Arthroscopic All inside Meniscal Repair of The Posterior Horn of The Medial Meniscus Using Outside-in Piecrusting Technique of The Medial Collateral Ligament

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Abstract: The posterior third of the medial meniscus is a common localization of meniscal tears, and an unrestricted view of this portion of the meniscus is a prerequisite for adequate resection. Since the medial femoral condyle obstructs the visualization of the posterior horn of the medial meniscus in stable knees, it is generally difficult to visualize and to use instruments to approach the meniscal pathologies in this area, especially in patients with tight knees. The aim of this study was to evaluate the technique of piecrusting technique for better arthroscopic evaluation of the posterior horn of the medial meniscus. Between June 2011 till May 2013, 32 patients had tight knees with difficult visualization of their posterior compartment. Their mean age was 30.30 year (±SD 5.65). All patients were assessed using IKDC subjective scoring. The mean preoperative IKDC score was 49.9% (39 – 57%). The overall results were considered as satisfactory in all patients except one patient who sustained MCL injury. The median IKDC score preoperatively was 50% (39%-57%). The median IKDC score had increased after one month postoperatively to 76% (67%- 85%) with P value < 0.05 which was statistically significant. After three months, the median IKDC was 91% (87%-98%). In most of the patients a 3mm to 5 mm increase in medial compartment height with an average number of 13 punctures (5-15 punctures) was achieved. Piecrusting technique is a very safe, effective technique for the visualization of the PHMM in tight knees.
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1. Introduction:

Despite refinements in arthroscopic technology over the past decades, posteromedial meniscus lesions have remained the single greatest source of diagnostic errors when arthroscopic access is limited to anterior portals. Most errors occur in tight knees that have hidden lesions at the periphery of the posterior horn of the medial meniscus. (Spahn, 2003; Tolin and Sepaga, 1993; Boytim el al, 1995)

The posterior root attachment of the medial meniscus is critical for preserving important functions of the meniscus. Tears of the posterior root of the meniscus are clearly associated with major extrusion (>3 mm) of the medial meniscus, and meniscal extrusion appears to be associated with progression of osteoarthritis. (Park et al, 2011)

Arthroscopic resection of symptomatic and irreparable meniscal tears is commonly performed with successful clinical outcomes and low rates of complications. Some authors performed meniscal repair but the anterior arthroscopic approach can cause iatrogenic chondral injury because the narrow medial joint space makes it difficult to handle the suture hook and place the guide to make the tibial tunnel. The posterior approaches are technically demanding because a posteromedial or trans-septal portal is required. (Park et al, 2011)

Often the arthroscopists complain of 'tight knees'. The tight knee has tight medial capsular and ligamentous structures. There may be anatomic variations in the size and shape of medial femoral condyle and tibial plateau, which can make entry into the posterior compartment of the knee somewhat difficult. The femoral condyle may not be as wide as normal and thus instrument placement must be nearer to the midline than in normal knee. In addition, if there is marked curvature of either the femoral condyle or tibial plateau, there can be restricted entry into posterior aspects of the knee. The short radius of curvature of the femoral condyle does not allow one to place an 18-gauge needle in a straight path from anterior to posterior aspects of the knee. (Carson, 1990).

Many techniques developed to overcome the problem of tight knees for better arthroscopic visualization of posterior horn of medial meniscus including use of accessory portals (posteromedial portal, undermeniscal portal, transseptal portal) or the use of piecrusting technique of the medial collateral ligament. (Fakioglu et al, 2012).

The piecrusting technique was first advocated Ranawat et al (Ranawat et al, 1997) for releasing posterolateral structures for valgus deformity correction in total knee arthroplasty. This technique was also described by Insall. (Vail and Lang, 2006)

For correcting severe valgus deformity during total knee arthroplasty. In 2003, Clarke et al also performed lateral ligament release using pie-crusing technique for valgus knees. (Clarke and Scuderi, 2003; Clarke et al, 2004) In all these studies it was done using scalpel. Verdonk et al (Verdonk et al, 2009) used pie-crusting of the superficial MCL by using scalpel blade. They concluded that this technique is not safe for balancing the medial side in varus knees because of the risk for iatrogenic transsection of the medial collateral ligament (MCL).

Bellemans (Bellemans et al, 2010; Bellemans, 2011) modified this technique by using a 19-gauge needle instead of scalpel. This "multiple needle puncture" technique was used for correcting vasrus deformity during ligament balancing in total knee replacement. Agneskirchner and Lobenhoffer (Agneskirchner and Lobenhoffer, 2005; Agneskirchner et al, 2005) and also Bosch (Bosch, 2002) described a minimally invasive technique to open the medial compartment by puncturing the posteromedial capsuloligamentous structures percutaneously (modified pie-crusting technique) with the use of a needle.

This study was done to evaluate the clinical results of using modified piecrusting technique of the medial collateral ligament for accurate arthroscopic suturing of the tears of the posterior horn of the medial meniscus without causing any iatrogenic chondral injury.

2. Patients and Methods:

Between June 2011 till May 2013 about 157 patients admitted to our department with torn posterior horn of the medial meniscus. Of them only 32 patients had tight knees with difficult visualization of their posterior compartment. Considerable chondral injury was anticipated on attempting to repair the posterior horn of the medial meniscus. Moreover, two patients had meiscal tears that were not evident before piecrusting of the medial collateral ligament.

This study included 32 patients with tight posterior capsuloligaments structures, hindering the visualization and handling of the posterior horn of the medial meniscus. All patients with proven MCL injury or other associated ligamentous instabilities were excluded from the study. There were 30 males and only two females. Their mean age was 30.30 year (±SD 5.65). All patients sustained acute longitudinal tears of the posterior horn of the medial meniscus ± body of the meniscus. All patients were assessed using IKDC subjective scoring. The mean preoperative IKDC score was 49.9% (39 – 57%). The time lapse before operation ranged from 2-6 weeks with mean of 3.8 weeks (S.D. ± 1.8). All patients complained of pain, locking, tender medial joint line and positive McMurrey test for medial meniscus.

A conventional Xray knee, AP and lateral views were done. Whole limb scanogram was also done. Stress xray films were ordered to exclude any ligaments damage. MRI of the affected knee was done to demonstrate the tear type and location and to exclude any other pathologies. General anesthesia was given to all patients.

Examination under anesthesia was performed in all patients. Standard knee arthroscopy was done using anterolateral and low anteromedial portals using 30 degrees scope. Next, a probe was inserted through the anteromedial working portal into the medial compartment. With the knee in extension to 30 degrees flexion, gentle valgus and external rotation were applied by the assistant to help better visualization of the PHMM. When the complete visualization was difficult, the modified Pie-crusting technique was done.

Controlled release of the posteromedial capsuloligamentous structures was done with the metal inner shaft of the 16 gauge syringe needle. The targeted point for release was the posterior third of the superficial MCL proximal to the medial meniscus. The needle was used to pierce the tensest fibers by puncturing in a perpendicular or slightly oblique fashion, whereas the knee was stressed in valgus.

Punctures were performed every 3 to 5 mm apart proximodistal and anteroposterior. After repeated perforation, the capsuloligamentous structures were felt to give way and enlargement of the medial joint space was achieved. Better visualization of the foot print was obtained, and the subsequent medial meniscal repair was done using Ultra FastFix device (all inside repair). Modification of the postoperative treatment was not necessary. The partial rupture of the posteromedial capsuloligamentous structures heals uneventfully. So, all patients were managed with a compressive bandage, ice compresses and elevation.

Early active exercise of the knee and quadriceps exercises were explained to the patient from the first postoperative day and were encouraged as tolerated by the patient. Stitches were removed after two weeks. Weight bearing was allowed after 6 weeks. Every patient was subjected to regular visits every 4 weeks for three months. Then a last visit after 6 months.

All patients were assessed intraoperatively for the following: Difference in medial compartment height after pie-crusting using arthroscopic probes: either the same, mild increase (3mm) or marked increase (>5mm). Number of punctures needed to fully visualize posteromedial meniscocapular junction were estimated. Discovery of a hidden pathology within posterior compartment not evident before pie-crusting.

The severity of the medial collateral ligament injury on physical examination was evaluated by: The extent of joint line opening with valgus stress with the knee in 30o flexion. The presence of any swelling, tenderness, ecchymosis on medial aspect of the knee were noted. (Rasneberg et al, 1995)

3. Results:

The overall results were considered as satisfactory in all patients except one patient who susatained MCL injury. The median IKDC score preoperatively was 50% (39%-57%). The median IKDC score had increased after one month postoperatively to 76% (67%- 85%) with P value < 0.05 which was statistically significant. After three months, the median IKDC was 91% (87%-98%). It is evident that the pie-crusting technique did not affect the final IKDC score, indicating its safety. (Table 1)

An increase in the IKDC score was noted in most of the patients postoperatively with no medial instability. Only one patient had medial instability (grade III) postoperatively. His IKDC score preoperatively was 49%, and has increased only to 67% after one month. However, his IKDC score after three months was 91%, indicating very good healing of his medial collateral ligament.

Table 1: improvement of IKDC score till the end of follow up

IKDC	Preop	2 W PO	1m PO	3 m PO
Mean	49.9 %	56.9%	75.9 %	91.6%
Median	50%	56%	76%	91%
Minimum	39%	47%	67%	87%
Maximum	57%	66%	85%	98%

In most of the patients the procedure was successful, with 3mm to 5 mm increase in medial compartment height with an average number of 13 punctures (5-15 punctures). There was a significant relationship between the mean number of punctures and the field of vision.

More punctures were needed in very tight knees where meniscosynovial junction was hidden. Also, two patients had hidden posterior compartment pathology and the tear of the posterior horn was not evident before pie-crusting. Those two patients needed more punctures to avoid chondral damage during navigation to their posterior compartment. It was also noticed that valgus instability only occurred when the mean number of punctures exceeded 13 punctures.

Moreover, the estimated preoperative medial joint space (MJS) under valgus load approximately was equal to estimated MJS under valgus load after 3 months postoperatively. This indicated very good healing of the injured ligament fibers caused by pie-crusting. (Table 2)

Table 2: The increase width of MJS after piecrusting technique.

	Preoperative MJS under valgus load	Immediate PO MJS under valgus load	3 months PO MJS under valgus load
Mean	5.7 mm	8.2 mm	5.8 mm
Median	6 mm	8 mm	6 mm
Range	4-7 mm	6-12 mm	4-8 mm
SD	1.0195	1.2814	0.73237

All patients reported postoperative medial ligament tenderness that lasted for 7-10 days only and it was relieved by analgesics and ice. On valgus stress test 30o there was < 5mm opening of medial joint space with firm end point (grade I injury) in all patients compared to the uninjured side except in one patient who reported > 10 mm opening of medial space (grade III injury) with no firm end point. He was a 34 years old male patient. The number of punctures used in this patient was 15 punctures. However, after 3 months of follow up, full integrity of MCL was retained. There was no reported cases of any neurological symptoms (saphenous nerve) postoperatively and after 3 months follow up.

4. Discussion:

Each arthroscopic approach to the knee has a blind area which cannot be directly viewed. (Mariani and Gillquist, 1981) Jackson and DeHaven pointed out the “blind spots” to the arthroscope, including the posterior periphery of the menisci, the posterior cruciate ligament, and the posterior capsule, that may lead to false-negative arthroscopic diagnosis. (Jackson and DeHaven, 1975)

Morin and Steadman performed a cadaveric study to determine the field of view and potential blind spots during arthroscopy. They defined the blind spot as "the region of meniscocapsular periphery not visualized with the 30 degrees and/or 70 degrees arthroscope via anterior portals". The blind spot of the

medial compartment in all specimens encompassed a cross-sectional region from the posterior border of the deep medial ligament to the extracapsular course of the gracilis and semitendinosus. (Morin and Steadman, 1993)

Surgeons rated posteromedial visualization as simple to perform in 78% of the patients, somewhat difficult in 12% of the patients, difficult in 9% of the patients, and impossible to perform in 1% of the patients. (Boytim et al, 1995) In the present series, posteromedial visualization was difficult in 20% of cases (32 out of 157 cases). Fakioglu et al reported tight knees in eighteen patients of total 66 patients (27%) (Fakioglu et al, 2012)

In knee joints with a narrow medial joint space, there is a risk that cartilage may be damaged by the resection instruments, even by an arthroscopy specialist. In the arthroscopic repair of the posterior horn of the medial meniscus in knee joints with a narrow medial joint compartment, there is a risk that cartilage will be damaged by the suture instruments or the insertion instruments for the implants despite the manual application of valgus stress. Even superficial cartilaginous lesions due to hits or scratches caused by instruments and affecting the cartilage of the posterior femoral condyle and the tibial plateau do not heal with normal hyaline cartilage. They may predispose to osteoarthritis of the knee joint, especially if extensive partial meniscectomy is performed simultaneously. (Bosch, 2002)

Different techniques do exist for safety and properly excising most meniscal tears even in the extreme posterior portion of the knee and even with the most difficult tight knees. (Carson, 1990) Accessory diagnostic portals may be needed to view the anterior and posterior horns and must be used as clinically indicated. (Kuhlman and Sepagia, 1995) Access to the posteromedial compartment through the intercondylar notch has been practiced since at least the mid-1970 and had been advocated by Mariani and Gillquist. (Mariani and Gillquist, 1981). Gold et al introduced the accessory posteromedial portal. (Gold et al, 1995) Ahn and Ha introduced a posterior trans-septal portal. (Ahn and Ha, 2000) Jung et al presented a novel medial quadriceptal portal for root tear of the medial meniscus. (Jung et al, 2012) Also, Jo et al developed the under-meniscal portal as an alternative portal which is located under the medial menisci. (Jo et al, 2009)

The main idea of pie-crusting technique is enlargement of the medial joint space by percutaneous perforation of the posteromedial capsuloligamentous structures with a 16 gauge indwelling venous cannula under consistently applied valgus stress. (Bosch, 2002) Using multiple needle punctures, the shortened medial soft tissue sleeve is progressively stretched while applying a constant valgus stress during the puncturing maneuver. In the present study, we were able to demonstrate that this technique is safe and does not compromise mediolateral stability of the knee, up to 3 months postoperatively. It is, however, important to note that; the needle was moved forth and backwards onto the surface of the tight structure, thereby, acting as a micro knife cutting through the fibrotic structures.

Park et al (Park et al, 2011) and Atoun E et al (Atoun et al, 2013) performed modified MCL pie-crusting technique to obtain good visualization of the footprint of posterior root of medial meniscus and sufficient working space for arthroscopic double transosseous pullout repair through the anterior approach. An 18 gauge needle was inserted into the posterior part of the deep MCL just above the joint line. Puncturing to sever the deep MCL fiber was performed by moving the needle in-out. In order to avoid medial instability, they recommended preservation of the superficial MCL as much as possible. In their technique, only the posterior portion of the deep MCL was released partially under careful control. It was essential to preserve the superficial MCL to avoid medial instability.

Agneskirchner and Lobenhoffer, (Agneskirchner and Lobenhoffer, 2005) Bosch (Bosch, 2002) and Fakioglu (Fakioglu, 2012) described the modified pie-crusting technique to open the medial compartment during arthroscopic medial menisectomy in tight knees by puncturing the posteromedial capsuloligamentous structures percutaneously with the use of 16-G indwelling venous cannula under consistently applied valgus stress.

In most of the patients we were able to achieve a 3 mm to 5 mm increase in medial compartment height with an average number of 13 punctures (5-15 puncture). In Fakioglu et al (Fakioglu et al, 2012) no more than four punctures were required for this purpose. The mean joint line opening on maximal valgus stress in our study was 6.2 mm (6-12 mm). In Fakioglu et al (Fakioglu et al, 2012), the mean medial joint space opening was 9.1 mm (6.2–11.3 mm).

All our patients were evaluated using IKDC score. The median IKDC score preoperatively was 50% (39%-57%). The median IKDC score had increased postoperatively to 56% (47%- 66%) with P value < 0.05 which was statistically significant. After three months, the median IKDC score was 91% (87%-98%). In Fakioglu et al (6) subjective discomfort of the patients was evaluated by Lysholm score. The median Lysholm knee score, which was 42 points (24–64 points) before the operation and had increased to 94 points (88–100 points) at the final follow up ($p= 0.0002$).

In this study, all patients reported postoperative medial ligament tenderness (grade I MCL injury) that

lasted for 7-10 days. On valgus stress test 30o there was < 5mm opening of medial joint space with firm end point in all patients compared to the uninjured side except in one patient that reported > 10 mm opening of medial space (grade III injury) with no firm end point. He was a 34 years old male patient. The number of punctures used in this patient was 15 punctures. However, after 3 months of follow up, full integrity of MCL was retained.

Fakioglu et al (Fakioglu et al, 2012) reported no intraoperative complications. In the postoperative period, all patients reported mild pain at the medial needle tract lasting for 15 days. In the final follow-up, there was no pain on palpation within this area. Moreover, there was no sign of saphenous nerve or vein injury. There was superficial ecchymosis that resolved spontaneously in all patients. On physical examination, during valgus stress with the knee in 30o flexion, there was a < 5 mm opening with a firm end point on the medial side (grade I injury) in all patients compared to the uninjured side, which recovered in an average of 3.5 weeks.

Park et al (Park et al, 2011) reported little postoperative instability in arthroscopic medial release to approach the posterior horn of medial meniscus in the tight knees. The normal knee structures, particularly the ACL, compensates for the functional deficit of the transected MCL. Atoun et al (Atoun et al, 2013) recommend inside-out technique because MCL piecrusting is painful to the patients because of multiple puncturing of the skin.

However, this study has a number of shortcomings; manual stress testing was performed to assess mediolateral laxity, and although it was done by an experienced surgeon, some degree of variability in the forces exerted during testing cannot be excluded. It was a prospective therapeutic case series with no control groups. The precision and margin for error on calculation of the joint space width is another limitation of this study.

6. Conclusions:

The multiple needle puncturing (piecrusting) is an effective and safe technique for progressive correction of medial structures in the tight knee. Controlled release of the MCL in tight knees allows easier handling in posterior medial meniscus tears and a better understanding of tear configurations, thereby avoiding iatrogenic chondral lesions. Maximum number of 10-15 puncture should be used if pie-crusting of MCL to be done.

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