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Medial meniscal extrusion is significantly increased in meniscal root tears: A systematic review with meta-analysis

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Disclosures

- Dr Dave Lee Yee Han has received speaker fees for Smith & Nephew

Medial meniscal extrusion (MME)

01

Medial meniscal extrusion (MME): Medial displacement of the medial meniscus with respect to the central margin of the medial tibial plateau

02

Occurs due to disruption of collagen fibres within the meniscus that provide hoop tension strength. [1]

03

When a meniscal tear occurs, there is a potential loss of meniscus hoop stress, resulting in increased MME.

Definitions

Terms	Definitions
Major MME	1. Costa et al MME of >3mm[4] 2. Lerer et al MME of ≥3mm[5]
Absolute MME	MME recorded during weight-bearing MRI
Widely-Displaced MMRT (WD-MMRT)	Measurable tear gap on MRI[6]
Non-Displaced MMRT (ND-MMRT)	No measurable tear gap on MRI[6]
Non-OA knees	Kellgren and Lawrence (KL) Grade 0-1[7]
OA knees	Kellgren and Lawrence (KL) Grade 2-4[7]

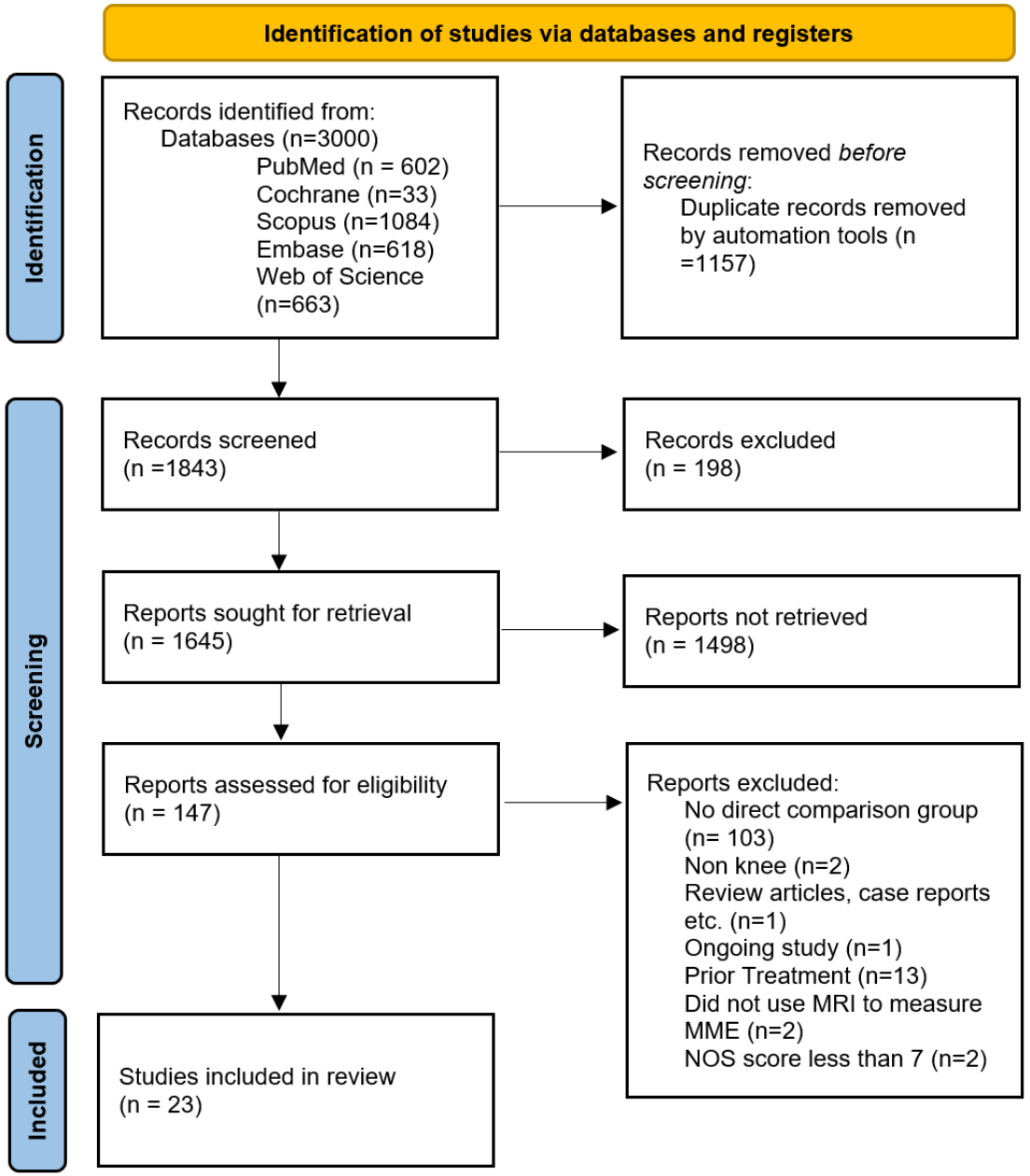
Aims

1. To evaluate if MMRT significantly increases MME compared to non-root tears (NRT) and no tears

2. To determine the clinical outcomes of increased MME

Methodology

- An electronic search of 5 databases using keywords relating to “Meniscus Tear” and “Extrusion”
- Screened 3000 articles and included 23 studies involving 7984 knees in a random-effects meta-analysis
- All statistical analysis was performed using the Review Manager version 5.3 (Revman, Cochrane Information Management System) software
- Subgroup and sensitivity analysis performed to evaluate for potential sources of heterogeneity



Results

Subgroup analysis: Medial Meniscus Root Tear vs Non-Root Tear (NRT)

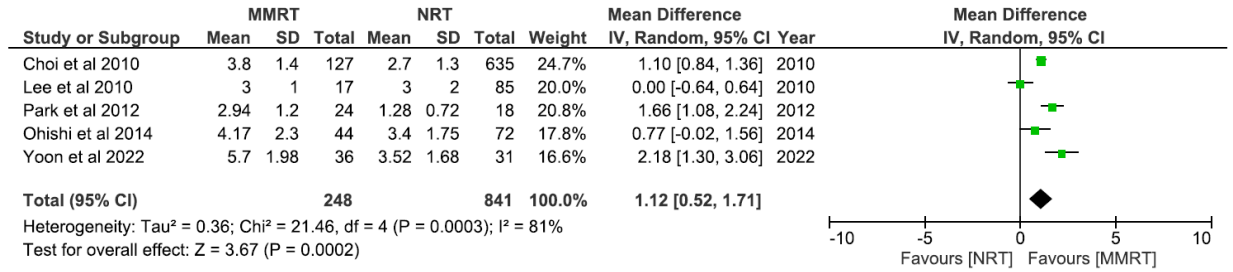
1. Absolute Meniscal Extrusion (AME)

- 5 studies, involving 1089 patients
- MMRT patients had a mean AME of **4.00±1.82 mm**
- NRT patients had a mean AME of **2.79±1.47 mm**
- MMRT had a **1.12 mm** significantly greater AME than NRT

2. Incidence of Major MME

- 8 studies, involving 2628 patients
- MMRT were **2.51 times** more likely to have major MME compared to those who had NRT

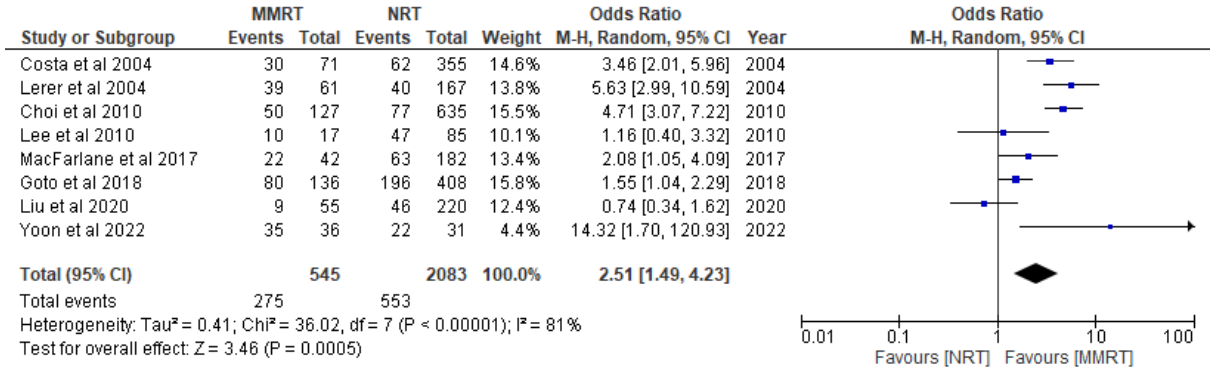
Mean Absolute Meniscal Extrusion



Study or Subgroup	MMRT Mean	MMRT SD	MMRT Total	NRT Mean	NRT SD	NRT Total	Weight	Mean Difference IV, Random, 95% CI	Year
Choi et al 2010	3.8	1.4	127	2.7	1.3	635	24.7%	1.10 [0.84, 1.36]	2010
Lee et al 2010	3	1	17	3	2	85	20.0%	0.00 [-0.64, 0.64]	2010
Park et al 2012	2.94	1.2	24	1.28	0.72	18	20.8%	1.66 [1.08, 2.24]	2012
Ohishi et al 2014	4.17	2.3	44	3.4	1.75	72	17.8%	0.77 [-0.02, 1.56]	2014
Yoon et al 2022	5.7	1.98	36	3.52	1.68	31	16.6%	2.18 [1.30, 3.06]	2022
Total (95% CI)			**248**			**841**	**100.0%**	**1.12 [0.52, 1.71]**	

Heterogeneity: Tau² = 0.36; Chi² = 21.46, df = 4 (P = 0.0003); I² = 81%
Test for overall effect: Z = 3.67 (P = 0.0002)

Incidence of Major MME



Study or Subgroup	MMRT Events	MMRT Total	NRT Events	NRT Total	Weight	Odds Ratio M-H, Random, 95% CI	Year
Costa et al 2004	30	71	62	355	14.6%	3.46 [2.01, 5.96]	2004
Lerer et al 2004	39	61	40	167	13.8%	5.63 [2.99, 10.59]	2004
Choi et al 2010	50	127	77	635	15.5%	4.71 [3.07, 7.22]	2010
Lee et al 2010	10	17	47	85	10.1%	1.16 [0.40, 3.32]	2010
MacFarlane et al 2017	22	42	63	182	13.4%	2.08 [1.05, 4.09]	2017
Goto et al 2018	80	136	196	408	15.8%	1.55 [1.04, 2.29]	2018
Liu et al 2020	9	55	46	220	12.4%	0.74 [0.34, 1.62]	2020
Yoon et al 2022	35	36	22	31	4.4%	14.32 [1.70, 120.93]	2022
Total (95% CI)		**545**		**2083**	**100.0%**	**2.51 [1.49, 4.23]**	
Total events	275		553				

Heterogeneity: Tau² = 0.41; Chi² = 36.02, df = 7 (P < 0.00001); I² = 81%
Test for overall effect: Z = 3.46 (P = 0.0005)

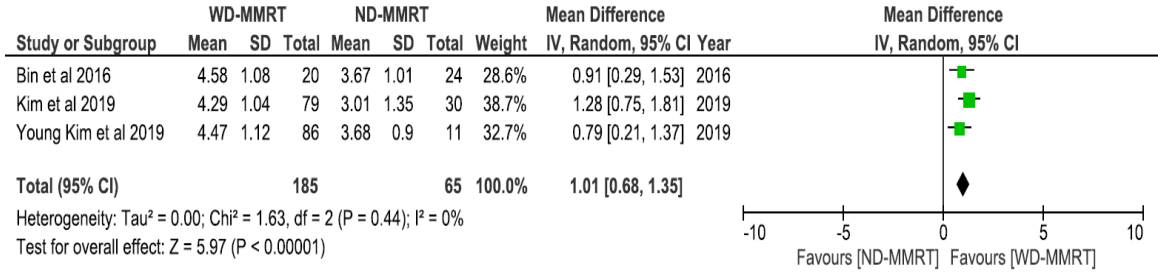
Results

Subgroup analysis: WD-MMRT vs ND-MMRT

1. Absolute Meniscal Extrusion (AME)

- 3 studies involving 250 patients
- WD-MMRT patients had a mean AME of **4.41±1.08 mm**
- ND-MMRT patients had a mean AME of **3.67±1.20 mm**
- WD-MMRT had a **1.01 mm** significantly greater AME than ND-MMRT

Mean Absolute Meniscal Extrusion

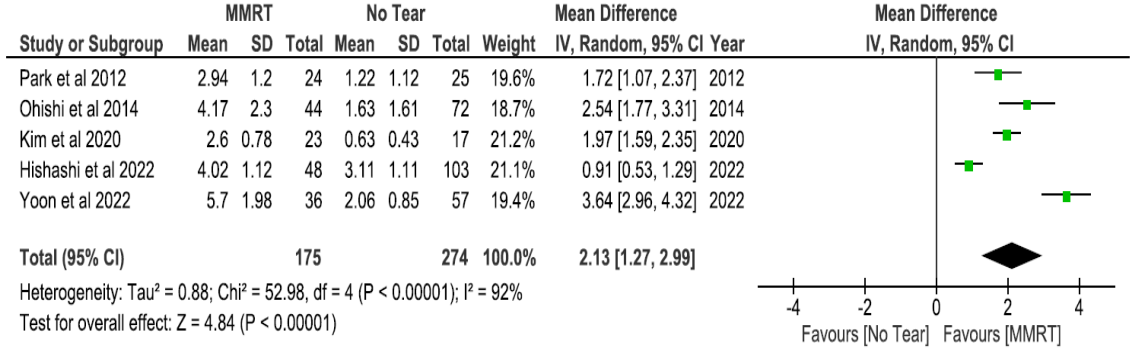


Subgroup analysis involving patients with MMRT vs No Meniscal Tears

2. Absolute Meniscal Extrusion (AME)

- 5 studies involving 449 patients
- MMRT patients had a mean AME of **4.07±1.93 mm**
- No Meniscal Tears patients had a mean AME of **2.18±1.43 mm**
- MMRT had a **2.13 mm** significantly greater AME than No Meniscal Tears

Mean Absolute Meniscal Extrusion



Results

Subgroup analysis: OA vs Non-OA Knees

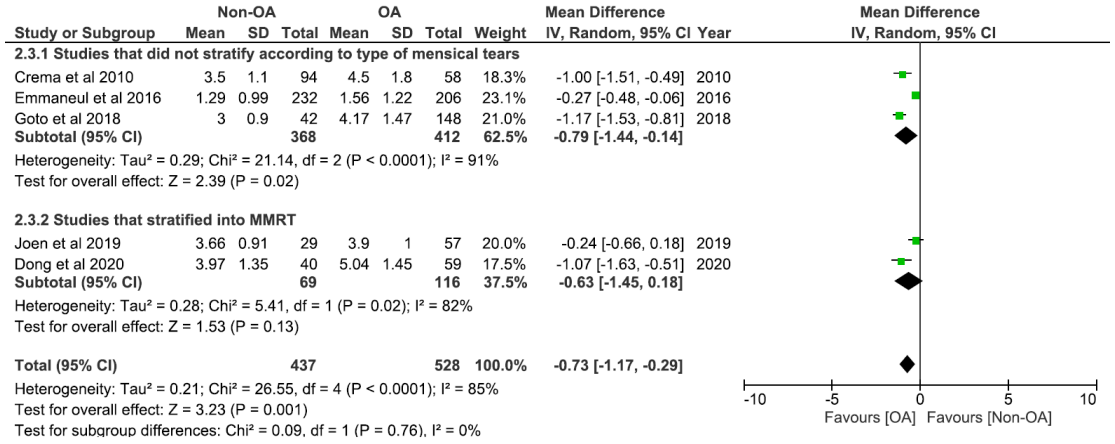
1. Absolute Meniscal Extrusion (AME)

- 5 studies, involving 1211 patients
- Patients with OA had a mean AME of **3.27±1.95 mm**
- **P**atients with non-OA had a mean AME of **2.33±1.53 mm**
- OA patients had a **0.73mm** significantly greater AME than non-OA patients

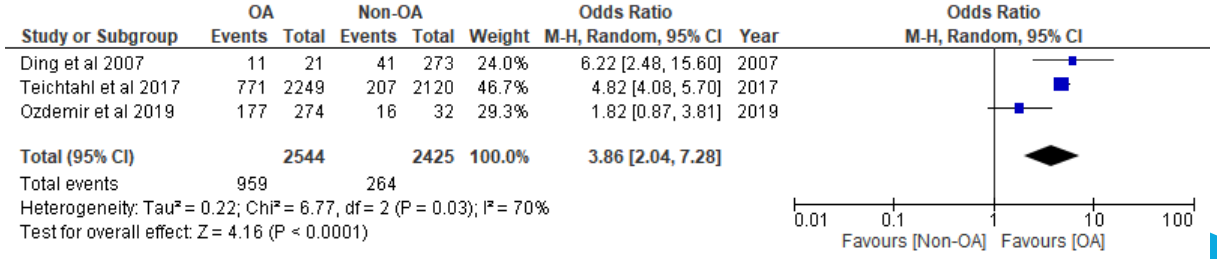
2. Incidence of Major MME

- 3 studies, involving 4969 patients
- OA patients were **3.86 times** more likely to have major MME compared to non-OA patients

Mean Absolute Meniscal Extrusion



Incidence of Major MME



Discussion: Subgroup analysis for patients with MMRT

Results

In general, patients with knee OA had a greater AME than non-OA knees

Within patients with MMRT, **NO** difference in AME between OA vs non-OA knees

WD-MMRT had greater AME compared to ND-MMRT

Discussion

Reinforces the relationship between MME, cartilage degeneration and OA development.

Increased MME is a pathognomonic finding of MMRT (regardless of the OA severity)

a. When physiological loading (1800 N) is applied, torn meniscal roots have a wider gap compared to an absence of a load (0 N)[8]

b. Prolonged weight-bearing results in greater displacement of the tear gap and MME, increasing the risk of chondral wear progression.

Discussion: Causes of Increased MME in Non meniscal tears and Non OA knees

1. No meniscal tears and non-OA knees had a mean MME of **2.18±1.43mm** and **2.33±1.53mm** respectively.

2. This may be related to a variety of possible etiologies:
    a. Meniscal degeneration→ meniscus increases in size due to the formation of microcyst and separation of fibrils, altering the meniscus ability to resist hoop strain[9]

    b. Varus malalignment
        i. When structurally intact, the meniscus can offset the influence of the varus alignment
        ii. In meniscus degeneration or with a root tear, varus malalignment becomes significant, increasing the risk of OA progression[10].

    c. Obese individuals→ nearly 5x more likely to have increased MME[11]

    d. Past knee injury → nearly 4x more likely to have increased MME[11]

Discussion: Future Directions

- Increased MME in an MMRT can be likened to a **"total meniscectomy"** [12]
- Root repair achieves superior clinical outcomes compared to partial meniscectomy. [13]
- However, 33.5% of patients treated by meniscal repair underwent conversion to total knee arthroplasty within 10 years[14]
- **Pre-operative varus alignment** and **increased post-operative MME** are poor prognostic factors of meniscus repair[15]
- Currently, root repairs does not significantly decrease post-operative MME[16] and OA progression[17]

Conclusion

1. Patients with MMRT have higher MME compared to other types of meniscal tears and those without any meniscal tears.

2. Patients with knee OA were more likely to have higher MME compared to Non-OA.

3. Given the results, the authors recommend that meniscal extrusion be routinely measured in patients to aid with diagnosing, decision-making and prognostication for patients with MMRTs.

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