriksson K et al**¹⁴, **Marder RA et al**²¹ and **Aglietti P et al**³ reported poor results in hamstring group for postoperative Pivot shift test whereas few studies, including ours, report that both grafts are equally good in terms of postoperative Pivot shift test.
- ❖ **Compartment findings:** In comparing both the groups, pre and postoperative evaluation showed statistically no significant change. **Eriksson K et al**¹⁴ reported that use of either graft did not affect the postoperative clinical compartment finding, whereas few other studies reported significant postoperative patellofemoral crepitations in BPTB group^{6,16,21,23}.

- ❖ **Harvest site pathology:** At 1 year postoperative evaluation there was statistically very highly significant occurrence of harvest site pathology in group A as compared to group B. However, various studies show that in longer follow-up the occurrence of harvest site pathology reduced in group A ^{1,10,11,29}.
- ❖ **X-ray findings:** No statistically significant change was seen in X-ray findings pre and post-operatively in both the groups. At 1 yr evaluation use of neither graft was associated with any significant X-ray finding.
- ❖ **Functional test:** In comparing both the groups pre and post-operatively no statistically significant change was observed, similar to that reported in other studies ^{3,16,21,23}. This suggests that both grafts are equally good in regaining postoperative functional ability. However, **Wagner M et al**²⁶ showed significantly better results in the hamstring group.

CONCLUSION

This study was conducted at Primus Hospital, New Delhi, to compare the results of ACL reconstruction using BPTB and four stranded Semitendinosus-Gracilis graft. It comprised of 30 patients (15 in each group) with 1 year follow-up. There were two limitations in this study:

- 1 Small sample size of only 15 patients was taken for study in each group.
- 2 Relatively small period of 1 year follow-up was possible.

Patients were divided into two groups depending on the type of graft used for ACL reconstruction:

- Bone-Patellar tendon- Bone graft (Group A)
- Four Strand Semitendinosus- Gracilis(Group B)

IKDC subjective knee evaluation and knee examination forms were used to evaluate the outcome of the study. Following conclusions were drawn after observation, statistical analysis and discussion.

- As ACL does not primarily take part in weight transmission, its reconstruction with either of the grafts did not really show superiority of one over the other.
- Intensive preoperative quadriceps strengthening exercises if performed preoperatively, helped regaining squatting in BPTB group as efficiently as in hamstring Tendon group.
- Significant occurrence of anterior knee pain was observed in BPTB group as compared to hamstring Tendon group. Bone- patellar tendon- bone graft for anterior cruciate ligament has a limited role in people engaged in kneeling activities.

- It was observed that the satisfaction level of patient was same irrespective of the type of graft used for ACL reconstruction.
- Although ACL reconstruction using either of the grafts showed significant improvement in IKDC knee evaluation, none of the grafts showed superiority over the other.
- In our study, acute injury to knee was given time to heal and patient was taken up for surgery when swelling subsided fully and range of motion was as good as >110 degrees. In none of our cases we performed surgery before 2 months.
- Patients should be put on intensive knee mobilization exercises along with quadriceps and hamstring strengthening regime in preoperative period. Moreover, intra-operatively it should be made sure that the graft is not impinging in femoral notch during extension. Our patients in either group regained preoperative level of flexion and extension with this regime.
- Results show that in our study both grafts are equally good in terms of postoperative ligament testing.
- At 1 year evaluation we found neither of the graft to be superior over the other in respect to postoperative compartment findings.
- Significant occurrence of harvest site pathology was observed in BPTB as compared to Hamstring Tendon group, especially in shorter follow-up. Nevertheless, BPTB graft has a limited role in peoples engaged in kneeling activities.
- At 1 year evaluation, use of neither graft was associated with any postoperative significant X-ray finding. Also, both were equally good in regaining postoperative functional ability.

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ABBREVIATIONS USED IN THE TEXT

- ACL - Anterior cruciate ligament
- PCL - Posterior cruciate ligament
- BPTB - Bone-Patellar tendon-Bone
- IKDC - International Knee Documentation Committee
- AKP - Anterior knee pain
- Squatt - Squatting
- SIKDC - Subjective International Knee Documentation Committee score
- PMD - Passive motion deficit
- EXT - Extension
- FLEX - Flexion
- LE - Ligament examination
- LACH - Lachman's test
- AP 25 - Total anterior posterior translation (25degrees flex)
- AP 70 - Total anteroposterior translation (70degrees flex)
- MJO - Medial joint opening (20 degrees flexion/valgus rotation)
- LJO - Lateral joint opening (20 degrees flexion/varus rotation)
- ERT 30 - External rotation test (30 degrees flexion prone)
- ERT 90 - External rotation test (90 degrees flexion prone)
- PST - Pivot shift test
- CF - Compartment finding

- ANT - Crepitus anterior compartment
- MED - Crepitus medial compartment
- LAT - Crepitus lateral compartment
- HSP - Harvest site pathology
- X-RAY - X-ray finding
- MJS - Medial joint space
- LJS - Lateral joint space
- PF - Patello-femoral joint space
- AJS - Anterior joint space
- PJS - Medial joint space
- FT - Functional test
- GR GD - Group grade
- WT BEARING- Weight bearing

**2000
IKDC KNEE EXAMINATION FORM**

Patient Name: _____ Date of Birth: ____/____/____
Day Month Year

Gender: F M Age: _____ Date of Examination: ____/____/____
Day Month Year

Generalized Laxity: tight normal lax

Alignment: obvious varus normal obvious valgus

Patella Position: obvious baja normal obvious alta

Patella Subluxation/Dislocation: centered subluxable subluxed dislocated

Range of Motion (Ext/Flex): Index Side: passive ____/____/____ active ____/____/____
 Opposite Side: passive ____/____/____ active ____/____/____

SEVEN GROUPS	FOUR GRADES				*Group Grade			
	A Normal	B Nearly Normal	C Abnormal	D Severely Abnormal	A	B	C	D
1. Effusion	<input type="checkbox"/> None	<input type="checkbox"/> Mild	<input type="checkbox"/> Moderate	<input type="checkbox"/> Severe	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Passive Motion Deficit ΔLack of extension ΔLack of flexion	<input type="checkbox"/> <3° <input type="checkbox"/> 0 to 5°	<input type="checkbox"/> 3 to 5° <input type="checkbox"/> 6 to 15°	<input type="checkbox"/> 6 to 10° <input type="checkbox"/> 16 to 25°	<input type="checkbox"/> >10° <input type="checkbox"/> >25°	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Ligament Examination (manual, instrumented, x-ray) ΔLachman (25° flex) (134N) ΔLachman (25° flex) manual max Anterior endpoint: ΔTotal AP Translation (25° flex) ΔTotal AP Translation (70° flex) ΔPosterior Drawer Test (70° flex) ΔMed Joint Opening (20° flex/valgus rot) ΔLat Joint Opening (20° flex/varus rot) ΔExternal Rotation Test (30° flex prone) ΔExternal Rotation Test (90° flex prone) ΔPivot Shift ΔReverse Pivot Shift	<input type="checkbox"/> -1 to 2mm <input type="checkbox"/> -1 to 2mm <input type="checkbox"/> firm <input type="checkbox"/> 0 to 2mm <input type="checkbox"/> 0 to 2mm <input type="checkbox"/> 0 to 2mm <input type="checkbox"/> 0 to 2mm <input type="checkbox"/> 0 to 2mm <input type="checkbox"/> <5° <input type="checkbox"/> <5° <input type="checkbox"/> equal <input type="checkbox"/> equal	<input type="checkbox"/> 3 to 5mm(1 ⁺) <input type="checkbox"/> <-1 to -3 <input type="checkbox"/> 3 to 5mm <input type="checkbox"/> 3 to 5mm <input type="checkbox"/> 3 to 5mm <input type="checkbox"/> 3 to 5mm <input type="checkbox"/> 3 to 5mm <input type="checkbox"/> 6 to 10° <input type="checkbox"/> 6 to 10° <input type="checkbox"/> glide <input type="checkbox"/> glide	<input type="checkbox"/> 6 to 10mm(2 ⁺) <input type="checkbox"/> <-3 stiff <input type="checkbox"/> 6 to 10mm <input type="checkbox"/> 6 to 10mm <input type="checkbox"/> 6 to 10mm <input type="checkbox"/> 6 to 10mm <input type="checkbox"/> 6 to 10mm <input type="checkbox"/> 11 to 19° <input type="checkbox"/> 11 to 19° <input type="checkbox"/> ++(clunk) <input type="checkbox"/> gross	<input type="checkbox"/> >10mm(3 ⁺) <input type="checkbox"/> >10mm <input type="checkbox"/> >10mm <input type="checkbox"/> >10mm <input type="checkbox"/> >10mm <input type="checkbox"/> >10mm <input type="checkbox"/> >20° <input type="checkbox"/> >20° <input type="checkbox"/> +++(gross) <input type="checkbox"/> marked	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Compartment Findings ΔCrepitus Ant. Compartment ΔCrepitus Med. Compartment ΔCrepitus Lat. Compartment	<input type="checkbox"/> none <input type="checkbox"/> none <input type="checkbox"/> none	<input type="checkbox"/> moderate <input type="checkbox"/> moderate <input type="checkbox"/> moderate	crepitation with <input type="checkbox"/> mild pain <input type="checkbox"/> >mild pain <input type="checkbox"/> mild pain <input type="checkbox"/> >mild pain <input type="checkbox"/> mild pain <input type="checkbox"/> >mild pain		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Harvest Site Pathology	<input type="checkbox"/> none	<input type="checkbox"/> mild	<input type="checkbox"/> moderate	<input type="checkbox"/> severe	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. X-ray Findings Med. Joint Space Lat. Joint Space Patellofemoral Ant. Joint Space (sagittal) Post. Joint Space (sagittal)	<input type="checkbox"/> none <input type="checkbox"/> none <input type="checkbox"/> none <input type="checkbox"/> none <input type="checkbox"/> none	<input type="checkbox"/> mild <input type="checkbox"/> mild <input type="checkbox"/> mild <input type="checkbox"/> mild <input type="checkbox"/> mild	<input type="checkbox"/> moderate <input type="checkbox"/> moderate <input type="checkbox"/> moderate <input type="checkbox"/> moderate <input type="checkbox"/> moderate	<input type="checkbox"/> severe <input type="checkbox"/> severe <input type="checkbox"/> severe <input type="checkbox"/> severe <input type="checkbox"/> severe	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Functional Test One Leg Hop (% of opposite side)	<input type="checkbox"/> ≥90%	<input type="checkbox"/> 89 to 76%	<input type="checkbox"/> 75 to 50%	<input type="checkbox"/> <50%	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
**Final Evaluation					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

* Group grade: The lowest grade within a group determines the group grade
 ** Final evaluation: the worst group grade determines the final evaluation for acute and subacute patients. For chronic patients compare preoperative and postoperative evaluations. In a final evaluation only the first 3 groups are evaluated but all groups must be documented. Δ Difference in involved knee compared to normal or what is assumed to be normal.

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2000 IKDC SUBJECTIVE KNEE EVALUATION FORM

Your Full Name _____

Today's Date: _____ / _____ / _____ Date of Injury: _____ / _____ / _____
Day month / Year Day month / Year

SYMPTOMS*:

*Grade symptoms at the highest activity level at which you think you could function without significant symptoms, even if you are not actually performing activities at this level.

1. What is the highest level of activity that you can perform without significant knee pain?
- 4 Very strenuous activities like jumping or pivoting as in basketball or soccer
 3 Strenuous activities like heavy physical work, skiing or tennis Moderate activities like 2 moderate physical work, running or jogging
 1 Light activities like walking, housework or yard work
 0 Unable to perform any of the above activities due to knee pain

2. During the past 4 weeks, or since your injury, how often have you had pain?

	10	9	8	7	6	5	4	3	2	1	0	
Never	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	constant
No pain	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Worst pain Imaginable

3. Worst pain imaginable

4. During the past 4 weeks, or since your injury, how stiff or swollen was your knee?

- Not at all
 Moderately
 Very
 Extremely

5. What is the highest level of activity you can perform without significant swelling in your knee?
- Very strenuous activities like jumping or pivoting as in basketball or soccer Strenuous activities like heavy physical work, skiing or tennis
 Moderate activities like moderate physical work, running or jogging
 Light activities like walking, housework, or yard work
 Unable to perform any of the above activities due to knee swelling

6. During the past 4 weeks, or since your injury, did your knee lock or catch?

- Yes No

7. What is the highest level of activity you can perform without significant giving way in your knee?

- 4 Very strenuous activities like jumping or pivoting as in basketball or soccer
 3 Strenuous activities like heavy physical work, skiing or tennis
 2 Moderate activities like moderate physical work, running or jogging
 1 Light activities like walking, housework or yard work
 0 Unable to perform any of the above activities due to giving way of the knee

2000 IKDC SUBJECTIVE KNEE EVALUATION FORM SPORTS ACTIVITIES:

8. What is the highest level of activity you can participate in on a regular basis?

- 4 Very strenuous activities like jumping or pivoting as in basketball or soccer 3 Strenuous activities like heavy physical work, skiing or tennis
 2 Moderate activities like moderate physical work, running or jogging
 1 Light activities like walking, housework or yard work
 0 Unable to perform any of the above activities due to knee

9. How does your knee affect your ability to:

		Not difficult at all	Minimally difficult	Moderately Difficult	Extremely difficult	Unable to do
a.	Go up stairs	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>	0 <input type="checkbox"/>
b.	Go down stairs	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>	0 <input type="checkbox"/>
c.	Kneel on the front of your knee	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>	0 <input type="checkbox"/>
d.	Squat	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>	0 <input type="checkbox"/>
e.	Sit with your knee bent	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>	0 <input type="checkbox"/>
f.	Rise from a chair	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>	0 <input type="checkbox"/>
g.	Run straight ahead	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>	0 <input type="checkbox"/>
h.	Jump and land on your involved leg	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>	0 <input type="checkbox"/>
i.	Stop and start quickly	4 <input type="checkbox"/>	3 <input type="checkbox"/>	2 <input type="checkbox"/>	1 <input type="checkbox"/>	0 <input type="checkbox"/>

FUNCTION:

10. How would you rate the function of your knee on a scale of 0 to 10 with 10 being normal, excellent function and 0 being the inability to perform any of your usual daily activities which may include sports?

FUNCTION PRIOR TO YOUR KNEE INJURY:

Couldn't perform	No limitation
Daily activities	Daily activities
0 1 2 3 4 5 6 7	8 9 10
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

CURRENT FUNCTION OF YOUR KNEE:

Couldn't perform	No limitation
Daily activities	Daily activities
0 1 2 3 4 5 6 7	8 9 10
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

Scoring Instructions for the 2000 IKDC Subjective Knee Evaluation Form

Several methods of scoring the IKDC Subjective Knee Evaluation Form were investigated. The results indicated that summing the scores for each item performed as well as more sophisticated scoring methods.

The responses to each item are scored using an ordinal method such that a score of 0 is given to responses that represent the lowest level of function or highest level of symptoms. For example, item 1, which is related to the highest level of activity without significant pain is scored by assigning a score of 0 to the response "Unable to Perform Any of the Above Activities Due to Knee" and a score of 4 to the response "Very strenuous activities like jumping or pivoting as in basketball or soccer". For item 2, which is related to the frequency of pain over the past 4 weeks, the response "Constant" is assigned a score of 0 and "Never" is assigned a score of 10.

The IKDC Subjective Knee Evaluation Form is scored by summing the scores for the individual items and then transforming the score to a scale that ranges from 0 to 100. **Note:** The response to item 10 "Function Prior to Knee Injury" is not included in the overall score. To score the IKDC, simply add the score for each item (the small number by each item checked) and divide by the maximum possible score (which is 87 if all items have been completed):

$$\text{IKDC Score} = \left(\frac{\text{Sum of Items}}{\text{Maximum Possible Score}} \right) \times 100$$

Thus, if the sum of scores for the 18 items is 65 and the patient responded to all the items, the IKDC Score would be calculated as follows:

$$\text{IKDC Score} = \frac{66}{87} \times 100 \left(\quad \right)$$

IKDC Score = 75.9

The transformed score is interpreted as a measure of function such that higher scores represent higher levels of function and lower levels of symptoms. A score of 100 is interpreted to mean no limitation with activities of daily living or sports activities and the absence of symptoms.

The IKDC Subjective Knee Form score can be calculated when there are responses to at least 90% of the items (i.e. when responses have been provided for at least 16 items). In the original scoring instructions for the IKDC Subjective Knee Form, missing values are replaced by the average score of the items that have been answered. However, this method could slightly over- or under-estimate the score depending on the maximum value of the missing item(s) (2, 5 or 11 points). Therefore, in the revised scoring procedure, the IKDC Subjective Knee Form score is calculated as (sum of the completed items - # of completed items) / (maximum possible sum of the completed items - # of completed items) * 100. This method of scoring the IKDC Subjective Knee Form is more accurate than the original scoring method. A scoring spreadsheet is also available at: www.sportsmed.0fg/research/index.asp