Posterior Meniscal Root Repairs with All-Suture Anchors Could Restore the Normal Medial Tibiofemoral Joint Mechanics

Porcine cadaveric study

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DECLARATION OF INTEREST

No held shares

No received royalties

Not done consulting work

Not given paid presentations

Received institutional support from :
Faculty of Medicine Ramathibodi Hospital, Mahidol university

INTRODUCTION

The transtibial pullout suture (TPO)repair technique has been reported to obtain good tibiofemoral contact mechanics after posterior medial meniscus root(PMMR) tear and improved functional outcomes, but 62 % complete healing rate and 9.7% revision rate has been observed.

The anchor suture technique has been restored incomplete healing of TPO but still requires creating an accessory posteromedial portal, which could injure neurovascular structures

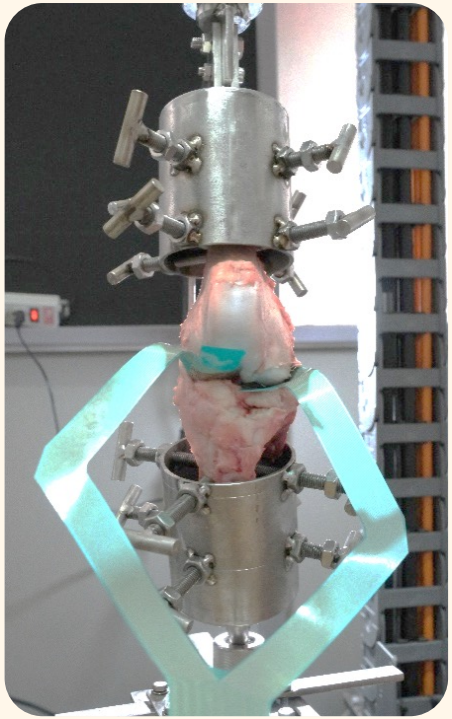
Recently study purposed a repair technique using an all-suture anchor (ASA) and claimed it could surpass all limitations of previous anchor suture repair techniques

PURPOSE OF STUDY

To compare the tibiofemoral contact mechanics(contact pressure area, contact pressure) between the TPO technique and ASA techniques for PMMR repair

To assess the magnitude of the time-zero displacement of the posterior medial meniscal root in response to the maximal compression force of each testing condition.

MATERIALS & METHODS



20 fresh porcine hindleg knee specimens was prepared and randomly distributed to one of 4 groups (5 specimens per group)

(1) Intact PMMR
(2) PMMR tear
(3) TPO repair technique
(4) ASA repair technique

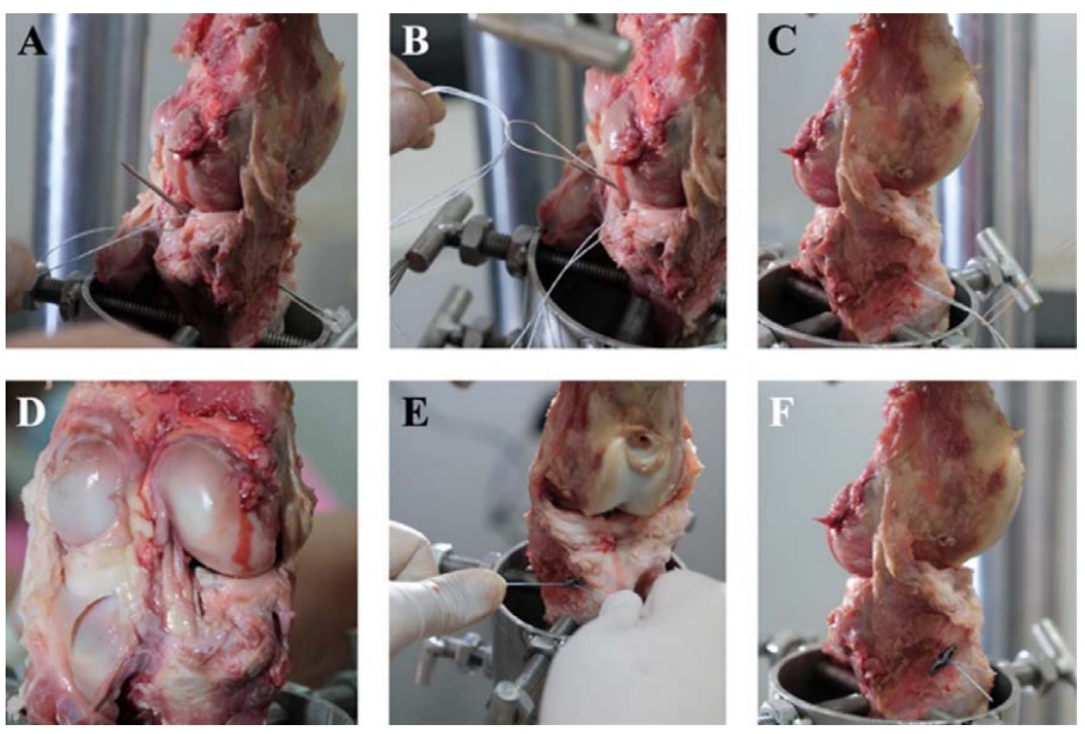
The tibiofemoral contact mechanics were investigated using a pressure sensor(Tekscan model 4000)

All knee specimens were tested by being loaded with 600N axial compressive force (Instron E10000) at 3 different flexion angles (0˚ ,45˚ ,and 90˚)

The contact surface area, contact pressure, peak pressure, and time-zero displacement were recorded

MATERIALS & METHODS

Steps for PMMRT repair with TPO technique

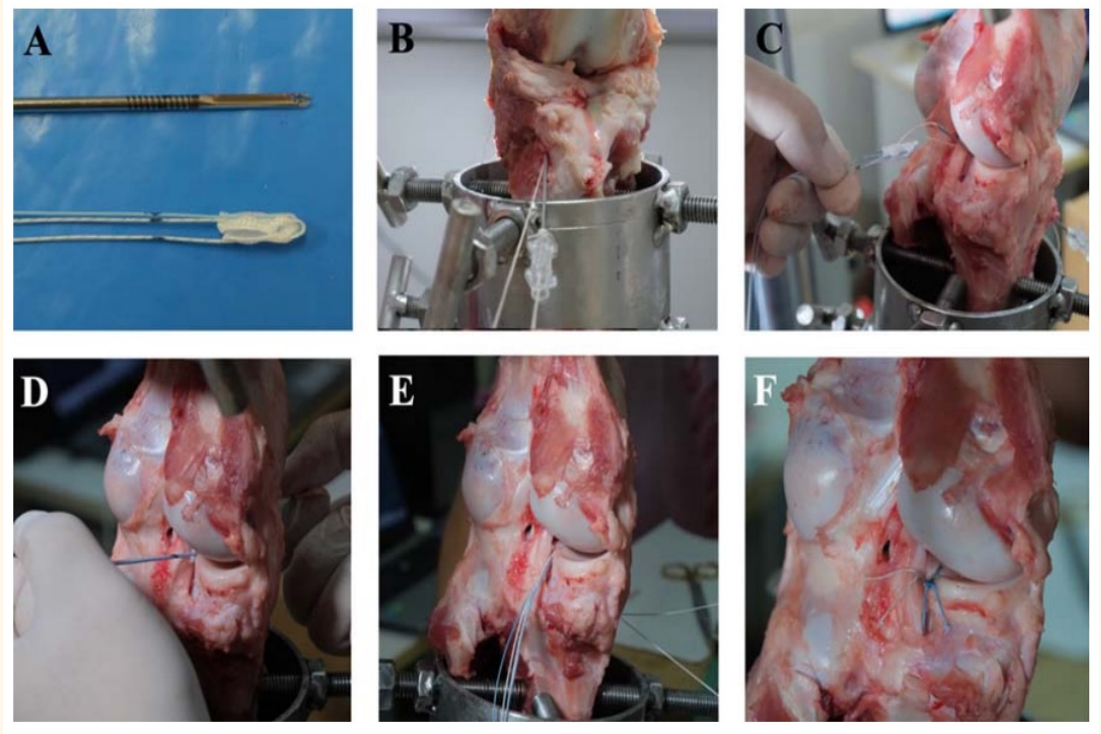


Materials
No. 2 Hi-Fi suture
XO button

Modified
Mason-Allen
Suture configuration

MATERIALS & METHODS

Steps for PMMRT repair with ASA technique

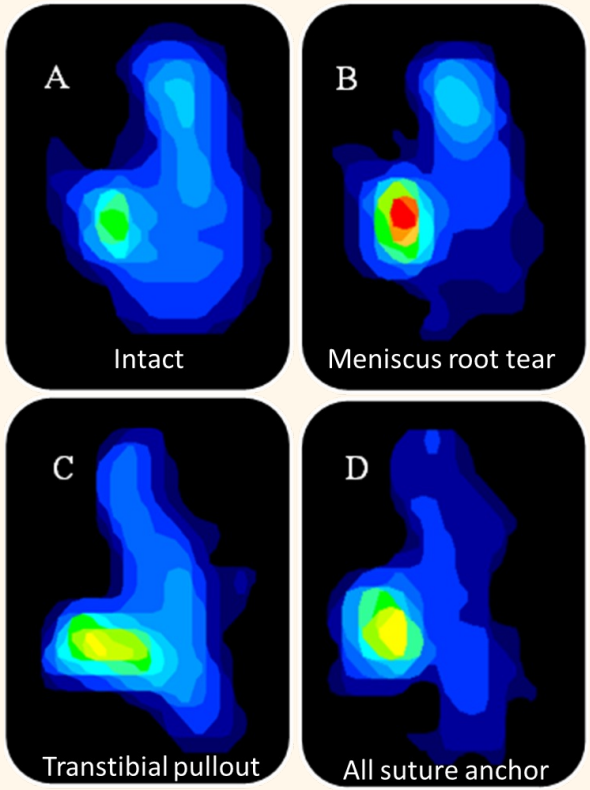


Materials

2.8 mm Y knot

Modified
Mason-Allen
Suture configuration

RESULTS



Representative medial compartment pressure map of the four testing conditions at 0° knee flexion angle.

These pressure maps illustrate the distribution of contact surface area, contact pressure, and peak pressure at 0° knee flexion in different testing conditions.

Higher pressures are indicated by orange and yellow color, and lower pressures by green and blue color.

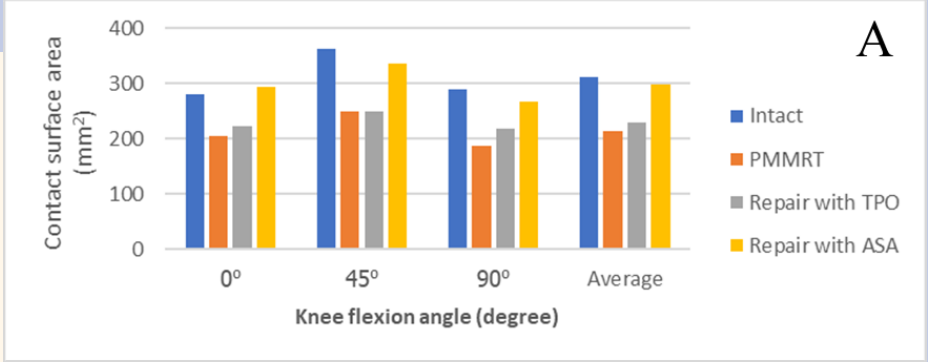
RESULTS

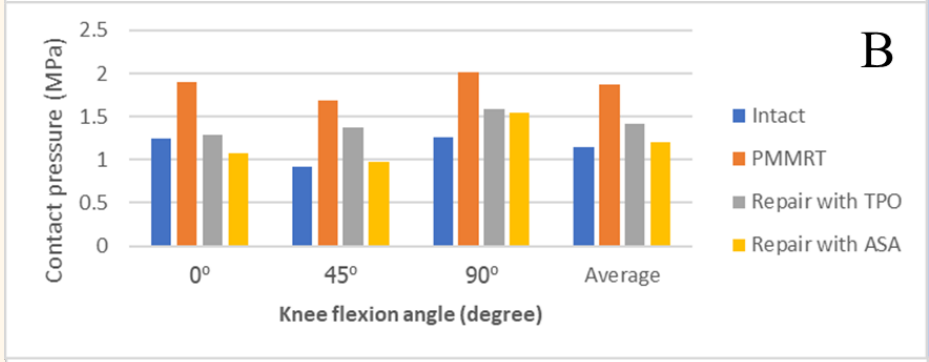
The PMMR tear significant decrease in contact surface area, an increase in contact pressure and peak pressure from the reference values observed in the intact meniscus group
($P = 0.003$, 0.002, <0.001)

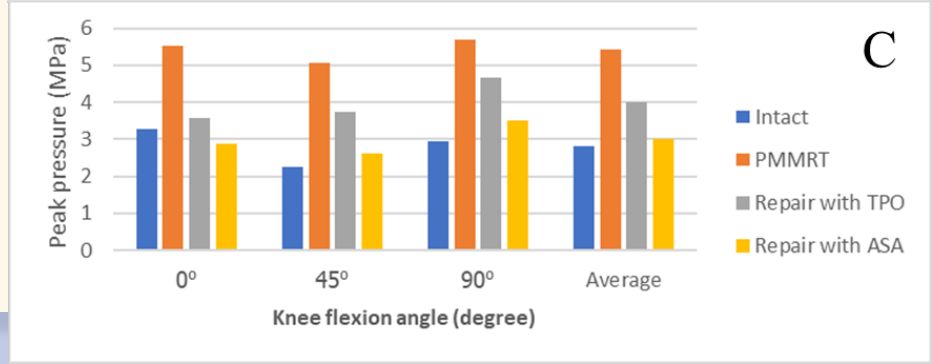
No significant difference observed between the ASA and intact group in all parameters

Significant differences were found between the TPO and intact group in terms of
- contact surface area ($P = 0.021$)
- contact pressure ($P = 0.032$)
- peak pressure ($P = 0.032$)

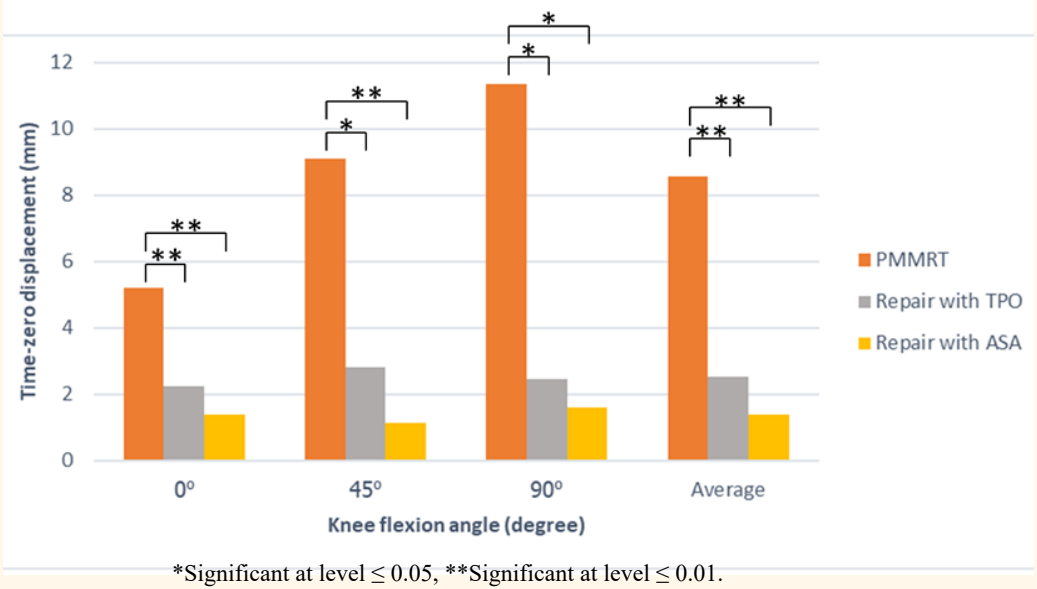
ASA group demonstrated higher contact surface area than the TPO group at averaged knee flexion angle ($P = 0.007$)







RESULTS



*Significant at level ≤ 0.05, **Significant at level ≤ 0.01.

Both repair techniques had the potential to reduce tear displacement but could not restore to zero as an intact condition

The ASA group tends to have lower displacement compared to the TPO group. However, the difference was not achieved at a statistically significant level

DISCUSSION

PMMR tear affected the tibiofemoral mechanics by significantly decreasing the contact surface area increased contact pressure and peak pressure

The ASA technique demonstrated superior biomechanical properties in terms of contact surface area, as compared with the TPO technique

The ASA technique could also restore the same tibiofemoral contact mechanics compared with the native knee, without any statistically significant difference between groups

Both repair techniques could significantly decrease the displacement compared with the PMMRT; however, no such technique could restore to zero as an intact condition

CONCLUSION

The preferable
all-suture anchor repair technique
might be beneficial in restoring
tibiofemoral contact mechanics
compared with the native knee in
PMMR tear

REFERENCES

1.Matheny LM, Ockuly AC, Steadman JR, LaPrade RF. Posterior meniscus root tears: associated pathologies to assist as diagnostic tools. Knee Surg Sports Traumatol Arthrosc. 2015;23(10):3127-31.
2.Hwang BY, Kim SJ, Lee SW, Lee HE, Lee CK, Hunter DJ, et al. Risk factors for medial meniscus posterior root tear. Am J Sports Med. 2012;40(7):1606-10.
3.Johannsen AM, Civitarese DM, Padalecki JR, Goldsmith MT, Wijdicks CA, LaPrade RF. Qualitative and quantitative anatomic analysis of the posterior root attachments of the medial and lateral menisci. Am J Sports Med. 2012;40(10):2342-7.
4.Bhatia S, LaPrade CM, Ellman MB, LaPrade RF. Meniscal root tears: significance, diagnosis, and treatment. Am J Sports Med. 2014;42(12):3016-30.
5.Allaire R, Muriuki M, Gilbertson L, Harner CD. Biomechanical consequences of a tear of the posterior root of the medial meniscus. Similar to total meniscectomy. J Bone Joint Surg Am. 2008;90(9):1922-31.
6.Kim JG, Lee YS, Bae TS, Ha JK, Lee DH, Kim YJ, et al. Tibiofemoral contact mechanics following posterior root of medial meniscus tear, repair, meniscectomy, and allograft transplantation. Knee Surg Sports Traumatol Arthrosc. 2013;21(9):2121-5.
7.Marzo JM, Gurske-DePerio J. Effects of medial meniscus posterior horn avulsion and repair on tibiofemoral contact area and peak contact pressure with clinical implications. Am J Sports Med. 2009;37(1):124-9.
8.Han SB, Shetty GM, Lee DH, Chae DJ, Seo SS, Wang KH, et al. Unfavorable results of partial meniscectomy for complete posterior medial meniscus root tear with early osteoarthritis: a 5- to 8-year follow-up study. Arthroscopy. 2010;26(10):1326-32.
9.Neogi DS, Kumar A, Rijal L, Yadav CS, Jaiman A, Nag HL. Role of nonoperative treatment in managing degenerative tears of the medial meniscus posterior root. J Orthop Traumatol. 2013;14(3):193-9.
10.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;106(1):91-115.
11.Vyas D, Harner CD. Meniscus root repair. Sports Med Arthrosc Rev. 2012;20(2):86-94.
12.Chung KS, Ha JK, Yeom CH, Ra HJ, Jang HS, Choi SH, et al. Comparison of Clinical and Radiologic Results Between Partial Meniscectomy and Refixation of Medial Meniscus Posterior Root Tears: A Minimum 5-Year Follow-up. Arthroscopy. 2015;31(10):1941-50.
13.LaPrade RF, Matheny LM, Moulton SG, James EW, Dean CS. Posterior Meniscal Root Repairs: Outcomes of an Anatomic Transtibial Pull-Out Technique. Am J Sports Med. 2017;45(4):884-91.
14.Padalecki JR, Jansson KS, Smith SD, Dornan GJ, Pierce CM, Wijdicks CA, et al. Biomechanical consequences of a complete radial tear adjacent to the medial meniscus posterior root attachment site: in situ pull-out repair restores derangement of joint mechanics. Am J Sports Med. 2014;42(3):699-707.
15.Feucht MJ, Izadpanah K, Lacheta L, Südkamp NP, Imhoff AB, Forkel P. Arthroscopic transtibial pullout repair for posterior meniscus root tears. Oper Orthop Traumatol. 2019;31(3):248-60.
16.Feucht MJ, Grande E, Brunhuber J, Rosenstiel N, Burgkart R, Imhoff AB, et al. Biomechanical comparison between suture anchor and transtibial pull-out repair for posterior medial meniscus root tears. Am J Sports Med. 2014;42(1):187-93.
17.Nakamura R, Takahashi M, Kuroda K, Katsuki Y. Suture Anchor Repair for a Medial Meniscus Posterior Root Tear Combined With Arthroscopic Meniscal Centralization and Open Wedge High Tibial Osteotomy. Arthrosc Tech. 2018;7(7):e755-e61.
18.Kim JH, Chung JH, Lee DH, Lee YS, Kim JR, Ryu KJ. Arthroscopic suture anchor repair versus pullout suture repair in posterior root tear of the medial meniscus: a prospective comparison study. Arthroscopy. 2011;27(12):1644-53.
19.Kramer DE, Bahk MS, Cascio BM, Cosgarea AJ. Posterior knee arthroscopy: anatomy, technique, application. J Bone Joint Surg Am. 2006;88 Suppl 4:110-21.
20.Kim JH, Shin DE, Dan JM, Nam KS, Ahn TK, Lee DH. Arthroscopic suture anchor repair of posterior root attachment injury in medial meniscus: technical note. Arch Orthop Trauma Surg. 2009;129(8):1085-8.
21.Balke M, Akoto R, Offerhaus C, Hoeher J. Suture Anchor Refixation of Meniscal Root Tears Without an Additional Portal. Arthrosc Tech. 2018;7(5):e511-e5.
22.Feucht MJ, Grande E, Brunhuber J, Burgkart R, Imhoff AB, Braun S. Biomechanical evaluation of different suture techniques for arthroscopic transtibial pull-out repair of posterior medial meniscus root tears. Am J Sports Med. 2013;41(12):2784-90.
23.Röpke EF, Kopf S, Drange S, Becker R, Lohmann CH, Stärke C. Biomechanical evaluation of meniscal root repair: a porcine study. Knee Surg Sports Traumatol Arthrosc. 2015;23(1):45-50.
24 Rosslenbroich SB, Borgmann J, Herbort M, Raschke MJ, Petersen W, Zantop T. Root tear of the meniscus: biomechanical evaluation of an arthroscopic refixation technique. Arch Orthop Trauma Surg. 2013;133(1):111-5.
25.LaPrade CM, Foad A, Smith SD, Turnbull TL, Dornan GJ, Engebretsen L, et al. Biomechanical consequences of a nonanatomic posterior medial meniscal root repair. Am J Sports Med. 2015;43(4):912-20.