European Journal of Molecular & Clinical Medicine
ISSN 2515-8260 Volume 07, Issue 9, 2020

Trans-Tibial Pull-Out technique in repair of posterior root tear of medial meniscus

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ABSTRACT:
Background*: Damage to the medial meniscus root, destroyed knee to withstand hoop strain abilities, came from increasing the contacting pressures and osteoarthritis progression and kinematic alterations. Many techniques were developed for repairing medial meniscus posterior root tear (MMPRT), Available surgical techniques were proved to failed on reducing meniscus extrusion and associated with osteoarthritis developing, despite improving which observed in postoperative clinical were achieve. Technical Note was described as arthroscopic technique for the medial meniscus posterior root tear and repair was augmented by centralization technique to restored and maintaining medial meniscus function by reduced meniscus extrusion.*
Patients and Methods: *Thirty patients presented with posterior root tear of medial meniscus managed arthroscopically by Trans-tibial pull-out technique.*
Results*: Between March 2018 and July 2019, 30 patients aged from 25-55 years, were operated, lysholm score increase from 56.5 ± 10.34 preoperative to 78.25 ± 7.13 after 3 months postoperative and increase to 89 ± 8.16 at last follow up visit.*
Conclusion: *Arthroscopic repairing medial meniscus posterior root tears using Trans-osseous pull out sutures techniques showed significant improvement to the studied population in terms of functional knee scores (Lysholm and Tegner) and meniscal integrity.*
Key-words: *Knee, Medial meniscus, Posterior root tear, Suture techniques, transtibial pull-out suture.*

Introduction:

A root tear is radial tear occurred within one cm from meniscal horn insertion. Meniscal root tears account for 10.1% of all arthroscopic meniscectomies.[1,2,3]

Pagnani et al [1] was the first to report a case of medial meniscus posterior root tear (MMPRT) in 1991. The case was a football player who rapidly developed degenerative changes after injury that was confirmed arthroscopically. Since then MMPRTs have become increasingly documented when other researchers reported a related course of arthritis in their patients with such an injury. This gave rise to the supposition that one of the causes to secondary OA may be of meniscal origin, as pressure distribution and meniscal integrity are critical for preventing joint degeneration. However, little has been reported in orthopaedic literature. [4,5,6]

Encouragingly, however, several recent studies have begun to examine the meniscal roots attachments. Pervious investigations observed meniscus anatomical reconstruction for bones interfaces for prevent pathological load transmissions, and excessively meniscal translations, eventually preventing osteoarthritis.[2,7]

Structural anatomy :

The medial and lateral menisci have semilunar and circular shapes respectively. The meniscal roots are anterior and posterior attachments for every meniscus to tibial plateau at intercondylar area. (Figure 1).[8, 9, 10]

The meniscal root is coverte throughout vascular synovium and rich blood supplies, where meniscal root tears could be heal in early stages.[11]

Recently the medial meniscus is divided topographically into five anatomical zones; the anterior root (1st zone); the anteromedial area (2nd zone a, b); the medial area (3rd zone); the posterior area (4th zone); and the posterior root (5th zone) (Figure2.3). This classification is based on variable anatomical nature at each zone and it differs from past descriptions, which divided the meniscus into 3 zones only.[12]

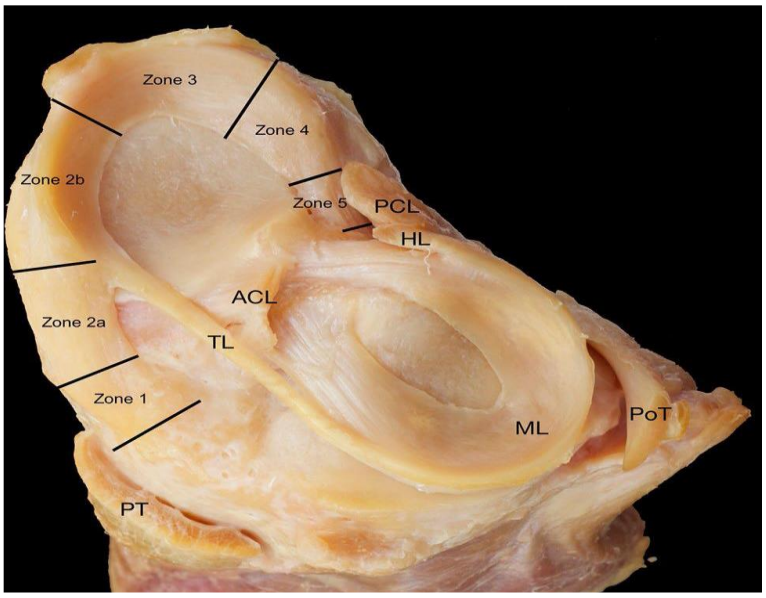

Figure 1: the new topographic anatomical zones within the medial meniscus. Anterior cruciate ligament (ACL), transverse ligament (TL), patellar tendon (PT) , posterior cruciate ligament (PCL), lateral meniscus (ML), Popliteus tendon (PoT), Humphry ligament (HL).[12]

Clinical Evaluation:

Clinical examinations for meniscal root tears were very difficult. Where several diagnosis on posterior horn meniscal body tear were observed . Might be complain about posterior joint line pain at high flexion degrees or, rarely, about locking or giving way for knee.[13]

Meniscal root tears can occur during traumatic events, but many cases occurred in degenerative knees without specific injury or followed by minor traumatic movements.[24]

Most commonly reported in physical examinations where pains with full knee flexion represented 66.7%, joint line tenderness represented 61.9%) and positive McMurray represented 57.1%. Extrusion disappeared when normal knee alignment was restored.[15]

Radiological Evaluations:

MRI is imaging modality of choices for diagnoses meniscal root tears.[15]

For assessment meniscal root injury, T2-weighted sequenceing were utilized by coronal, sagittal and axial images.[16]

3 signs evaluate on MRI when Medial meniscus posterior root tear was suspected:

1) Linear high signal intensity perpendicular to meniscus at the meniscal root in axial plane.[17]

2) Vertical linear defecting on meniscal root where associatewith medial meniscal extrusion less than 3 mm.[17]

3) ghost sign where absence of normal meniscus signal in sagittal plane.[18]

High sensitivities and specificities when using pervious sings.[19]

Treatment
Root tears treatment was very variable depending on injury severity, injury times for surgical interventions and articular cartilage conditions. Our target of surgical repair was restoring joint contact pressures, joint kinematics and delay development for OA. it might consider in those with focal chondral deficits to relieve symptom.[17]

Posterior Meniscal Root Repair
Anatomic repaired for meniscal root attempted and could be possible to preventing meniscus damages and OA, except when case was has poor surgical candidat.[15]

Repair with pull-out (trans-osseous) Technique
The pull-out technique is indicate if roots were avulsed from tibial insertion. Small tunnel drilled with ACL guide at meniscal root avulsed levels. Curved suture passer was use to arm meniscal roots with 2 n°0 non absorbable suture and sutures were then retrieve throughout tunnels from anteromedial tibia and tying over post, button or anterior tibia bone bridge.[10]

Figure 2: Transtibial pull-out repair technique used single transtibial bone tunnel . 2 No. 2 nonabsorbable sutures are passed throughout meniscal roots and later pull throughout transtibial bone tunnel drilled at center of ntire posterior root of medial meniscus. [20]

PATIENTS AND METHODS:

This prospective study was carried on thirty patients from March 2018 to July 2019.twelve men and eighteen females. All Patients admitted to Nasser Institute hospital 1351 Kornish elnile Cairo government. They had tear in posterior root tear of medial meniscus.
The hospitals Research/Ethics Committee approval was obtained as well as written informed consents from the patients.

Surgical techniques:
After general or regional anesthesia, cases are position in supine positions. A high above knee tourniquet is used in all cases.
A general knee exploration was first applied in all cases to inspect the articular cartilage status of the femur and the tibia especially the articulating surfaces and articular injury. Cruciates were examined and both menisci were examined as well.

The tear preparation was 1st applied by refreshening the tear edge itself as well as scratching the undersurface of the posterior horn using shaver. Curettage of the meniscal root bed and posterior horn undersurface articular cartilage down to cancellous tibial plateau bones at meniscal root site and reimplantation do for promoting healing and helping root reattaching for bed.
A transosseous pull out suture technique was employed in all cases to re-implant the torn root insitu, 2 simples suture pass throughout torn root 1st pre drilled tunnel to not lost intra-articular pressures quickly.
The easiest, safest and the most reproducible way to pass 2 simple sutures through the meniscal root, was the use of sutures passed with lasso device (Arthrex, USA) according to injured knee side, to facilitate suture pssage and pass in upward to downward directionly, loaded number 0 prolene (blue monofilament Ethicon co USA) according for availability. The prolene was then used to act like a shuttle to pass number 2 Fiber-Wire (Arthrex USA) throughout meniscal roots. All these maneuveres were applied through the single anteromedial working portal. We had to make sure that the suture tips exit the knee through the same aperture in the working portal to avoid having synovial bridge that can hinder further steps. This was done via the use of a ring forceps, retrieving the four limbs of the sutures from an intraarticular location and exiting the knee through a single aperture, or by using an arthroscopic cannula as an alternative. After passing the 2 simple sutures through the posterior horn of torn root keeping at least 5mm distance between an anteriorly located and a posteriorly located suture loops in the torn posterior root, the tibial tunnel was later drilled. An accurate re-implantation point was chosen (in situ in case of radial tears and in front of PCL tibial origin in cases of root avulsion) which allows meniscal reduction without buckling and keeps meniscal tension. Low profiles tibial ACL marking hook (Arthrex, USA) is apply. It must be a low profile guide not a conventional guide in order to slide smoothly below the femoral condyles avoiding injury to the articular cartilage. The tip of the ACL drill guide put in chooses re-implantation points and guide base contained bullet which put anteriorly in an inferomedial position, so tibial tunnel oriented from anterior, inferior and medial position to posterior, superior and medial trajectory. Through a three cm incision applied at the aiming device base, starting at the tip of the bullet and going upward towards the joint line, an original ACL guide wire drill throughout device till tip appears at desired re-implantation sites. Careful attention with slow speed drive was used to deliver the wire through the tibial plateau to avoid neurovascular injury. A size 7 mm cannulated drill bit was the preferred choice in all case. Its orifice allows much of the meniscal root substance to be re-implanted again to the tibial plateau. Curettage spoon apply over guide wire tip for avoided sudden cannulated drill bit entry into the knee joint or can force the guide wire directly into the popliteal fossa injuring the neurovascular bundle or can cause an injury to the femoral condyle articular cartilage. The 4 limbs of the 2 simple sutures were retrieved by several ways. Operated limb is extend at operating table side with 15^0 (flexion) to allow directly for arthroscopic visualization of meniscal root while tension four sutures limbs over washer. The washer or miniplate must have a diameter larger than the tibial tunnel to avoid being pulled to inside the tunnel losing the tension of the repair. 3 mm to 5 mm of meniscal roots were confirm throughout arthroscopy to be inside tibial tunnel so healing gives better results and counteract any laxity that may occur to sutures by future cyclic loading. The tibial incision was then closed in layers together with the 2 arthroscopy portals after suction of extra irrigation fluid from inside the knee joint.

Postoperative follow up and rehabilitation programs:
Post surgery cases are non-weight bearing on crutches for six weeks. Hinged knee brace apply at first 2 weeks with leg in fully extended position. Cases were instructed to perform quadriceps muscles strengthen exercises, as straight-leg raising exercises many times daily start at postoperative and allow to increased in motion active range by 30° / 2 weeks untill reachto 135°. Gradual weights bearing start at 6 weeks. Full flexion and squatting are allow for three months post surgery. Cases return to full activities 6 months post-operatively.
Statistical Analysis:
All results analyzed were done using SPSS Vs.25

RESULTS:
30 patients aged from 25-55 years, who have posterior medial meniscal root tears, were operated. All met the inclusion criteria and constituted the population of this one arm clinical trial. The follow up duration ranged between 17 months for the first operated case to 7 months for the last operated case, with an average follow up duration of 10 months.

Table 1 showing patients' demographics:

Variables	**Mean + SD**	**Age**
Age	40.8+6.9	26-49
Weight	87.2+15	60-110
Height	1.68+0.10	1.55-190
BMI	30.5+4.9	23.4-35
Gender		
Male	12	40%
Female	18	60%

This table shows that 60% of the studied group were females and the mean age was 40.8 years.

Table 2 Changes in Lysholm score pre and postoperatively:

Variables	Mean+SD	% Of Change	T	P
Pre	56.5 ± 10.34			
After 3 months	78.25 ± 7.13	72	9.485	<0.001
Last follow up	89 ± 8.16	88	13.514	<0.001

This table shows statistically highly significant increase in the score post-operatively by using paired t-test.

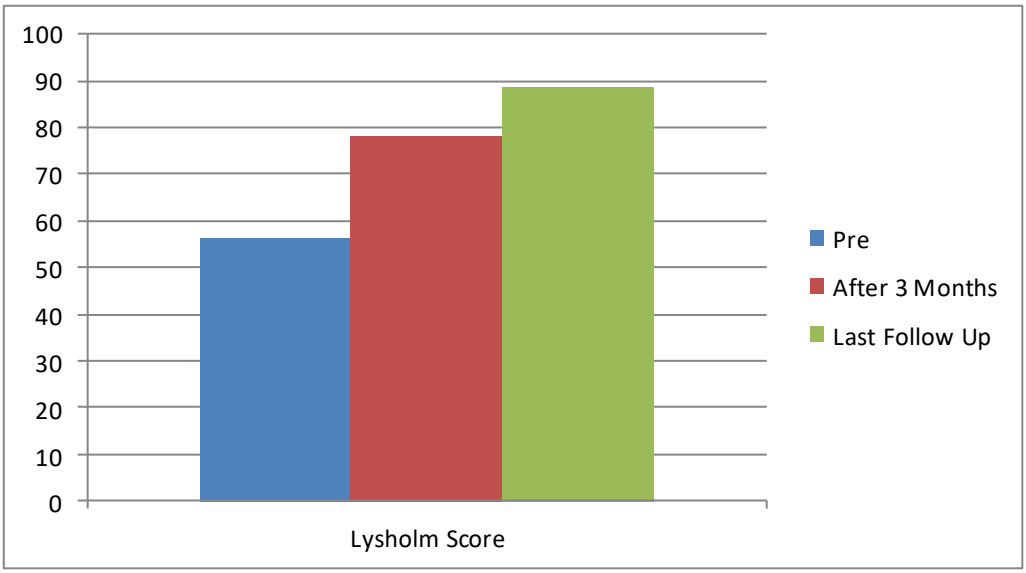

Figure 3: showing improvement in Lysholm score from preoperative to 6 months postoperatively till latest postoperative follow up.

DISCUSSION:

In the current study, the arthroscopic transtibial pull out suture technique (TPS) using two simple sutures, was tested as regard its effectiveness in restoring the meniscal function back to normal hopefully reversing any deleterious effects caused during the time lapse between root tear occurrence and its repair. In the current study the BMI, age, root tear type and time lapse between injury and operation had no significant effect on the results. Similarly, in 2014, J.H.Cho et al [31] applied arthroscopic transtibial pull out suture (TPS) for 20 cases with posterior root tear of medial meniscus (MMPRT). where healing status had no correlation neither with the age at operation time nor with the symptoms duration.[21] As regard current study subjective knee scoring systems results, statistically significant changes occurred, comparing the preoperative scores to the final follow up scores. Both Lysholm, and Tegner scores improved from 56.5 + 10.34 to 89 + 8.16 and from 2.65+1.6 to 3.9+1.7 respectively P< 0.001 for both scores. Similarly, in 2009, 21 cases with medial meniscus root tears (MMPRT) were repaired by J.Lee et al [32] using transosseous pull out sutures technique (TPS),

showed that average of preoperative Lysholm knee scores improve (57.0 to 93.1).[22] Also, in 2011, S.Kim et al [33] carried out a comparative study between 2 groups of patients with MMPRT. The first group underwent root tear partial meniscectomy while the second group underwent meniscal root tear repair using transosseous pull out sutures (TPS), but the repair group had better improvement in Lysholm scores, from 56.8 to 85.1 ($P < 0.001$) and while Lysholm score improvement was from 56.1 to 81.7 in the menisectomy group ($P < 0.001$).[23] Moreover, in 2012, Jung et al [34] repaired 13 medial root tear cases (MMPRT) with all inside anchors. They reported improvement in the mean Tegner activity level from 1.9 preoperatively to 3.9 postoperatively ($P < 0.001$), average of Lysholm score increased from 69.1 to 90.3 at last follow-up, average follow up duration was 30.8 months, ($P < 0.001$). Although the repair technique was different from the current study, yet, the results were similar.[24] Finally, in 2014, D.W.Lee et al [35] applied a comparative study between modified Masson Allen and the 2 simple suture techniques (TPS) for repair of posterior root tear medial meniscus (MMPRT). Both scores significantly improved at both groups, where Lysholm score in the 2 simple sutures group improved from 56.1+ 8.3 to 85.4 + 3.6 ($P <0.001$), and Tegner score in the same group improved from 4.3 + 1 to 4.7 + 1.4 ($P<0.05$).[25]

CONCLUSION:

Meniscal root tear is a grave pathological condition that endangers the knee joint longevity, yet, proper management protocols can save it.

Arthroscopic repaired of the medial meniscus posterior root tear, using trans-osseous pull out sutures techniques by 2 simple sutures configuration, showed significant improvement to the studied population in terms of functional knee scores (Lysholm and Tegner) and meniscal integrity as regard extrusion, ghost sign, gap size and tear healing. Good preparation of the tear bed and edge together with the usage of tibial tunnel size 7 mm amplified the healing rates and facilitated the surgical technique reproducibility, the precise chosen re-implantation point lead to anatomical or near anatomical repairs played an axial role to objectively assess the outcomes.

REFERENCES:

1. **Pagnani MJ, Cooper DE, Warren RF**. Extrusion of the medial meniscus. Arthroscopy: The Journal of Arthroscopic & Related Surgery. 1991 Sep 1;7(3):297-300..
2. **Papalia R, Vasta S, Franceschi F, D'Adamio S, Maffulli N, Denaro V**. Meniscal root tears: from basic science to ultimate surgery. British medical bulletin. 2013 Jan 31;106(1):91-115.
3. **Nha KW, Wang KH, Shetty GM, Lee CS, Kim JI.** Posterior reattachment of a radial tear in the posterior root of the medial meniscus. Orthopedics. 2011 Apr 1;34(4):276-80.
4. **Beasley L, Armfield RD, West R, Irrgang J, Gilbert M, Harner CD.** Medial meniscus root tears: an unsolved problem—demographic, radiographic, and arthroscopic findings. Pittsburgh Orthop J. 2005;16:155.
5. **Jones AO, Houang MT, Low RS, Wood DG.** Medial meniscus posterior root attachment injury and degeneration: MRI findings. Australasian radiology. 2006 Aug;50(4):306-13..
6. **Bedi A, Kelly NH, Baad M, Fox AJ, Brophy RH, Warren RF, Maher SA.** Dynamic contact mechanics of the medial meniscus as a function of radial tear, repair, and partial meniscectomy. JBJS. 2010 Jun 1;92(6):1398-408..
7. **Shrive NG, O'connor JJ, Goodfellow JW.** Load-bearing in the knee joint. Clinical orthopaedics and related research. 1978(131):279-87..
8. **Guermazi A.** Meniscal pathology in the development and progression of knee osteoarthritis. Aspetar Sport Med J. 2014:582-588.
9. **Yamamoto MA, Hirohata KA.** Anatomical study on the menisco-femoral ligaments of the knee. The Kobe journal of medical sciences. 1991 Oct;37(4-5):209-26..
10. **Heller L, Langman J.** The menisco-femoral ligaments of the human knee. The Journal of bone and joint surgery. British volume. 1964 May;46(2):307-13..
11. **Brody JM, Hulstyn MJ, Fleming BC, Tung GA.** The meniscal roots: gross anatomic correlation with 3-T MRI findings. American Journal of Roentgenology. 2007 May;188(5):W446-50.

12. Śmigielski R, Becker R, Zdanowicz U, Ciszek B. Medial meniscus anatomy—from basic science to treatment. Knee Surgery, Sports Traumatology, Arthroscopy. 2015 Jan 1;23(1):8-14.
13. Bonasia DE, Pellegrino P, D' Amelio A, Cottino U, Rossi R. Meniscal root tear repair: why, when and how?. Orthopedic reviews. 2015 Jun 3;7(2).
14. Lee DW, Ha JK, Kim JG. Medial meniscus posterior root tear: a comprehensive review. Knee surgery & related research. 2014 Sep;26(3):125.
15. Bhatia S, LaPrade CM, Ellman MB, LaPrade RF. Meniscal root tears: significance, diagnosis, and treatment. The American journal of sports medicine. 2014 Dec;42(12):3016-30.
16. De Smet AA, Blankenbaker DG, Kijowski R, Graf BK, Shinki K. MR diagnosis of posterior root tears of the lateral meniscus using arthroscopy as the reference standard. American Journal of Roentgenology. 2009 Feb;192(2):480-6..
17. Pache S, Aman ZS, Kennedy M, Nakama GY, Moatshe G, Ziegler C, LaPrade RF. Meniscal root tears: current concepts review. Archives of Bone and Joint Surgery. 2018 Jul;6(4):250.
18. **Harper KW, Helms CA, Lambert III HS, Higgins LD.** Radial meniscal tears: significance, incidence, and MR appearance. American Journal of Roentgenology. 2005 Dec;185(6):1429-34...
19. **LaPrade RF, Ho CP, James E, Crespo B, LaPrade CM, Matheny LM.** Diagnostic accuracy of 3.0 T magnetic resonance imaging for the detection of meniscus posterior root pathology. Knee Surgery, Sports Traumatology, Arthroscopy. 2015 Jan 1;23(1):152-7.
20. LaPrade CM, LaPrade MD, Turnbull TL, Wijdicks CA, LaPrade RF. Biomechanical evaluation of the transtibial pull-out technique for posterior medial meniscal root repairs using 1 and 2 transtibial bone tunnels. The American journal of sports medicine. 2015 Apr;43(4):899-904.
21. Cho JH, Song JG. Second-look arthroscopic assessment and clinical results of modified pull-out suture for posterior root tear of the medial meniscus. Knee surgery & related research. 2014 Jun;26(2):106..
22. Lee JH, Lim YJ, Kim KB, Kim KH, Song JH. Arthroscopic pullout suture repair of posterior root tear of the medial meniscus: radiographic and clinical results with a 2-year follow-up. Arthroscopy: The Journal of Arthroscopic & Related Surgery. 2009 Sep 1;25(9):951-8..
23. Kim SB, Ha JK, Lee SW, Kim DW, Shim JC, Kim JG, Lee MY. Medial meniscus root tear refixation: comparison of clinical, radiologic, and arthroscopic findings with medial meniscectomy. Arthroscopy: The Journal of Arthroscopic & Related Surgery. 2011 Mar 1;27(3):346-54.
24. Jung YH, Choi NH, Oh JS, Victoroff BN. All-inside repair for a root tear of the medial meniscus using a suture anchor. The American journal of sports medicine. 2012 Jun;40(6):1406-11.
25. Lee DW, Kim MK, Jang HS, Ha JK, Kim JG. Clinical and radiologic evaluation of arthroscopic medial meniscus root tear refixation: comparison of the modified Mason-Allen stitch and simple stitches. Arthroscopy: The Journal of Arthroscopic & Related Surgery. 2014 Nov 1;30(11):1439-46.