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ORIGINAL ARTICLE

Randomized Trial Investigating the Efficacy of Manual Lymphatic Drainage to Improve Early Outcome After Total Knee Arthroplasty

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Abstract

Objective: To investigate the efficacy of manual lymphatic drainage (MLD) in the early postoperative period after total knee arthroplasty (TKA) to reduce edema and pain and improve knee range of motion.

Design: Prospective randomized controlled trial.

Setting: Private hospital and functional rehabilitation clinic.

Participants: Consecutive sample of patients (N=43; 53 knees) scheduled for TKA.

Intervention: MLD (vs no MLD) on days 2, 3, and 4 postoperatively. Both groups underwent conventional, concomitant physical therapy.

Main Outcome Measures: Clinical assessment was undertaken pre- and postoperatively prior to and after the designated postoperative MLD sessions (days 2, 3, and 4) and at 6 weeks postsurgery. This included active knee flexion and extension range of motion, lower limb girths (ankle, midpatella, thigh, and calf), and knee pain using a numeric rating scale and the Knee Injury and Osteoarthritis Outcome Score.

Results: A significant group effect was observed for active knee flexion, with post hoc tests demonstrating a significantly greater active knee flexion in the MLD group when compared with the control (no MLD) group at the final measure prior to hospital discharge (day 4 postsurgery) and at 6 weeks postsurgery. There were no further group effects observed for the remaining patient-reported and functional outcomes.

Conclusions: MLD in the early postoperative stages after TKA appears to improve active knee flexion up to 6 weeks postsurgery, in addition to conventional care.

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The incidence of articular cartilage injury to the knee is extremely common,[1] and given the poor capacity of cartilage to repair, the inevitable, long-term pathologic progression is to knee osteoarthritis (OA).[2] The most common treatment for severe knee OA is total knee arthroplasty (TKA),[3] and given the increasing number of patients with debilitating knee OA,[4] the number of patients undergoing TKA surgery is also expected to increase with time.[4-6]

Most patients experience a good clinical result after TKA[7]; however, 1 study reported that 15% of patients can have substantial dysfunction for a variety of reasons, including persistent pain, limited knee range of motion (ROM) secondary to edema, and/or the development of arthrofibrosis.[8] Because of the nature of orthopedic surgery, significant trauma and muscular tightness often result, which act to restrict tissue fluid movement creating edema, defined as excess fluid in the interstitium.[9] Acute edema immediately follows, brought about by a cascade of events produced by the body's inflammatory response to trauma.[10,11] Much of what we know about the tissue and edematous response to trauma have arisen through animal models,[11] which conclude with the release of excess plasma proteins into the interstitium. Although the body's lymphatic system is designed to cope with this process to a certain degree by absorbing these proteins and emptying them into the central circulatory system,[12] when the lymph load exceeds functional transport capacity and/or efficiency, this protein content stagnates in the interstitium.[12] This causes incompetence of the lymphatic system and persistent

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edema.[10] With respect to TKA, this may also create a local ischemia, which acts to increase postoperative pain through nutritional deprivation of the affected soft tissues.[13] The effect of swelling, inflammation, and pain on muscle inhibition has been well documented.[14]

Remedial massage techniques are often used to reduce edema and improve early postoperative pain and joint ROM. With regard to the postoperative TKA patient, one such technique that may be used is manual lymphatic drainage (MLD),[15,16] a light massage technique in a proximal to distal and then distal to proximal direction, following the lymphatic pathways.[10] MLD treatment is designed to optimize the lymphatic system by clearing lymphatic drainage areas adjacent to the regions of edema, and develop new pathways for travel.[10]

MLD has been shown to enhance blood circulation and stimulate the movement of lymphatic and other tissue fluids,[17] and it has demonstrated effectiveness in fluid clearance to different and unblocked lymphatic territories and the softening of tissues.[18] It is further proposed that increased clearance reduces local levels of inflammatory mediators, which are often associated with edema and pain.[11] In addition, physical pressure applied on hypertonic surrounding soft tissues and mechanical stretching of the contractile component of musculature can improve tissue tension,[19] potentially providing further improvement in edema and pain. Although passive knee ROM will improve from the aforementioned benefits of MLD, it is thought that active knee joint ROM may benefit additionally through the reduced influence of swelling, inflammation, and pain on muscle inhibition.[14] Restricted postoperative knee ROM remains one of the most frequent postoperative complications and indicators for patient dissatisfaction after TKA.[20]

The ability of massage to improve pain in patients with knee OA[21] and after arthroscopic knee surgery has been demonstrated,[22] although the benefits after TKA have yet to be investigated. The aims of this study were to investigate the efficacy of MLD in the early postoperative period after TKA to improve active knee flexion (primary outcome variable) and extension, and to reduce edema and knee pain, in addition to conventional postoperative care. We hypothesized that MLD used within the early inpatient hospital stay (days 2–5 postsurgery) would significantly reduce knee pain and lower limb girth while increasing knee ROM after treatment and at the time of hospital discharge. Furthermore, we hypothesized that these early benefits would be retained at 6 weeks postsurgery.

Methods

A randomized study design was used to allocate 43 patients (53 knees) scheduled for TKA between January and August 2012 to a postoperative MLD treatment or no-treatment protocol (fig 1). An a priori power calculation was initially determined based on the recommendations of Cohen,[23] which indicated that for an anticipated moderate effect size (d=.50) in the primary outcome variable (active knee flexion at 6wk), a total of 128 knees (64 in each group) was required to reveal differences at the 5% significance level, with 80% power. Because of time and funding limitations encountered with this study, we were unable to recruit the desired amount of patients within each treatment arm.

List of abbreviations:

ADL	activities of daily living
BMI	body mass index
KOOS	Knee Injury and Osteoarthritis Outcome Score
MLD	manual lymphatic drainage
NRS	numeric rating scale
OA	osteoarthritis
ROM	range of motion
TKA	total knee arthroplasty

Study eligibility was determined by the orthopedic surgeon, although patients were enrolled by a research coordinator not involved in the assessment of patients. Patients were invited to participate if they were either a man or woman, 45 to 90 years of age, had a primary diagnosis of knee OA, and provided acceptance of the study procedures. Patients were excluded if they were classified as morbidly obese with a body mass index (BMI) >40 because of the potential difficulty and reduced accuracy in the objective assessments used (eg, accurate palpation of anatomic landmarks when assessing knee ROM). Patients were also excluded if they had an active infection, malignant tumor, major cardiac pathology, or thrombus or venous obstruction that was prediagnosed or revealed on a routine preadmission hospital screening.[24,25] Concealed allocation was used, whereby randomization was also undertaken by the research coordinator using a random number generator (undertaken prior to study onset) that created a random list of numbers (1=MLD, or 2=no MLD). All patients underwent TKA surgery and early inpatient study measures in the Hollywood Private Hospital, and all 6-week measures were undertaken at the Hollywood Functional Rehabilitation Clinic. Ethics approval was obtained from the Hollywood Private Hospital Human Research Ethics Committee and was undertaken according to the Declaration of Helsinki.

All patients underwent TKA by a single experienced orthopedic surgeon specializing in joint replacement surgery. The prosthesis used in all patients was the Nexgen LPS-Flex Knee,[a] and a midline incision and medial parapatellar arthrotomy were used in all cases. Apart from the application of MLD to patients randomized to the treatment arm, as subsequently discussed, postoperative inpatient rehabilitation was standardized across all study patients. On the day after surgery (day 1), the orthopedic surgeon referred the patient to the hospital physiotherapist. Physical therapy was undertaken twice daily for the first 3 postoperative days and then once daily from day 4 until hospital discharge. This consisted of the following: teaching of proficient use of crutches and safe ambulation; ambulatory and transfer activities commencing on day 1, and as tolerated; deep breathing and coughing exercises; active dorsi- and plantarflexion of the ankle to encourage lower extremity circulation; and isometric contraction of the quadriceps, hamstrings, and gluteal musculature to maintain muscle tone and minimize muscle loss.

Knee-based exercises were undertaken in supine (active-assisted knee flexion using a bandage, inner range quadriceps contractions, and straight-leg raises), seated (active-assisted knee flexion using the contralateral limb and inner range quadriceps contractions), and standing (hip and knee flexion, active hamstring curls, lunges on a step, hamstring stretches) postures. These exercises were undertaken in sets of 10 repetitions, 3 times daily; the physiotherapist was present to assist, as required, on 2 occasions per day for the first 3 postoperative days and then once daily from day 4 until hospital discharge. Cryotherapy was used for 20 minutes at least 3 to 4 times daily; continuous passive motion was used for 1 hour, twice daily, initiated on day 1 postsurgery.

Between 12 PM and 2 PM on the second day (day 2) postsurgery, patients allocated to the MLD group underwent a standardized

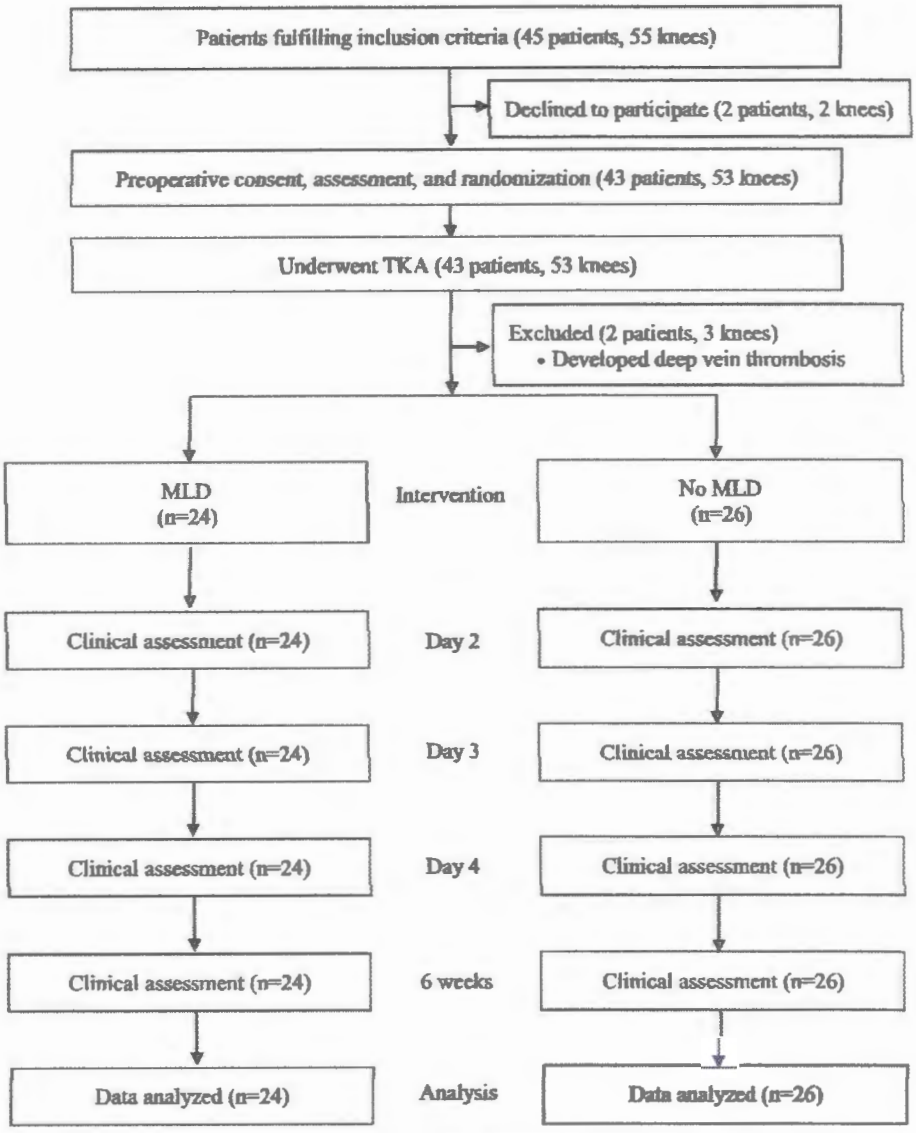

Fig 1 Patient randomization and assessment throughout the trial.

30 minute MLD treatment on the operated limb by an experienced remedial massage therapist trained in delivering MLD and post-operative lower limb orthopedic massage. Immediately before (10 AM–12 PM, morning assessment) and after (2 PM–4 PM, afternoon assessment) this designated MLD treatment time, all enrolled study patients (irrespective of group randomization) underwent clinical measures of knee pain, ROM, and knee and lower limb girth (subsequently discussed). These clinical measures were undertaken by the patient's allocated physiotherapist, who was blinded to the study randomization. However, although the same physiotherapist undertook the morning and afternoon measures on a particular patient on any given day, assessment by the same physiotherapist could not be guaranteed from one day to the next. This assessment and treatment process was repeated on days 3 and 4 postsurgery. At 6 weeks, clinical measures were again repeated, and at this time all patients were assessed by the same blinded therapist.

Effective MLD massage relies on clearance of proximal pathways, which is critical for the uptake of fluids by initial lymphatics and collecting ducts, and then the pumping away from the area to the cisterna chyli and thoracic duct.[18] Limb elevation while in a supine position, deep slow abdominal breathing to assist thoracic duct pumping, and application of gentle abdominal pressure (on exhalation) were followed by superficial inguinal lymph node stimulation.[12] Light, stationary circular movements were used to stimulate the superficial lymph nodes. Focus was initially on the proximal tissue, gradually moving distally to the area around the knee, popliteal region (and lymph nodes), and back proximally. The light hand movements over the skin stroke, stretch, and release the skin from the underlying subcutaneous tissue to allow filling and transport within the superficial ducts and collecting vessels.[12,26] Passive dorsi- and plantarflexion of the ankle were used to encourage lower limb lymphatic pumping.[26] This process of working proximal to distal and back again was repeated 3 to 4 times over the 30-minute massage period. Remedial massage techniques of rhythmic limb traction and release followed by a gentle rocking action of the limb were used at completion of the MLD treatment.[27]

The following clinical scores were undertaken at the aforementioned designated pre- and postoperative time points by the patient's allocated physiotherapist blinded to the study randomization. First, active knee flexion and extension were measured using a handheld goniometer, creating an angle made by 3 anatomic landmarks: the greater trochanter of the femur at the hip, the lateral femoral condyle at the knee, and the lateral malleolus at the ankle. The patient initially lay supine with both legs extended. They were then instructed to keep their heel on the hospital bed at all times and move their foot (ie, flex their knee) proximally toward their bottom as far as possible, with the maximum knee flexion being recorded. The patient was then instructed to straighten the leg by actively forcing the knee into the bed, with the maximum extension, or hyperextension, recorded. This process was undertaken 3 times, and the maximum values were recorded.

Second, a series of lower limb girths was taken to assess the degree of edema at and around the operation site. These were taken with the knee flexed to 20° and included the following: (1) knee circumference at the level of the midpatella; (2) ankle circumference 3cm proximal to the lateral malleolus at the ankle; (3) thigh circumference one third of the distance proximally from the midpatella to the anterior superior iliac spine; and (4) shank circumference one third of the distance distally from the midpatella to the lateral malleolus at the ankle. Treating physiotherapists undertaking the patient assessments were educated on a standardized protocol for girth measurement. This initially involved marking of the designated skin locations using a semipermanent marker on the first postoperative assessment to ensure that all measures from that point on could be replicated as accurately as possible. For each subsequent girth measure, the tape measure was then placed distal to the mark, tightened to allow a firm tape without skin depression, and recorded. This process was undertaken twice for each site, and the minimum value was recorded. The midpatella site could not be marked because of the postoperative wound dressing; for this reason, appropriate palpation and measurement was required each time. Although error in tape measure girths may be present, best evidence suggests that circumferential measurement is satisfactory when chosen segments are consistently used throughout the evaluation interval.[28,29]

Third, a numeric rating scale (NRS) was used to assess the level of knee pain at rest, on a whole number rating scale from 0 (no pain) to 10 (worst pain). Patients were asked to circle the number that best corresponded to their knee pain level. Finally, the Knee Injury and Osteoarthritis Outcome Score (KOOS)[30] was used preoperatively and at 6 weeks postoperatively. The KOOS is a knee-specific questionnaire that includes 42 questions in 5 individual subscales: pain, symptoms, activities of daily living (ADL), sport and recreation, and knee-related quality of life. Each of these 5 subscales is scored from 0 (worst) to 100 (best).

A repeated-measures analysis of variance was initially used to investigate differences in the primary outcome variable (active knee flexion) between the MLD and control groups over the 6-week period, followed by secondary subjective (NRS and KOOS subscales) and objective outcome (active knee extension and lower limb girths) measures. In the occurrence of significant main or interaction effects, a protected Bonferroni post hoc correction was used to assess significant findings between the 2 groups at specific assessment time points. Statistical analysis was performed using SPSS software (version 17.0),[b] where experimental significance was set at an alpha of .05.

Results

We approached 45 consecutive patients (55 knees) scheduled for TKA with a single surgeon to participate in this study, of which 2 patients declined (see fig 1). Of the 43 patients (53 knees) enrolled and randomized, 2 patients (1 bilateral) were excluded immediately postsurgery because of the presence of deep vein thrombosis, a contraindication for MLD (see fig 1), and did not undergo any postoperative treatment or assessments. Therefore, the analysis undertaken includes a total of 41 patients (50 knees) with complete follow-up to 6 weeks postoperatively; 24 patients randomized to the MLD treatment, and 26 patients randomized to the no-treatment protocol (table 1). Patient demographics appeared similar between the 2 groups and are summarized in table 1.

A significant group effect ($P<.05$) was observed for active knee flexion (primary outcome variable), and post hoc testing demonstrated a significantly greater active knee flexion in the MLD group at the second assessment time on day 4 postsurgery ($P=.014$; effect size=.79; 95% confidence interval, 1.68−16.67) and at 6 weeks postsurgery ($P=.012$; effect size=.87; 95% confidence interval, 2.32−16.78) when compared to the no MLD group (table 2 and fig 2). There were no significant group or interaction effects ($P>.05$) for active knee extension or lower limb girths (see table 2). Although this rendered the post hoc investigation invalid, after the initial postoperative assessment, the MLD group demonstrated a lower active knee extension at all time points, culminating in a 3.84° difference at 6 weeks postoperatively (see table 2 and fig 2).

There were no significant group or interaction effects ($P>.05$) for any of the subjective scores (see tables 2 and 3). Although this rendered the post hoc investigation invalid, a lower NRS score was reported in the MLD group (1.50) at 6 weeks postsurgery when compared with the no MLD group (3.00) (see table 2).

Discussion

TKA is a traumatic orthopedic procedure, and as a result of the significant trauma and muscular tightness that occurs, tissue fluid movement is restricted, which creates persistent edema. The aim of this study was to investigate the efficacy of MLD in the early postoperative period after TKA to reduce edema and knee pain and, most importantly, improve active knee ROM, in addition to conventional postoperative care.

As outlined by Ranawat et al,[8] the goal after TKA surgery is to prepare patients so that they can participate in ADL or return

Table 1 *Preoperative descriptive parameters for the (MLD) and control (no MLD) groups*

Parameter	Treatment (MLD)	Control (no MLD)
No. of knees	24	26
Sex (M/W)	17/7	19/7
Age (y)	70.80 (48.00−89.00)	69.20 (51.00−87.00)
Height (m)	1.73 (1.46−1.88)	1.72 (1.50−1.91)
Body weight (kg)	84.20 (60.10−107.00)	81.50 (55.00−119.40)
BMI	28.20 (23.90−32.50)	27.70 (20.60−38.50)

NOTE. Values are means (range) or as otherwise indicated.
Abbreviations: M, men; W, women.

Table 2 Pre- and postoperative clinical outcomes (active knee ROM, lower limb girth, and knee pain) for the MLD and control (no MLD) groups

Time Point	Group	Active Knee Extension (deg)	Active Knee Flexion (deg)	Midpatella Girth (cm)	Thigh Girth (cm)	Calf Girth (cm)	Ankle Girth (cm)	NRS (0–10)
Presurgery	MLD	4.50±3.38	124.04±9.91	41.40±2.51	47.88±3.13	36.75±2.15	23.24±1.22	4.67±1.59
	No MLD	5.30±4.92	127.31±10.34	40.63±2.92	46.66±4.01	36.21±2.82	22.82±0.98	4.71±1.64
Day 2 (A)	MLD	4.29±3.15	84.33±15.16	47.31±2.58	53.37±3.54	39.29±2.61	23.94±1.75	1.71±1.00
	No MLD	4.00±3.41	82.62±16.10	45.95±3.01	52.12±3.94	38.61±2.58	23.17±1.02	1.62±0.91
Day 2 (B)	MLD	2.42±1.39	91.92±13.22	47.24±2.32	53.01±2.13	39.53±2.07	24.02±1.34	1.31±1.21
	No MLD	3.85±3.88	86.58±13.24	45.94±3.09	52.03±3.42	38.63±3.24	23.29±1.29	1.38±1.06
Day 3 (A)	MLD	2.96±2.36	89.42±14.01	47.08±3.12	53.26±2.54	39.77±1.87	24.16±1.54	1.46±1.10
	No MLD	3.36±2.44	87.96±13.57	45.78±2.94	53.09±2.91	39.32±2.26	23.77±1.72	1.88±1.38
Day 3 (B)	MLD	2.63±2.36	90.58±12.36	47.18±2.89	52.89±3.30	39.74±1.81	24.13±1.71	1.54±1.27
	No MLD	3.20±2.59	89.28±13.36	45.90±2.67	52.90±3.81	39.45±2.05	23.82±1.68	1.50±1.11
Day 4 (A)	MLD	2.13±1.94	92.13±13.13	46.77±2.34	52.78±2.81	40.15±1.47	24.68±1.15	1.54±1.43
	No MLD	2.48±1.37	87.30±13.45	46.05±2.45	53.21±3.14	39.68±2.36	24.69±1.09	2.13±1.73
Day 4 (B)	MLD	1.30±0.82	97.39±10.02	46.63±2.54	52.52±3.25	39.90±1.95	24.20±1.63	1.79±1.29
	No MLD	2.78±1.76	88.22±13.15	46.08±2.99	53.08±4.18	39.80±2.47	24.91±1.78	2.00±1.08
6-wk postsurgery	MLD	1.77±1.43	118.95±8.89	42.83±2.22	47.55±2.91	36.54±1.58	23.28±1.11	1.50±1.10
	No MLD	5.61±4.22	108.96±14.12	42.63±2.57	47.00±3.01	36.24±1.82	23.44±1.31	3.00±1.28
Time effect (*P*)		<.001	<.001	.001	.823	.118	<.001	.007
Group effect (*P*)		.067	.031	.242	.962	.733	.789	.214
Interaction effect (*P*)		.162	.040	.464	.056	.412	.008	.189

NOTE. Values are means ± SD or as otherwise indicated.
Abbreviations: A, morning assessment; B, afternoon assessment.

to sporting activities. However, in addition to the development of required muscle strength, active knee ROM should be maximized and normative ambulatory mechanics restored. Certainly, the success of TKA is often measured based on the restoration of knee ROM.[31] Significant benefits were demonstrated in active knee flexion as a result of the MLD intervention in this study. In each MLD treatment, a greater improvement in active knee flexion was observed in the MLD group compared with controls. In particular, the largest comparative gains were made on the first (MLD, 7.59°; no MLD, 3.96°) and third (MLD, 5.26°; no MLD, .92°) MLD treatments on days 2 and 4, respectively. Although not statistically significant, a similar trend was exhibited for active knee extension, whereby the first MLD treatment on day 2 postoperatively resulted in a 1.87° decrease in knee extension compared with only .15° in the controls, whereas the third and final MLD treatment on day 4 resulted in a .42° fall in the MLD group compared with a .30° increase in controls. This would suggest that the largest gain offered by early postoperative MLD (day 2) was the activation of the lymphatic circulatory system for early interstitial fluid movement. However, the accumulative effect over the 3-day MLD treatment period produced a significantly greater active knee flexion in the MLD group, compared with controls, at the final inpatient assessment time on day 4. This significant difference was retained at 6 weeks postsurgery.

After TKA, passive knee ROM at the time of hospital discharge appears to be strongly associated with passive ROM at 12 months postsurgery[32]; however, the greatest change in ROM occurs within the first 12 months with little improvement thereafter.[33] Although we assessed active knee ROM in this study, anecdotally we observed a clear association between passive and active ROM after TKA surgery. A difference of 1.48° in extension and 9.17° in flexion, both in favor of the MLD group, was observed at the final assessment time point prior to hospital discharge. Furthermore, a significantly better active knee flexion was demonstrated in the MLD group at hospital discharge and at 6 weeks postsurgery. In addition to the associated long-term benefits in knee ROM that result from the attainment of higher acute (inpatient) knee ROM, Davies et al[34] also demonstrated that patients with a discharge knee ROM <60° were likely to have a longer rehabilitation period, a slower return to functional ROM, and use more health services than those with a discharge ROM >60°. This further highlights the critical importance of improving the patient's knee flexion as early as possible postoperatively to provide sound long-term knee movement. Based on these results, it would appear that MLD in the early postoperative phase may provide an avenue for therapists in assisting with this progression in active knee flexion.

Returning the patient to full active knee flexion is imperative to his or her ability to undertake a range of normative ADL. Activities, such as rising from sitting (93°), ascending stairs (105°), descending stairs (107°), and picking an object up off the floor (117°), require high levels of active knee flexion.[35] Although previous research suggests that patients after TKA generally acquire 95° to 114° at 12 months postsurgery,[32,33,36,37] the results of this study suggest that patients undergoing MLD have the active flexion (118–119°) at 6 weeks postsurgery required to undertake all of the aforementioned daily tasks, unlike those that did not have MLD in the acute postoperative stages. Furthermore, Devers et al[20] demonstrated that greater postoperative knee flexion was correlated with a higher level of perceived patient satisfaction, whereas patients with <110° of knee flexion were not satisfied with their TKA outcome, nor did they perceive their knee function or quality of life any better than presurgery. Again, this highlights the importance of early attainment of active knee flexion for long-term actual and perceived benefits.

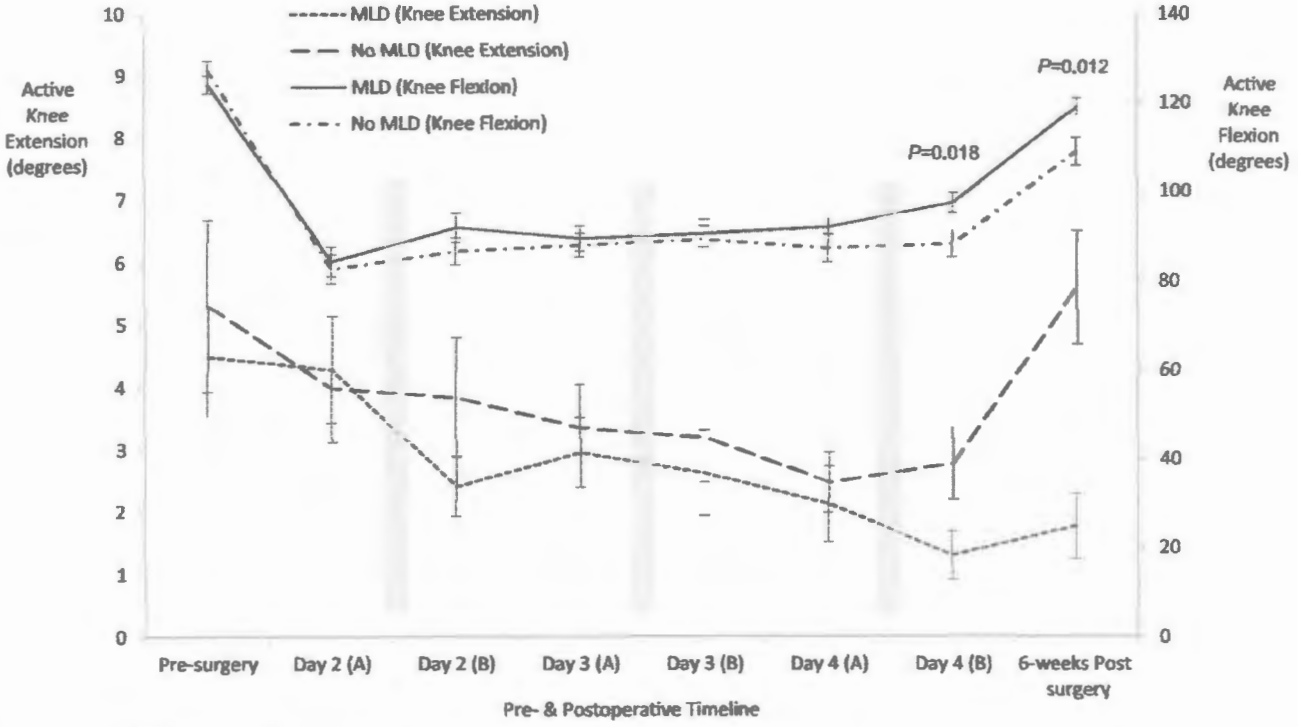

Fig 2 *Active knee extension (degrees from full extension, left vertical axis) and flexion (degrees, right vertical axis) ROM over the pre- and* postoperative timeline for MLD and control (no MLD) groups. The MLD group demonstrated significantly greater knee flexion range on day 4 postsurgery (4B: the final measure prior to hospital discharge) ($P=.018$) and at 6 weeks postsurgery ($P=.012$). Shown are means ± SE. The vertical gray shaded bars indicate the MLD treatments on days 2, 3, and 4. Abbreviations: A, morning assessment; B, afternoon assessment.

Interestingly, the aforementioned improvements in active knee flexion did not translate to differences in patient function, as indicated by the KOOS ADL subscale. As also mentioned previously, a high degree of active knee flexion is imperative for undertaking a range of daily tasks.[35] However, the KOOS ADL subscale also incorporates activities such as stair ascent/descent, bending to the floor to pick up an object, and performing heavy domestic duties, which are all activities that many patients have difficulty with within the first 6 weeks after TKA (unilateral or bilateral). Although we may expect to see an association between improved active knee flexion and ease in performing these activities at a later postoperative stage, the time frame by which the KOOS ADL subscale was used may have been too early, thereby not providing a true reflection of how knee ROM may influence patient function. Furthermore, although anecdotally we have found that patients who undergo bilateral TKA are able to discriminate pain between the 2 knees, function can be a more difficult entity to separate. Given that we had a high number of bilateral TKA patients in this sample, the KOOS ADL subscale may have been compromised.

There were no significant differences in reported pain (NRS or KOOS pain subscale) or lower limb girth measures between the 2 groups throughout the inpatient MLD treatment period. This would suggest that the improvement in active knee flexion throughout this period, culminating in significantly greater active knee flexion in the MLD group on hospital discharge and at 6 weeks postsurgery, has been influenced by factors other than pain and swelling. Anecdotally, patients do tend to report reduced pain and an improved sense of relaxation from the MLD massage therapy. Although pain scores did not necessarily reflect this, an improved feeling of well-being and a more relaxed physical and/or mental state provided by the calming effect of the treatment

Table 3 Preoperative and 6-week postoperative KOOS for the MLD and control (no MLD) groups

Time Point	Group	KOOS Pain	KOOS Symptoms	KOOS ADL	KOOS Sport and Recreation	KOOS Quality of Life
Presurgery	MLD	50.75±11.60	52.16±11.32	54.01±14.98	18.44±15.62	24.35±14.23
	No MLD	50.86±9.98	59.07±12.56	56.62±12.91	14.04±13.80	28.85±14.99
6 wk postsurgery	MLD	68.23±12.32	73.14±9.82	75.46±11.30	10.21±12.13	51.04±11.23
	No MLD	67.79±13.00	72.32±10.37	72.37±12.08	8.85±12.66	50.07±12.45
Time effect (P)		<.001	<.001	<.001	.006	<.001
Group effect (P)		.962	.399	.943	.463	.672
Interaction effect (P)		.921	.167	.227	.514	.373

NOTE. Values are means ± SD or as otherwise indicated.

decreased muscle tension and/or reduced involuntary muscular contraction used as a joint protective mechanism were not benefits that would have been measured through the applied clinical scoring tools.

Furthermore, a range of other factors has been reported to affect the progression and final postoperative knee ROM, including preoperative knee ROM, pain, physical activity level, age, BMI, underlying disease and tibiofemoral varus/valgus angle, surgical technique, implant design, height of the postoperative joint line, patellar diameter, and postoperative physical therapy.[8,33,35,38-45] Although preoperative knee ROM[36,42,46] has been shown to influence postoperative ROM, both groups in this study had comparable preoperative knee flexion and extension. Furthermore, preoperative patient demographics (age, height, weight, BMI) were comparable, surgery was performed by 1 orthopedic surgeon using a particular knee prosthetic implant, and apart from the MLD treatment, postoperative physical therapy was standardized for both groups. However, preoperative patient activity level was not acquired, nor were other measures including tibiofemoral anatomic angle, patellar diameter, and height of the postoperative joint line. Although it is unlikely that significant group differences in these variables were present, any minor differences may provide potential answers to the observed differences in knee movement.

Study limitations

In addition to the aforementioned study design issues, such as the wide array of factors that can affect knee ROM postoperatively, several other study limitations did exist. First, our attempt to blind reporting and measurement bias was attained by ensuring that all inpatient clinical assessments were undertaken by an independent physiotherapy group blinded to patient randomization. Daily clinical assessments (morning and afternoon) and MLD treatments were undertaken within the same time period each day to ensure that the supervising physiotherapist had no contact with the remedial massage therapists providing treatment to patients randomized for MLD. Patients were also informed several times not to discuss study information with their supervising physiotherapist; however, although efforts were made, complete blinding of a study of this type proves difficult. Furthermore, although all preoperative and 6-week postoperative assessments were undertaken by the same blinded therapist, and the same physiotherapist undertook the morning and afternoon measures on a particular patient on any given day, assessment by the same physiotherapist could not be guaranteed from one day to the next. In total, 4 were involved in the patient evaluation process.

Second, there are known limitations with the objective measures used, with particular reference to lower limb girth measures. Although the physiotherapists were well educated on a standardized protocol for assessing these girths, small differences with respect to tape position and alignment, overlapping of the tape, and pressure placed on the tape/limb can result in girth error. The postoperative wound dressing meant that the midpatella girth site could not be marked for consistent site location. This potential for error, in combination with our inability to assess intra- or intertester reliability for girth and knee ROM measures because of time and personnel constraints, limited the accuracy and reproducibility of such objective measures.

Third, in order to ensure no contact between supervising physiotherapists and remedial massage therapists entering and exiting patient rooms throughout the patient's inpatient hospital stay, it was necessary to provide a designated time frame for clinical assessment and MLD treatment. Therefore, we were unable to control the frequency and intensity of patient activity after the MLD treatment and up until the afternoon clinical assessment. This delay may have influenced the girth measures, and had the clinical assessment after the MLD treatment been taken immediately after treatment, differences in girth measures may have been observed, with possibly greater differences in knee movement than those measured.

Fourth, self-reported questionnaires (NRS and KOOS) were used to assess patient pain and function pre- and postoperatively. Although patients were asked to answer all questionnaires truthfully and to the best of their ability, the degree of potential bias resulting from patient knowledge of their own treatment protocol (MLD vs no MLD) remains unknown.

Finally, because of aforementioned time and funding problems, we were unable to recruit the desired amount of patients within each treatment arm. Therefore, although statistical significance was indeed observed between the 2 groups (MLD and no MLD) for our primary outcome variable (active knee flexion), the patient sample was underpowered to detect differences in secondary outcome variables, such as active knee extension and pain scores of an effect size $<.80$ at a single time point. Group differences were observed, but they were not statistically significant at $P=.05$. Furthermore, patients were recruited from a single surgeon, which may be seen to reduce generalizability of study outcomes. TKA remains a traumatic procedure in the hands of any orthopedic surgeon, but we also see this as an important strength of the study in that all patients underwent TKA using the same prosthesis and approach by an experienced surgeon specializing in joint replacement surgery.

Conclusions

The ability of massage to improve pain in patients with knee OA[21] and after arthroscopic knee surgery has been demonstrated.[22] *However, to our knowledge, any benefit that may relate specifically* to postoperative TKA does not exist, nor does the use of MLD as a specific type of massage therapy to aid in traumatic edema, a result of TKA. Our results suggest that MLD in the early postoperative stages may be beneficial for improving active knee flexion; however, the clinical significance of this effect is currently unclear, despite previous research demonstrating the strong association between early knee ROM on hospital discharge and long-term outcome.[32] The increased knee flexion in this study did not translate into superior patient-reported knee function and activity at 6 weeks. A longer-term follow-up of these patients and a greater sample may clarify our findings, and future studies require a greater patient sample and should include a cost-benefit analysis.

Suppliers

a. Zimmer, PO Box 708, 1800 W Center St, Warsaw, IN 46581-0708.
b. SPSS Inc, 233 S Wacker Dr, 11th Fl, Chicago, IL 60606.

Keywords

Arthroplasty, replacement, knee; Massage; Rehabilitation

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