



A new scoring system for prediction of meniscal repair in traumatic meniscal tears

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Abstract

Purpose Traditionally, MRI has not been used to predict meniscus tear reparability. An attempt has been made in this study to predict meniscal reparability using MRI, and a new scoring system to help with the same has been developed and tested.

Methods Thirty repaired menisci were compared with equal number of meniscectomy cases retrospectively. Various clinical and radiological (radiographs and MRI) characteristics like chronicity of tear, pattern of tear, etc, were tabulated. Based on their association with the outcome of repair or meniscectomy, odds ratio of each attribute were calculated. A scoring system—Ortho One PROMT Score (Prediction of Reparability of Meniscal Tears)—to predict meniscal repair was formulated. Using this score, meniscus surgery outcomes were prospectively predicted in 120 cases and results tabulated.

Results The newly devised Ortho One PROMT score predicted medial meniscus repair with a sensitivity of 90.9% and a specificity of 93.2% and medial meniscectomy with a sensitivity of 93.2% and a specificity of 90.9%. It predicts lateral meniscus repair with a sensitivity of 69.2% of patients and lateral meniscectomy with a sensitivity of 78.8% of patients.

Conclusion Ortho One PROMT score is a useful scoring system to predict the outcomes of meniscus surgery preoperatively. It uses a combination of clinical and radiological (MRI and plain radiograph) characteristics. With this scoring system, both the surgeon and the patient are better prepared preoperatively regarding the outcome of a particular meniscus surgery. The scoring shall make day-to-day arthroscopic meniscus surgery less stressful.

Level of evidence III.

Keywords Meniscus repair · Meniscectomy · Scoring · Prediction

Abbreviations

PROMT Prediction of Reparability of Meniscus Tears
BHMT Bucket handle meniscus tear
MRI Magnetic resonance imaging

Introduction

Meniscal repair and meniscectomy (partial or total) are most commonly performed arthroscopic surgeries for meniscal tears [1, 2]. However, the cost, surgical time, expertise needed during surgery and the results are

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significantly different in these two surgical procedures. However, the decision to perform either a meniscectomy or a meniscal repair is usually an intraoperative one. Thus, neither the surgeon nor the patient knows, prior to the surgery which procedure will be performed on the involved knee beforehand. Hence, prediction of meniscus reparability is useful for surgeons to optimize surgical scheduling, so that both the surgeon and the patient know what shall be the probable results after the surgery and duration of rehabilitation. Conventional Magnetic Resonance Imaging (MRI), although, is the most widely accepted and accurate technique for diagnosing meniscal derangements, its effectiveness in predicting the reparability of meniscus lesions is controversial [4–8, 12, 13]. Whereas the early reviews suggested that MRI could be used to indicate the likelihood of reparability, Matava et al. [9] in a 1999 study concluded that MRI ‘‘adds little to the predictability of treatment’’ of meniscal tears. Over the past decade, the conclusion of Matava et al. has been challenged as imaging modalities have advanced and studies have shown an improved ability of MRI to diagnose meniscal tears [10]. In fact, some groups have published studies, showing that modern scanners allow the accurate prediction of meniscal tear reparability in at least some subsets of patients [12, 14]. Literature search has shown that MRI is not an effective or efficient predictor of reparability of meniscal tears with the current arthroscopic criteria [1].

The focus of the present research was to evaluate a new scoring system for prediction of meniscal repair using MRI. An attempt was made to develop a scoring system to predict meniscal reparability. The scoring system has been named ‘Ortho One PROMT (Prediction of Reparability Of Meniscal Tears) score’. The hypothesis of the present study was ‘Ortho One PROMT score is useful in the prediction of outcome of meniscus surgery’.

Materials and methods

1.5 T MRI (GE Medical systems) was used for the study. Proton density fat-saturated, T1-weighted, and T2-weighted images were used in sagittal, coronal, and axial sequences to study the meniscal injuries.

The study was started by listing various clinical and radiographic attributes of a torn meniscus which were thought to have a bearing on the reparability or respectability of the meniscal tear (Table 1).

There were two parts to the study. Part one was when various clinic-radiological attributes of a meniscal tear were noted and were correlated with the outcome of the surgery [meniscectomy or meniscus repair]. This was a retrospective pilot study involving our previous 30 meniscal repairs and 30 meniscectomies. Sample size of 30 was calculated based on the formula:

$$\text{Total sample size} = N = \left[(Z_{\alpha} + Z_{\beta}/C)^2 + 3 \right] [12].$$

The standard normal deviate for $\alpha = Z_{\alpha} = 1.960$; the standard normal deviate for $\beta = Z_{\beta} = 0.842$:

$$C = 0.5 \times \ln [(1 + r)/(1 - r)] = 0.693.$$

Therefore, the total sample size needed, N , was 29.

Various clinical and radiographic attributes of a torn meniscus which were thought to have a bearing on the reparability or respectability of the meniscal tear were tabulated (Table 1) and their co-relation with the outcome of meniscal surgery (meniscectomy or repair) was studied.

Standard indications for meniscus repair were followed during surgery [3]:

1. Tear > 1 cm and < 4 cm in length.
2. Red–red zone tears.
3. Vertical tears.
4. Patient age < 40 years.
5. No mechanical axis malalignment.

Table 1 Clinical and radiological features which were thought to have correlation with the outcome of the meniscus surgery

Sl no.	Attributes thought to have correlation with the outcome of the meniscus surgery (Meniscectomy or meniscal repair)
1	Age of the patient
2	Chronicity of injury
3	Clinical presence of joint line tenderness
4	Mc Murray’s test
5	Plain radiographic changes of osteoarthritis in the knee [Kellgren Lawrence grading]
6	MRI features <ol style="list-style-type: none"> 1. Zone of the tear (Red–Red/Red–White/White–White) 2. Pattern of the tear (Longitudinal, Radial, Complex, etc) 3. Thickness of tear (Full/Partial thickness) 4. Length of tear

Thirty repaired menisci were compared with equal number of meniscectomy cases and various clinical and imaging (Radiographs and MRI) characteristics like chronicity of tear, pattern of tear, zone of tear, etc, were tabulated. Based on these characteristics and their association (Co-relation) with the outcome of repair or meniscectomy, odds ratio of each attribute were calculated. Logistic regression was used to calculate odds ratio for the variables. Two surgeons predicted different characteristics of meniscus. Based on the odds ratio and correlation of the variables with the outcome of surgery (meniscectomy or meniscus repair), the final Ortho One PROMT score was formulated.

Step two of the research involved a double-blind study using the Ortho One PROMT score to predict the outcome of surgery prospectively (meniscectomy or meniscus repair) and to compare with the actual outcome post operatively. Two independent blinded surgeons predicted the outcome of surgery using the Ortho One PROMT score in 120 consecutive meniscus surgeries and the average of their predictions was tabulated to assess the accuracy of Ortho One PROMT score in predicting the outcome of meniscus surgery.

Statistical analysis

Sensitivity, specificity, positive predictive value, and negative predictive value of scoring system were calculated. Inter-observer agreement between the two surgeons' was calculated and the Kappa score was calculated. SPSS 16 (IBM) was used to calculate the statistical results.

Sample size of 30 was calculated for the retrospective pilot study based on the following formula:

$$\text{Total sample size} = N = [(Z_{\alpha} + Z_{\beta}/C)]^2 + 3 \text{ [12].}$$

The detailed sample-size calculation has been described previously.

Results

Amongst the attributes age, chronicity of tear, plain radiography, and MRI features were found to have correlation with the outcome of the meniscus surgery (Table 2). Some of the attributes like joint line tenderness, associated Anterior Cruciate Ligament (ACL) injury, mechanism of injury, length of tear on MRI, etc were considered initially, but were not found to have a statistically significant correlation with the outcome of the surgery and, hence, were removed from the final scores. Based on these results, a Ortho One PROMT score (Prediction of Reparability Of Meniscal Tears) was formulated (Table 3). Scores were assigned to individual variables based on odds ratio value (Table 2).

Using this score, meniscus surgery outcomes were prospectively predicted in 120 cases and results tabulated.

- Maximum score: 14 (meniscectomy).
- Minimum score: 1 (meniscal repair).
- ≤ 6 : Meniscus repair (six or less).
- ≥ 7 : Meniscectomy (seven or more).

The cut-off score for meniscectomy or meniscus repair was set as above after the statistical analysis of results of the scoring system applied to the 60 retrospective cases (30 meniscectomies and 30 meniscus repairs).

The Ortho One PROMT score was applied prospectively on 120 consecutive cases of meniscus surgery at our centre. This was a double-blind study. The clinical examination and images were studied preoperatively by two independent observers and scores were tabulated. Both authors were not aware of each other's predictions. This prediction was correlated with the outcome of meniscus surgery (meniscectomy or meniscus repair). The decision to do meniscectomy or meniscus repair intra operatively was taken using the

Table 2 Correlation of various attributes which may predict the outcome of meniscus surgery and their odd ratio values calculated using logistic regression

	Odds ratio	Result
Age	3.6	
Chronicity (> 6 weeks vs < 6 weeks)	1.5	
Joint line tenderness (Present or absent)	No significant correlation	Deleted
Mc Murray's Test	No significant correlation	Deleted
KL scale (radiograph) (Gr 0,1 V s Gr 2, 3, 4)	9	
Length of tear	3.7	Deleted
Zone of tear, pattern of tear	0, 3, 9	
Type of tear		
Longitudinal, horizontal	1.2	
Radial, oblique	2.3	
Complex	3.1	
Displaced bucket handle	4.4	
Thickness–full thickness tear	–	Essential criteria

Table 3 Ortho One PROMT score (prediction of reparability of meniscal tears)

Criteria	Characteristics	Score
Age	<20 years	0
	20–30 years	1
	30–40 years	2
	>40 years	3
Chronicity	<1 year	0
	>1 year	1
Plain radiograph (KL grading)	0, 1	0
	2, 3, 4	3
Zone of the tear	RR	0
	RW	1
	WW	3
Pattern of the tear	L, H	1
	R, O	2
	C	3
	Displaced BH	4

Maximum score: 14 (meniscectomy)

Minimum score: 1 (meniscal repair)

≤6: Meniscus repair (six or less)

≥7: Meniscectomy (seven or more)

standard meniscus repair indications [3] and the operating surgeon was kept blinded to the predictions of meniscus outcomes using PROMT score. The average of correct prediction for meniscectomies or meniscus repair was tabulated. Inter-observer agreement was good for the prediction of reparability ($\kappa=0.7$) (see Table 4).

Examples of the scoring system being applied to two typical cases are given in Table 5.

Figures 1 and 2 show MRI pictures of sagittal sections of Case 1 and Case 2, respectively.

Discussion

The most important finding of the present study was to be able to predict the outcome of meniscus surgery preoperatively in an objective using a scoring system. This had not been possible previously. It is of utmost importance to know whether a patient will undergo a meniscus repair or meniscectomy, because there are gross differences in both their costs, recovery time, rehabilitation, loss of work time, and long-term outcomes, etc. In the literature, there have been random attempts at predicting the outcomes of meniscus surgery preoperatively, i.e., meniscectomy or meniscus repair, but no uniform success is seen to date [1, 10, 12, 14]. Ortho One PROMT score is an attempt to fill up this gap and to provide a systematic criterion to arthroscopy surgeons worldwide to try to counsel their patients preoperatively if

Table 4 Results of prospective prediction of outcome of meniscus surgery (meniscectomy or meniscus repair) using Ortho One PROMT Score in 120 consecutive meniscus surgeries

Outcome of surgery	Number of procedures	Correct predictions	Accuracy	True positive (A)	False positive (B)	False negative (C)	True negative (D)	Positive predictive value (A/A+B)	Negative predictive value (D/D+C)	Sensitivity (A/A+C)	Specificity (D/D+B)
Medial meniscus repair	11	10	90.9	10	3	1	41	76.9	97.6	90.9	93.2
Medial meniscus meniscectomy	44	41	93.2	41	1	3	10	97.6	76.9	93.2	90.9
Lateral meniscus repair	13	9	69.2	9	11	4	41	45	91.1	69.2	78.8
Lateral meniscus meniscectomy	52	41	78.8	41	4	11	9	91.1	45	78.8	69.2
Total	120	101	81.6								

Table 5 Examples of Ortho One PROMT score applied to two typical case scenarios (see Figs. 1 and 2 also)

Criteria	Characteristics	Score	Case 1	Case 2
Age	< 20 years	0		
	20–30 years	1	1 (Age 22 years)	3 (Age 42 years)
	30–40 years	2		
	> 40 years	3		
Chronicity	< 6 weeks	0	0 (Duration: 8 days)	
	> 6 weeks	1		1 (Duration 6 months)
Plain radiograph (KL grading)	0, 1	0	0 (No osteoarthritis changes in X-ray)	0 (No osteoarthritis changes in X-ray)
	2, 3, 4	3		
Zone of the tear	RR	0		
	RW	1	1	1
	WW	3		
Pattern of the tear	L, H	1	1	
	R, O	2		
	C	3		3
	Displaced BH	4		
Final Scores			3 (Score ≤ 6 ; hence, Meniscus Repair)	8 (Score ≥ 7 ; hence, Meniscectomy)



Fig. 1 MRI pictures of sagittal sections of Case 1 where the Ortho One PROMT score was 3, and hence, a meniscus repair was predicted and was done

they may undergo a meniscus repair surgery or a meniscectomy procedure in the preop scenario. Standard indications for meniscus repair were followed [3]. These were the following:



Fig. 2 MRI pictures of sagittal sections of Case 2 where the Ortho One PROMT score was 8, and hence, a meniscectomy was predicted and was done

1. Tear > 1 cm and < 4 cm in length.
2. Red–red zone tears.
3. Vertical tears.
4. Patient age < 40 years.
5. No mechanical axis malalignment.

Ortho One PROMT score is excellent in predicting the outcome of medial meniscus surgeries. It predicts medial meniscus repair with a sensitivity of 90.9% and a specificity of 93.2%, and medial meniscectomy with a sensitivity of 93.2% and a specificity of 90.9%. The accuracy drops while predicting lateral meniscus injuries. It predicts lateral meniscus repair with a sensitivity of 69.2% cases and lateral meniscectomy with a sensitivity of 78.8% cases. This lower accuracy in predicting lateral meniscus outcome using Ortho One PROMT score may also be partly due to the lower sensitivity of MRI in picking up lateral meniscus injuries. For MM lesions, MRI showed sensitivity of 92.50%, specificity of 62.50%, while, for LM injuries, it showed sensitivity of 65.00% and specificity of 88.46% [11]. Since MRI in general is less sensitive in picking up lateral meniscus tears our scores are also inferior in predicting lateral meniscus outcome. However, at a sensitivity of 69.2% and 78.8% in predicting lateral meniscus repair and meniscectomy, respectively, it can still predict lateral meniscus surgery outcome with good accuracy.

Earlier attempts at predicting meniscus surgery outcome have not proved to be very useful. Bernthal et al. tried to predict the outcome of meniscus surgery, but concluded that magnetic resonance imaging is not an effective or efficient predictor of reparability of meniscal tears with the current arthroscopic criteria. The Ortho One PROMT score uses MRI features along with clinical and plain radiographic criteria. Hence, the predictions using Ortho One PROMT score have been more effective compared to the previous literature studies [1]. A good inter-observer agreement for the prediction of meniscal outcome using Ortho One PROMT score ($\kappa=0.7$) was also found. Unweighted κ analysis was undertaken to analyze the concordance between the two observers.

Matava et al. [9] analyzed 115 meniscal tears with regard to morphology. A tear was considered repairable when it met all of the following four criteria: at least 10 mm long, within 3 mm of the meniscosynovial junction, passing through greater than 50% of the thickness of the meniscus, and minimal damage to the inner meniscal fragment independent of tear configuration. Matava et al., in their 1999 study, concluded that MRI “adds little to the predictability of treatment” of meniscal tears.

Thoreux et al. [14] tried to predict meniscal reparability in only bucket handle meniscus tears (BHMTs) and were very successful in doing that. They could correctly predicted reparability in four of five repairable BHMTs and irreparability in 22 of 23 irreparable BHMTs (26/28 lesions). Their results suggest that knee bucket handle meniscus tears that are predicted to be repairable by MRI would have a high likelihood of actually being repairable. The results of Ortho One PROMT score are also in agreement with Thoreux et al.’s results. Meniscal tear patterns were also included in our scoring system. The incorrect predictions in lateral

meniscus tears in our study have been 4 cases out 65 lateral meniscus tears. These were patients in whom the meniscus tear was not picked up at all in the MRI films and were only found during arthroscopy.

The limitations of the present study are that it is a single-centre study where this scoring system was found very useful and accurate. It is simple to understand and reproducible. Only when this study is used by many centers across the world, it shall be validated. There is still scope for improvement in predicting the outcomes of lateral meniscus surgeries. More relevant findings may be added to this scoring system to make it more accurate. With improvement in MRI technology happening every year and with advanced techniques and coils, the results will only improve.

Conclusion

Ortho One PROMT score is a useful scoring system to predict the outcomes of meniscus surgery preoperatively. Ortho One PROMT score uses a combination of clinical and radiological [MRI and plain radiograph] characteristics, and is excellent in predicting medial meniscus reparability or meniscectomy outcomes and very good in predicting lateral meniscus procedure outcome. It shall be a useful adjunct to the armamentarium of an arthroscopy surgeon and would help him in counseling the patient appropriately.

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Compliance with ethical standards

Conflict of interest There are no conflict of interest involved in the study.

Ethical approval All procedures carried out in our study have been in accordance with the ethical standards of the national research committee and is in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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