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Research Article

Arthroscopic Repair of radial meniscal tear by Double Vertical cross sutures through Inside-Out technique



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Abstract

Background: The knee meniscus is essential for lubricating the joint, absorbing shocks, and distributing loads & weight-bearing. Aim and objectives: To develop a novel suture technique in repairing radial meniscal tear for better healing of the meniscus and better functional outcome. Patients & methods: This was Prospective controlled study on 20 individuals with radial meniscal tear were underwent repair with a combination of inside-out sutures & secondary reinforcement to the tibia utilizing all-suture knotless anchors in Minia University Hospital. Results: About one half of cases had marching cleft sign on MRI before operation, 30% had ghost meniscus sign and only 20% had fluid cleft sign. Regarding time to operation, it ranged from 5 weeks to 20 weeks from time of trauma with mean 10.6 \pm 3.2. For time of arthroscopic repair, it ranged from 40:90 minutes with mean 57 min. also mean time of hospital stay after operation was 1.6 days ranged from 1:3 days. There was highly significant reduction in mean score of VAS after 3 months and 6 months of operation compared to baseline before operation (p value <0.001). There was high significant increase in mean knee society score and function score after 3 months and 6 months of operation compared to baseline before operation (p value<0.001). Conclusion: This novel suture technique in repairing radial meniscal tear by double vertical cross sutures through inside-out technique had better healing of the meniscus and better functional outcome.

Key words: Arthroscopic Repair, radial meniscal tear, Double Vertical cross sutures

Introduction

The knee meniscus is crucial for lubricating the joint, absorbing shocks, bearing loads, and distributing loads. As a result, it frequently experiences various stresses & is prone to injuries ⁽¹⁻⁴⁾.

The incidence of radial meniscal tears has been on the rise, especially in the field of sports traumatology ⁽⁵⁾.

Nevertheless, studies tracking individuals who received meniscectomy therapy have shown joint degeneration and the early onset of knee osteoarthritis ⁽⁶⁾.

Solitro et al., found that their enhanced repair approach exhibits a greater failure load compared to the usual repair method with 2 parallel sutures ⁽⁷⁾.

Concurrently, suture methods employing a vertical alignment are being developed & contrasted to procedures utilizing horizontal stitches ⁽⁸⁻⁹⁾.

The single loop vertical suture, a method pioneered by Beamer et al, was shown to possess more strength compared to the single loop horizontal suture when used to repair a full radial rupture. Nevertheless, Lemos et al., have documented that the vertical suture exhibits a

much inferior failure load compared to the inside-out parallel suture ^(10, 9).

In addition, the conventional all-inside device can only horizontally pass sutures and deploy anchors at the edges of the meniscus. Consequently, the suture is unable to completely ring the rip, and the repair is compromised due to failure at the anchors ⁽¹⁰⁻¹²⁾.

The purpose of this research was to develop a novel suture technique in repairing radial meniscal tear for better healing of the meniscus and better functional outcome.

Patients & methods

This was Prospective controlled research on 20 individuals with radial meniscal tear were underwent repair with a combination of insideout sutures & secondary reinforcement to the tibia using all-suture knotless anchors in Minia University Hospital.

Inclusion criteria: Age group (15 - 45), Patients with acute onset with history of trauma, Recent trauma within 6 months, Complete meniscal tear with positive white meniscus sign on MRI, Isolated meniscal tear and Simple radial meniscal tear.

Exclusion criteria: patients < 15 years or > 45 years, Chronic meniscal degeneration, old trauma more than 6 months, Partial meniscal tear or confusing sign on MRI, Associated other ligamentous injury (ACL OR PCL) and Complex radial meniscal tear.

Methods

All patients were subjected to:

Complete history taking: Personal history, Complaint & its length, Present history, Past, Medical history, Past Surgical history. Physical examinations: General examination & Local examination by McMurray test. Investigational Studies: Radiological investigation by X-Ray and Radiographic positioning for Knee AP Weight Bearing.

Surgical technique

Surgery was performed under spinalanaesthesia, supine position, and upper thigh tourniquet. Standard anterolateral and anteromedial portals were utilized. Thorough lavage was performed to evacuate any hemarthrosis to improve visualization. The joint was then inspected to insure there was not any associated injuries. The presence of a radial meniscal tear was verified during arthroscopic examination using the anterolateral portal.

In addition to removing fibrous tissues encircling the ruptured meniscus margin, adhesions were eliminated using a motorized razor. The working portal was transformed back into the viewing portal prior to the commencement of the suture procedure, and vice versa. Following the removal of the meniscal lesion with a meniscal rasp, the anteromedial portal was utilized to insert the Meniscal Viper (Arthrex, Naples, FL). Initially, the Viper was positioned in the middle segment side, five to ten mm away from the site of the rupture. A stacked vertical suture was constructed using no. 2-0 fiber wire. After retrieving the Fiber Wire loop via the anteromedial portal, the Viper system was reconfigured utilizing the identical looped thread. Furthermore, a single oblique thread traverses the reducing radially torn meniscus after the Viper grasps the posterior horn five to ten mm apart from the tear through the same portal once more. The thread was retrieved & extracted from the same portal by drawing the two ends of a consecutive looped thread through the portal. The two ends were retrieved outside the joint to form extra capsular knot. Two drilled holes were done to the femoral notch were made to stimulate healing process of the meniscus



Fig: Showing double vertical suture technique

Outcome Measurements and Follow-up

Outcome was assessed by VAS Score: VAS Score (Visual Analogue Pain Score) to assess the improvement of pain by giving a number from 0-10 according to pain tolerability. Also, Knee society score

Ethical consideration

The information collected from participants is strictly confidential. Regarding this investigation, the names of the participants were not included in any report or publication. The participants were provided with a comprehensive explanation of the study's objectives, characteristics, and the risk-benefit analysis prior to their admission. A consent that was informed was obtained.

Statistical Analysis

The gathered data was encoded, processed, & analyzed utilizing the SPSS software (Version 25) designed for the Windows operating system. Descriptive statistics were computed to encompass measures such as means, standard deviations, medians, ranges, and percentages. For continuous variables, independent t-tests were used to compare the means of data that followed a normal distribution. In contrast,

Mann–Whitney U tests were employed to examine the differences in medians for data that did not follow a normal distribution. Lastly, chisquare tests were utilized to analyze categorical data. A p-value below 0.05 is deemed to be statistically significant. For statistical significance, the following thresholds are commonly used: P<0.05 is considered nonsignificant (NS), P>0.05 is considered significant (S), and P>0.01 is considered highly significant (HS).

Results

(Table 1) revealed that the mean age of studied cases 29.5 ± 5.5 ranged from 21:40 years and 90% of studied cases were males and about 55% had meniscus tear during activities as sports.

Table (2) showed that 25% of cases had joint pain and joint tenderness, 15% had popping or click sound at time of injury, also 15% had both pain and popping sound and 15% had all symptoms together, only 5% had Sensation of knee giving away. Majority of cases about 85% had positive McMurray test. As regard zone of tear about 45% had red-red tear and only 15% had red-white tear.

Table (3) about one half of cases had marching cleft sign on MRI before operation, 30% had ghost meniscus sign and only 20% had fluid cleft sign. Regarding time to operation, it ranged from 5 weeks to 20 weeks from time of trauma with mean 10.6 \pm 3.2. For time of arthroscopic repair, it ranged from 40:90 minutes with mean 57 min. also mean time of hospital stay after operation was 1.6 days ranged from 1:3 days.

Table (4) showed that there was highly significant reduction in mean score of VAS after 3 months and 6 months of operation

compared to baseline before operation (p value <0.001).

Table (5) revealed that there was high significant increase in mean knee society score and function score after 3 months and 6 months of operation compared to baseline before operation (p value<0.001).

Table (6) showed that 70% of studied cases had picture of complete healing in MRI after 6 months of follow up and 30% had partial healing, with 95% success rate and only 1 case failed and needed second arthroscopic repair.

Demographic data (N=20)		Descriptive statistics
Age	Mean ± SD	29.5 ± 5.5
	(Range)	(21:40)
Sex	Male	18(90%)
	Female	2(10%)
Weight	Mean ± SD	76.5 ±12.3
	(Range)	58:99
Mechanism of trauma	During activities	11(55%)
	Fall	3(15%)
	Motor car accident	3(15%)
	Lift heavy object	3(15%)

Table (1): Demographic data of the examined cases.

Table (2): clinical history of the studied cases before operation

Clinical history before operation		Frequency (%)
	(N=20)	
Symptoms	Joint pain	5(25%)
	Popping sound at time of injury	3(15%)
	Sensation of locking	3(15%)
	Sensation of knee giving away	1(5%)
	Pain and popping sound	3(15%)
	Pain, popping sound and locking	5(15%)
McMurray test	Negative	3(15%)
	Positive	17(85%)
Zone of tear	Ramp	8(40%)
	Red-red	9(45%)
	Red-white	3(15%)

Radiological and Operative data		Descriptive statistics
(N=20)		
MRI finding	marching cleft sign	10(50%)
	ghost meniscus sign	6(30%)
	fluid cleft	4(20%)
Time to operation in weeks	Mean \pm SD	10.6 ±3.2
	(Range)	5:20
Time of operation in min	Mean \pm SD	57 ±12.4
	(Range)	40:90
Length of hospital stay post	Mean \pm SD	1.6 ± 0.5
operative in days	Median (Range)	1(1:3)

Table (3): Radiological and Operative data of the studied cases.

Table (4): VAS score foe pain before operation and after operation of the studied cases.

Time of assessment	VAS score (n=20)	P value
Before operation		
Mean \pm SD	6.6±1.2	
Median (Range)	7(4:9)	
After 3 months of follow up		< 0.001*
Mean \pm SD	3.6±1 ^(a)	
Median (Range)	4(2:5)	
After 6 months of follow up		
Mean \pm SD	1.65±0.6 ^(a)	
Median (Range)	1(1:3)	

* Significant p value at level<0.05 ^(a) mean significant difference with base line.

Table (5): comparison of knee society scores before operation and after operation of the studied cases.

	Knee society score	
Time of assessment	Knee score	Function score
Before operation		
Mean \pm SD	35.8±7.9	27.25±8.5
Median (Range)	38(20:49)	25(15:45)
After 3 months of follow up		
Mean ± SD	62±7.9 ^(a)	54.5±7.2 ^(a)
Median (Range)	62(50:77)	55(40:65)
After 6 months of follow up		
Mean \pm SD	83.5±7.6 ^(a)	79.5±7.8 ^(a)
Median (Range)	87(69:93)	77.5(70:90)
P value	<0.001*	<0.001*

* Significant p value at level<0.05 (a) mean significant difference with base line.

Post operative results (N=20)		Descriptive statistics
MRI finding at 6 months of	Complete healing	14(70%)
follow up	Partial healing	6(30%)
outcome	Success	19(95%)
	Failure	1(5%)
Pivote shift test	Stable	13(65%)
	Grade 1	5(25%)
	Grade II	2(10%)

Table (6): post operative results of the studied cases.

Discussion

The primary findings of this investigation were as follows:

Regarding demographic data; mean age of studied cases 29.5 ± 5.5 ranged from 21:40years and 90% of studied cases were males and about 55% had meniscus tear during activities as sports. Regarding clinical history; 25% of cases had joint pain and joint tenderness, 15% had popping or click sound at time of injury, also 15% had both pain and popping sound and 15% had all symptoms together, only 5% had Sensation of knee giving away. Majority of cases about 85% had positive McMurray test with pain, clicking, or a clunking sensation within the joint on bending the knee, then straightening and rotating it before arthroscopic repair. As regard zone of tear about 45% had red-red tear three mm from the synovialmeniscal junction & only 15% had red-white tear three to five mm from the synovialmeniscal junction.

Regarding radiological and operative data; about one half of cases had marching cleft sign on MRI before operation, 30% had ghost meniscus sign and only 20% had fluid cleft sign. Regarding time to operation, it ranged from 5 weeks to 20 weeks from time of trauma with mean 10.6 ± 3.2 . For time of arthroscopic repair, it ranged from 40:90 minutes with mean 57 min. also mean time of hospital stay after operation was 1.6 days ranged from 1:3 days.

Our results showed that regarding outcome; as regard VAS score; there is significant reduction in mean score of VAS after 3 months of operation compared to baseline before operation and also after 6 months of operation compared to baseline before operation (p value<0.05). As mean score before operation was 6.6 and declined to 3.6 after 3 months and finally to 2.6 after 6 months. There are significant effusions, a positive result on McMurray test, & subsequent surgery after meniscal repair generally are considered as failures.)

In a prior investigation conducted by Yeh et al., ⁽¹³⁾, the objective was to evaluate the rate of failure and clinical results of the all-inside, double-vertical, cross-suture approach for mending full radial rips of the lateral meniscus. A total of 27 people received the operation. The average (with a measure of variability) Lysholm knee score before the operation was 63.2 ± 9.3 , and the Tegner activity scale scores were $4 \pm .7$. During the last follow-up, which occurred at least one year after surgery, the scores showed an increase to 90.8 ± 4.2 and 6.1 \pm 1.3, respectively. These changes were statistically significant (P < .05) for both scores. 23 individuals exhibited full healing of the meniscus, whereas 4 patients experienced either a re-tear or non-healing of the meniscus Re-tear or non-healing constituted 14.8 percent of the total. Comparable healing rates were observed among patients who sustained isolated radial tears (87.5 percent) & those who sustained combined anterior cruciate ligament ruptures (84.2 percent; P = .826). The progression of sagittal & coronal meniscus extrusion did not differ (P =.797 and.133, respectively).

In the past, partial meniscectomy was the treatment of choice for radial injuries.

Meniscectomy has been extensively documented to result in osteoarthritis that develops prematurely. As a result, in recent years, restoration of radial injuries of the meniscus has emerged as the prevailing therapeutic approach. Meniscal suturing has the potential to induce healing by stabilizing the rupture and promoting cell proliferation, as well as decreasing the contact pressure at the tibiofemoral joint. Despite the technical complexity of meniscus repair, there has been a proliferation of clinical, biomechanical, and technical reports detailing diverse repair methodologies in recent times. Prior clinical investigations employed either an inside-out or all-inside approach, utilizing horizontal or vertical suturing methods that were parallel in nature. The circumferential fibers are bisected perpendicularly by a radial rupture of the meniscus; thus, the all-inside double vertical cross-suture method can be employed to obviate the need to position the suture parallel to the circumferential fibers. Additionally, it has the potential to decrease the likelihood of suture cut-out & accelerate the rate of healing $^{(14)}$.

The development of all-inside devices has enabled the repair of meniscuses to be more intricate and robust. As an illustration, Beamer et al., ⁽¹⁵⁾ passed sutures vertically through the meniscus using a meniscus repair device, which functions similarly to the Knee Scorpion device utilized in the research by Hang et al., ⁽¹⁶⁾. It was determined that fixation was enhanced in the case of single vertical suture repair as opposed to single horizontal loop repair performed using the inside-out method (15). Analogous to the outcomes obtained in the research by Beamer et al., Hang et al., ⁽¹⁶⁾ utilized two suture threads oriented vertically and utilized the double vertical technique to achieve more robust fixation than the double horizontal method. Additionally, its mean failure load & rigidity were greater than twice as high as those of the single vertical sutures examined in the study by Beamer et al ⁽¹⁴⁾.

Moreover, their double vertical & double vertical cross configurations produced significantly stronger repairs than the double horizontal cross configuration utilized by Matsubara et al., ⁽¹⁷⁾, which produced an ultimate failure load of 78.9 ± 19.3 N and

stiffness of 8.0 ± 1.5 N/mm, and the cross tiegrip method, which utilizes parallel sutures but modified configurations, as described in the research by Nakanishi et al., ⁽¹⁸⁾, which generated an ultimate failure load of 154.9 ± 29.0 N.

The cross tie-grip group experienced a substantially lesser displacement after 500 cycles $(0.4 \pm 0.3 \text{ mm})$ than the double horizontal (1.2 \pm 0.7 mm), cross suture (1.4 \pm 0.6 mm), & tie-grip $(0.9 \pm 0.6 \text{ mm})$ groups (P <.05). The cross tie-grip and tie-grip (145.2 \pm 39.1 N) groups exhibited a considerably higher ultimate failure load $(154.9 \pm 29.0 \text{ N})$ than the double horizontal (81.2 ± 19.9 N) and cross suture $(87.3 \pm 17.7 \text{ N})$ groups (P <.05). In every cohort, tissue failure was the most prevalent form of failure. They reason that by employing vertical sutures that are perpendicular to the radial fibrils, both the double vertical & double vertical cross methods secure the radial fibrils more securely at the site of the rupture $^{(15)}$.

Attaining optimal stability of the mended meniscus is the key objective in achieving a successful meniscal repair ⁽¹⁷⁾. Herbort et al., ⁽¹⁹⁾ discovered that using double-loop horizontal sutures in repairing radial meniscus lesions resulted in higher failure load, less gap development, & a stronger construct compared to using single-loop horizontal sutures. In their study, Matsubara et al., (17) shown that the 2 horizontal suture loops arranged in a cross pattern were more effective in terms of biomechanics compared to the double horizontal sutures approach for repairing radial meniscus lesions. They demonstrated that sutures positioned at an angle to the collagen fibrils encircling the area provided superior fixation compared to sutures aligned parallel to the circumferential fibrils.

In a case series conducted by Choi et al., ⁽²⁰⁾, a total of fourteen individuals who had radial rips in the midbody of the lateral meniscus underwent repair utilizing an all-inside method. This technique involved the use of a suture hook and PDS suture. Despite the technical demands of their procedure, they achieved both partial and total healing of the meniscus and received positive feedback from patients on their achievements.

Furthermore, a double horizontal mattress repair is utilized by Lin et al., ⁽²¹⁾ to meniscuscapsule radial perforations of the anterior horn body junction through a mini open outside-in technique. They conclude that the evidence for the optimal suture pattern remains limited, despite the fact that their review article discusses a number of suture pattern repair techniques.

Limitations: The small sample size is the main limitation. Also, it is a single center study, is another limitation. Lack of previous similar comparable study, also limitation.

Conclusion

This novel suture technique in repairing radial meniscal tear by double vertical cross sutures through inside-out technique had better healing of the meniscus and better functional outcome.

References

- 1. Allen, Christina R., et al., Importance of the medial meniscus in the anterior cruciate ligament-deficient knee. Journal of Orthopaedic Research, 2000, 18.1: 109-115.
- Allen, P. R.; Denham, R. A.; Swan, A. V. Late degenerative changes after meniscectomy. Factors affecting the knee after operation. The Journal of Bone & Joint Surgery British Volume, 1984, 66.5: 666-671.
- 3. Makris, Eleftherios A.; Hadidi, Pasha; Athanasiou, Kyriacos A. The knee meniscus: structure–function, pathophysiology, current repair techniques, and prospects for regeneration. Biomaterials, 2011, 32.30: 7411-7431.
- Tissakht, M.; Ahmed, A. M.; CHAN, K. C. Calculated stress-shielding in the distal femur after total knee replacement corresponds to the reported location of bone loss. Journal of Orthopaedic Research, 1996, 14.5: 778-785.
- KOPF, Sebastian, et al., Management of traumatic meniscus tears: the 2019 ESSKA meniscus consensus. Knee Surgery, Sports Traumatology, Arthroscopy, 2020, 28: 1177-1194.
- 6. Lynch, Mary A.; Henning, Charles E.; GLICK JR, KARL R. Knee Joint Surface Changes: Long-term Follow-up Meniscus Tear Treatment in Stable Anterior Cruciate

Ligament Reconstructions. Clinical Orthopaedics and Related Research (1976-2007), 1983, 172: 148-153.

- Massey, Patrick, et al., The rebar repair for radial meniscus tears: a biomechanical comparison of a reinforced suture repair versus parallel and cross-stitch techniques. Journal of Experimental Orthopaedics, 2019, 6.1: 1-8.
- BRANCH, Eric A., et al., Biomechanical comparison of arthroscopic repair constructs for radial tears of the meniscus. The American Journal of Sports Medicine, 2015, 43.9: 2270-2276.
- DOIG, Timothy, et al., The all-inside allsuture technique demonstrated better biomechanical behaviors in meniscus radial tear repair. Knee Surgery, Sports Traumatology, Arthroscopy, 2020, 28: 3606-3612.
- 10. Srimongkolpitak, Surasak; Chernchujit, Bancha. Current concepts on meniscal repairs. Journal of Clinical Orthopaedics and Trauma, 2022, 27: 101810.
- LEE, Yee Han Dave, et al., Cyclic test comparison of all-inside device and insideout sutures for radial meniscus lesion repair: an in vitro porcine model study. Arthroscopy: The Journal of Arthroscopic & Related Surgery, 2012, 28.12: 1873-1881.
- Rosso, Claudio, et al., Comparison of allinside meniscal repair devices with matched inside-out suture repair. The American journal of sports medicine, 2011, 39.12: 2634-2639.
- 13. Yeh SH, Hsu FW, Chen KH, Chiang ER, Chang MC, Ma HL. Repairing complete radial tears of the lateral meniscus: arthroscopic all-inside double vertical cross-suture technique is effective and safe with 2-year minimum follow-up. Arthroscopy: The Journal of Arthroscopic & Related Surgery.2022 Jun 1;38(6):1919-29.
- 14. Bhan K. Meniscal tears: current understanding, diagnosis, and management. Cureus. 2020 Jun 13;12(6).
- 15. Beamer BS, Masoudi A, Walley KC, Harlow ER, Manoukian OS, Hertz B et al. Analysis of a new all-inside versus insideout technique for repairing radial meniscal tears. Arthroscopy, 2015, 31:293–298.
- 16. Hang, Guanqi, et al., Biomechanical comparison of vertical suture techniques

for repairing radial meniscus tear. Journal of Experimental Orthopaedics, 2020, 7:1-8.

- 17. Matsubara H, Okazaki K, Izawa T, Tashiro Y, Matsuda S, Nishimura T et al . New suture method for radial tears of the meniscus: biomechanical analysis of crosssuture and double horizontal suture techniques using cyclic load testing. Am J Sports Med, 2012, 40:414–418.
- NAKANISHI, Yuta, et al., Radial meniscal tears are best repaired by a modified "cross" tie-grip suture based on a biomechanical comparison of 4 repair techniques in a porcine model. Orthopaedic Journal of Sports Medicine, 2020, 8.7: 2325967120935810.
- 19. Herbort M, Siam S, Lenschow S, Petersen W, Zantop T. Strategies for repair of radial tears close to the meniscal rim-biomechanical analysis with a cyclic loading protocol. Am J Sports Med , 2010, 38:2281–2287.
- Choi, T.H. Kim, K.M. Son, B.N. Victoroff. Meniscal repair for radial tears of the midbody of the lateral meniscus. Am J Sports Med, 38 (2010), pp. 2472-2476.
- 21. Lin, A. Akers, T.L. Miller. Updates and advances in the management of lateral meniscal radial tears: A critical analysis review. JBJS Rev, 8 (11) (2020), Article e2000056