ORIGINAL ARTICLE

ARTHROSCOPIC ACL RECONSTRUCTION USING HAMSTRING TENDON AUTOGRAFT FIXED WITH ENDOBUTTON CL® AND BIORCI- HA® INTERFERENCE SCREW

P. Saravanan¹, Dobson Dominic²

HOW TO CITE THIS ARTICLE:

P. Saravanan, Dobson Dominic. "Arthroscopic ACL Reconstruction using Hamstring Tendon Autograft Fixed with Endobutton CL® and Biorci- HA® Interference Screw". Journal of Evolution of Medical and Dental Sciences 2015; Vol. 4, Issue 47, June 11; Page: 8190-8199, DOI: 10.14260/jemds/2015/1186

ABSTRACT: INTRODUCTION: Arthroscopic ACL reconstruction has become the gold standard for ACL insufficiency in active patients. Hamstring tendon is the most favoured graft choice for ACL reconstruction. The aim of this study is to prospectively evaluate the clinical and radiological results (tunnel widening) of a series of 120 patients who underwent Arthroscopic ACL reconstruction using hamstring tendons fixed with Endobutton CL® on femur and Bio RCI-HA® interference screw on the tibial end, with a follow-up of 2 years. **MATERIALS & METHODS:** One hundred and twenty patients with ACL insufficiency were operated upon Arthroscopic ACL reconstruction using hamstring tendon autograft fixed with Endobutton CL® and BioRCI-HA® interference screw between January 2012 to April 2013 at Chettinad Academy of Research and Education, Chennai were included in the study. All the patients were assessed clinically (IKDC) and radiologically at 6 months, 1 year and 2 years follow-up in this study. **RESULT:** At the final follow up of 2 years, according to IKDC classification 98(83%) patients were in normal group and 16 (13.6%) patients in nearly normal group and 4(3.4%) patients in abnormal group. All the patients had an increase in tunnel width of 0.5mm at 6 months follow up. 26(21.6%) patients had femoral tunnel widening between 0.5 to 2mm (Mean-1.2mm) and 8(6.6%) patients with the tunnel width of 2mm and 4mm (Mean 2.2mm) at one year follow-up. At 2 years follow up there were 38(31.6%) patients had a tunnel width of 0.5mm and 2mm (Mean-1.4mm) and 16s (13.3%) patients with the femoral tunnel widening between 2 and 4mm (Mean 2.6mm). **CONCLUSION:** Arthroscopic anatomical ACL reconstruction has been the treatment of choice for ACL tear and hamstring tendon is the graft choice for ACL reconstruction. It is necessary to provide sufficient mechanical stability for the graft to obtain good clinical outcome. Endobutton CL® on the femoral side and BioRCI-HA® on the tibial end is proven to be the best fixation device for ACL reconstruction which is reliable and strong fixation devices currently.

KEYWORDS: ACL Reconstruction, Hamstring graft, Endobutton CL®, BioRCI-HA®.

INTRODUCTION: Arthroscopic ACL reconstruction has become the gold standard for ACL insufficiency in active patients. This has markedly reduced the postoperative morbidity and enables early vigorous physiotherapy.¹ Widely accepted and time tested graft choices are patellar tendon and hamstring tendon autografts.² Of these two, the hamstring tendon autograft scores over in many parameters. The ultimate strength of quadruple hamstring is 4108 N whereas that of BTB is 2376 N, the intact ACL has strength of 2160 N.^{3,4} Though the patellar tendon allows bone-to-bone healing at both the ends, it is found to have a potential donor site morbidity.⁵ The hamstring grafts avoid the disturbance of extensor mechanism. The few disadvantages in hamstring tendon graft are technical expertise of harvesting and laxity after hamstring graft at the end of one year as compared to BTB graft. However at the end of two years both are found to be of equal tightness.⁶ Endobutton CL®

ORIGINAL ARTICLE

(Smith & Nephew Endoscopy, Andover, MA, USA) on the femoralside⁷ and BioRCI-HA® (Smith & Nephew Endoscopy, Andover, MA, USA) interference screw on the tibial side has been one of the commonly used fixation devices for ACL reconstruction. The advantages being choice of the length of Endobutton CL® in relation to the measurement of femoral tunnel. The use of BioRCI-HA® interference screw in tibial fixation will add to the advantage of graft healing with the bone, MRI compatible and avoidance of metal implants.⁸ The disadvantage of Endobutton CL® is that it is the indirect fixation device in femoral fixation which causes micro motion in the graft leading to the tunnel widening.^{9,10} Similarly the disadvantage of the BioRCI-HA® interference screw is the chance of its breakage and increase in cost.

This is a prospective study to evaluate the clinical and radiological results (Tunnel widening) of a series of 120 patients who underwent Arthroscopic ACL reconstruction using hamstring tendons fixed with Endobutton CL® on femur and BioRCI-HA® interference screw on the tibial end, with a follow-up of 2 years.

MATERIALS AND METHODS: One hundred and twenty patients with ACL insufficiency treated by Arthroscopic ACL reconstruction using hamstring tendon autograft fixed with Endobutton CL® and BioRCI-HA® interference screw between January 2012 to April 2013 at Chettinad Academy of Research and Education, Kelambakkam, Chennai were included in the study. Ninety six of them were males and 24 females with mean age of 27 years (Range 19-43 years). There were 67 right knee involvement and 53 left knee were involved. The mode of injury was commonly due to Road Traffic Accident (RTA) and sports injury. The time of injury to index procedure ranged between three weeks to five years (Mean - 3 months).

Fig. 1: Magnetic Resonance Image of T1 & T2 weighted images showing a mid-substance tear of Anterior Cruciate Ligament.

Fig. 1

All the patients were assessed clinically and confirmed by MRI (Fig. 1). History of instability or sense of knee giving way and positive Lachmann's test and Anterior Drawer test with soft end point were the criteria based on which the patients were considered for surgery. Multi ligament instability, elderly patients above the age of 50 years, adolescent individuals and previously operated knee were excluded in this study.

ORIGINAL ARTICLE

Fig. 2: Arthroscopic picture of Right in chronic ACL tear where the ACL is absent.

Fig. 2

All the patients were examined under anesthesia. A positive Lachmann with soft end point and Pivot shift test with glide or clunk were present in all the patients. With the limb under tourniquet control and leg positioned over a leg holder a diagnostic arthroscopy was done through the standard anterolateral portal and confirmation of ACL tear (Fig. 2), the associated lesions were dealt at first. Partial meniscectomy or trimming of unstable segments for meniscal tears and shaving, abrading and microfracture were done for patients with chondral lesions according to its grading.

The hamstring tendons (Semitendinosus and Gracilis) were harvested through a 4 cm long paramedian incision 2.5 cm distal to joint line and 1.5 cm medial to tibial tuberosity. Both the Semitendinosus and Gracilis tendons were harvested for all the cases. These tendons were prepared in a graft master board and the end sutures were whip stitched using 1 vicryl. The two tendons were either quadrupled, five or six strand made by assessing the thickness of both tendons. The graft is kept moist in a wet sponge and tensioned in a graft master board (15 pounds) for 15 minutes. The length of Endobutton CL® depends on depth of femoral tunnel and lateral femoral cortex. Endobutton CL® of 15mm (83) and 20mm (37) loop length were used in this study.

All the patients underwent anatomical ACL reconstruction of the femoral tunnel was made through transportal. The femoral tunnel was drilled first through the anteromedial portal approach, through inside-out technique, with the knee flexed between 110°-130°. A guide wire is passed at the anatomical insertion zone of ACL in the lateral femoral condyle. It was over drilled using 4.5mm cannulated drill bit for the passage of the Endobutton®. The length of the tunnel was then measured using depth gauge. Femoral tunnel was reamed according to the thickness of the prepared graft and also to the required tunnel length. The tunnel was then over reamed for another 10mm for the flipping of the Endobutton CL®. Once the femoral tunnel made, a thread is passed through the tunnel inserted into the guide wire and brought outside at the lateral thigh and tied temporarily to the other end from the anteromedial portal.

The tibial tunnel was made using elbow Aimer zig® (Acufex- Smith & Nephew), at an angle of 50° in all cases. The entry point at 3.5 cm from joint line and the intraarticular aperture was just anterior to PCL. Required size of the tunnel was made on the tibial side. After the tibial tunnel made, the loop thread which was present in the anteromedial portal is pulled through the tibial tunnel using a probe and placed outside. This will help in pulling the Endobutton® loop with graft into the femoral tunnel through the tibial tunnel.

ORIGINAL ARTICLE

The outer two holes in the Endobutton CL® were loaded with Ethibon and nylon, which are strong enough to withstand the pulling strength while pulling the graft into the tunnel. The prepared graft is then passed into the Endobutton loop. Both the threads were now loaded into the loop thread which was already placed in both the tunnels and pulled outside the lateral thigh. Now with knee in 120° flexion, the nylon thread as leading and Ethibon as trailing (Fig. 3) the graft was positioned in the femoral tunnel and the trailing suture toggled to flip the Endobutton. The graft was pulled out distally on the tibial end to check for secure fixation of Endobutton® (Fig. 4). Cycling the graft was done to stretch the graft to its maximum and also to avoid slackening.

Fig. 3: Arthroscopic picture of Right knee showing the passage of Endobutton with the nylon in white as leading and Ethibon in green as trailing.

Fig. 3

Fig. 4: Arthroscopic picture of Right knee showing a reconstructed ACL with Hamstring tendon graft.

Fig. 4

The knee was taken through full range of motion to check for impingement. The tibial fixation was done using BioRCI-HA® interference screw with good tension given to the graft. Thus the ACL was reconstructed with a stable and secure fixation.

Post-operatively knee immobilized in full extension with a knee brace. Quadriceps, foot and ankle exercises were started from the evening of surgery. Full weight bearing was allowed on first post-operative day for the patients with isolated ACL tear. Partial weight bearing for 10 – 14 days and full weight bearing by 2 to 3 weeks for the patients with partial meniscectomy or microfracture for the chondral lesions were allowed. Knee brace was discarded at three weeks postoperatively and

ORIGINAL ARTICLE

Range of Motion started. Half squat, cycling, full squat and jogging were allowed progressively as the condition improved. Active sports were allowed after 1 year.

All the patients were followed at 3 weeks, 6 weeks, 3, 6, 12 and 24 months after the index procedure. The assessment was done according to the IKDC form that takes into account subjective impression, functional signs, Range of Motion and harvest site pathology. The patients were graded accordingly and compared with their preoperative grading. X-ray was taken at immediate post-operative (Fig. 5), at 1 year follow up and final follow-up at 2 year to compare and assess both the femoral and tibial tunnel width.

Fig. 5: Immediate post-operative x-ray AP and Lateral view of Right knee showing the Endbutton on lateral end of femur.

Fig. 5

RESULTS: Of the 120 patients, there were 96(80%) males and 24(20%) females in the age group of 19 to 43 years (Mean-27 years). Right knee involvement was found to be predominant in our study, 67 patients had injury on the right side and 53 patients on the left knee. The minimum time of injury to index procedure was three weeks whereas the maximum was five years (Mean – 3 months). The mode of injury in majority of patients was RTA in 86(71.6%) and sports related in 24(20%) and simple fall during activities in 10(8.4%) patients. All the patients underwent Arthroscopic ACL reconstruction using hamstring tendon autograft fixed with Endobutton CL® and BioRCI-HA® interference screw by the author. The postoperative regimen followed was similar in all patients.

Isolated ACL tear was found in 76(63.3%) patients who had reported to us at the earlier stage after injury. Associated lesions were found in 44 out of 120 patients. Meniscal tears were found in 39 patients, 22 lateral and 10 medial meniscal tears and 7 patients with both medial and lateral meniscal tears. The bucket handle type of tears were dealt with by partial meniscectomy and small radial and oblique tears in the avascular zone were trimmed. The chondral lesions were noticed in 25 of them- single lesion in 15 and two lesions in ten patients. The site of these lesions was in patella, medial femoral condyle and lateral tibial plateau. The severe or grade IV lesions and more than one lesions were found in five patients with chronically injured knees substantiating the possibility of repeated sub clinical injury of an ACL deficient knee. Shaving, abrading and microfracture were done with

ORIGINAL ARTICLE

grade IV chondromalacia and with lesion less than 2cm. Two patients had serous soakage in the immediate postoperative period which did not grow any organism on culture. A probable synovial fluid seepage was considered and antibiotics were continued for longer than usual. Two patients had reinjury upon return to sports after one year of surgery, the graft was found to be pulled into the joint in both the patients. The Endo button and Bio RCI-HA interference screw were intact. Revision ACL reconstruction was done for both the patients after the removal of Endobutton and BioRCI-HA interference screw along with the hamstring graft. Patellar BTB graft was used for the revision surgery since there was a moderate femoral tunnel widening present and fixed with metal interference screws on both the femoral and tibial side in both the patients.

At follow-up of two years 98(83%) patients were normal and 16(13.6%) patients were nearly normal as per IKDC score, 4(3.4%) patients were in abnormal group who remained in the preoperative status (Table 1). This was due to lack of gaining full range of flexion and poor compliance with rehabilitation. None of the patients had either clinical symptoms of instability or a positive Lachmann's at final follow-up. Six patients had paresthesia at donor site at three months follow-up which improved subsequently. Return to sports was allowed after one year post op. Sixteen patients has returned to active sports after one year of surgery.

Fig. 6: Two years follow up x-ray AP and Lateral view of Right knee showing the widened femoral and tibial tunnel. Femoral tunnel appears conical.

Fig. 6

X-ray was taken all patients at six months, one year and two year follow-up to assess the tunnel widening. Though there were mild increase in tunnel width of 0.5mm at 6 months follow up in all the patients. We found 26(21.6%) patients had femoral tunnel widening between 0.5 to 2mm (Mean-1.2mm) and 8(6.6%) patients with the tunnel width of 2mm and 4mm (Mean 2.2mm) at one year follow-up. At 2 years follow up there were 38(31.6%) patients had a tunnel width of 0.5mm and 2mm (Mean-1.4mm) and 16(13.3%) patients with the femoral tunnel widening (Fig. 6) between 2 and 4mm (Mean 2.6mm) (Table 2). The widened tunnels were conical in shape and no cavitary enlargement found. There was no laxity found in patients with tunnel widening.

ORIGINAL ARTICLE

IKDC Grade	No. of patients Pre-operative	No. of patients at 6 months follow up (n=120), (%)	No. of patients at 1 year follow up (n=120), (%)	No. of patients at 2 years follow up (n=118), (%)
A Normal	0	42(35%)	81(67.5%)	96(81.35%)
B Near Normal	0	66(55%)	35(29.2%)	18(15.25%)
C Abnormal	102 (85%)	10(8.3%)	4(3.3%)	4(3.4%)
D Severely Abnormal	18 (15%)	2(1.7%)	0	0

Table 1: IKDC Grade

Femoral Tunnel Width	0.5-2mm	> 2mm
At 1 year postoperative	N = 26 (21.6%), mean = 1.2 mm	N = 8 (6.6%), mean = 2.2 (range, 2-4)
At D + 4 years minimum	N = 38 (31.6%), mean = 1.4 mm	N = 16 (13.3%), mean = 2.6 (range, 2-4)

Table 2: Femoral tunnel width (X-ray AP view)

DISCUSSION: Though the debate over an ideal graft choice for ACL reconstruction is going on, the use of hamstring tendons has become increasingly popular. This is because the ultimate tensile strength of the quadruple graft is as high as 4108 N with a stiffness of 807 N.^{3,4} In addition, there are well advanced fixation devices, which in earlier days, were of potential disadvantage. Donor site morbidities like patellar fracture, patellar tendon rupture, quadriceps weakness and anterior knee pain as seen in patellar BTB graft are considerably lessened with hamstring graft.⁵ The incision made is smaller for harvesting the hamstring tendon and also choice of length of the graft is available for the surgeon. Though the BTB graft is set to provide more stiffness, excessive stiffness may lead to abnormal knee kinematics, greater stress on the fixation or micro fracture of the graft. Noyes et al demonstrated that the stiffness of a semitendinosus graft is nearly equal to that of the ACL, while BTB grafts are approximately 3.76 times stiffer than the ACL.³ Thus a four strand hamstring graft appears stronger than comparable BTB grafts and closer in linear stiffness to the anterior cruciate ligament. The soft tissue healing in the tunnel which supposedly delays accelerated rehabilitation, has not produced any significant change in the overall outcome.¹¹

The choice of fixation in ACL reconstruction is still evolving and the current fixation device which has been widely used were the Endobutton CL® and the Bio composite interference screws which has helped to render an improved rehabilitation program post operatively.¹² All patients in our study underwent ACL reconstruction with hamstring graft fixed with Endobutton CL® and Bio RCI-HA® interference screw.

Although Endobutton CL® is not a direct fixation device into the graft, there is a nylon material present between the graft and the button. This suspensory fixation has been associated with increased anterior joint laxity.¹³ In our study we found 16 patients had grade I laxity after 1 year follow-up which has been explained to their generalized laxity to the other joints but their functional

ORIGINAL ARTICLE

outcome has been good in final follow-up. Due to the indirect fixation of the graft there is a cyclic stretching of the graft under load which leads to the tunnel widening^{14,15} and inhibit the tendon-bone healing.¹⁶ There is an anteroposterior movement occurring inside the widened tunnel described as the “windscreen wiper” effect. Nebeking et al¹⁷ has described that there will be femoral tunnel enlargement when fixing the hamstring tendon with Endobutton in his study. In our study of 120 patients, there were 26 patients had a femoral tunnel widening between 0.5 and 2mm and 12 patients between 2.5 and 4.5mm which are slight and moderate tunnel widening according to Nebulung classification.¹⁸ The moderate tunnel widening was more like a conical as per the classification of Peyrache’s description.¹⁹ The conical shape is probably due to extra reaming of the femoral tunnel for the flipping of the Endobutton. Bartlett et al compared widening of the tunnel in ACL reconstruction using four different techniques of fixation, showed less widening in those fixed by Endobutton® compared with stabilisation by interference screws.²⁰ Therefore, widening of the tunnel may not be attributed to mechanical effects alone as it may involve a biological component too. Kuskucu et al²¹ did a comparative study between the Endobutton and cross pin technique in femoral fixation and with interference screw and staple in tibial end, in his 1 year follow up there was a greater tunnel widening in Endobutton (43.7% femur and 51.1% tibia) in comparison with cross pin (32.6% femur and 25.6% tibia). However the clinical outcome has been the same for both the fixation devices in his study.

The choice of fixation with interference screw on the tibial end has the advantage of directly fixing the graft into the bone.²² It enhances the tendon-bone healing due to the compression of the graft against the wall of tunnel. This helps to increase the stability of the knee when compared to the device fixed away from the joint.¹³ The advantages of Biodegradable interference screw like Bio RCI-HA® is that it is a MRI compatible and revision surgery is much easier when compared to metal screws.²³ The disadvantage is breakage of the screw while inserting and the biocompatibility concern.²⁴ Biodegradable screw with polymer matrix mixed with hydroxyapatite will enhance the bone regrowth.²³

However with much benefits of the interference screw in fixing the graft there is a failure in fixation during cyclical loading of the graft which concerns the rehabilitation.^{25,26} There were no fixation failure present in our study with the BioRCI-HA® interference screw. Benjamin et al²⁷ evaluated both the bioabsorbable interference screw and Endobutton CL® for ACL reconstruction with the hamstring graft in two years follow-up had a mean IKDC score of 85 and 81 respectively. The mean IKDC in our study of two years follow-up were 96% of patients with normal to near normal knees.

CONCLUSION: Arthroscopic anatomical ACL reconstruction reproduce the mechanical and biological properties of the native ACL. The hamstring graft is reliable, strong, lesser donor site morbidity, smaller incision which make this more attractive and dependable graft choice for ACL reconstruction when compared to patellar BTB graft. Nonetheless the choice of fixation is evolving, Endobutton CL® on the femoral side and BioRCI-HA® interference screw on the tibial side provide a firm construct where accelerated rehabilitation can be achieved. Endobutton CL® provides good stability to the graft inside the tunnel. Biodegradable devices like BioRCI-HA® will help the graft to facilitate graft tunnel healing and also maintain its strength until there is a good graft to bone healing occurs completely.

REFERENCES:

1. Delay BS, Smolinski RJ, Wind WM, et al. Current practices and opinions in ACL reconstruction and rehabilitation: results of a survey of the American Orthopedic Society for Sports Medicine. *Am J Knee Surg* 2001; 14: 85-9.
2. Lipscomb AB, Johnston RK, Snyder RB, et al. Evaluation of hamstring strength following use of semitendinosus and gracilis tendons to reconstruct the anterior cruciate ligament. *AM J Sports Med* 1982; 10 (6): 340-2.
3. Noyes FR, Butler DL, Grood ES, et al. Biomechanical analysis of human ligament grafts used in knee ligament repairs and reconstructions. *J Bone Joint Surg AM* 1984; 66A (3): 344-52.
4. Cooper D, Deng X, Burnstein A, Warren R. The strength of the central third patellar tendon graft. *Am J sports med* 1993; 21 (6): 41-7.
5. Kleipool A, Loon T, Marti R. Pain after use of the central third of the patellar tendon for cruciate ligament reconstruction. *ActaOrthop Scan* 1994; 65 (1): 62-6.
6. Eriksson K, Anderberg P, Hamburg P, et al. A comparison of quadruple semitendinosus and patellar tendon graft in reconstruction of the anterior cruciate ligament. *J Bone J Surg Br* 2001; 83: 348-54.
7. Barrett Gr, L. Papendick, C. Miller EndoButton® endoscopic fixation technique in anterior cruciate ligament reconstruction. *Arthroscopy*, 11 (1995), pp. 340-343.
8. Cheung P, Chan WL, Yen CH, Cheng SC, Woo SB, Wong TK, Wong WC. Femoral tunnel widening after quadrupled hamstring anterior cruciate ligament reconstruction. *J OrthopSurg (Hong Kong)*. 2010 Aug; 18 (2): 198-202.
9. M.G. Clatworthy, P. Annear, J.U. Buelow. Tunnel widening in anterior cruciate ligament reconstruction: a prospective evaluation of hamstring and patella tendon grafts. *Knee Surg Sports TraumatolArthrosc*, 7 (1999), pp. 138-145.
10. J. Hoher, G.A. Livesay, C.V. Ma, J.D. Withrow, L.H. Fu, S.L. WooHamstring graft motion in the femoral bone-tunnel when using titanium button/polyether tape fixation. *Knee Surgery sports TraumatolArthrosc*, 7 (1999), pp. 215-219.
11. Cooley VJ, Deffner KT, Rosenberg TD. Quadrupled semitendinosus anterior cruciate ligament reconstruction: five year results in patients without meniscus loss. *Arthroscopy* 2001; 17: 795-800.
12. Freedman KB, D'AmantoMjkaz A Nedoff. Arthroscopic anterior cruciate ligament reconstruction: A meta-analysis comparing patellar tendon and hamstring tendon autografts. *Am J Sports Med* 31 (1): 2-11, 2003.
13. Ishibashi Y, Rudy TW, Livesay GA, et al. The effect of anterior cruciate ligament graft fixation site at the tibia on knee stability: evaluation using a robotic testing system. *Arthroscopy* 1997; 13: 177-82.
14. Hoher J, Livesay G, Ma CB, et al. Hamstring graft motion in the femoral bone tunnel when using titanium button/polyester tape fixation. *Knee Surg Sports TraumatolArthrosc* 1999; 7: 215-19.
15. L'Insalata J, Klatt B, Fu FH, Harner CD. Tunnel expansion following anterior cruciate ligament reconstruction: a comparison of hamstring and patellar autografts. *Knee Surg Sports TraumatolArthrosc* 1997; 5: 231-8.
16. Clatworthy MG, Annear P, Bulow JU, Bartlett RJ. Tunnel widening in anterior cruciate ligament reconstruction: a prospective evaluation of hamstring and patellar tendon grafts. *Knee Surg Sports TraumatolArthrosc* 1999; 7: 138-45.

ORIGINAL ARTICLE

17. Nebeking W, Becker R, Meckel M, Ropke M. Bone tunnel enlargement after anterior cruciate ligament reconstruction with semitendinosus tendon using Endobutton fixation on the femoral side. *Arthroscopy* 1998 Nov-Dec; 14 (8): 810-5.
18. Nebelung W, Becker R, Merkel M. Bone tunnel enlargement after anterior cruciate ligament reconstruction with semitendinosus tendon using endobutton fixation on the femoral side. *Arthroscopy* 1998; 14: 810—5.
19. Peyrache MD, Djian P, Christel P, Witvoet J. Tibial tunnel enlargement after anterior cruciate ligament reconstruction by autogenous bone patellar tendon-bone grafts. *Knee Surg Sports Traumatol Arthrosc* 1996; 4: 2—8.
20. Bartlett RJ, Clatworthy MG, Nguyen TN. Graft selection in reconstruction of the anterior cruciate ligament. *J Bone Joint Surg [Br]* 2001; 83-B: 625-34.
21. Kuskucu SM. Comparison of short-term results of bone tunnel enlargement between EndoButton CL and cross-pin fixation systems after chronic anterior cruciate ligament reconstruction with autologous quadrupled hamstring tendons. *J Int Med Res* 2008; 36: 23-30.
22. Stahelin AC, Weiler A. All-inside anterior cruciate ligament reconstruction using semitendinous tendon and soft threaded biodegradable interference screw fixation. *Arthroscopy* 1997; 13: 773-9.
23. Bellelli A, Adriani E, Avitto A, David V. New femoral fixation system for tendon transplantation in ACL reconstruction: preliminary experience with MR imaging. *Radiol Med (Torino)* 2001; 102: 211-16 (In Italian).
24. Harvey. A, Thomas N.P, Amis A.A, Fixation of the graft in reconstruction of the anterior cruciate ligament *J Bone Joint Surg Br* May 2005vol. 87-B no. 5 593-603.
25. Giurea M, Zorilla P, Amis AA, Aichroth P. Comparative pull-out and cyclic loading strength tests of anchorage of hamstring tendon grafts in anterior cruciate ligament reconstruction. *Am J Sports Med* 1999; 27: 621-5.
26. Harvey AR, Thomas NP, Amis AA. The effect of screw length and position on fixation of four-stranded hamstring grafts for anterior cruciate ligament reconstruction. *Knee* 2003; 10: 97-102.
27. Benjamin C., Kimberly F., Freddie H.Fu., Jeffery T., Harner C.D. — Hamstring anterior cruciate ligament reconstruction: A comparison of bioabsorbable interference screw and Endobutton-post fixation. *Arthroscopy*. 20 (2): 122-128, Feb. 2004.

AUTHORS:

1. P. Saravanan
2. Dobson Dominic

PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Orthopaedics, Chettinad Academy of Research & Education.
2. Assistant Professor, Department of Sports Medicine & PMR, Chettinad Academy of Research & Education.

FINANCIAL OR OTHER

COMPETING INTERESTS: None

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:

Dr. P. Saravanan,
8/5, Raghav Arcade,
Balu Street, Thiruvannamipur,
Chennai-600041,
Tamil Nadu, India.
E-mail: psaravanan_21@yahoo.com

Date of Submission: 28/05/2015.
Date of Peer Review: 29/05/2015.
Date of Acceptance: 03/06/2015.
Date of Publishing: 10/06/2015.