



Physical Therapy Program
SCHOOL OF MEDICINE
UNIVERSITY OF COLORADO
ANSCHUTZ MEDICAL CAMPUS



MULTIMODAL EDEMA MANAGEMENT AFTER TOTAL KNEE ARTHROPLASTY: A PILOT STUDY WITH RETROSPECTIVE HISTORICAL COHORT COMPARISON

Joel Carmichael, DC¹; Jared Foran, MD; Daniel Levy, BS; Alexandra Garnett, MD; Michael Bade, PT, PhD^{1,2} Jennifer Stevens-Lapsley, PT, PhD^{1,2}

¹University of Colorado, Physical Therapy Program, Department of Physical Medicine and Rehabilitation, Aurora, CO

²Veterans Affairs Geriatric Research, Education and Clinical Center, Denver, CO



Clinical Science PhD Program

BACKGROUND

- Total knee arthroplasty (TKA) is the most commonly performed surgical procedure in the United States.
- Lower extremity swelling of the surgical limb is a universal complication after TKA leading to deficits in quadriceps strength and activation as well as limitations in knee range of motion and daily activities such as walking, rising from a chair, and stair climbing.
- The ideal treatment of swelling after TKA is unclear. Ice (cryotherapy) is commonly utilized; however, literature indicates that while ice can be used for temporary pain relief, it does not significantly reduce lower extremity swelling resulting from the surgical trauma of TKA. Conservative options such as an inelastic gradient compression garment, manual lymphatic drainage massage, and therapeutic exercise could be utilized to improve knee swelling; however, this multimodal approach has not been studied to date.

PURPOSE

To determine the feasibility and initial efficacy of a multimodal edema management (MEM) program including an inelastic, short-stretch gradient compression garment, manual lymph drainage massage, and therapeutic exercise for patients with lower extremity swelling after TKA.

METHODS

Design

- Prospective pilot study with historical cohort comparison.

Inclusion/Exclusion

- Patients were included if they were awaiting a primary unilateral TKA for end-stage osteoarthritis.
- Patients were excluded if they had: 1) a chronic lower extremity swelling condition including congestive heart failure, 2) BMI greater than 40.

Participants and Treatment

- Pilot Study (MEM): 11 patients (aged 68 ± 2 years; 7 females) participated in the MEM program daily for 3 weeks.
- Historical Cohort (Control): 56 patients (aged 64 ± 9 years, 48% females) participated in routine postoperative physical therapy that did not include specific management for swelling. All were instructed to elevate and apply ice to the surgical leg.
- Lower extremity swelling was measured using bioimpedance assessment (BIA) normalized to the nonoperative limb.

Data Analysis

- Outcomes between the MEM and Control group were analyzed using an independent samples t-test or Fisher's Exact Test.
- Effects size estimates were calculated using two-sample mean comparison, STATA 14.2 (StataCorp, College Station, TX).

MULTIMODAL EDEMA MANAGEMENT INTERVENTION

Short-stretch Gradient Compression Garment (CG)



Inelastic Gradient Compression:

- Circaid® Juxtafit Essentials leg and thigh garments were combined.
- Participants wore CG 10-12 hours daily after bathing and breakfast.
- Greater compression was applied in ankle, calf and lower leg, with progressively less compression applied across the knee and thigh using compression guide cards to facilitate relative compressive forces.

Therapeutic Exercise



Home Exercise Program:

- Hourly toe curls and ankle pumps to facilitate venous/lymphatic return.
- Elective choice of 4 additional exercises (total of 5 times per day, one minute) to facilitate active or active assisted knee ROM.

Manual Lymph Drainage Massage

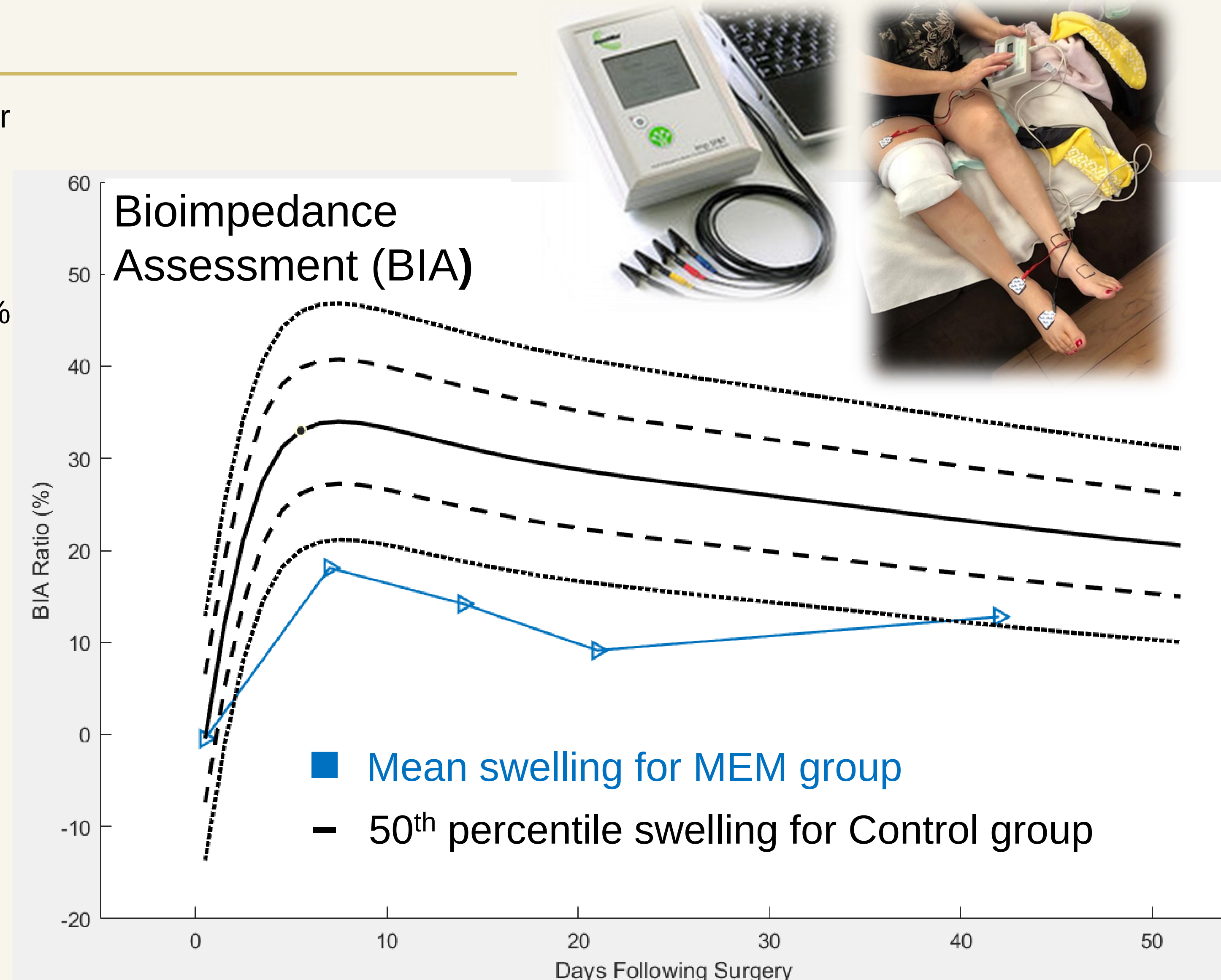


Manual Lymph Drainage Massage:

- Performed at end of day after doffing CG
- Light "skin-stretch" massage begins proximally at inguinal lymph nodes and progresses distally to thigh, then knee, and then calf.
- After completing the calf, a second cycle is repeated, but this time beginning distally at the calf and progressing proximally back up the leg, ending at the inguinal lymph nodes
- The entire massage process takes between 10 and 12 minutes.

RESULTS

- MEM and Control groups were similar at baseline for age, sex, BMI, knee ROM, quadriceps strength, quadriceps activation and preoperative swelling (all $p > 0.25$)
- High satisfaction and adherence to the MEM intervention were observed (99.8% satisfaction; 98% daily garment usage goal; 100% massage adherence; 100% exercise adherence).
- At 3 weeks mean swelling [BIA Ratio (%)] reduced 58% more for MEM group than Control† and 9 of 11 MEM participants were below Control's 10th percentile of swelling (See Figure to the right).
- Effect size estimates for swelling reduction for MEM vs. Control were 1.55 (95% CI 0.83 – 2.25) at 2 weeks and 0.91 (95% CI 0.23 – 1.58) at 6 weeks.
- Mean quadriceps activation for MEM improved 17.5% at week 6 compared to 9.4% for the Control group with effect size of 0.38 (95% CI -0.30 – 1.06).
- MEM showed smaller losses in normalized mean postoperative quadriceps strength at 6 weeks compared to Control group (0.98 N-m/kg vs. 0.75 N-m/kg; $P < 0.186$) with effect size of 0.44 (95% CI -0.21 – 1.09).



CONCLUSIONS

- Patients reported high satisfaction with the MEM program and demonstrated high levels of adherence with the daily use of the Circaid® Juxtafit Essentials compression garments.
- The MEM program may provide early lower extremity swelling reduction versus routine postoperative physical therapy.
- The MEM program may attenuate quadriceps strength loss and activation deficits compared to routine physical therapy.
- Future larger randomized controlled trials are needed to determine the efficacy of the MEM program as well as to determine the optimal patient characteristics predictive of success for the MEM program. Such studies should also examine the effect of swelling reduction on pain, ROM, and functional recovery.

CLINICAL RELEVANCE

- Use of the MEM program is feasible for patients experiencing lower extremity swelling after TKA.
- The MEM program may produce early reductions in swelling of the involved lower extremity after TKA.
- The MEM program may spare quadriceps muscle strength and activation after TKA.

REFERENCES

- Nam D, Berend ME, Nunley RM et al. Residual symptoms and function after unicompartmental and total knee arthroplasty: Comparable to normative controls? J Arthroplasty 2016; 31:2161-2166.
- Pichonnaz C, Bassin J-P, Lecureux E, et al. Bioimpedance spectroscopy for swelling evaluation following total knee arthroplasty: a validation study. BMC Musculoskelet Disord 2015; 16:100-107.
- Hidding JT, Viehoff PB, Beurskens CHG, et al. Properties of instruments for measuring of lymphedema: Systematic review. Phys Ther 2016; 96:1965-1981.
- Pua Y-H. The time course of knee swelling post total knee arthroplasty and its associations with quadriceps strength and gait speed. J Arthroplasty 2015; 30:1215-1219.
- Loyd BJ, Kittelson AJ, Forster J, et al. Development of a reference chart to monitor postoperative swelling following total knee arthroplasty. Disabil Rehabil 2019; Jan 22:1-8. doi:10.1080/09638288.2018.1534005. [Epub ahead of print]
- Loyd BJ, Stackhouse S, Dayton M, Hogan C, Bade M, Stevens-Lapsley (2019) The relationship between lower extremity swelling, quadriceps strength, and functional performance following total knee arthroplasty. Knee 2019; 26:382-91.

ACKNOWLEDGEMENTS

- Rheumatology Research Foundation Graduate Student Preceptorship Grant
- Medi Corporation for donating the Circaid® Juxtafit Essentials compression garments utilized in this study.
- RJL Systems for donating a BIA system for use in this study.