

Modified Suture Bridge Technique Fixation of Posterior Cruciate Ligament Tibial Avulsion

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Abstract

Purpose: The aim of this study is to outline the technique and report the results of using modified suture bridge technique fixation in PCL tibial bony avulsion through Burks and Schaffer's approach

Methods: Starting at november 2016 to december 2018, 33patients (25males and 8females)who had PCL bony tibial avulsion were treated using modified suture bridge method through Burks and Schaffer's approach by direct cannulated screw fixation followed by indirect fixation using non absorbable suture tied over screw and washer post . The mean followup period was 16 months with the clinical followup (stability by posterior drawer test, functional Lysholm score and possible complications) and radiological union.

Results: Clinically assessed in final follow up visit, all patient showed improvement regarding stability by posterior drawer test (normal in 81.8% of cases), Lysholm score (mean 94) with no complications except one case with superficial infection responded to repeated dressing and antibiotics according to culture and sensitivity with no drawbacks. Radiographic union was achieved in all cases as far as 8 weeks (mean 6.2 weeks). No secondary displacement occurred at any point in the follow-up.

Conclusion: Modified suture bridge method through Burks and Schaffer's approach for PCL bony tibial avulsion is effective, economic, safe, rapid and reliable clinically and radiologically that can be reproduced with no demanding learning curve or equipment as compared to other methods.

Keywords: PCL, avulsion, double fixation, Burks and Schaffer's approach

1. INTRODUCTION

The PCL is the corner stone in knee stability. It is the main restraint against posterior translation of tibia regarding the femur. PCL injury either tendon substance injury or avulsion means loss of fundamental element in the knee biomechanics [1].

In this study, focus brought on PCL tibial avulsion. Once, it was considered rare, maybe it was overlooked due to lack of awareness but the last decade showed that this injury is not uncommon.

In our institute which is responsible for treatment of pelvic and acetabular fractures in 8 million people community, the association between PCL tibial avulsion and posterior wall fracture acetabulum cannot be underestimated. In our community, rise of use of motor Bi or Tri cycles produced rise of wide variety of injuries amongst PCL tibial avulsion [2-3].

In literature, PCL tibial avulsion fixation is agreed by most authors to facilitate early

mobilization and rehabilitation [4-6]. Two points of concern emerged, the first is the access which varies between arthroscopic, Burks and Schaffer's approach to standard posterior approach to knee and popliteal fossa [7-8]. The second point is fixation variety which include navicular screws and washers, cannulated screws, suture anchors and posterior plate [9-10]. We described the use of Burks and Schaffer's approach [11] to double fix the injury directly by modified suture bridge combining cannulated screw and washer fixation followed by indirect fixation using non absorbable suture tied over screw and washer post.

2. PATIENTS AND METHODS

Thirty three patients were enrolled in this study prospectively (25 males and 8 females), age ranged from 22 to 63 (mean 34±12), the right side was affected in 17 patients and the left in 16. The mechanism of injury was motor vehicle accident in 19 and fall from high in 14 patients. 20 cases had fracture acetabulum (posterior elements mainly), 10 had associated upper

extremity injury and three cases were isolated PCL tibial avulsion injury.

All cases were operated upon within 3 weeks ranging from 5 to 19 days (mean 12 ± 7). Delay in some cases occurred due to staged procedures to treat associated injuries delay in 4 cases occurred due to previous misdiagnosis outside our hospital. All cases were initially assessed as polytrauma patients according to (ATLS) guidelines, afterwards patients were managed according to orthopedic injuries priorities.

Regarding to our study, all patients had X-ray for initial diagnosis, CT with 3D reconstruction for outlining the degree of injury and comminution and MRI to exclude other associated knee injuries before examination under anaesthesia which was mandatory for all.

2.1. Surgical Technique: (Burks and Schaffer's approach) [11] (Fig. 1, 2)

Spinal anaesthesia was applied for all patients, pneumatic tourniquet was used throughout the

procedure, prone position was adopted with bolster below the front of the ankle to maintain $30-45^\circ$ flexion to relax the gastrocnemius and facilitate the exposure.

Inverted hockey stick incision was made with the transverse limb just below the posterior knee crease smoothly curving into the vertical limb along medial gastrocnemius. After haemostasis, deep fascia blunt dissection proceed along medial head of the gastrocnemius muscle developing a plane between the semimembranosus tendon and the medial head of the gastrocnemius with the later retracted laterally protecting popliteal vessels.

Partial elevation of popliteus muscle from back surface of the tibia may be needed. If the posterior knee capsule was opened during the trauma then the crater of the pcl avulsion is easily palpated, if the capsule is intact the oblique popliteal ligament and posterior aspect of the joint capsule are incised lateral to the posterior root of the medial meniscus.



Figure1. *Burks and Schaffer's approach* done with the avulsed PCL fragment (white arrow) and the crater of the avulsion (red arrow)

After clearing the crater from clots and tissue debris. The avulsed fragment is examined to determine the degree of comminution. Number 5 ethibond suture is whipstitched (3 stitches) for short distance in the pcl ligament proper to facilitate maipulation.

Preliminary reduction is achieved and secured using reduction clamp with one limb resting on the fragment and the other limb resting on medial surface of the tibia. Fluoroscopic examination of the reduction is performed followed by cannulated screw guide insertion perpendicular to fracture line (if possible) with the addition of anterior drawer force to the tibia.

After fluoroscopic check of guide position, appropriate drilling, measuring and placement of 4.0mm cannulated screw with washer to

secure the primary fixation. The secondary fixation is achieved by applying distal screw (4.0mm canulated or partially threaded 4mm cancellous screws) with a washer 1 inch below the first screw to act as a post for the previous mentioned Ethibond suture (holding the PCL itself) will be tied over, covering the primary fixation screw and decreasing pullout stresses of the PCL.

Fluoroscopic check is done before irrigation and wound closure in layers including the posterior capsule and suction drain is applied for 24 hours. Postoperatively posterior above knee slab was applied to be changed to above knee cast (15° flexion) for 3 weeks on discharge with window over site of sutures for dressing the wound.

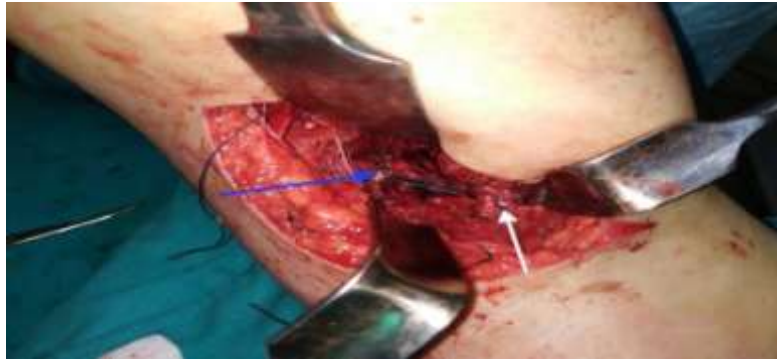


Figure2. Modified suture bridge completed with primary fixation (white arrow) and secondary fixation (blue arrow) with ethibond suture bridge in between.

2.2. Postoperative Follow-Up

At 2 weeks postoperative, sutures were removed and at 3 weeks, we applied hinged knee support for another 3 weeks with closed chain exercises allowed. Recent oral anticoagulants were used after 24 hours from operation (Eliquis 2.5 every 12 hours) for 1 month. mobilization on crutches were allowed from day one with weight bearing on the affected site forbidden for 1 and half month from operation day(after confirmed clinical and radiological union) then to be started gradually afterwards along with physiotherapy. Afterwards patients were assessed every 3 months with follow-up 12 months at minimum.

Clinical assessment was done and recorded every visit. After confirmed radiological union (8 weeks postoperative), Posterior drawer test (PDT) [12] was performed measuring the degree of posterior translation of proximal tibia anterior cortex (normally 10mm anterior) to distal end of

femoral condyles at 90° flexion. Instability was measured as grade I : the normal 10 mm reduced to 5 mm translation with the tibia still anterior, grade II:10 mm translation bringing the tibial anterior cortex in line with the femoral condyles and grade III: the tibia become 5-10 mm posterior to the femoral condyles [13]. The mean follow-up time was 16 months±3.6 ranging from 12-20 months.

Radiographs were obtained at first to detect union to allow weight bearing, then to follow the consolidation of the union and detect any secondary displacement. Functional Lysholm score [14] (grading limp, support instability, locking, pain, swelling, stair climbing and squatting) was adopted in this study and interpreted as poor (<65), Fair (65–83), good (84–90) and excellent (>90). Return to sports or labour work was delayed to 12 months after full rehabilitation and muscle strength compared to the other side. (Fig.3)

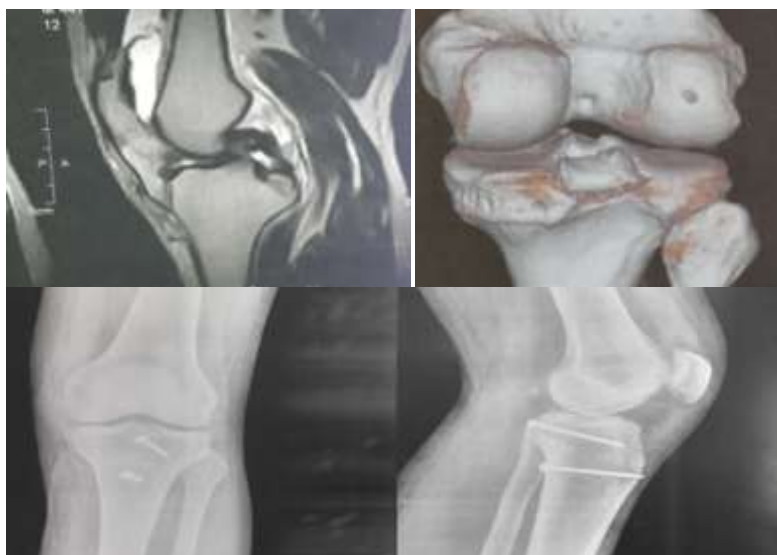


Figure3. Above: preoperative MRI (left) and 3D CT (right), Below: the same patient 16 months postoperative

Statistical assessment: It was done by independent biostatistion not directly involved in the study. The t test (unpaired two-tailed)

and analysis of variance (ANOVA) were used for statistical analysis. Statistical significance was set at a P-value of <0.05.

3. RESULTS

This study was conducted for a period of two years. 36 patients were operated by the same technique, only 33 three were available at final assessment minimum 12 months after operation, the mean followup period was 21.4 ± 5.7 months. Operative time ranged between 38 to 55 minutes (mean 42 minutes). Assessment included Lysholm questionnaire, clinical and radiological examination. Range of motion was recorded using standard goniometer and posterior drawer

was performed as mentioned in postoperative followup to assess integrity of the PCL.

The range of motion at the final visit showed complete range of motion in 28 patients (84.8%), the remaining five patients showed differences between 5° and 10° compared to normal side. This could be explained by concomitant ipsilateral injuries at time of trauma in four patients and another incident of trauma in one patient (fracture distal femur fixed by distal anatomical locked plate (Fig.4). No patients had arthrofibrosis or stiffness.



Figure4. *Left: another trauma incident to one of our patients, Right: the same patient 13 months after fixation*

Regarding The posterior drawer test (PDT) examination, it was normal in 27 patients (81.8%), grade I in 5 patients (15.1%) and grade II in one patient (3.03%) the same patient who had fracture distal femur. No patients had grade III PDT at the final follow-up. The PDT positive change was statistically significant (p-value < 0.05).

culture and sensitivity with no drawbacks. We had no secondary displacement, failure of fixation or needed hardware removal. There were no DVT or neurovascular insult intra or post operative intervention. No patients had gross knee instability or arthrofibrosis.

Radiographic healing assessed using plain x-ray and when in doubt, we used postoperative CT. All patient showed healing radiographically after 5–8 weeks postoperatively (mean 6.2 weeks).

Regarding Lysholm score 1 year postoperative , the mean was 92.56 ± 4.7 . Excellent scores represented in 25 patients (75.75%) and good scores in 6 patients (18.2%) (Table 1). one patient only had a fair result (score 78) the same one patient mentioned above. Lysholm score regarding the posterior drawer test was statistically significant P-value (0.02). (Table 1) (Fig.5, 6)

Regarding complications, we had one case of superficial infection which responded to repeated dressing and antibiotics according to **Tabel.1**

	Score	Patients number	Percentage
Posterior drawer test	Grade 0	27	81.8%
	Grade I	5	15.1%
	Grade II	1	3.03%
	Grade III	0	0%
Lysholm score	Excellent	25	75.75%
	Good	6	18.2%
	Fair	1	3.03%
	Poor	0	0%
Fracture union	N/A	33	100%

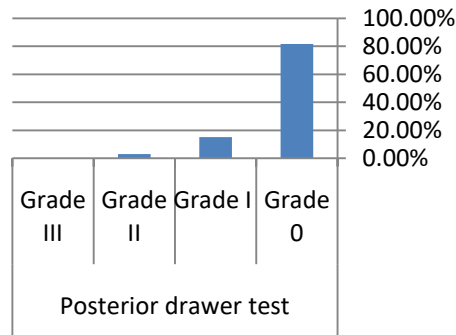


Fig.5

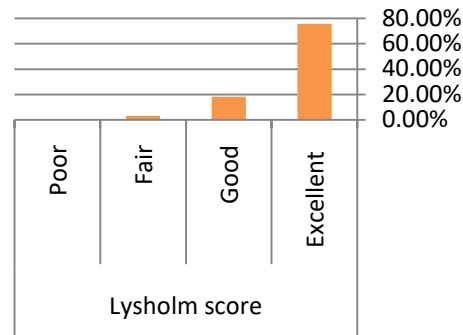


Fig.6

4. DISCUSSION

There is general agreement in literature regarding operative fixation of PCL tibial avulsions, Excellent results by operative intervention were achieved versus poor outcomes from nonoperative treatment [15-17]. Yet, there is no consensus regarding open versus arthroscopic techniques, which approach to use, type of fixation and postoperative regiment. Functional Scores like musculoskeletal functional assessment (MFA) were used in earlier studies, more studies used Lysholm scores and to lesser extend international knee documentation committee (IKDC) grades.

Arthroscopic fixation of tibial PCL avulsion showed satisfactory outcomes clinically and radiologically and it was comparable to the satisfactory outcomes of the open techniques. Song et al [18] in their systematic review comparing open techniques versus arthroscopic techniques found that both achieved good clinical outcomes, radiological healing, and stable knees with few complications despite significant heterogeneity among studies regarding different surgical techniques, fixation methods, comminution degree of fragments, and follow-up time. And no technique was superior to the other. Yet, arthroscopic techniques were technically demanding requiring experienced surgeon, financially expensive, time consuming, even questionable in comminuted fragments and needed longer learning curve which makes its reproducibility challenging [19, 20]. In our study, we adopted open technique to bypass difficulties of arthroscopic method.

Open technique approaches evolved over time from the standard classical posterior approach by Abbott [21] which was time consuming with mandatory exposure of sural nerve, small saphenous vein and popliteal vessels. Later, Trickey et al [22] added release of medial head of gastrocnemius which decreased operative time on expense of delayed rehabilitation. Ogata

et al [23] described osteotomy of fibular neck which increased the complexity of technique and rehabilitation problems. Burks and Schaffer [11] simplified the procedure and did not require release of medial head of gastrocnemius or fibular osteotomy. The post-operative rehabilitation was superior to other approaches and excellent outcomes were achieved. We adopted this approach in this study. Some authors' recorded limitations in Burks and Schaffer exposure which we overcome by using bolster in front of leg, flexing the knee to decrease the tension of medial gastrocnemius. Tension of medial gastrocnemius can cause difficulties directing the drill and the screw insertion, we overcome that by using drill sleeve.

Suture bridge technique, described originally in rotator cuff injuries has been exploited to various aspects of orthopedic injuries. It depends on primary fixation at the insertion site followed by secondary fixation distal to tendinous insertion neutralizing the pullout strength of the tendon. It was proven to be secure and biomechanically comparable to other methods facilitating early rehabilitation and much decreasing failures. The standard tool in such fixation is anchor suture which is economically expensive. Pandey et al [24] employed this technique in Pcl tibial avulsion with favourable outcomes even in the presence of comminution. In one in vitro study Sawyer et al [25] compared screw fixation versus suture fixation versus suture bridge technique fixation and reported superior results of suture bridge technique regarding ultimate failure load.

Aiming at reproducing such merits and hoping to establish standardized fixation for comminuted and non comminuted avulsions, we combined the primary screw and washer fixation of Pcl tibial avulsion with suture bridge composed of number 5 Ethibond suture at osseotendinous junction tied over another screw

and washer below the avulsion crater. Our technique obviated the need to anchor sutures so that it much lowered the cost which was one major disadvantage in Zhang et al [26] and Pandey et al [24] studies. That cost is major issue in our country and developing countries as well.

Our study outcomes were comparable to Piedade et al [27] in 2007, who used Burks and Schaffer's approach on 15 patient versus 6 standard posterior approach (total 21 PCL bony avulsions). They reported the shorter time and the ease of the technique. Kumar et al [28] in 2011 used the same technique on 18 PCL bony avulsions treated acutely with also a low complication rate and obtained good radiographic healing with immediate postoperative range of motion exercises. In our study for fear of patient compliance we choosed to delay range of motion although the fixation quality proved itself in following trauma incidents in our series. Dhillon et al [29] treated 9 patients lately up to three months using preoperative scopes for all patients and a technique of multiple stab incisions for retracted PCL to bring it down to its insertion. Their study outcomes were good regarding stability and range of motion in 8 out of the 9 patients. We operated in our study early we did not need to bring down the fragment by their technique and avoided use of preoperative arthroscopy to prevent fluid accumulation in the leg if the knee capsule was torn causing iatrogenic compartmental syndrome. We found no typically similar study in literature regarding the fixation.

Limitations in this study were assessed to optimize future studies design, The need to increase sample size, Follow up period needs to be increased to assess long term effect of injury and the intervention, lack of Comparison between different approaches, lack of solid biomechanical validation study of different fixation methods and lack of comparison between different functional score.

5. CONCLUSION

There is quite diversity inoperative fixation of PCL tibial avulsions about approaches, fixation, measuring outcome scores and rehabilitation protocols. In this study, using modified suture bridgmethod through Burksand Schaffer's approach is simple, easy to learn, safe to be done by average experienced surgeonand reproducible even in average trauma centers. This technique is economically efficient

compared to expensive use of anchors, demanding expertise for surgeon and demanding equipment in centers. Excellent radiological and functional outcomes were obtained comparable to other techniques including arthroscopic methods with secure rehabilitaion .

Conflict of Interest

The authors declare no conflict of interest.

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