

Functional Outcome of Arthroscopic Reconstruction of Anterior Cruciate Ligament using Quadrupled Semitendinosus Autograft

Vikas Singh Negi^{1*}, Utkarsh Pawar² and Sandeep Pangwane³

¹PG Resident, Department of Orthopaedics, Dr. Vasant Rao Pawar Medical College, Hospital and Research Centre, Nashik 422003, India; drnegi2405@gmail.com

²PG Resident, Department of Orthopaedics, Dr. Vasant Rao Pawar Medical College, Hospital and Research Centre, Nashik 422003, India

³Professor & Head, Department of Orthopaedics, Dr. Vasant Rao Pawar Medical College, Hospital and Research Centre, Nashik 422003, India

Abstract

Introduction: The anterior cruciate ligament is truly a “CRUCIAL” ligament of the knee. It prevents anterior translation of tibia over femur and has definite role in providing rotational stability of knee. The aim is to restore ligamentous stability and preserving a functional pain free range of motion of knee. The graft has initial load to failure greater than native ACL, its stiffness more closely approximates native ACL. **Material and Methods:** This study was conducted in department of orthopaedics of NDMVP’S Medical college and hospital. 25 cases with “Tear/Rupture” anterior cruciate ligament were treated with arthroscopic reconstruction with quadrupled semitendinosus graft. Patients were assessed for the functional outcome using Tegner Lysholm score. **Results:** All 25 cases had fair to excellent functional outcomes. **Conclusion:** Arthroscopic anterior cruciate ligament reconstruction “using quadrupled semitendinosus” is an effective method and gives stable fixation with excellent results.

Keywords: ACL Reconstruction, Complications, Fixation Method, Functional Outcome, Quadrupled Semitendinosus Autograft

1. Introduction

Anterior Cruciate Ligament (ACL) rupture is one of the major knee injuries throughout the world. The incidence of Anterior Cruciate Ligament tears has increased in the general population with the rise of participation in sports. The expectations of young male and female professional and recreational athletes have also risen as they expect to return to the pre-injury activity levels. Number of patients undergoing ACL reconstruction has risen and more favourable results have been obtained with the advances in Arthroscopic surgery and developments in ACL reconstruction equipment.

The Anterior Cruciate Ligament (ACL) serves an important stabilizing and biomechanical function for the knee joint. Rupture of the ACL leads to abnormal kinematics and predisposes the joint to degenerative changes. Several authors agree that in the young and

active patient surgical reconstruction of the torn ACL is the treatment of choice, which allows the patient to their previous activity level¹⁻³. Moreover, reconstruction of a torn ACL seems to prevent meniscal and chondral secondary lesions⁴⁻⁷.

Surgical method of reconstruction of the torn anterior cruciate ligament can be divided into three broad categories

- The intra-articular reconstruction.
- The extra-articular reconstruction.
- Combined intra and extra articular reconstruction.

With advances in arthroscopy and surgical techniques intra-articular reconstruction of anterior cruciate ligament is preferred as it is more anatomical, accurate and effective with less morbidity.

A number of graft types are available for ACL reconstruction. BTB (Bone-Tendon-Bone) and hamstring

*Author for Correspondence

Autografts are the most commonly used grafts of choice today⁸. Graft selection is dependent on the surgeon's expertise, surgeon's preference, tissue availability, patient activity level and priority.

The Bone-Patellar Tendon-Bone (BPTB) and hamstring tendon autografts are the most common graft in ACL reconstruction⁹. Some studies suggested that a harvest of the central third of the patellar tendon have associated donor site morbidity, such as patella-femoral osteoarthritis, patellar tendon shortening, loss of terminal extension and patella-femoral pain^{10,11}.

There has been an increase in the popularity of hamstring tendons as autografts for ACL reconstruction, which can avoid harvest site morbidity⁹. The hamstring grafts were first introduced as a choice for Anterior Cruciate Ligament (ACL) reconstruction three decades ago¹². With the use of the quadrupled semitendinosus technique as a reconstruction material, this graft has become frequently used in ACL reconstruction material.

The main disadvantages of the BPTB technique are the donor -site morbidity, risk of patellar fracture, remaining patella-femoral pain, loss of strength in the extensor muscles and the development of extension deficit. Problems with the use of the Semitendinosus and Gracilis (STG) technique, on the other hand, are increased knee laxity, the development of flexion deficit and increased risk of tunnel widening¹³⁻¹⁵.

In late 1970's and early 1980's open ACL reconstruction were thought to require protracted period of postoperative immobilization in order to facilitate healing. The side effects like joint stiffness, articular surface damage and delayed return to athletic activity, brought to notice the need to develop ACL substitutes with high initial strength and rigid fixation which allow immediate immobilization and potential early return to normal activity.

Simultaneous advances in Arthroscopic ACL surgical techniques as well as dramatic advances in both fixation and rehabilitation techniques have reduced surgical complications.

Arthroscopic ACL reconstruction has multiple advantages over open technique.

- Small surgical incision.
- Less extensor mechanism trauma.
- Improved inter – condylar notch view for tunnel screw placement.
- Less postoperative pain.
- Early mobilization and rehabilitation.

The goals of ACL reconstruction are to provide a functionally stable knee, relief from symptoms and

return patients to their pre-injury activity level. It has been assumed accordingly that the success rate of ACL reconstructive surgery would be improved by a surgical technique that more closely reproduced the configuration and function of the native ACL.

The optimal ACL reconstruction techniques include selection of graft with sufficient strength, minimal graft site morbidity, accurate bone tunnel placement, strong reliable graft fixation, and adequate early graft-bone integration. Surgical reconstruction is also considered in multiple ligament injuries, associated meniscus injury, chronic symptomatic anterior knee instability.

The purpose of this study is to evaluate functional outcome of arthroscopic reconstruction of anterior cruciate ligament with quadrupled semitendinosus autograft.

2. Methods

Total number of study participants are 25. The patients complaining of knee pain, limp during activity, instability due to anterior cruciate ligament rupture were admitted during the period August 2013 to December 2015. They were evaluated for their disability.

The Clinical examination included detailed history taking, noting the exact mechanism of the injury, degree of instability and disability i.e., giving way, locking, instability to take part in active sports, recurrent swellings, etc. Local examination consisted of examination for the rotatory instability and laxity of other ligaments by various tests as outlined earlier.

2.1 Radiological Work up Included

X-rays including the antero-posterior and lateral view of the knee joint.



Figure 1. MRI of the knee.

MRI findings suggestive of ACL injury:
ACL injury diagnosed was either complete or incomplete

MRI findings to classify both complete and incomplete were:

Complete ACL injury:

Direct Signs: Complete fiber disruption

Abnormal course of cruciate ligament

Intracapsular Pseudomass in place of ACL Indirect Signs:

Acute angulation of PCL

Drawer phenomenon

Incomplete ACL injury:

Thinning of ACL <10 mm

Increased intra ligamentous signal with remnants of intact fibers



Figure 2.

Inclusion Criteria:

Age: 20 to 50 years

- Complete anterior cruciate ligament tear confirmed clinically and radiologically on MRI.
- Duration of injury more than 6 weeks.

Exclusion Criteria:

Any other comorbid condition of the same knee joint such as osteoarthritis of knee, local infection etc.

Previous ligamentous injury in the same knee joint.

Bilateral ACL injury.

- Associated injuries like osteochondral defects requiring drilling or mosaicoplasty, concomitant posterior cruciate ligament injury, PCL avulsion fractures, extraarticular ligament injuries, associated meniscal tears requiring simultaneous meniscus repair.
- Associated fractures of the lower limbs.
- Incidental finding of ACL injury found during diagnostic arthroscopy.

- Neurovascular compromise.
- Non-compliant patient.

3. Methodology

During the period from August 2013 to December 2015, all the patients of the ACL injuries were evaluated. On visit to OPD or casualty, a detailed history was taken regards to the nature of injury, mechanism of injury, duration of injury, symptoms, associated injury, details of the primary treatment and past medical illnesses. A detailed general and physical examination was carried out followed by radiographic investigation.

Diagnosis:

- History.
- Physical examination.
- Radiology: Roentgenogram and MRI.

Diagnostic arthroscopy before the graft harvesting to confirm the nature of injury at the same setting as ACL reconstruction.

3.1 History

- Nature of injury.
- Mechanism of injury.
- Duration since injury.
- Pain: onset, duration, location and the site of maximum pain.
- Effusion: onset, duration.
- Stiffness.
- History of giving way (instability).
- Locking.
- Associated injuries.
- Primary treatment if any.
- Past medical illness if any.

3.2 Physical Examination

- Gait.
- Tenderness.
- Effusion of the knee joint.
- Wasting.
- Range of movements.
- Patellar tracking.
- Signs of instability of the anterior cruciate ligament.
- Anterior drawer test.
- Lachman test.
- Pivot shift test.
- Tests for associated ligamentous injuries and meniscal injuries were performed.

3.2.1 For Posterior Cruciate Ligament Injury

- Sag sign.
- Godfrey's test.
- Posterior drawer test.
- Active quadriceps test.

3.2.2 For Lateral Collateral Ligament Injury

- Varus stress test.

3.2.3 For Medial Collateral Injury

- Valgus stress test.

3.2.4 For Meniscal Injury

- McMurrays test.
- Apleys grinding test.

3.2.5 For Posterolateral Corner Injury

- Varus recurvatum test.
- Dial test.

3.3 Steps of Surgery

3.3.1 Position of the Patient and Draping

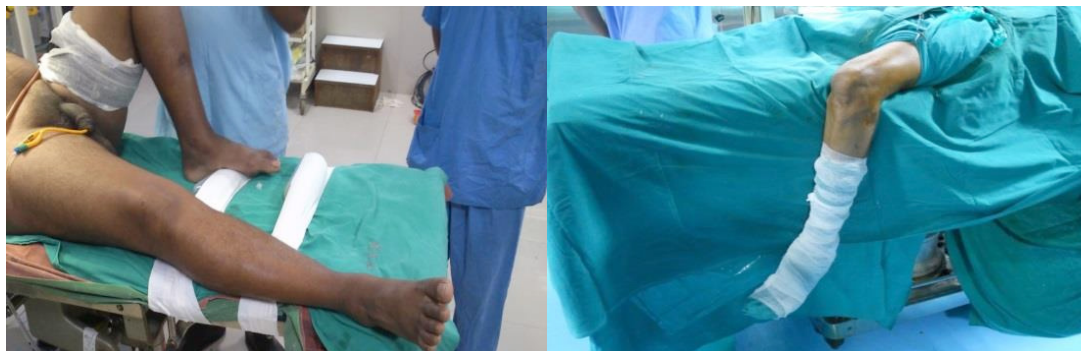


Figure 3.



Figure 4.

3.3.2 Marking of the Landmarks

3.3.3 Diagnostic Arthroscopy

Diagnostic arthroscopy was done through standard medial and lateral parapatellar portals. Diagnosis was confirmed.

Injured
ACL

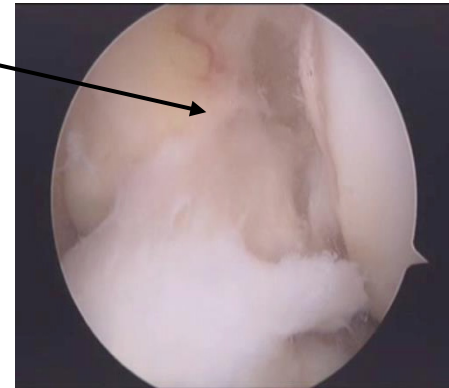


Figure 5.

3.3.4 Harvesting of Graft

Semitendinosus harvest is accomplished with knee in 90 degrees of flexion. A 4-5 cm longitudinal incision is made over the pes tendon beginning 2-3 cms distal to the joint

line and 1 cm-2 cm medial to the tibial tuberosity. The sartorius apponurosis is identified and semitendinosus tendon are palpated. The sartorius apponurosis is incised in line with its fibers distal to underlining semitendinosus tendon. Using digital palpation the semitendinosus tendon is isolated where it naturally separates from gracilis tendon, approximately 5-8 cms proximal to their tibial insertions. A no. 2 non absorbable suture was used to place running whipstitch at five to six level in distal tendon to control the free end. While transaction is applied to the free end of the tendon using the whipstitch, the deep fascial band to the medial gastrocnemius fascia can be identified and released. Premature traction to the semitendinosus tendon can occur without release of fascial attachment. With the knee flexed 70-80 degrees gently traction is maintained on the distal end while close end stripper is advanced proximally in the line with tendon. Inspection of superficial part of medial collateral ligament is carried out.



Figure 6.

3.3.5 Graft Preparation

It is performed on graft preparation board. After harvest the graft is kept moist at all time with a wet sponge to prevent tissue dessication. Overall tendon length is measured and final quadrupled graft is calculated. The required minimum graft length is about 22 cm, because minimum of 15 mm of quadrupled graft is needed within a both the tibia and femoral tunnel. The tendon is sharply divided in two halves and all the ends are prepared by whipstitch. The two graft are doubled over endobutton CL or no. 5 non-absorbable suture through two central holes of endobutton and diameter is determined. The graft is kept moist wrapped in a wet sponge.



Figure 7.

3.3.6 Identification of the ACL Footprints

- The scope was re-inserted and torn ACL substance was shaved off.
- The ACL footprint on tibial and femoral side was identified.
- Remnants of the ACL were preserved at the footprint sites as identification landmark for the graft insertion and also to help proprioceptive stimulation.

3.3.7 Femoral Tunnel Drilling by Medial Portal (Anatomic Femoral Tunnel) Technique

- With knee in 90 degrees flexion, an additional medial portal was created about 2/3rd medially across above the medial meniscus.
- A spinal needle was used to determine the exact location and to avoid accidental insertion of the medial meniscus.
- Knee was then flexed maximally to > 120 degrees with leg on the operating table.



Aiming guide-wire in the femoral footprint

Figure 8.

- The scope was then shifted to medial portal. A drill tip pin was passed from accessory medial portal through the femoral insertion of the anterior cruciate ligament out of the lateral femoral cortex. This pin would exit lateral and horizontal on the femoral shaft as compared to the previous trans-tibial technique.
- This femoral tunnel is drilled with a 4.5 mm Endobutton drill over the drill tip pin. Depth of the femoral tunnel is measured and appropriate Endobutton is selected. The femoral tunnel was then over drilled with required diameter femoral drill. 10 mm additional length apart from femoral tunnel graft length was drilled with the same diameter femoral drill for allowing flipping of Endobutton.



Figure 9.

- Femoral Tunnel drilling through anteromedial portion.

3.3.8 Tibial Tunnel Drilling

The tibial insertion was identified and an ACL tibial elbow aimer jig with an angle set to 55 degrees was used to pass a guide wire up to the medial tibial metaphysis into the joint. The tunnel was enlarged with an appropriate reamer.



Figure 10.

Tibial elbow aimer kept in line with anterior horn of lateral meniscus and approximately 7 mm anterior to PCL.

3.3.9 Graft Loading and Passage

- A No. 2 ethibond leading suture loop was passed

through the accessory medial portal and out laterally. This retrieved out of the tibial tunnel.

- The prepared graft was loaded with appropriate Endobutton, the leading and trailing sutures and was passed over the No. 2 Ethibond suture.

3.3.10 Tibial Side Fixation

- The tibial side fixation was performed with an interference screw that was passed up to the tibial tunnel with knee in 15 degrees of flexion with a posterior drawer given for applying tension distally. The size of the interference screw was generally 1 mm more than the diameter of the tibial tunnel.
- Excess graft coming out of the tibial tunnel was excised.

3.3.11 Postoperative Protocol

- The wound was closed over a negative suction drain. A long knee brace was applied over a padded compression dressing.



Figure 11.

- Drains were removed on the 2nd postoperative day. Injectable antibiotics were given till the 5th post op day and then shifted on oral antibiotics. Patient was subsequently discharged on 5th post-operative day. Suture removal was done on post-operative day 12 if the wound was healthy. Patient was asked to follow up on 2nd, 4th and 6th post-operative months. Pre-operative and post-operative scoring according to Tegner–Lysholm scoring system was done and records maintained.

Table 1. Pre-operative Tegner Lysholm score

Knee Score	No. of Patients	Percentage
Excellent	0	0.00%
Good	0	0.00%
Fair	8	32.00%
Poor	17	68.00%
Total	25	100.00%

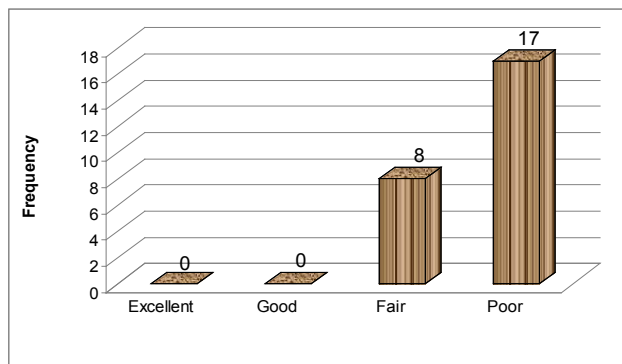


Figure 12.

The Mean ± S. D. pre operative Tegner Lysholm knee score of patients in the present study was 60.2 ± 6.02

Table 2. Post-operative Tegner Lysholm score (after 6 months)

Knee Score	No. of Patients	Percentage
Excellent	14	56.00%
Good	11	44.00%
Fair	0	0.00%
Poor	0	0.00%
Total	25	100.00%



Figure 13.

56 % of the patients had excellent result, while 44 % had good. None of the patients had poor result.

Mean ± S.D. Tegner Tegner Lysholm knee score after 6 month of follow up was 91.72 ± 3.17

4. Discussion

ACL reconstruction surgery has progressed considerably in the last decade with many recent advances and new developments. A lot of studies explored many factors involved in the different technical aspect of ACL fixation.

Single versus double reconstruction, anatomical versus non anatomical, non absorbable versus absorbable screws and different modalities of graft fixation are to name a few.

Anterior cruciate ligament tear usually leads to torsional instability of the knee joint, which can cause secondary progressive degenerative meniscal and chondral lesions. Kennedy et al compared the long term results of 19 acute tears of the anterior cruciate ligament treated surgically and 31 acute tears not subjected to surgery. A follow up study after seven years showed that the untreated group had deteriorated far more significantly as compared to the treated group, though the short term follow up at 44 months had not shown any significant differences between the two groups. Therefore, he recommended repair of all acute anterior cruciate ligament tears to prevent long term sequelae. Reconstruction of anterior cruciate ligament with quadrupled semitendinosus autograft is a popular procedure. The goal of treatment is to return the injured patient to the desired level of function.

In present study, selection of cases has been done based on four basic criteria i.e., degree of anterior cruciate ligament laxity. Extent of disability, age of the patient, and injury to other capsulo-ligamentous structures of the knee. Only those patients who had laxity of anterior laxity as tested by anterior drawer test and who had minimal or no other rotatory instability were considered for study and subjected to surgery. This has been done to eliminate interference of other rotational instabilities in the results of anterior cruciate ligament reconstruction.

Our series comprises 25 cases treated over last two years. We have used Tegner Lysholm knee scoring scale to evaluate the results as this is statistically proven as a better rating system and is widely used.

Wilson et al using combined reconstruction utilizing semitendinosus tendon for intra-articular and ilio-tibial band for extra-articular augmentation obtained 20% excellent, 73% good, 7% fair results. They did not have any poor results. However they used their own grading system¹⁶.

Sharma et al studied 17 patients who had undergone intra-articular reconstruction of anterior cruciate ligament using medial 1/3rd of patellar tendon along with wafer of the patella. They had 59% excellent, 19% good and 11% each for fair and poor results¹⁷.

O' Neil D.B in his study of 127 cases .compared results of three techniques i.e.,

Group I: Two incision reconstruction with the use of semitendinosus tendon graft.

Group II: Two incision reconstruction with use of patellar tendon graft.

Group III: Single incision reconstruction (endoscopic) with use of patellar tendon graft.

He had 88% excellent to good results for group I, 90% for group II and 93% for group III, according to tegner-lysholm knee score¹⁸.

Table 3.

Tegner-lysholm knee score	Pre-operative	After 6 months of surgery
Excellent	0	20
Good	0	08
Fair	8	02
Poor	22	0
Tegner-lysholm knee score	Preoperative	After 6 months of surgery
Mean±S.D	60.5±5.8	91.2±4.1

T test statistic = 20.83 p < 0.001 ; Highly significant

In our study, mean Tegner Lysholm score preoperatively was 60.2 + 6.02, and mean Tegner Lysholm score 6 months after surgery was 91.72+3.17.

By using t-test, p value of <0.001 was obtained, Which is highly significant statistically. Therefore, there is significant differences in pre-operative and post operative knee after 6 months.

4.1 Complications

In present study, wound infection of the graft site occurred in one patients, which resolved after regular dressings rest and antibiotics. Two patients had wound edge necrosis at grafts site

5. Summary and Conclusion

Anterior cruciate ligament injuries are fairly common in younger generations. More common in males and the most common cause is road traffic accidents followed by sports injuries and household falls.

Management of anterior cruciate ligament still remains an enigma to the orthopaedic surgeon. In the recent era, it's one of the most commonly seen sports injury and the incidence of anterior cruciate ligament due to vehicular accidents is also on the rise.

Giving way of the knees as a result of instability is the most common symptom in anterior cruciate ligament deficient for which the patients seeks advice. Locking is present in those patients having meniscal tears.

It is also very important to make an accurate diagnosis of anterior cruciate ligament injury. This can be achieved by detailed history (including exact mechanism of the injury), clinical examination including tests for rotatory

instability and proper investigations. These are essential for an accurate diagnosis of these injuries and to determine the severity of instability. Anterior drawer test was positive in all the cases of anterior cruciate ligament insufficiency.

Now with arthroscopy it is easily possible to diagnose and treat various ligament injuries of the knee. Arthroscopic reconstruction using quadrupled semitendinosus graft is an excellent modality of treatment in patients with complete ACL tear.

It provided excellent outcomes in terms of knee stability, range of motion and functional improvement of the operated knee.

There were no major complications in the study and negligible graft site morbidity.

Thus anterior cruciate ligament reconstruction using quadrupled semitendinosus autograft offer an excellent knee function, knee stability and restoration of preoperative functional status with minimal complications.

6. References

1. Clancy WG, Ray JM , Zoltan DJ. Arthroscopic reconstruction of ACL: A comparison of patellar tendon autograft and four- strand hamstring tendon autograft. *Am J Sports Med.* 1999; 27:444–54.
2. Frank C, Jackson DW. The science of reconstruction of anterior cruciate ligament. *The Journal of Bone and Joint Surgery.* 1997 Oct; 79A(10):1556–76.
3. Fu FH, Bennett CH, Ma CB, et al. Current trends in ACL reconstruction part II. Operative procedures and clinical correlations. *Am J Sports Med.* 2000 Jan-Feb; 28(1):124–30.
4. Andersson C, Gillquist J. Treatment of acute isolated and combined ruptures of ACL- A long term follow up study. *Am J Sports.* 1992 Jan-Feb; 20(1):7–12.
5. Dye SF, Chew MH. The use of scintigraphy to detect increased osseous metabolic activity about the knee. *Instr Course Lecture.* 1994; 43:453–69.
6. Tenuta JJ, Arciero RA. Arthroscopic evaluation of meniscal repairs. Factors that affect healing. *Am J Sports Med.* 1994 Nov- Dec; 22(6):797–802.
7. Kessler MA, Behrend H, Henz S, Stutz G, Rukavina A, Kuster MS. Function, osteoarthritis and activity after ACL-rupture: 11 years follow –up results of conservative versus reconstructive treatment. *Knee Surgery Sports Traumatology Arthroscopy.* 2008 May; 16(5):442–8.
8. Aglietti P, Buzzi R, Menchetti PM, Giron F. Arthroscopically assisted semitendinosus and gracilis tendon graft in reconstruction for acute anterior cruciate ligament injuries in athletes. *Am J Sports Med.* 1996 Nov-Dec; 24(6):726–31.
9. Sherman OH, Banffy MB. Anterior cruciate ligament reconstruction: Which graft is best? *Arthroscopy.* 2004 Nov; 20(9):974–80.

10. Mauro CS, Irrgang JJ, Williams BA, Harner Cd. Loss of extension following anterior cruciate ligament reconstruction: Analysis of incidence and aetiology using OKDC criteria. *Arthroscopy*. 2008 Feb; 24(2):146–53. Epub. 2007 Nov 5.
11. Breitfuss H, Frohlich R, Povacz P, Resch H, Wicker A. The tendon defect after anterior cruciate ligament reconstruction using the mid third patellar tendon: A problem for the patellofemoral joint? *Knee Surgery Sports Traumatology Arthroscopy*. 1996; 3(4):794–8.
12. Cho KO. Reconstruction of the anterior cruciate ligament by semitendinosus tenodesis. *The Journal of Bone and Joint Surgery Am*. 1975 Jul; 57(5):608–12.
13. Aglietti P, Giron F, Buzzi R, Biddau F, Sasso F. Anterior cruciate ligament reconstruction: Bone –patellar tendon–bone compared with double semitendinosus and gracilis tendon grafts. A prospective, randomized clinical trial. *The Journal of Bone and Joint Surgery Am*. 2004 Oct; 86-A(10):2143–55.
14. Galen C. *On the usefulness of parts of the body*. Mt. Ithaca, New York: Cornell University Press; 1968.
15. Bonnet A. *Traite des maladies des articulations*. Paris: Bailliere; 1845.
16. Wilson WJ, Fort Lewis, Scranton PE Jr; Combined reconstruction of anterior cruciate ligament in competitive athletes. *JBJS* 1990 Jan; 72A:742–48.
17. Sharma UC. Intra-articular cruciate ligament reconstruction. *Indian Journal of Orthopaedics*. 1991 July; 25(2):106–9.
18. O Neil DB (1996); Arthroscopically assisted reconstruction of anterior cruciate ligament. A prospective randomized trial of three techniques. *JBJS*; 1996 78(6):803–13