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Role of Medial Menisco-Tibial Ligament Enthesis in Knee Osteoarthritis Initiation

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Faculty Disclosure Information

- **Nothing to disclosure**

Introduction :

Inflammation of the ligamentous attachments (Synovio – Enthesis Complex : SEC) is important in the pathogenesis of osteoarthritis (OA)

Purpose

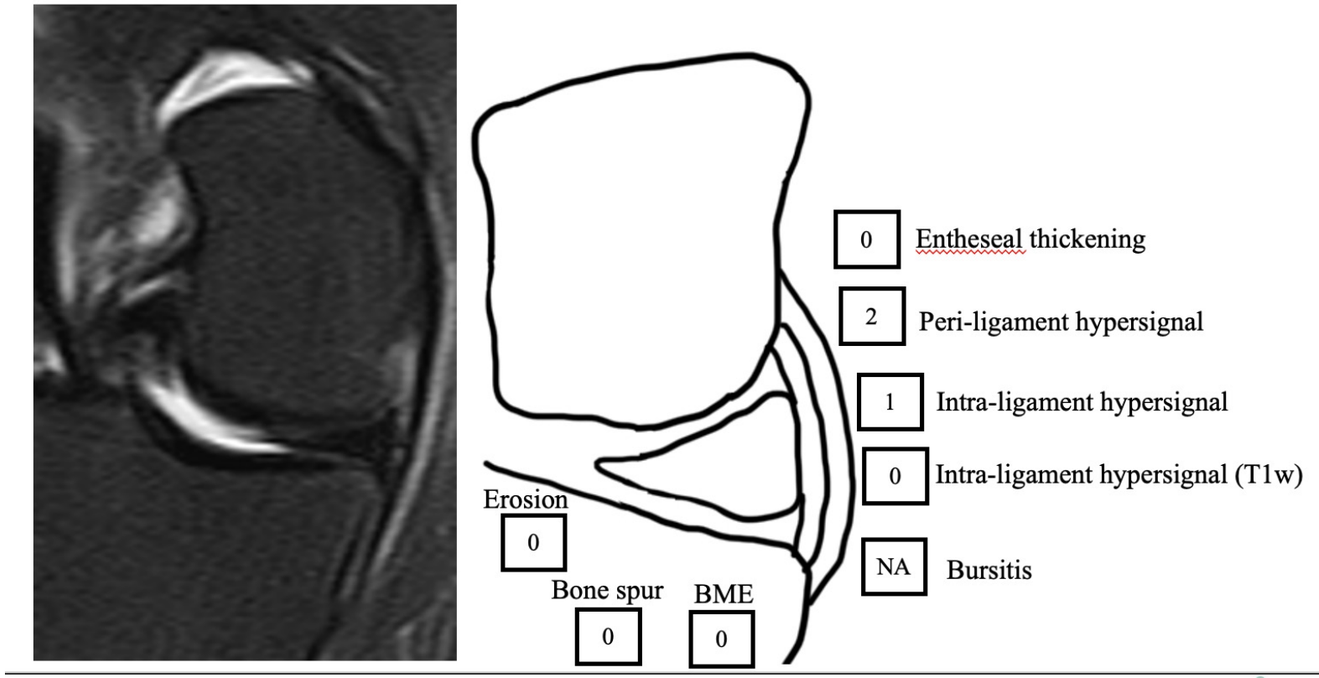
This study aims to clarify the interplay between SEC pathology, MMTL insufficiency, and MME in the context of medial knee OA.
By utilizing MRI-based assessments and structural equation modeling (SEM), we seek to establish causal relationships among these factors and provide insights into the underlying mechanisms driving OA progression

8 key MRI pathologies

Pathology	Definition
1. peri-ligament hyper signal	Signal characteristics consistent with increased water content/inflammation within the ligament close to its insertion
2. intra-ligament hyper signal	Signal characterristics consistent with increased water content/inflammation in the soft tissues surrounding the ligament, close to its insertion
3. bone marrow edema	Bone lesion with ill-defined margins and signal characteristics consistent with increased water content /inflammation, close to the ligament insertion
4. bursitis	Signal characterristics consistent with increased water content/inflammation in an above normal-sized bursa
5. ligament thickening	Abnormal thickening of the ligament close to its insertion
6. enthesophyte	Abnormal bone formation at the insertion of ligament insertion into the bone
7. bone erosion	A sharply marinated bone lesion, with typical signal characteristics and a visible cortical break, located close to the ligament insertion
8. intra-ligamenet hypersignal on T1w	Increased signal in T1-weighted (T2W) sequence within the ligament close to its insertion

The representation of scoring

The severity of (SEC) pathologies was assessed using a semi-quantitative MRI scoring system based on the OMERACT Enthesitis Score. Each pathology was scored on a 0–3 scale, and composite scores were calculated as follows: Total Inflammatory Score: Sum of intra-ligamentous hypersignal, peri-ligamentous hypersignal, BME, and bursitis scores. Total Structural Damage Score: Sum of entheseal thickening, osteophyte, and bone erosion scores.



Demographic and Clinical Characteristics

	Mean	SD	N (%)
Age (years)	74.3	10.7	
Female, N (%)			102 (85)
BMI (kg/m2)	23.7	3.5	
KL grade (0:1:2:3:4)			21 : 45 : 26 : 22 : 6
MRI pathologies			
peri-ligament hypersignal	0.78	0.53	43 (52)
intra-ligament hypersignal	0.34	0.49	79 (96)
bone marrow edema	0.19	0.45	46 (56)
bursitis	0.03	0.18	10 (12)
ligament thickening	0.08	0.27	31 (38)
enthesophyte	0.34	0.47	67 (81)
bone erosion	0.01	0.09	5 (6)
intra-ligament hypersignal on T1w	0.07	0.25	21 (26)
total inflammatory score	1.34	1.11	
total structural score	0.5	0.79	
SEC total score	1.84	1.76	
medial meniscus extrusion (mm)	2.96	0.29	
medial meniscotibial ligament insufficiency (MMTLI), N (%)			79 (66%)

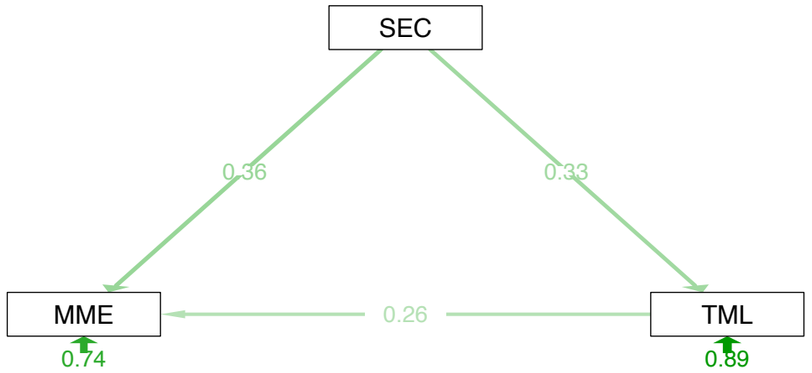
Correlation Analysis for Medial Meniscus Extrusion (MME)

Variable	Correlation Coefficient	95% CI	p-value
Age	0.144	-0.036 to 0.315	0.1164
Sex	-0.175	-0.343 to 0.005	0.0566
BMI	-0.089	-0.264 to 0.092	0.3354
Total inflammatory score	0.466	0.313 to 0.596	<0.0001
Total structural score	0.33	0.160 to 0.481	<0.0001
SEC score	0.445	0.288 to 0.578	<0.0001
MMTLI	0.377	0.212 to 0.521	<0.0001

Stepwise Multiple Linear Regression Analysis for Medial Meniscus Extrusion (MME)

Variable	Regression Coefficient	Standard Error	t-value	p-value
SEC score	0.366	0.086	4.26	<0.0001
MMTLI	0.936	0.305	3.07	0.0027

Structural Equation Model (SEM)



Parameter	Estimate	Std. Error	z-value	p-value	Std. LV	Std. All
Direct Effect						
SEC → MME (cc)	0.366	0.085	4.314	<0.001	0.366	0.359
Indirect Effect						
SEC → MMTLI (aa)	0.093	0.024	3.816	<0.001	0.093	0.329
MMTLI → MME (bb)	0.936	0.301	3.104	0.002	0.936	0.259
Total Effect						
SEC → MME (total)	0.453	0.083	5.436	<0.001	0.453	0.445

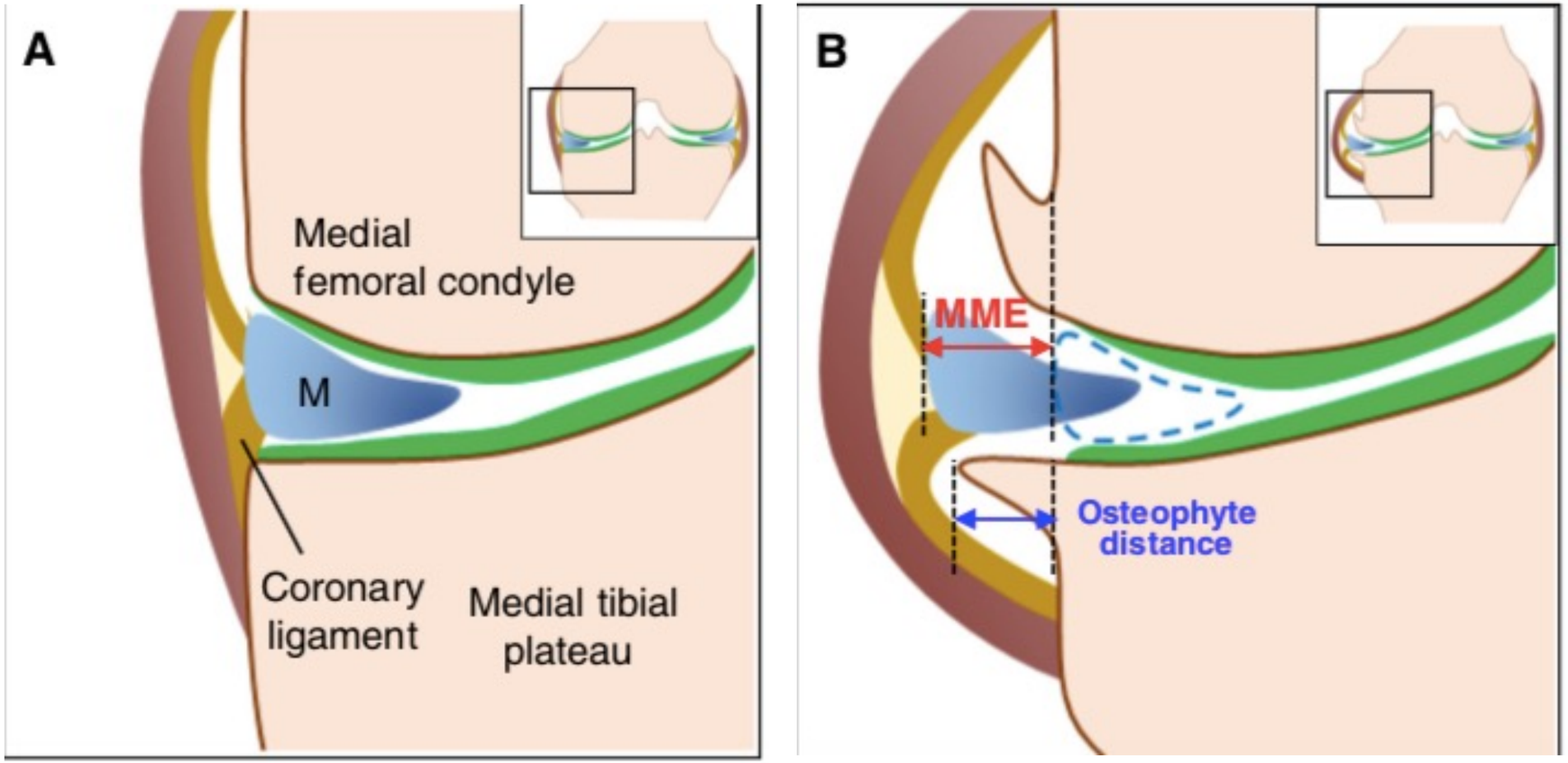
The model showed the direct effect of SEC lesions on MME (c=0.36) and the indirect effect mediated through medial meniscotibial ligament insufficiency (a=0.09, b=0.26). The total effect (total1=c+ab=0.45) is also shown. Standardized path coefficients are presented.

Which came first,

medial meniscotibial ligament insufficiency or osteophytes?

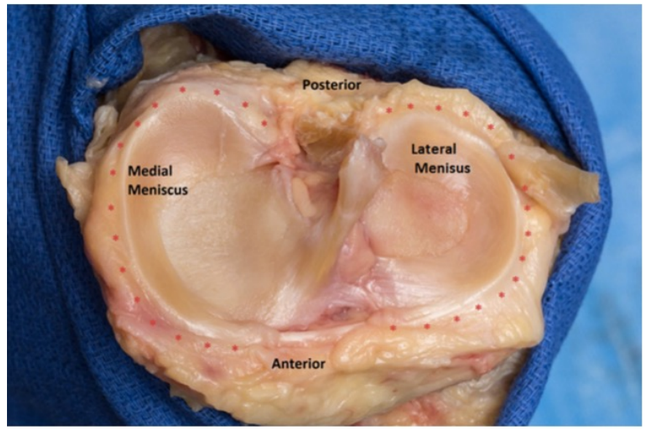
The Relationship between MME and osteophyte

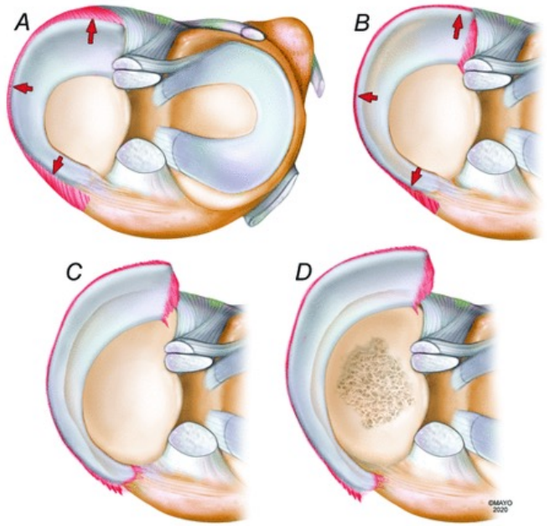
Hada S et al. Arthritis Research & Therapy, 2017



Osteophyte push out medial meniscus

Medial Meniscotibial Ligament insufficiency precedes MME





Krych AJ et al, KSSTA, 202

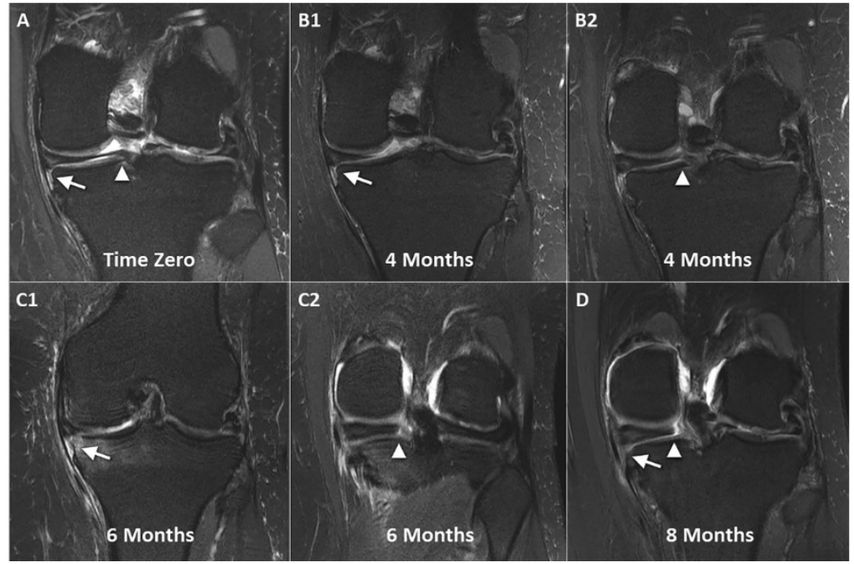


Table 2 Meniscal extrusion and meniscotibial ligament abnormality

Amount of extrusion	Meniscotibial disruption (%)	95% CI [3]	*p* value
Extrusion < 3 mm	36% (4 of 11)	15.0–64.8%	$p=0.048$
Extrusion ≥ 3 mm	100% (9 of 9)	73.1–100%	

MME > 3mm RR 2.75 (p = 0.048)

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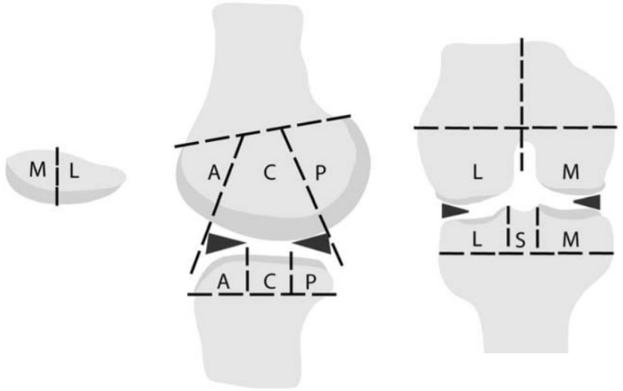
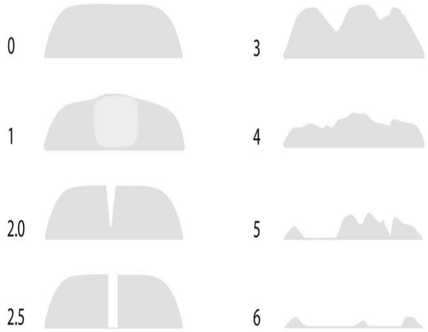
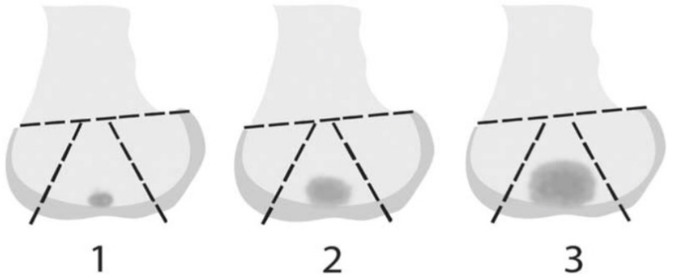
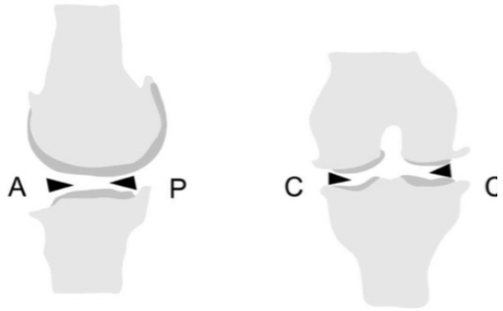
WORMS (Whole-Organ Magnetic Resonance Imaging Score)

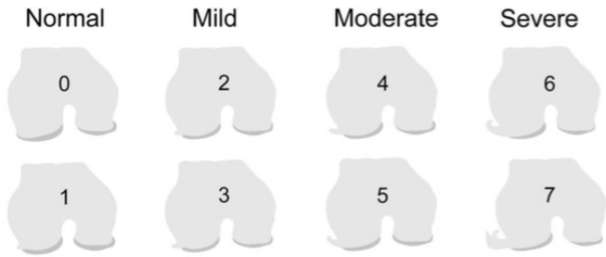




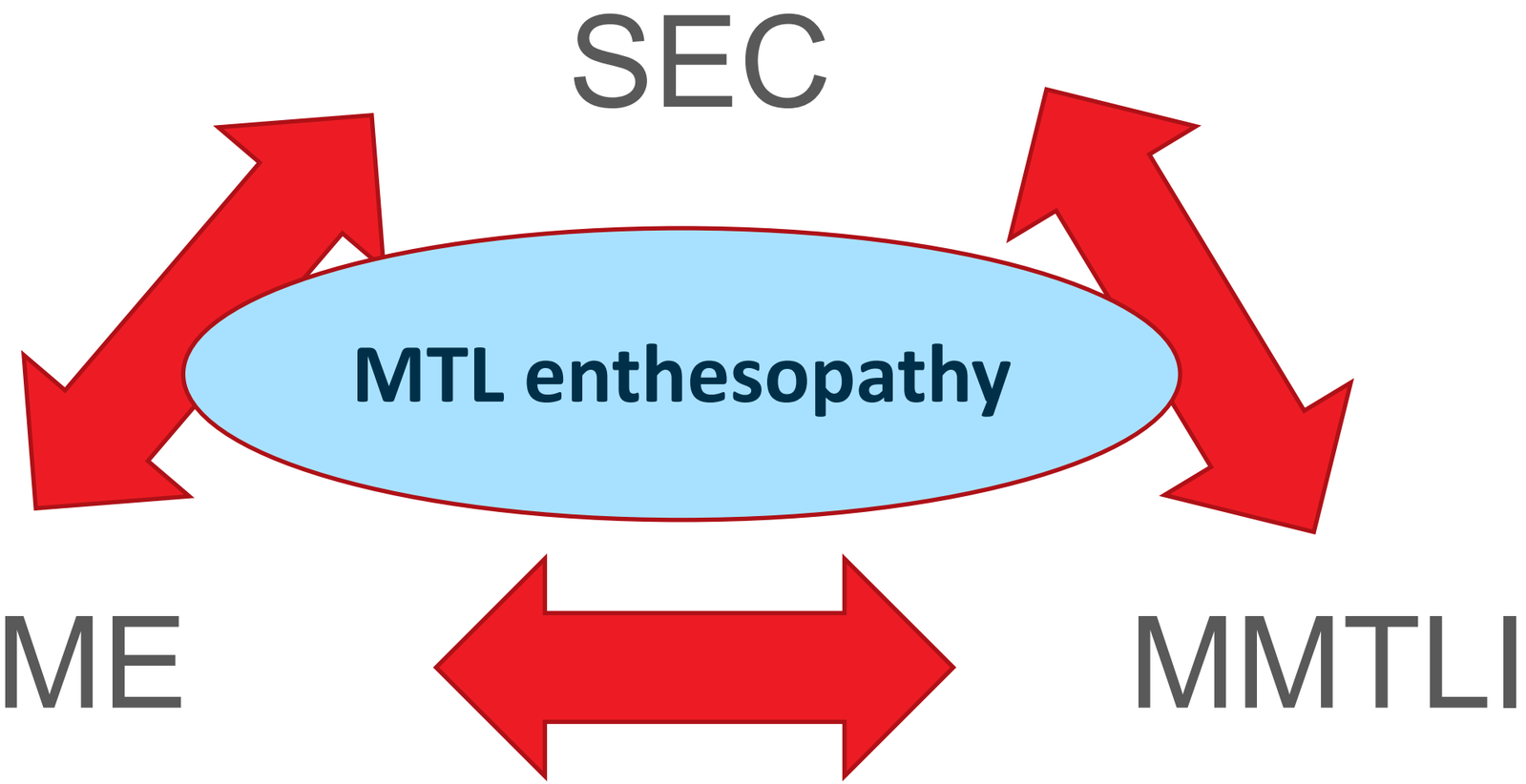


Less interest in ligament/tendon attachments





MTL enthesopathy is involved in the development of knee OA as SEC



MCL enthesopathy is involved in the development of knee OA as SEC