Effects of Prosthetic Design Features on Osteoarthritis Risk in the Sound Limb: A Scoping Review

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Background

- Osteoarthritis (OA) is a degenerative joint disease characterized by tissue breakdown.
- Prevalence of OA is higher in individuals with unilateral lower limb amputation than the general population.(1)
- Reliance on the sound limb in unilateral prosthesis users can result in overuse injuries and increase risk of OA on that limb, leading to pain and disability.(2)
- Energy storage and return (ESAR) feet are recommended for individuals at risk of overuse, but no comprehensive review of the literature exists regarding prosthesis design on biomechanical risk factors for OA.

Research Objectives

Review the literature to assess the effects of prosthesis design features on risk factors for OA development in the contralateral limb in individuals with unilateral transtibial (TTA) or transfemoral (TFA) amputation.

Methods

Search strategy:

- PubMed, Embase, CINAHL searched 9/16/23 using primary terms:
  - *amputation AND lower extremity AND osteoarthritis AND prosthesis AND biomechanical phenomena*

Screening & Selection
- Duplications removed in Endnote
- Title/Abstract reviewed in Rayyan using inclusion and exclusion criteria
- Data extracted from full texts

Data Extracted
- Population demographics
- Type of amputation
- Intervention descriptions
- Study purpose and design
- Outcomes

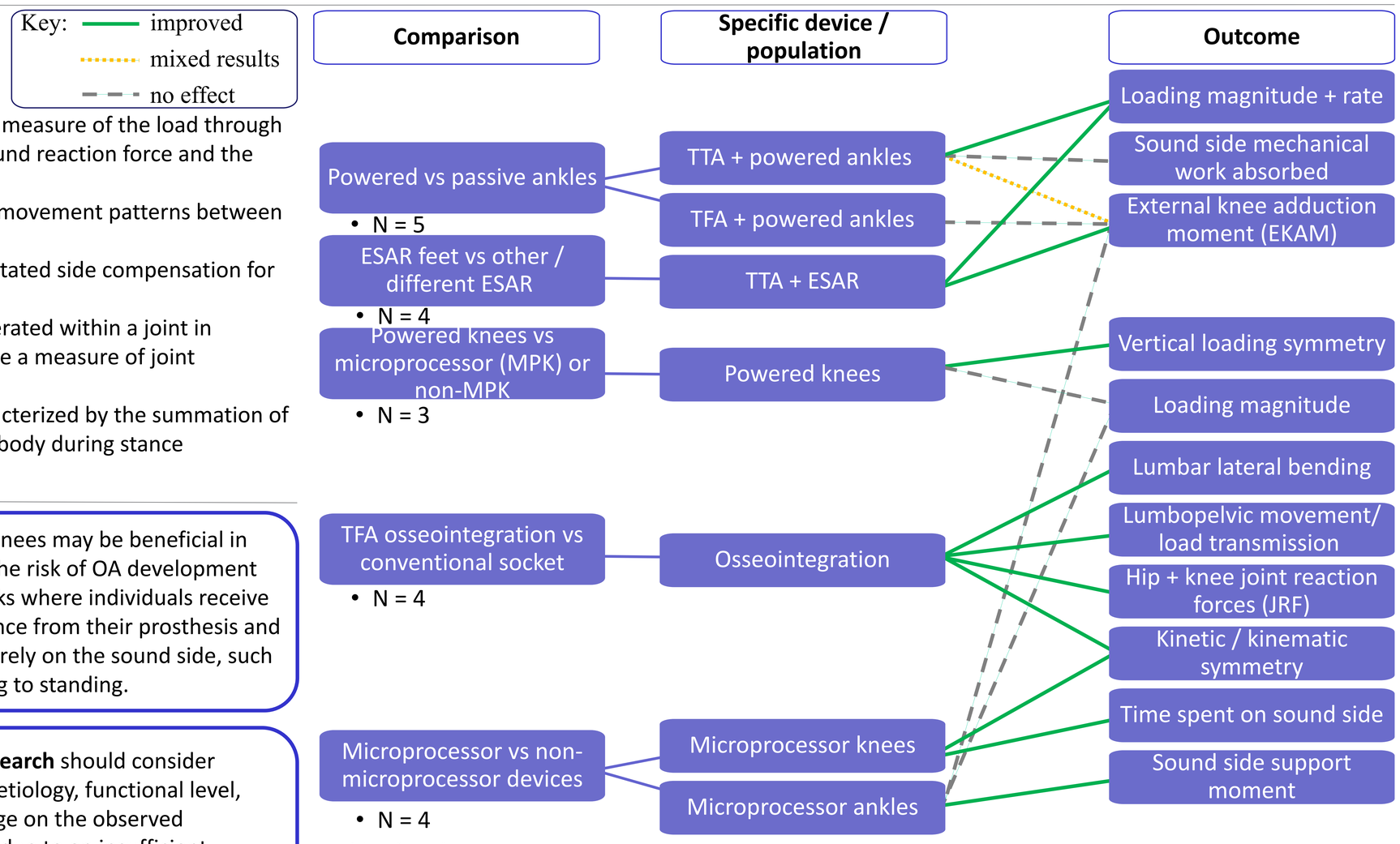
Inclusion Criteria
- Adults
- Ambulatory study participants with unilateral TTA or TFA
- Outcome comparison between prosthesis designs, or to sound side, or to able-bodied controls
- Biomechanical outcomes related to OA development

Exclusion Criteria
- Neuromusculoskeletal impairments on amputated side
- Internal joint prostheses

Results

- **250 articles identified** in the search
- **25 articles were included**

Outcomes:
- **External knee adduction moment (EKAM):** a kinetic measure of the load through the medial compartment of the knee due to the ground reaction force and the perpendicular distance from the knee joint
- **Kinetic/kinematic symmetry:** balance of forces and movement patterns between both sides of the body
- **Sound side mechanical work absorption:** non-amputated side compensation for energy generated on the amputated side
- **Hip and knee joint reaction forces (JRF):** forces generated within a joint in response to external forces acting on the joint, can be a measure of joint degeneration
- **Sound side support moment:** the limb pattern characterized by the summation of moments at the hip, knee, and ankle to support the body during stance



Conclusions

Powered prosthetic feet may be beneficial in reducing risk factors for OA.

Microprocessor knees may be better suited to reducing risk factors for OA than fluid-controlled knees.

Increased ankle push-off in ESAR feet leads to decreased contralateral EKAM and subsequent medial knee OA risk.

Powered knees may be beneficial in reducing the risk of OA development during tasks where individuals receive no assistance from their prosthesis and must fully rely on the sound side, such as in sitting to standing.

Future research should consider impact of etiology, functional level, sex, and age on the observed outcomes due to an insufficient number of articles that addressed these factors.

Limitations

- Exclusion of potentially relevant articles published after search conducted
- Limited databases
- "Osseointegration" terms not included in search string
- Few articles reported on other socket/alignment characteristics
- No longitudinal studies relating prosthesis changes to OA development
- Potential disparities in comparability between outcomes

References

1. Gailey R et al. J Rehabil Res Dev. 45, 15-29; 2008
2. O'Niell TW et al. Best Pract Res Clin Rheumatol. 32, 312-326; 2018