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Anterior Cruciate Ligament Functional Outcome Following Arthroscopic Reconstruction using Semitendinosus And Gracilis Tendon Graft

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ABSTRACT
Objective:
To study the functional outcome of arthroscopic single-bundle anterior cruciate ligamentreconstruction using quadrupled hamstring tendon (Gracilis andsemitendinosus) autograftin individuals with ACL injuries.
Design of study: Prospective study
Results: In this study, forty-seven cases of arthroscopic ACL reconstruction patients were regularly followed. There were 47 patients included in our study, of which 41 patients (87%) were male, and 6 (13%) were female. Thirty-one patients (66%) had a right-side injury, while 16 (34%) had an injury to the left knee. The patients were followed up for an average duration of 12.89 months with a minimum follow-up of 6 months, and a maximum follow-up of 20months. Most of the patients 19 (39%) were in the age group of 21 to 25 years. In this study, the right side was more commonly injured 31 (66%) than the left side16 (34%).The most common mode of injury in this study was Road Traffic Accidents 26 (56%), followed by sports 11 (23%). The other modes of injury in our study were due to self-fall or twisting injuries while climbing stairs. Most of the patients 21 (45%) presented 4 to 6 months after injury.In our study, there was associated meniscal injury in 42 (90%) of patients. The most commonly injured was the lateral meniscus (47%), followed by injury to the medial meniscus (33%). Isolated ACL tear was present in 5 patients (10%). In this study comparison of preop and postoperativesubjective pain, stiffness, locking of the knee,giving away sensation**,** Climbing, Squatting, able to start/stop quickly. The mean pre-op IKDC subjective score was 50.86, while the mean post-op score was 87.66. There was a significant improvement in post-op IKDC score when compared with pre-op score ($p<0.05$). The subjective mean functional score of knees on a scale of 1-10.
Conclusion: Proper selection of cases, accurate positioning, and fixation of graft, good and early postoperative rehabilitation, and regular follow-up are needed to achieve favorable results. We recommend aggressive rehabilitation therapy to regain a complete range of motion of the shoulder so that better functional outcomes are achieved in a shorterperiod. The absence of patellofemoral pain with the use of a hamstring graft makes it a more desirable option for patients with patellofemoral cartilage disorders or those with chronic patellofemoral pain. Hamstring graft fixation with the Endo button and interference screw gives a good functional outcome. Arthroscopic anterior cruciate ligament reconstruction with hamstring graft is an excellent treatment option for anterior cruciate ligament deficientknees.
Keywords: Anterior Cruciate Ligament (ACL), Semitendinosus and gracilis tendon graft, Endobutton, Interference Screw.

I. INTRODUCTION

The knee joint is one of the most injured joints in our body, and the most injured ligament in the knee is the anterior cruciate ligament. Due to the ever-increasing road traffic accidents and increased participation in sporting activities, there is an increase in the incidence of ligament injuries in the knee. The articular cartilage of the knee joint may be injured in acute ACL tears, whose incidence range from 16 – 46%, and in chronic tears, the incidence increases further. When an ACL injury occurs, the symptoms of knee instability, pain, and a decrease in joint function

occur. Although conservative treatment with intensive physiotherapy, bracing, and lifestyle modification can be tried in some patients with less anticipated knee function, in symptomatic young active individuals, ACL reconstruction is necessary. Also, ACL injuries are mostly associated with injury of the meniscus, which needs to be addressed, or else the person can develop early-onset of osteoarthritis of theknee.During walking, the intact ACL maintains a balance of rotation during the interval of the swing phase to the heel strike. However, in the ACL-deficient knee, increased internal rotation occurs between these phases of walking, which is maintained through the stance phase. Thus the ACL also contributes to the rotational stability of the knee[49]. As the insertional area of ACL is more (about 3.5 times) than that at the mid-substance, the stress of the ligament on the bone surface is reduced. The ligament gets attached to the bone by incorporating collagen fibers within the mineralizedbone by incorporating collagen fibers within the mineralizedbone.

II. MATERIALS AND METHODS

This is a Prospective study of the functional outcome of arthroscopic reconstruction of the anterior cruciate ligament using semitendinosus and Gracilis tendon graft conducted in Guntur Medical College and Hospital, Guntur, from November 2019 to October 2021.

There were 47 patients included in our study, of which 41 patients (87%) were male, and 6 (13%) were female. Thirty-one patients (66%) had a right-side injury, while 16 (34%) had an injury to the left knee. The patients were followed up for an average duration of 12.89 months with a minimum follow-up of 6 months, and a maximum follow-up of 20months. In a relaxed patient and supine position, the uninjured knee was examined first to establish ligament excursions, after which the affected knee wasexamined.

TECHNIQUE

The clinical evaluation of an ACL-injured patient starts with a detailed clinical history. The usual history consists of a non-contact deceleration injury or jumping action. The patient usually hears or feels a popping in the knee at the time of injury. After the injury, the patient often falls to the ground and is not able to get up immediately. The patient is not able to resume his activity immediately, and walking is also the most difficult. After a few hours, hemarthrosis develops. In the above circumstances, the possibility of an ACL injury is about 70%. If a physical examination is done before hemarthrosis develops, then it is easier. The common symptoms at presentation include pain and giving way of the knee joint. Non-contact injuries usually cause ACL tears whereas contact injuries cause injury of multiple ligaments. The symptoms of locking episodes, click or clunk, are indicative of associated meniscal injuries. Knowledge about the patient's occupation and personal requirements helps in individualizing patienttreatment.

Physical examination:

This includes inspection, palpation, measurements, and movements of the knee joint. Then the tests for cruciate ligaments, collateral ligaments, and menisci are done which help in diagnosis and further plan of management.

The various tests performed for ACL insufficiency are as follows are anterior drawer test, Lachman test, pivot shift test jerk test, Slocum's method, flexion rotation drawer test, valgus and varus laxity, McMurray'stest, Apley's grind test.

The AP and lateral radiographs of the knee are necessary to look for fractures, degenerative changes, and other associated injuries. The radiographs may reveal an avulsion fracture of the lateral tibial rim (known as Segond's fracture). Tibial spine avulsion fractures can also be seen on radiographs. These are more common in skeletally immature patients. Stress lateral radiographs can be used to show ACL injury radiographically while the anterior drawer test is done. More than 5mm anterior translocation is considered abnormal. A difference of more than 3cm, when compared with the contralateral knee, is also considered significant. A deep lateral femoral notch sign (prominent lateral condylopatellar groove), which occurs due to pivot-shift injury, can also be seen sometimes in X-rays.

Magnetic Resonance Imaging:

The MRI provides a non-invasive visualization of the ACL and other soft tissue structures in the knee joint, thereby helping the preoperative assessment of the patient. The minimal protocol required for imaging of ACL includes a T2 weighted sequence in two to three orthogonal planes. In a sagittal image, the normal ACL can be seen as a solid or striated band with slight divergence distally. The ACL is often straight, and sometimes mild convex inferior sagging may be seen in normalACLs.

The ACL has somewhat higher signal intensity than PCL. In a coronal section image, the ACL can be seen well, but the band is usually attenuated and less bulky when compared with the image of the

International Journal Dental and Medical Sciences Research
Volume 4, Issue 6, Nov-Dec 2022 pp 333-344 www.ijdmsrjournal.com ISSN: 2582-6018

sagittal plane.

Classification of ACL injuries:

According to the American Medical Association handbook, Standard Nomenclature of Athletic Injuries, a sprain is defined as an injury limited to ligaments (connective tissue attaching bone to bone). Sprains are classified into three degrees of severity. A first-degree sprain of a ligament is defined as a tear of a minimal number of fibers of the ligament with localized tenderness but no instability; a second-degree sprain is a disruption of more ligamentous fibers with more loss of function and more joint reaction with mild-to-moderate instability; and a third-degree sprain, as a complete disruption of the ligament with resultant marked instability. These often are classified as mild, moderate, and severe for first-, second-, and third-degree sprains, respectively. Third-degree sprains, that is, those demonstrating marked instability, can be further graded by the degree of instability demonstrated during stress testing. With 1+ instability, the joint surfaces separate 5 mm or less; with 2+ instability, they separate 5 to 10 mm, and with 3+ instability, they separate 10 mm or more. A standardized classification is important for accurate communication, and although it is not always precise, it does provide a workable scale for clinicalpurposes.

The treatment of first-degree sprains is symptomatic only; a person with a first-degree sprain usually can return to full activity within a few days. Second-degree sprains with moderate local injury and joint reaction but without demonstrable instability can be treated conservatively, but the ligament needs protection. A return to vigorous activity must be delayed until the inflammatory reaction has subsided, and rehabilitation has been completed.Afunctionalbracethatrestrictsmotionthro ughcertainarcscan provide protection. Third-degree sprains with complete disruption of the ligament may require surgical repair unless there is a specific contraindication.

Many specialized instruments are required for arthroscopic anterior cruciate ligament reconstruction. An arthroscopic system consists of Television, Camera, Light source and fiber optic light sourcecable, Arthroscope, Shaver system andhandpiece, Tourniquet(pneumatic), 2.4 mm drill tip guidepins, Trocar, cannula, ACLprobe, Meniscus punch, 4mm/5mm shaver burr,Tibial aimingguide, Cannulated headed reamers (5 to 10 mm), Femoral entry point aimer (6mm / 7mm offset), Extra-long 2.4 mm guide pin with suture eye (beath type guide pin), 4.5 mm cannulated reamer for passage of endobutton, Depth gauge, Sizing masterboard.

The various fixation options available for soft tissue grafts can be classified into direct methods and indirect methods. The commonly used direct fixation devices are

- Interferencescrews
- Endobutton
- Staples
- Washers
- Cross pins
- Polyester tape/Titaniumbutton
- Suturepost

In our study, we used interference screws and an endobutton.

Adequate illumination, joint distension, and proper positioning of portals for the entry of arthroscope and accessory instruments are important in arthroscopy. The precise placement of portals is necessary since improper placement results in an inability to see the joint and difficulty to maneuver the instruments within the joint. If an arthroscope is forced through an improperly placed portal, not only may injury to the joint occur but also the instrument may be damaged. The portal entry points should be precisely marked before joint distension. The outlines of the following bone and soft tissue landmarks are drawn – patella, patellar tendon, medial and lateral joint line, and posterior contours of the medial and lateral condyles of the femur. The surgeon should mark the portals and landmarks before and after distension to ensure the correct placement ofportals.

It has been found in a study by Stetsin and Templin that knee arthroscopy with two portals had an earlier rehabilitation time and quicker return to activity compared to arthroscopy with three portals. This was because the vastus medialis obliquus was violated when using threeportals.

The standard portals include,

- anterolateral
- anteromedial
- superolateral
- posteromedial

Anterolateral portal

This is the portal most used by surgeons for diagnostic arthroscopy. Almost all the structures within the knee joint may be visualized

International Journal Dental and Medical Sciences Research
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through this portal except PCL and the anterior part of the lateral meniscus. The location of this portal is 1cm superior to the lateral joint line and 1cm lateral to the patellar tendon. The level of the portal should be approximately 1cm distal to the inferior pole of the patella. Injury to the anterior horn of the lateral meniscus may occur if the port is placed close to the joint line. If the port is placed too close to the patellar tendon, the scope may penetrate the fat pad resulting in difficult viewing and maneuvering of the scope within the joint.

Anteromedial portal:

This portal is mainly used for additional visualization of the lateral compartment and for palpating the medial and compartment structures with the use of the probe. The portal is situated 1cm superior to the medial joint line, 1cm distal to the inferior pole of the patella, and 1cm medial to the patellar tendon. The exact placement of the portal can be confined by placing a spiral needle percutaneously, which is visualized via the anterolateral portal.

Posteromedial portal

The location of this portal is in a small triangular spot, which is bound by the posteromedial edges of the femoral condyle and the tibia. This triangle is palpated with the knee in 90deg of flexion before the joint is distended. The structures in the posteromedial compartment can be visualized via a 30deg angled arthroscope inserted through this portal. The location of this portal is 1cm superior to the posteromedial joint line and 1cm posterior to the posteromedial margin of the femoral condyle. This part is mainly used for dealing with pathologies of the posteriorhorn of the menisci and posterior loose bodies that cannot be approached through the anteriorportals.

Superolateral portal

This is mainly used for visualization of the dynamics of the patellofemoral joint, such as patellar tracking, and patellar congruity, when the knee is moved from extension to flexion. The location of this portal is 2.5cm above the superolateral border of the patella and lateral to the quadriceps tendon.

Optional portals: The optional portals include

1) Posterolateralportal
2) Proximal mid-patellar lateral and medialportals
3) Accessory for medial and lateralportal
4) Central transpatellar tendon (Gillquist)portal

The patient is positioned supine, and the knee joint is placed slightly away from the distal breakpoint of the standard operating table.The limb is held upright to exsanguinate the limb before the inflation of thetourniquet. The tendon ends are trimmed to achieve uniform size. A whipstitch is placed at both ends of the tendons. Around 3-4 cm of both ends of the tendon were stitched together.The composite graft is then passed through the graft sizer. The diameter of the tunnel to be made is equal to the smallest sizing sleeve through which the quadrupled graft passed with minimum friction.The femoral tunnel was made using the anteromedial portal thereby creating an anatomic femoral tunnel position.The graft was fixed at the tibial side using a bioscrew / titanium interference screw or endobutton and at the femoral side usingendobutton

Before the harvesting of the graft, diagnostic arthroscopy was done first. In 90 degrees of knee flexion, an anterolateral port (viewing portal) is made using 11 blade at the level of the inferior pole of the patella just lateral to the patellar tendon. Then the scope is introduced, and the knee is examined in a sequential manner following:

- Suprapatellarpouch
- Patellofemoraljoint
- Medialgutter
- Medial meniscus
- Intercondylarnotch
- Lateralmeniscus
- Lateralgutter
- Posterolateralcompartment

A 3cm oblique skin incision is made starting 5 cm below the medial joint line and 1 cm medial to the tibial tuberosity. The oblique incision is preferred because it gives a wider exposure of pes anserinus and there is less chance of injury to the infrapatellar branch of the saphenous nerve. It is planned to do the graft harvest and tibial tunnel drilling through the same incision.The superior border of the pes anserinus is identified using the fingers. This superior border is lifted and the fascia is incised. The tendons can be felt with fingers running from above downwards. The lowest one felt is the semitendinosus tendon. After the hamstring tendons are identified, the sartorius fascia is divided along the course of the tendons (gracilis and semitendinosus), taking care to preserve the deep layer containing the Medial Collateral Ligament. With the help of right-angled artery forceps, the gracilis and then the semitendinosus is hooked out. The tendon ends were tied with a double-loop knot to aid in

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Volume 4, Issue 6, Nov-Dec 2022 pp 333-344 www.ijdmsrjournal.com ISSN: 2582-6018

traction.the knee is placed at 90 degrees of flexion

III. OBSERVATION

In this study,47 patients' age ranged from 21 to 45 years.

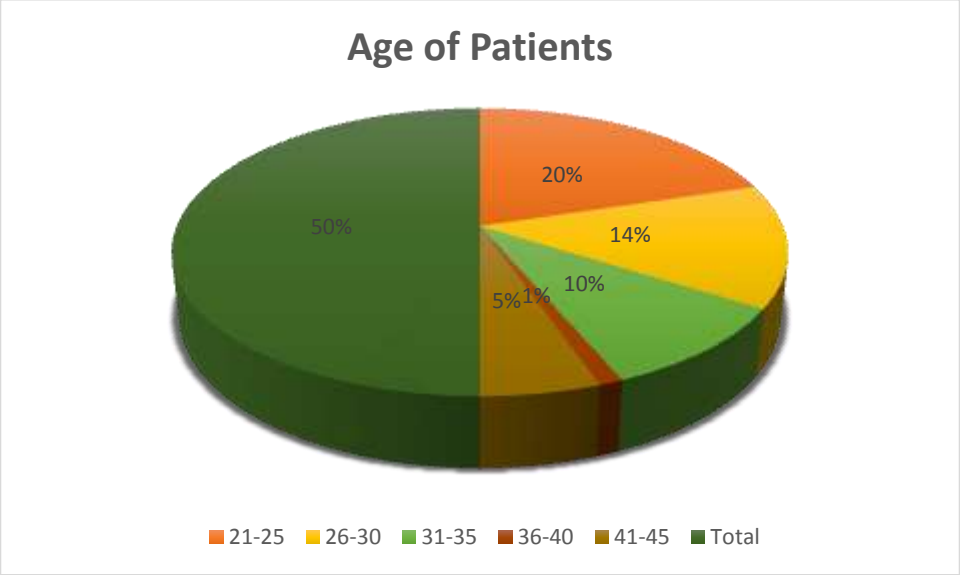

figure 1: Age distribution

Most of the patients 19 (39%) were in the age group of 21 to 25 years it is followed by 13 (28%) in the age group of 26 to 30 years.Out of the 47 patients included in our study, 41 (87%) were male patients, and 6 (13%) were female.

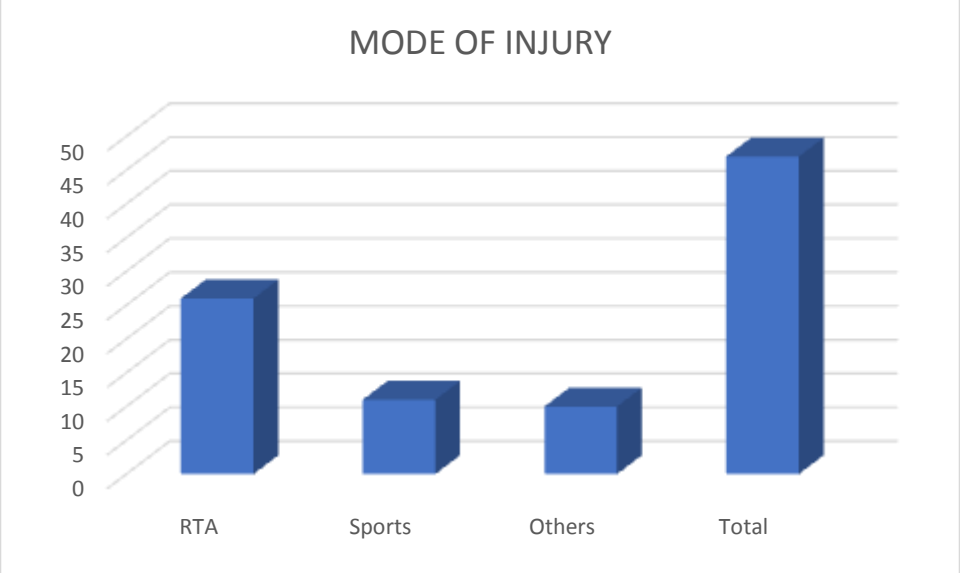

figure 2: Mode of injury

The most common mode of injury in our study was Road Traffic Accidents 26 (56%), followed by sports 11 (23%). The other modes of injury in our study were self-fall or twisting injuries while climbing stairs.

In our study, most of the patients 21 (45%) presented 4 to 6 months after injury.In this study, the right side was more commonly injured 31 (66%) than the left side16 (34%).

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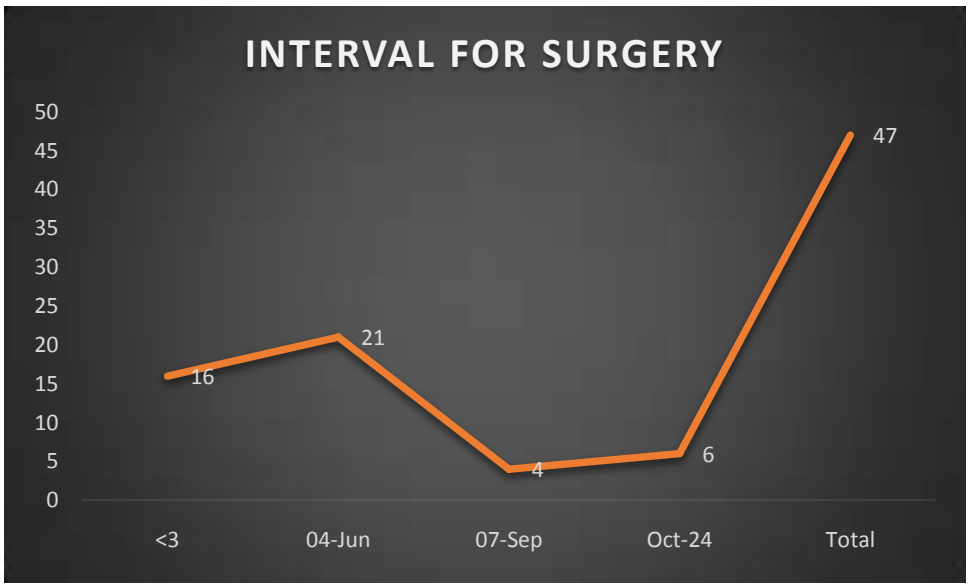


Figure 4: After an injury to surgery interval

There was associated meniscal injury in 42 (90%) of patients. The most injured was the lateral meniscus (47%), followed by injury to the medial meniscus (33%). Isolated ACL tear was present in 5 patients (10%).

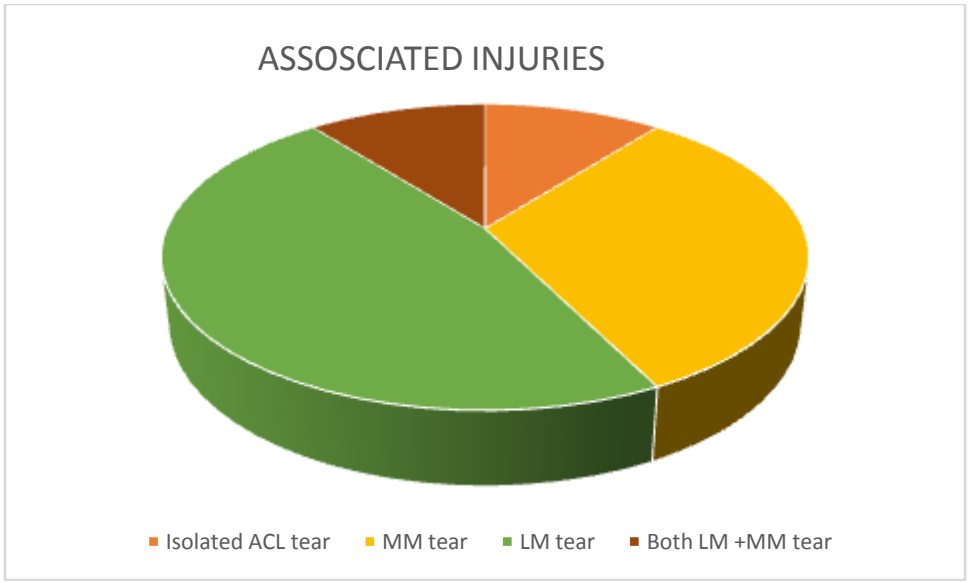


Figure 5:Associatedinjuries

Thepre and post-operative mean values of subjective pain on a scale of 0-10 were 7.02 and 1.37. Out of 47 patients, preoperatively 28 (59.57%) patients had moderate stiffness, and postoperatively 38 (80%) patients had no stiffness at all.Preoperatively 19 patients (40.4%) had locking episodes, and postoperatively none had locking of the knee.

Preoperatively 22 patients had given away the sensation of the knee even with light activities, and 17 patients had given away with moderate activities. Postoperatively patients had given away only with very strenuous or strenuous activities.Preoperatively 20 (42.55%) patients had moderate difficulty, 10 (21.27%) patients had extreme difficulty and 15 (31.91%) patients were unable to climb stairs.Postoperatively 34 (72.34%) patients had no difficulty and 13 (27.65%) patients had minimal difficulty while climbing stairs.Preoperatively, 18 (38.29%) patients had moderate difficulty, 16 (34.04%) patients had extreme difficulty, and 12 (25.53%) patients were unable to squat.Postoperatively, 28 (59.57%) patients had no difficulty, 17(36.17%) had

minimal, and 2 (4.25%) had moderate difficulty in squatting.Preoperatively 27 (57.44%) patients were unable to start or stop quickly, 12 (25.53%) patients had extreme difficulty in doing this activity, and 7(14.89%) patients had moderate difficulty. Postoperatively 29 (61.70%) patients had no difficulty, 15 (31.91%) patients had minimal difficulty, and 3 (6.38%) patients had moderate difficulty starting or stoppingquickly.

The mean pre-op IKDC subjective score was 50.86, while the mean post-op score was 87.66. There was a significant improvement in post-op IKDC score when compared with pre-op score ($p<0.05$). One patient in our study had a superficial infection at the donor site, which settled with intravenous antibiotics and wounddebridement. One patient developed a deep infection and discharge. The patient underwent a joint wash and was given intravenous antibiotics. The wound healed well, and sutures were removed after tendays. Immobilization in knee brace and limb elevation was done in the immediate post-op period. Intravenous antibiotics were given post-operatively for 3 days. The wound was inspected on the 2^{nd} postoperative day. The wound was inspected on the $2^{nd}$and 7^{th} postoperative days. The sutures were removed on the 12^{th}postoperative day. Rehabilitation started from day one.Staged ACL rehabilitation protocol was followed and achieved goals as per protocol.

IV. DISCUSSION

Due to the increased occurrence of Road Traffic Accidents and the increased number of persons participating in sports activities, the number of ACL reconstructions being done has increased. Arthroscopic reconstruction of the injured ACL has become the gold standard and is one of the most common procedures done in orthopedics thus, it has been extensively studied, and outcomes of ACL reconstruction have gained considerable attention.The choice of graft is a topic of great debate in recent years. The various options include bone-patellar tendon-bone graft, hamstring auto-graft, quadriceps tendon, various synthetic grafts, and allograft.

Among these, the most often used are the Bone patellar tendon-bone graft and hamstring graft. The advantages of Bone patellar tendon-bone graft include a high ultimate tensile load (approximately 2300 N) and a rigid fixation due to its bony ends.But the hamstring graft has been increasingly used recently. The advantages of arthroscopic ACL reconstruction using hamstring graft include decreased surgical site morbidity, decreased occurrence of patellofemoral adhesions, and reduced incidence of anterior knee pain. Though the semitendinosus tendon has only 75% and gracilis 49% of the strength of native ACL, the quadrupled semitendinosus or semitendinosus-gracilis have a tensile load of around 4108 N.

Our study is to evaluate the functional outcome of arthroscopic anatomical single-bundle ACL reconstruction using quadrupled hamstring autograft.In our study, the most common mode of injury was Road Traffic Accidents, followed by Sports injuries. Among the sports injuries, Kabaddi, cricket, and badminton were the most common sports causing ACL tears. Male predominance was found in our study. 41 (87%) patients were males, and 6 (13%) were females. Most of the patients were in the age group of 20 – 25 years (39%). 45% of patients (n=21) underwent ACL reconstruction 4 to 6 months after injury.The Right knee was involved in 31 (66%) of patients and the left knee in 16 (34%) patients. There was not much difference in lateralization of injury.The results of the study were compared with the studies of D Choudhary et al. 2005[58], Jomha et al. 1999[59], Riley et al. 2004[60], Mahir et al. 2005[61] and Ashok Kumar et al.2016[62].D.W Lewis et al.[57], in their study on the incidence of meniscal injuries at the time of ACL reconstruction, found that 58% of patients had meniscal injuries and that medial meniscus was most commonly injured. They also concluded that meniscal repair or resection did not alter the outcome.

In our study, there was associated meniscal injury in 90 % of patients. Five patients in our study had isolated ACL injuries. Fifteen patients had an injury to the medial meniscus, whereas twenty-two patients had an injury to the lateral meniscus alone. Five patients had an injury to both the medial and lateral meniscus. The most commonly injured was the lateral meniscus.Among the patients with meniscal injuries, all the patients were treated by partial meniscectomy. The rest of the patients were treated conservatively. The functional outcome of patients with isolated ACL injuries was comparable with that of the patients with associated meniscal injuries. This is per the study by D.W Lewis et al., who stated that the presence of meniscal injury does not alter the functional outcome.The most common symptom at presentation was knee pain. The other presenting symptoms were instability, locking, stiffness, and difficulty in squatting climbing stairs and pivoting.

Choudhary et al. made thestudy on 59 patients,Johma et al. on 100patients, and Railey et al.

International Journal Dental and Medical Sciences Research
Volume 4, Issue 6, Nov-Dec 2022 pp 333-344 www.ijdmsrjournal.com ISSN: 2582-6018

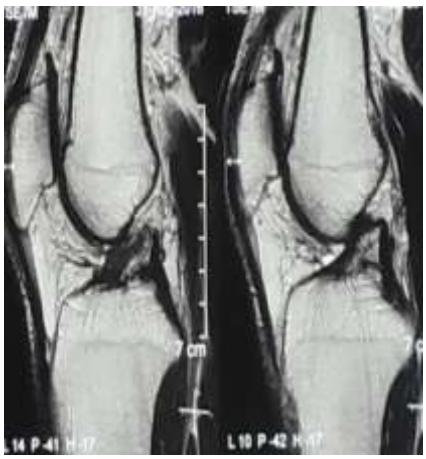
on 85 patients, Mahir et al. on 62 patients, Ashok Kumar et al. on 34 patients, and this study was performed on 47 patients.The average age of patients at the time of surgery in the present study was 29.11 years, whereas that of Johma et., D Choudhary, et al., Railey et al., Mahir et al., and Kumar et al.were 26, 27, 33, 24 and 27 years respectively.The average duration of follow-up of the present study was 12.89 months with a minimum follow-up period of three months, and a maximum follow-up period was 20 months. The average duration of follow-up of D Choudhary et al. was 12 months,that of Jomha et al. was 84 months, Railey et al. was 24 months, Mahir et al. were 18 months, and Ashok Kumar et al. 2016 was 17months. 73% of patients were males in D Choudhary et al., 93% were males in Johma et al., 59% were males in Railey et al., 100% were males in Mahir et al., and 97 % were males in Ashok Kumar et al. studies. This study had 87% males.Though females are more prone to ACL tears, most of the patients that present to the OP department for treatment aremales.The mean pre-operative IKDC score in this study was 51.523 whereas the postoperative score was 88.871. There was a significant improvement in the post-operative IKDC score when compared with the pre-operative score. The mean pre-operative IKDC score in the study by Kumar et al. was 55.63, Prasad et al.[63] were 42.45, and Aparajit et al.[64]was 50.5, whereas the postoperative scores were 89.38, 94.33, and 86.03, respectively.There was no significant patellofemoral pain noticed in the patients in our study. This is similar to the study by Railey et al., who did not observe any clinically relevant patellofemoral pain in patients in whom arthroscopic ACL reconstruction using a hamstring graft was done. Angeletti et al.[65,] in their study, found >5 mm tibial translation in 20% of knees in which the torn ACL was reconstructed with a hamstring graft. In our study, anterior tibial translation was eliminated in 85% of patients who were examined at a mean of 17 months post-operatively. The remaining 15% of patients (three) had a 1+ Lachman test at the follow-up examination. However, the laxity did not correlate with the functionalscores.

Williams et at.[66,] in their study of 2500 cases of arthroscopic ACL reconstruction, reported an infection rate of 0.3%. In our study, one patient had a deep infection, and one patient had a superficial infection. The patient with deep infection was managed with Joint wash and intravenous antibiotics, while the patient with superficial infection was managed with wound debridement andantibiotics.

V. CONCLUSION

Proper selection of cases, accurate positioning, and fixation of graft, good and early postoperative rehabilitation, and regular follow-up are needed to achieve favorable results.Hamstring graft fixation with endobutton and interference screw gives a good functional outcome. Arthroscopic anterior cruciate ligament reconstruction with hamstring graft is an excellent treatment option for anterior cruciate ligament deficientknees. We recommend aggressive rehabilitation therapy to regain a complete range of motion of the shoulder so that better functional outcomes are achieved in a shorterperiod.

CASES:



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