## Assessing the Efficacy of Meniscus Tear Diagnostic Maneuvers: A Comparative Analysis with MRI Imaging

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INTRODUCTION: Meniscus tears are common and rely on clinical diagnostic maneuvers and imaging to diagnose and appropriately manage the injury. Common diagnostic tests utilized include deep knee flexion pain, McMurray's test, localization of pain, and tenderness to palpation (TTP) of the joint line, each with different reported parameters in their sensitivities, specificities, and overall accuracies. Previous research has reported comparative statistical parameters on each diagnostic maneuver; however, no study has evaluated the efficacy of such maneuvers individually and jointly in correlation with MRI and confirmation of meniscus tear with arthroscopy.

METHODS: Data was retrospectively collected from 202 patients between January 2023 and January 2024 in an outpatient Orthopedic Sports Medicine clinic. Inclusion criteria consisted of patient's age at the time of suspected meniscal tear, the completion of all four clinical diagnostic maneuvers: McMurray's test, TTP of the joint line, localization of pain, and deep knee flexion pain, and having undergone a knee MRI. Patients with concomitant knee injuries were excluded from the study. Meniscus tears identified on MRI were confirmed with linear signal in the meniscus contacting the joint surface. Sensitivity, specificity, positive and negative predictive values, accuracy, and odds ratios were performed on all possible combinations of diagnostic maneuvers included in this study.

RESULTS: Statistical parameters of each individual diagnostic maneuver are listed in descending order of accuracy. TTP of the joint line accuracy 73.76%, sensitivity 86.9%, specificity 23.8%, PPV 81.3%, NPV 32.3%, DOR 2.07. McMurray's test accuracy 72.28%, sensitivity 85.6%, specificity 21.4%, PPV 80.6%, NPV 28.1%, DOR 1.62. Localization of pain accuracy 69.8%, sensitivity 81.3%, specificity 26.2%, PPV 80.7%, NPV 26.8%, and DOR 1.54. Deep knee flexion pain accuracy 59.9%, sensitivity 60%, specificity 59.5%, PPV 85%, NPV 28.1% and DOR 2.21. Combination of any two positive diagnostic maneuvers yielded the highest overall sensitivity, 91.88%, highest accuracy, 76.23%, but the lowest specificity, 16.67%, out of all measured combinations. Combination of all four positive maneuvers yielded the highest specificity, 73.8%, highest PPV of 86.42%, but lowest accuracy, 50%. The combination of localization of pain, TTP at the joint line, and deep knee flexion pain exhibited the greatest DOR at 2.32, while the combination of localization of pain and McMurray's test exhibited the lowest at 1.48.

DISCUSSION AND CONCLUSION: While MRI remains the gold standard for diagnosing meniscus tear injuries; time, financial and technological resources, and personnel required demonstrates the importance of efficacious diagnostic maneuvers to allow physicians to appropriately triage and manage care in a cost-effective manner. All four clinical tests and their possible combinations scored below the diagnostic accuracy of MRI, which may be attributed to the overall heterogeneity and complexity of meniscus tears and their mechanisms of injury. This data demonstrates that the combination of the four exam maneuvers would best be implemented in a diagnostic fashion, while a combination of two tests that mimic the mechanism of injury would be better implemented as a screening tool. Selection of a different combination of tests that better mimic injury mechanisms may optimize sensitivity and specificity in combination examination analysis for meniscus tears.

Table 1a: Diagnostic values of four clinical tests and combinations for meniscal tears

Variable	True +	True -	False +	False -	Acc (%)	Se (%)	Sp (%)	PPV (%)	NPV (%)	Diagnostic Odds Ratio (DOR)
Localization of Pain	130	11	31	30	69.8	81.3	26.2	80.7	26.8	1.54
TTP at Joint Line	139	10	32	21	73.36	86.9	23.8	81.3	32.3	2.07
McMurray's	137	9	33	23	72.28	85.6	21.4	80.6	28.1	1.62
Deep Knee Flexion	96	25	17	64	59.9	60	59.5	85	28.1	2.21
All 4 Positive	70	31	11	90	50	43.75	73.8	86.42	25.62	2.19
Any 3 Positive	125	14	28	35	68.8	78.13	33.33	81.7	28.57	1.79
Any 2 Positive	147	7	35	13	76.23	91.88	16.67	80.77	35	2.26

Variable	True +	True -	False +	False -	Acc (%)	Se (%)	Sp (%)	PPV (%)	NPV (%)	Diagnostic Odds Ratio (DOR)
Localization and TTP	123	14	28	37	67.82	76.88	33.33	81.46	27.45	1.66
Localization and McMurray	113	16	26	47	63.86	70.63	38.1	81.29	25.4	1.48
Localization and DKF	81	29	13	79	54.46	50.63	69.05	86.17	26.85	2.29
TTP and McMurray	124	14	30	36	68.32	77.5	31.82	80.52	28	1.61
TTP and DKF	85	28	14	75	55.94	53.13	66.67	85.86	27.18	2.27
McMurray and DKF	88	27	15	72	56.93	55	64.29	85.44	27.27	2.2
Localization and TTP and McMurray	110	18	26	50	63.36	68.75	40.91	80.88	26.47	1.52
Localization and TTP and DKF	77	30	12	83	52.97	48.13	71.43	86.52	26.55	2.32
Localization and McMurray and DKF	72	30	12	88	50.50	45	71.43	85.71	25.42	2.05
TTP and McMurray and DNF	78	29	13	82	52.97	48.75	69.05	85.71	26.13	2.12

Table 1b: Diagnostic values of specific combinations of clinical tests for meniscal tears