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Meniscus root refixation technique using a modified Mason–Allen stitch

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Abstract A complete posterior medial meniscus root tear results in the inability to withstand hoop stress and requires the repair of the posterior medial meniscus root. Several techniques to repair the posterior medial meniscus root have been proposed, but most techniques are based on simple stitching. A modified Mason–Allen technique, recognized as a superior stitching method to repair rotator cuff in shoulder surgery, was applied to overcome the potential weakness of those simple stitching techniques. This newly modified Mason–Allen technique reproduces the locking effect of a conventional modified Mason–Allen stitch allowing the physiological meniscal extrusion. The purpose of this article is to describe a posterior root repair technique using a modified Mason–Allen stitch with two strands consisting of a simple horizontal and a simple vertical stitch.
Level of evidence V.

Keywords Medial meniscus · Meniscus repair · Root refixation · Root repair · Mason–Allen stitch

Introduction

The principal functions of an intact knee meniscus include transmitting a compressive load across the joint, increasing tibiofemoral congruency, and stabilizing the joint [20]. The load transmission function is maintained by the hoop strain mechanism of the meniscus and crucial to prevent degenerative changes [4, 11]. A complete posterior medial meniscus root tear results in the failure of the hoop strain mechanism and a loss of the ability to resist extrusion under axial loading [17]. Such type of tear is biomechanically equivalent to a total meniscectomy [4, 10]. The posterior portion of the medial meniscus carries a greater proportion of the load than does the anterior portion [11, 25]. Hence, the early detection and repair of tears in the posterior medial meniscus root are important [10].

A number of simple-stitching-based techniques to repair the medial meniscus root have been proposed [2, 3, 12–15, 21, 22]. However, several studies have shown that simple stitching produces low level of holding strength and can lead to less ideal recuperating experience of patients through potential treatment failure [5, 6, 8, 18]. Therefore, the use of the modified Mason–Allen stitch is proposed as a treatment option for damaged medial meniscus root. This simple and convenient modified Mason–Allen stitching technique is commonly used for rotator cuff repair in shoulder surgery [7, 19] and will provide superior binding of the torn end of the posterior medial meniscus.

Technical note

A number of posterior root refixation and superficial medial collateral ligament release (MCL) methods were reported previously [13, 14]. The same general procedure is used, with the additional technique of creating a crossed horizontal and vertical suture limb to provide better holding strength. After preparing a bony bed at the insertion site of the posterior horn of the medial meniscus and creating a single tibial tunnel from the anteromedial proximal tibia to

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the insertion site, a crescent-shaped suture hook (Linvatec, Largo, FL, USA), loaded with No. 1 polydioxanone (PDS), was passed through the anteromedial portal. The detached portion of the medial meniscus posterior horn was penetrated by the sharp tip of the suture hook at 3–5 mm medial to the torn edge in a vertical direction from the femoral side to the tibial side (Fig. 1a). Then, No. 1 PDS was advanced through the suture hook, and the tibial side of the No. 1 PDS was taken out through the anteromedial portal using a suture retriever. The superior end of the suture was marked with curved mosquito forceps for tying with the other suture in the next step. The other strand was placed anterior to the first suture in the same manner through the same portal (Fig. 1b). As a next step, the superior ends of the two simple sutures were tied outside of the portal, and the inferior end of the first suture was then pulled (Fig. 2). Using the shuttle relay method, the first suture was exchanged with the second suture. Finally, the horizontal loop was completed. This method is similar to the technique described by Ahn et al. [1]. Once again, a crescent-shaped suture hook loaded with No.1 PDS was passed through the anteromedial portal. A simple vertical stitch was made that overlaid and crossed the centre of the horizontal suture (Fig. 3), and both ends of the suture were taken out through the anteromedial portal. This resulting cruciate-shaped stitch (Fig. 4) is similar to the modified Mason–Allen technique (the Mac stitch or Allex stitch) used in arthroscopic rotator cuff repair [7, 19]. By pulling the ends of the sutures under adequate tension through the tibial tunnel, the meniscus was reduced and stabilized (Fig. 5). The suture ends are then tied over a Hewson button (Ethicon, Somerville, NJ, USA) that was placed under the periosteum overlying the anteromedial tibial cortex (Fig. 6a) with the knee at 30°–45° of flexion and with adequate tension to allow physiological excursion (Fig. 6b). A final arthroscopic evaluation is performed to confirm reattachment of the torn posterior root and tension of the entire medial meniscus.

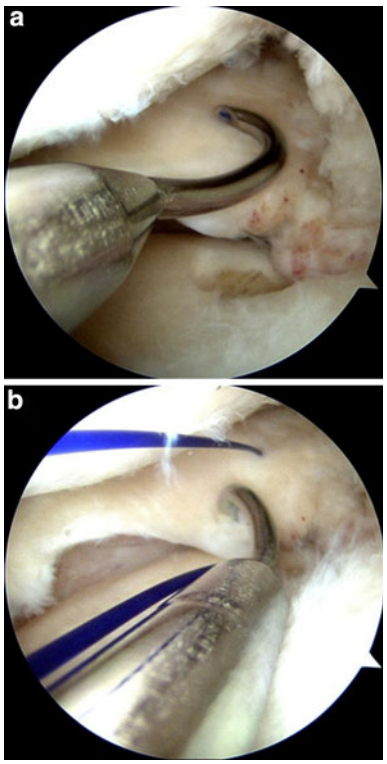


Fig. 1 **a** After preparing a bony bed with a curette, a crescent-shaped suture hook is placed 3–5 mm medial to the torn margin. **b** The other strand is placed anterior to the first simple stitch in a *vertical direction*

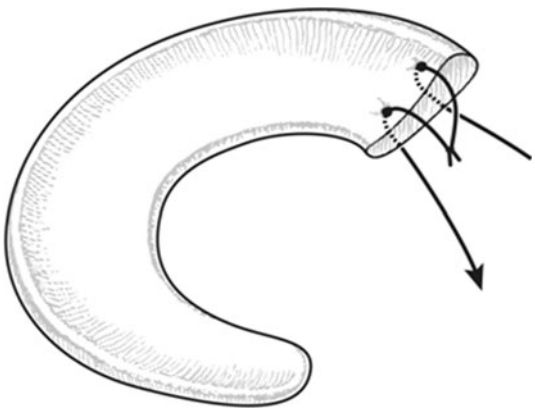


Fig. 2 Extra-portal view: the superior end of the first suture is tied with the *superior end* of the second suture and the *inferior end* of the first suture is pulled out

Discussion

The purpose of this report is to describe a newly modified Mason–Allen stitch to refix the meniscus root. The most important criteria for complete and successful healing of the meniscus root are good initial holding strength and a large tissue–bone contact area. These basic principles of meniscus root repair are similar to those of rotator cuff repair, and the modified Mason–Allen stitch has been recognized as the superior holding methods to the currently available stitches used for rotator cuff repair [5, 6, 8, 18]. The modified Mason–Allen stitch leads to the least slippage and elongation of the longitudinally oriented fibres of the tendon and has stronger tensile load [8, 9]. Because the main fibres of the meniscus are circumferential fibres that are tangentially oriented to root insertion [25], the risk of premature suture pullout can be reduced with the modified Mason–Allen stitch. However, as it is difficult and time-consuming to place the original modified Mason–Allen stitch made with a single strand arthroscopically, the new modified Mason–Allen stitch with two strands consisting of a simple horizontal and a simple vertical stitch is

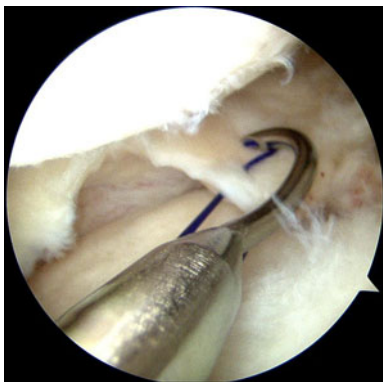


Fig. 3 A simple *vertical stitch* is made across the *centre* of the previous horizontal loop

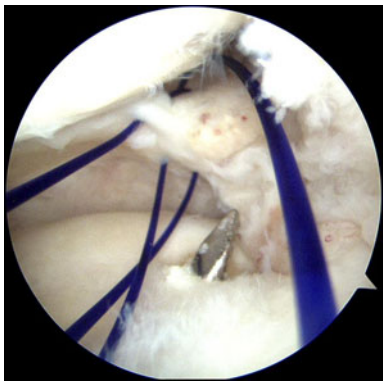
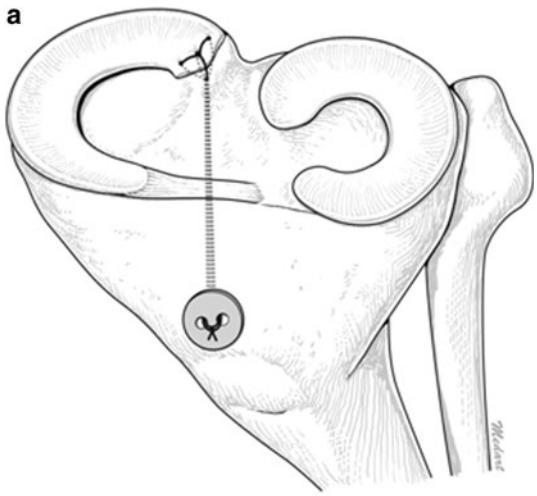


Fig. 4 A *cruciate-shaped stitch* is used to finish and the two suture strands are taken out through the anteromedial portal

Fig. 5 The torn root is pulled towards the insertion site through the tibial tunnel under adequate tension

performed. It is technically easier to place two separated loops and to reproduce the "locking effect" of the modified Mason–Allen stitch, occurring when the simple loop engages the horizontal loop [16, 18].

A single tibial tunnel was made by drilling from the anteromedial cortex of the proximal tibia to the root insertion site. However, some authors have advocated the use of two tibial tunnels to increase and to evenly distribute



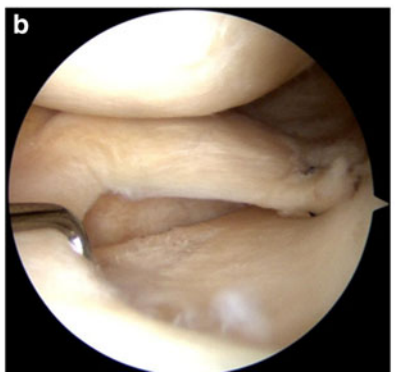


Fig. 6 **a** A schematic of tying the four ends of the two strands to a Hewson button instead of rigid fixation. **b** After tying the suture materials, the stability and physiological excursion of the repaired meniscus are checked by probing

contact pressure between the meniscus root and the insertion site [2, 21]. With such a double transosseous pullout suture technique, problematic tunnel coalition or breakage can result in the limited small root insertion area. The proposed technique in this report reduces the disadvantages of single-point fixation by providing strong grasping power, provides a relatively wide and balanced contact area between the root and the insertion area, and reduces required operation time.

A recent study reported that complete healing with simple suturing and cortical screw fixating technique is not observed in all cases and that the repaired meniscus no longer shows the firm attachment on the second-look arthroscopy [22]. Instead of rigidly fixating the pullout sutures, the modified technique in this study ties the suture ends over a Hewson button (Ethicon) that was placed under the periosteum adjusting the tension. This technique allows the mobility of the meniscus for maximum dynamic congruity, and it facilitates load transmission of the meniscus avoiding excessive strain on the sutures [23, 24]. In sum, this new proposed technique incorporates not only strong holding power, but the flexibility at the fixture point, as well.

The proposed technique, however, do need further biomechanical studies. The assumption that it can provide greater holding strength than the conventional simple stitch method when it is applied to the meniscal tissue must be demonstrated. Also, the technical limitation lies in suturing the horizontal stitch using the same colour for the two strands, because they tend to tangle easily in the joint space. It is also very important and requires a learning curve to execute the vertical suture to the centre of the horizontal suture to provide symmetrical tension at the insertion site.

The technique described here allows the surgeon to readily place a biomechanically superior modified Mason–Allen stitch with only a simple horizontal and a vertical stitch [5, 18].

Conclusion

This new modified Mason–Allen stitch with two strands consisting of a simple horizontal and a simple vertical stitch is technically easier to place two separated loops compared with conventional modified Mason–Allen stitch made with a single strand and also reproduces the "locking effect".

References

1. Ahn JH, Lee YS, Chang JY, Chang MJ, Eun SS, Kim SM (2009) Arthroscopic all inside repair of the lateral meniscus root tear. Knee 16(1):77–80
2. Ahn JH, Wang JH, Lim HC, Bae JH, Park JS, Yoo JC, Shyam AK (2009) Double transosseous pull out suture technique for transection of posterior horn of medial meniscus. Arch Orthop Trauma Surg 129(3):387–392
3. Ahn JH, Wang JH, Yoo JC, Noh HK, Park JH (2007) A pull out suture for transection of the posterior horn of the medial meniscus: using a posterior trans-septal portal. Knee Surg Sports Traumatol Arthrosc 15(12):1510–1513
4. Allaire R, Muriuki M, Gilbertson L, Harner CD (2008) Biomechanical consequences of a tear of the posterior root of the medial meniscus. Similar to total meniscectomy. J Bone Joint Surg Am 90(9):1922–1931
5. Baleani M, Ohman C, Guandalini L, Rotini R, Giavaresi G, Traina F, Viceconti M (2006) Comparative study of different tendon grasping techniques for arthroscopic repair of the rotator cuff. Clin Biomech (Bristol, Avon) 21(8):799–803
6. Castagna A, Conti M, Markopoulos N, Borroni M, De Flaviis L, Giardella A, Garofalo R (2008) Arthroscopic repair of rotator cuff tear with a modified Mason–Allen stitch: mid-term clinical and ultrasound outcomes. Knee Surg Sports Traumatol Arthrosc 16(5):497–503
7. Castagna A, Garofalo R, Conti M, Borroni M, Snyder SJ (2007) Arthroscopic rotator cuff repair using a triple-loaded suture anchor and a modified Mason–Allen technique (Alex stitch). Arthroscopy 23(4):440
8. Gerber C, Schneeberger AG, Beck M, Schlegel U (1994) Mechanical strength of repairs of the rotator cuff. J Bone Joint Surg Br 76(3):371–380
9. Gerber C, Schneeberger AG, Perren SM, Nyffeler RW (1999) Experimental rotator cuff repair. A preliminary study. J Bone Joint Surg Am 81(9):1281–1290
10. Harner CD, Mauro CS, Lesniak BP, Romanowski JR (2009) Biomechanical consequences of a tear of the posterior root of the medial meniscus. Surgical technique. J Bone Joint Surg Am 91(Suppl 2):257–270
11. Kan A, Oshida M, Oshida S, Imada M, Nakagawa T, Okinaga S (2010) Anatomical significance of a posterior horn of medial meniscus: the relationship between its radial tear and cartilage degradation of joint surface. Sports Med Arthrosc Rehabil Ther Technol 2:1
12. Kim JH, Chung JH, Lee DH, Lee YS, Kim JR, Ryu KJ (2011) Arthroscopic suture anchor repair versus pullout suture repair in posterior root tear of the medial meniscus: a prospective comparison study. Arthroscopy 27(12):1644–1653
13. Kim SB, Ha JK, Lee SW, Kim DW, Shim JC, Kim JG, Lee MY (2011) Medial meniscus root tear refixation: comparison of clinical, radiologic, and arthroscopic findings with medial meniscectomy. Arthroscopy 27(3):346–354
14. Kim YJ, Kim JG, Chang SH, Shim JC, Kim SB, Lee MY (2010) Posterior root tear of the medial meniscus in multiple knee ligament injuries. Knee 17(5):324–328
15. Koenig JH, Ranawat AS, Umans HR, Difelice GS (2009) Meniscal root tears: diagnosis and treatment. Arthroscopy 25(9):1025–1032
16. Koganti AK, Adamson GJ, Gregersen CS, Pink MM, Shankwiler JA (2006) Biomechanical comparison of traditional and locked suture configurations for arthroscopic repairs of the rotator cuff. Am J Sports Med 34(11):1832–1838
17. Lerer DB, Umans HR, Hu MX, Jones MH (2004) The role of meniscal root pathology and radial meniscal tear in medial meniscal extrusion. Skeletal Radiol 33(10):569–574
18. Ma CB, MacGillivray JD, Clabeaux J, Lee S, Otis JC (2004) Biomechanical evaluation of arthroscopic rotator cuff stitches. J Bone Joint Surg Am 86-A(6):1211–1216
19. MacGillivray JD, Ma CB (2004) An arthroscopic stitch for massive rotator cuff tears: the Mac stitch. Arthroscopy 20(6):669–671
20. Makris EA, Hadidi P, Athanasiou KA (2011) The knee meniscus: structure-function, pathophysiology, current repair techniques, and prospects for regeneration. Biomaterials 32(30):7411–7431
21. Park YS, Moon HK, Koh YG, Kim YC, Sim DS, Jo SB, Kwon SK (2011) Arthroscopic pullout repair of posterior root tear of the medial meniscus: the anterior approach using medial collateral ligament pie-crusting release. Knee Surg Sports Traumatol Arthrosc 19(8):1334–1336
22. Seo HS, Lee SC, Jung KA (2011) Second-look arthroscopic findings after repairs of posterior root tears of the medial meniscus. Am J Sports Med 39(1):99–107
23. Seo JH, Li G, Shetty GM, Kim JH, Bae JH, Jo ML, Kim JS, Lee SJ, Nha KW (2009) Effect of repair of radial tears at the root of the posterior horn of the medial meniscus with the pullout suture technique: a biomechanical study using porcine knees. Arthroscopy 25(11):1281–1287
24. Vedi V, Williams A, Tennant SJ, Spouse E, Hunt DM, Gedroyc WM (1999) Meniscal movement. An in vivo study using dynamic MRI. J Bone Joint Surg Br 81(1):37–41
25. Villegas DF, Hansen TA, Liu DF, Donahue TL (2008) A quantitative study of the microstructure and biochemistry of the medial meniscal horn attachments. Ann Biomed Eng 36(1):123–131