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Effects of Partial Meniscectomy on *in vivo* Gait Biomechanics: Systematic Review and Metanalysis

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Faculty Disclosure Information

- Enzo Salviato Mameri[1,2]: Nothing to disclose
- Felipe Gonzalez[2]: Nothing to disclose
- Lucas Pallone[2]: Nothing to disclose
- Eliane Guadagnin[2]: Nothing to disclose
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- Carlos Franciozi[1]: VRX Technology
- Jonathan Gustafson[2]: nothing to disclose
- Jorge Chahla[3]: *Paid Consultant: CONMED, LINVATEC, OSSUR, SMITH & NEPHEW; Board Committee Member: AOSSM, AANA, ISAKOS*
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BACKGROUND

Improved understanding of the role of the meniscus in load transmission and knee stability paved the way for the current point of emphasis on meniscus repair

Partial Meniscectomy, however, is still one of the most commonly performed procedures (17:100,000 in the US)

Current knowledge-base stems from *in vitro* studies

Limited to time-zero condition

Effects of dynamic/functional weight-bearing activities?

Motion analysis studies: assessment of dynamic *in vivo* biomechanics

OBJECTIVES

To systematically review and appraise the literature on the effects of partial meniscectomy on *in vivo* biomechanics of the knee

Hypothesis: significant alterations in knee kinetics and kinematics

METHODS

PubMed, Scopus, Cochrane
≤ May/2023

SEARCH TERMS

MENISCUS	DISORDER	IN VIVO BIOMECHANICS	EXCLUSION CRITERIA
Meniscus	Tear	Kinematics	Finite Element
Menisci	Injury	Kinetics	Cadaveric
Meniscal	Avulsion	Motion Analysis	Animal
	Extrusion	Gait	Porcine
	Discoid	Angle	Bovine
	Abnormal	Moment	Ovine

ELIGIBLITY CRITERIA

Level I-III
(1) in vivo motion analysis
(2) Partial meniscectomy cohorts
(3) kinetics, kinematics outcomes

DATA EXTRACTION

Lvl of Evidence
Sample and Control Group characteristics
System used for Motion Analysis
Tasks Performed
Kinetics / Kinematics Outcome Measures

DATA ANALYSIS

Qualitative Synthesis
(Meniscus disorder, motion analysis methods, KINETICS, KINEMATICS)

Metanalysis - SMD and Effect Estimates of commonly reported outcomes – KINEMATICS of Partial Medial Menisc.
(Random effects inverse variance model)

RESULTS

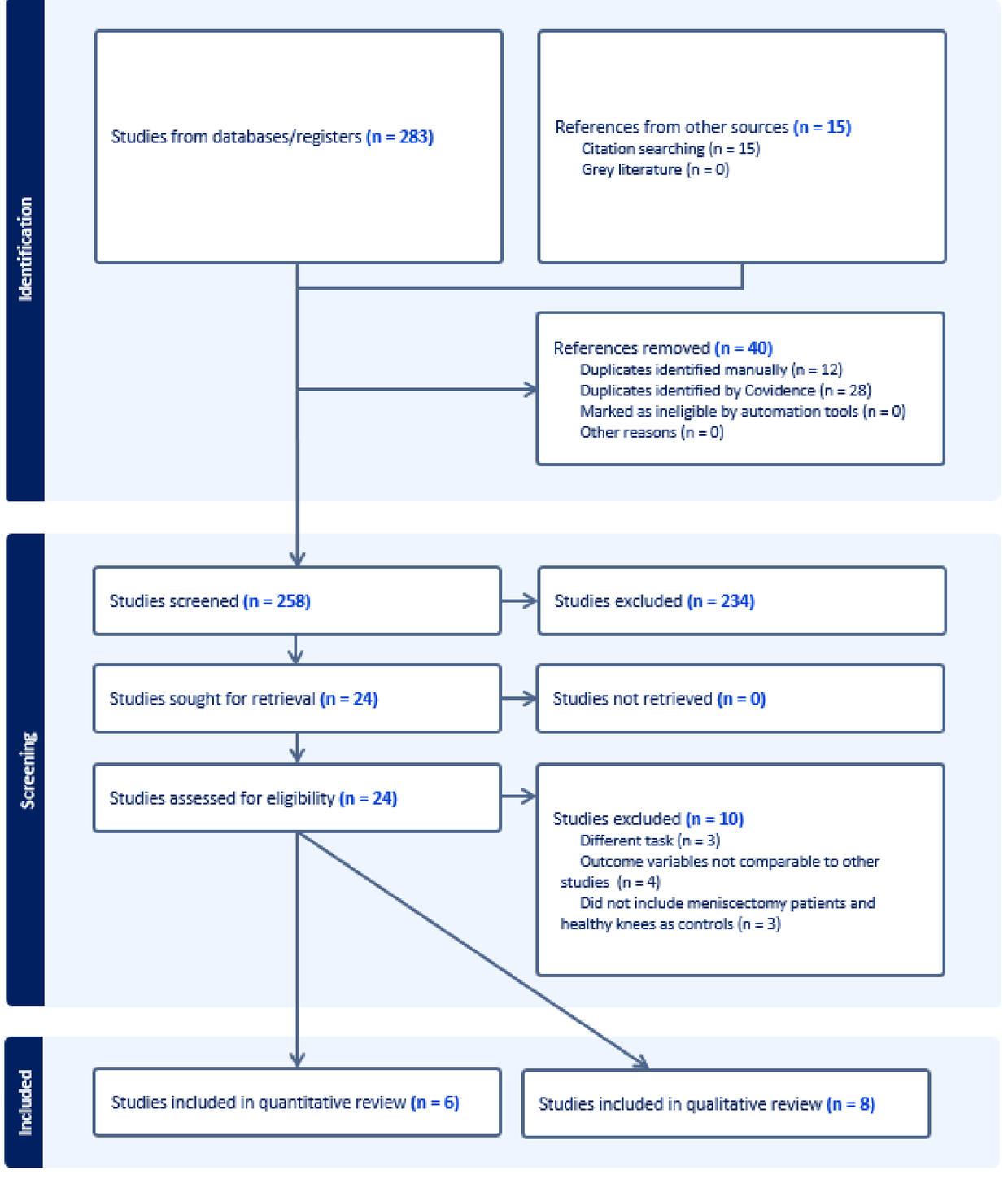
14 studies SR (6 Metanalysis)

n = 338 partial mensicectomies

231 controls (contralateral knee or healty cohort)

11 studies: Medial; 2 studies: lateral; 1 study: both

Heterogeneity in types of tear



RESULTS

TASKS PERFORMED

- GAIT (n = 10)
- STAIRS (n = 3)
- DROP LANDING (n = 1)
- RUNNING (n = 1)
- FORWARD LUNGE (n = 1)

METHOD OF MOTION ANALYSIS

- OPTOELETRONIC SYSTEM (n = 11)
- COMPUTERIZED ULTRA-SOUND-BASED SYSTEM (n = 1)
- FLEXIBLE GONIOMETERS (n = 2)

RESULTS

QUALITATIVE EVIDENCE - KINETICS

<1 year: 4 STUDIES (2 MM, 2 LM): GAIT – ALTERED SAGITTAL PLANE KINETICS

Medial Meniscus: DECREASED PEAK KNEE EXTESION MOMENTS at 6 months vs CL knee

> 1 Year: 2 STUDIES (2 MM) – CONCERNING LONG TERM LOADING PATTERNS

Thorlund et al.: **INCREASED PEAK ADDUCTION MOMENT at 1 year**
Hall et al.: **INCREASED PEAK VERTICAL FORCES at 2 years**

QUALITATIVE EVIDENCE - KINEMATICS

4 STUDIES: ALTERED SAGITTAL PLANE KINEMATICS **+ METANALYSIS**

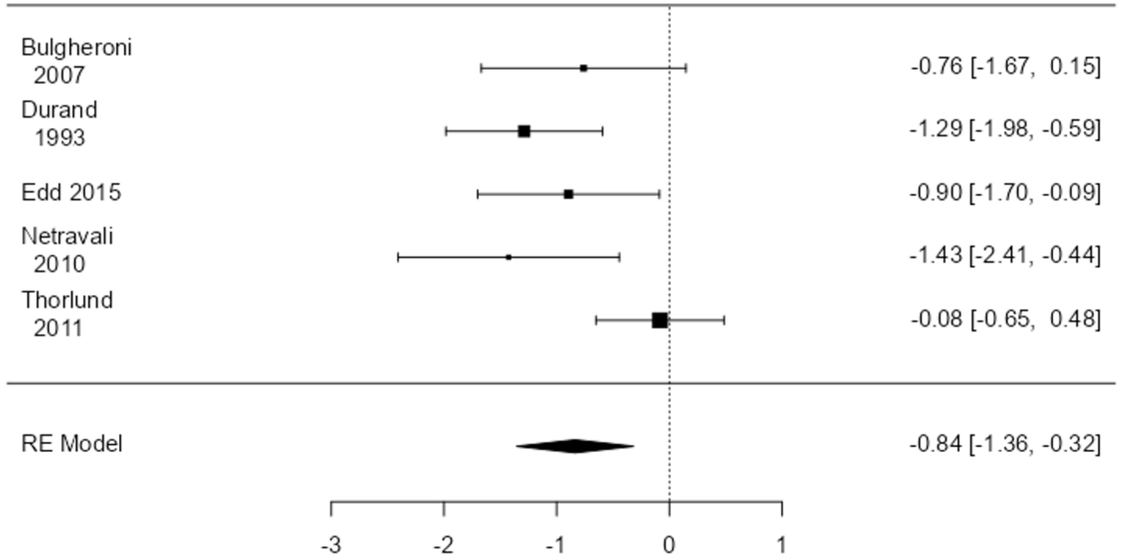
2 STUDIES: ALTERED AXIAL PLANE KINEMATICS

INCREASED EXTERNAL ROTATION ANGLE DURING GAIT at 12 monthss

RESULTS

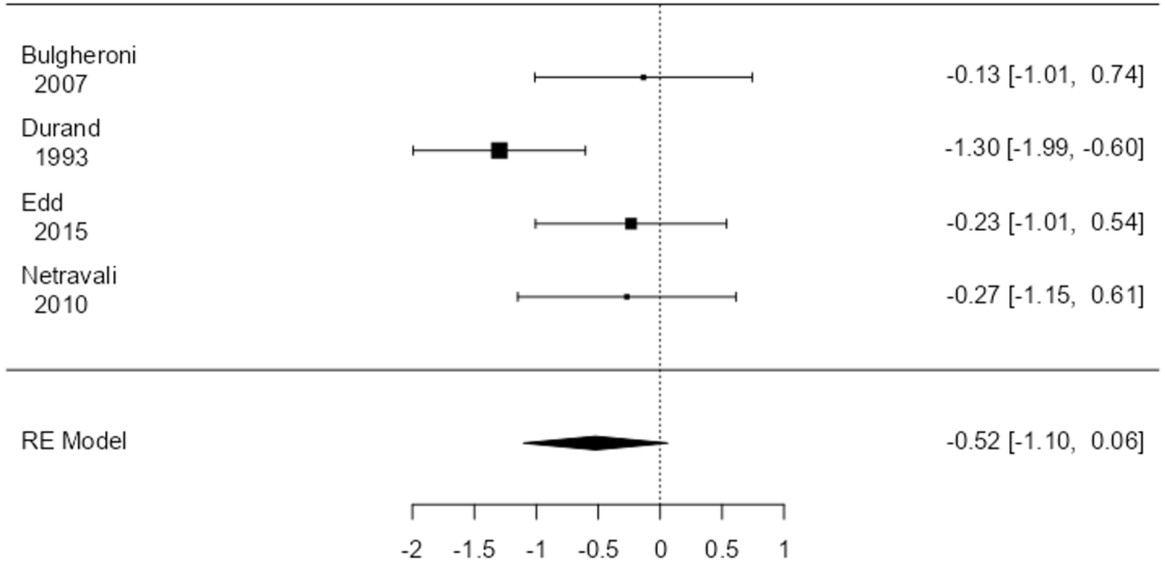
METANALYSIS - KINEMATICS

Range of Knee FLEXION-EXTENSION - STANCE



SIGNIFICANT DECREASE (p = 0.002)

Peak KNEE FLEXION ANGLE - STANCE

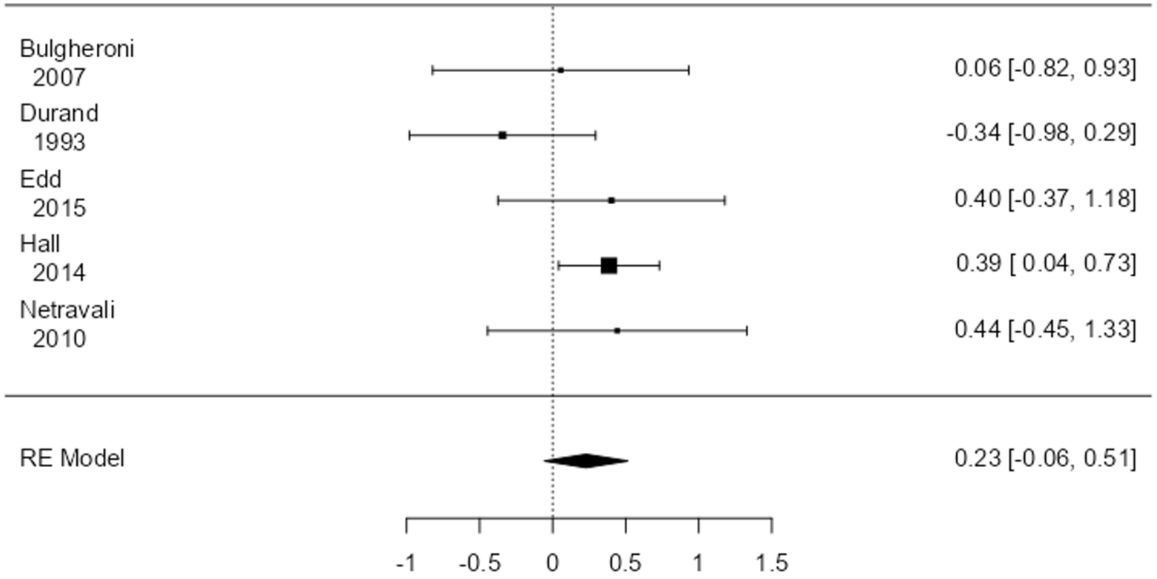


(decrease) NO SIGNIFICANT DIFFERENCE (p = 0.07)

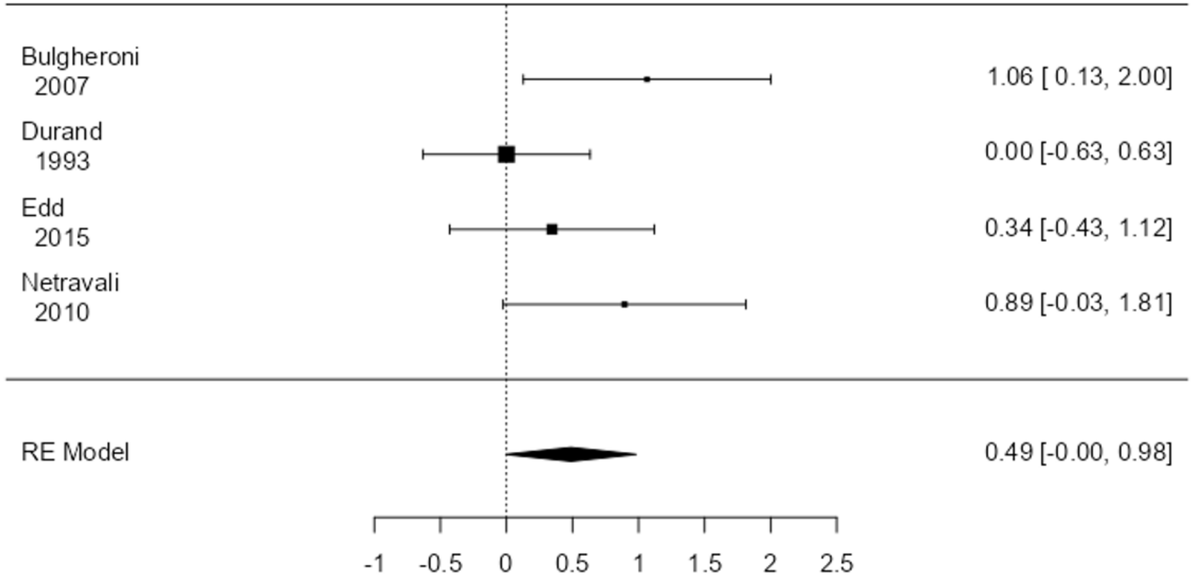
RESULTS

METANALYSIS - KINEMATICS

Knee Flexion Angle at Initial Contact



Minimum Knee Flexion Angle at Terminal Stance



(Increase) NO SIGNIFICANT DIFFERENCE (p = 0.11)

BORDERLINE SIGNIFICANT INCREASE (p = 0.05)

KEY TAKEAWAYS

FOLLOWING PARTIAL MENISCECTOMY...

KINEMATICS

STATISTICALLY SIGNIFICANT EVIDENCE OF **DECREASED KNEE FLEXION RANGE OF MOTION DURING THE STANCE PHASE OF GAIT**.

QUALITATIVE EVIDENCE FROM MULTIPLE STUDIES (APPROACHING STATISTICAL SIGNIFICANCE) OF **EXTENSION DEFICIT AT INITIAL CONTACT** AND **FLEXION DEFICIT AT TERMINAL STANCE**

KINETICS

QUALITATIVE EVIDENCE OF IMPAIRED KNEE EXTENSION MOMENT AS LATE AS 6 MONTHS POST-OPERATIVELY

QUALITATIVE EVIDENCE OF CONCERNING (POTENTIAL FOR DEGENERATIVE JOINT DISEASE) LOADING PATTERNS IN LATE POST-OPERATIVE PERIODS, NAMELY **INCREASED KNEE ADDUCTION MOMENT** AND **PEAK VERTICAL FORCES**

KEY TAKEAWAYS

CURRENT LITERATURE

FEW STUDIES, LIMITED SAMPLE SIZES

LIMITED FOLLOW-UP

ANALYSIS MOSTLY LIMITED TO GAIT (OVERGROUND WALKING)

MORE DEMANDING TASKS MIGHT REVEAL MORE CHANGES

HETEROGENEITY:

- PATTERNS OF MENISCUS TEARS
- LATERAL vs MEDIAL MENISCUS
- AMOUNT OF RESECTED TISSUE
- ETIOLOGY (DEGENERATIVE vs TRAUMATIC)

CONCLUSION

While the available literature is currently limited by **HETEROGENEITY and LOW DEMAND TASKS...**

There is **significant quantitative evidence** that partial medial meniscectomy leads to **decreased range of motion during the stance** phase of gait

As well as qualitative evidence of (**KINEMATICS**) decreased extension during early stance and decreased flexion during late stance... And (**KINETICS**) limited extension moment during the first post-operative year, and increased loading patterns after 1 year

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