Original Article

The Modified Robert Jones Bandage Does Not Improve Performance or Functional Outcome after Total Knee Arthroplasty: A Randomized Controlled Trial

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Objective: Pain and effusion after surgery can lead to limited range of motion (ROM) and quadriceps dysfunction. The modified Robert Jones bandage (MRJB) has been proposed to reduce bleeding, pain, tissue edema, effusion and hemarthrosis after total knee arthroplasty (TKA). However, the benefit of the MRJB in improving performance and functional outcome after TKA is still questionable. The present study compared timed up-and-go test scores (TUG) and Oxford knee score (OKS) between cases using the MRJB and those using a non-compressive dressing (NCD) after TKA.

Materials and Methods: Seventy patients undergoing unilateral primary TKA were randomly assigned to one of two groups of 35 patients each according to type of postoperative dressing. Group 1 had an MRJB applied for 24 hours while Group 2 received an NCD. Six weeks after surgery, TUG and OKS were measured and scores were compared between the groups. Postoperative drained blood loss, pain score, degree of knee swelling, ROM, and complications were also recorded and compared as secondary outcomes.

Results: There were no significant differences in the mean TUG scores (MRJB 16.5±7.5 scores versus NCD 17.6±11.4 scores, p=0.769) or mean OKS (MRJB 34.8±5.6 points versus NCD 35.3±5.8 points, p=0.722). Postoperative drained blood loss, pain score, degree of knee swelling, ROM, and complications were also similar between the group using the MRJB and that using an NCD.

Conclusion: The use of the MRJB does not improve either performance or functional outcome after primary unilateral TKA.

Trial registration: Clinicaltrial.gov NCT02701946.

Keywords: Knee arthroplasty, Bandage, Dressing, Performance, RCT

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The Robert Jones bandage is a thick, bulky compressive dressing frequently used after injuries and after elective orthopedic surgery. According to a review by Brodell et al[1], Charnley[2] was the first to describe it as "…three layers of wool and three layers of domette bandage. The layers were put on gently but firmly and the whole bandage extended some six inches above and below the knee and attained a thickness of about two inches". This bandage was later modified by changing the materials and application techniques[1,3,4] to produce the modified Robert Jones bandage (MRJB).

The MRJB was proposed to reduce bleeding, tissue edema, effusion, and hemarthrosis by the tamponade effect[1,5]. It also has been applied after total knee arthroplasty (TKA). To quantify its compressive capacity, Brodell et al(1) measured and monitored the anterolateral compartment of the leg in patients after TKA. They found the MRJB could create and maintain an external compressive force for at least 24 hours after surgery. In clinical applications, pain and effusion after surgery can lead to limited range of motion (ROM) and quadriceps dysfunction[6]. Theoretically, the use of the MRJB should help improve the ROM,

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functional outcome, and performance of patients after TKA.

The efficacy of the MRJB is still questionable and has never been conclusively demonstrated. Some studies have reported that the use of the MRJB could reduce pain and swelling after surgery[7,8] while other studies recommend against its use[4]. To the best of the authors' knowledge, no study has focused on the improvement of performance and functional outcome after TKA from using the MRJB. Therefore, the authors aimed to compare 1) timed up-and-go test scores (TUG), 2) Oxford knee score (OKS), and 3) ROM six weeks after TKA surgery in patients receiving the MRJB and those receiving a non-compressive dressing (NCD).

Materials and Methods

A randomized controlled trial was conducted between March 2016 and January 2017 with 70 patients diagnosed with primary osteoarthritic knee who were undergoing unilateral primary TKA. The exclusion criteria were patients who had coagulation disorders, had received an antiplatelet drug within the previous week, had a history of thromboembolic events, had vascular compromise in the operated limb, had chronic kidney disease, had liver cirrhosis, were allergic to tranexamic acid, sulfa, or morphine, were not able to follow the anesthetic protocol, or refused to participate in the study.

Sample size estimation was based on discovering a minimal detectable change of 2.27 seconds in TUG time after TKA[3]. To be able to test the difference between two independent means (two-tailed test) with an alpha value of 0.05, a beta value of 0.1 and a within-group SD of 2.9 seconds[9], the necessary a sample size was calculated to be 35 patients per group. Assuming a dropout rate of approximately 10%, the authors aimed to enroll a minimum of 80 patients in the present study (40 patients per group). Informed consent was obtained from all participants. Patients were randomized to each intervention arm via the block-of-ten method. A randomized sequence was generated using a computer program and then concealed in individual opaque envelopes.

All procedures were performed using the same anesthetic method (spinal anesthesia without morphine and an adductor canal block) and the same surgical technique was used by two experienced knee surgeons (Chareancholvanich K and Narkbunnam R). All patients received 10 mg/kg of intravenous tranexamic acid (Transamin 250 mg/5 mL, OLIC, Thailand) before the tourniquet was inflated and again three hours after the operation. They then received 1,500 mg orally (Transamin 250 mg/capsule, OLIC, Thailand) per day for five days[10]. The tourniquet was inflated to a pressure of 300 mmHg before skin incision and was deflated after the dressing had been applied. A mini-medial parapatellar approach was used. A cemented posterior-stabilized TKA (Nexgen LPS-Flex, Zimmer, Warsaw, Indiana, USA) was implanted in all patients without patellar resurfacing. The periarticular analgesic cocktail, which included 20 mL of 0.5% bupivacaine, 20 mL of normal saline and 30 mg of ketolorac and 1 mL of 1% lidocaine with adrenaline, was injected before wound closure. One Ultravak drain (Poly Medicure Limited, India) was placed intra-articularly and left in place for 48 hours after surgery.

At the conclusion of the operation, the patients were randomly assigned to one of two groups, the MRJB group (Group 1) or the NCD group (Group 2). In the MRJB group, sterile gauze pads were placed over the wound, followed by Webril padding (Covidien plc, Mansfield, MA, USA). The thick cotton wool layers were put on firmly, each overlapping the previous layer by half and at each turn and extending from above the ankle joint to six inches above the knee. The elastic layers were pulled snugly, with more tension distally than proximally. Before wrapping each turn, the elastic bandage was stretched to approximately two inches below and 1.5 inches above the tibial tuberosity level. The entire bandage, including the Webril padding, three layers of cotton wool, and two layers of elastic bandage, attained a thickness of about two inches at the knee joint (Figure 1). In the NCD group, sterile gauze pads were placed over the wound, which were then covered with hypoallergenic self-adhesive, non-woven fabric tape (Figure 2). All wound dressings were applied before tourniquet deflation.

After surgery, all drains were clamped for three hours, released for three hours and re-clamped for three hours after which the drain ran continuous and the clamp was permanently released[11]. Ankle pumping, ROM exercise, and ambulation on the bed were started as soon as possible. Cold compression was applied around the knee for at least eight hours per day. The MRJB was left in place for 24 hours and then changed to an NCD. The postoperative pain management protocol included 40 mg of intravenous parecoxib every 12 hours for two days followed by 25 mg of diclofenac and 300 mg of acetaminophen with 15 mg of codeine orally every eight hours until discharge. Patients with blood loss per wound or

Figure 1. A modified Robert Jones bandage (MRJB).

Figure 2. A non-compressive dressing (NCD).

unintended drainage tube migration were excluded from analysis.

Drained blood volumes as well as maximal visual analogue pain scores at rest and during ambulation were recorded at 24 and 48 hours after surgery. Degree of knee swelling was determined based on changes in knee and thigh circumferences (TC) from preoperative baseline at 24 and 48 hours postoperatively. Knee

Table 1. Patient characteristics

Characteristic	MRJB group (n = 35) Mean±SD	NCD group (n = 35) Mean±SD
Age (year)	69.3±8.2	71.0±8.3
Sex (female:male), n	28:7	33:2
Operated limb (right:left), n	22:13	20:15
Weight (kg)	65.2±14.0	60.4±9.4
Height (cm)	156.5±7.5	152.4±5.4
BMI (kg/m^2)	26.5±5.0	26.0±3.8
Preoperative ROM (degrees)	116.9±15.7	110.1±16.7
Operative time (minutes)	81.9±24.2	73.2±15.1
Preoperative OKS (points)	26.7±5.7	25.4±7.1

MRJB=modified Robert Jones bandage; NCD=non-compressive dressing; BMI=body mass index; ROM=range of motion; OKS=Oxford knee score

circumference (KC) was measured at the mid-patellar level, and TC was measured at 7 cm above mid-patellar level. Measurements were recorded to the nearest 1 mm using an ordinary tape measure[12]. ROM was measured at discharge and two and six weeks after surgery. As the primary outcome, TUG and OKS were recorded at six weeks after TKA. Complications, including skin complications (ecchymosis, blisters, subcutaneous hematoma), wound infection, peroneal nerve palsy, and venous thromboembolism were also recorded.

Statistical analysis was performed using SPSS version 18.0 (IBM, Chicago, IL, USA). Numerical and categorical data were described using mean ± standard deviation (SD) and percentage, respectively. The Kolmogorov-Smirnov test was used to determine the normality of data. Group differences in numerical data were analyzed using the unpaired t-test for normally distributed data and the Mann-Whitney U test for non-normally distributed data. Chi-square or Fisher's exact test were used to compare the categorical data. A p-value smaller than 0.05 was set as the level for statistical significance.

Results

Eighty-six patients were recruited and randomized into the two groups. After assessment for eligibility, six patients were excluded due to cirrhosis (2), chronic kidney disease (1), and inability to follow the anesthetic protocol (3). However, an additional five patients in each group were excluded from the analysis because of blood loss per wound (one from the MRJB group and two from the NCD group) and unintended drainage tube migration (four from MRJB and three

Table 2. Outcome variables of interest

Variable	MRJB group (n = 35) Mean±SD	NCD group (n = 35) Mean±SD	p-value
Drained blood volume (mL)			
0 to 24 hours	204.9±160.5	206.0±108.9	0.972
24 to 48 hours	108.7±99.5	118.3±93.2	0.544*
0 to 48 hours	313.6±232.9	324.3±166.6	0.826
VAS of postoperative first day (points)			
At rest	1.5±1.9	1.5±2.0	0.883*
During ambulation	1.5±2.3	2.0±2.5	0.369*
VAS of postoperative second day (points)			
At rest	1.5±2.0	1.5±2.3	0.812*
During ambulation	1.7±2.3	1.3±2.0	0.506*
Knee circumference (mm)			
Preoperative	374.1±43.5	375.1±20.7	0.903
Change in first day	15.0±17.0	16.4±14.5	0.609*
Change in second day	7.3±13.8	–0.5±20.0	0.031*
Overall change	22.3±21.6	15.9±22.5	0.228
Thigh circumference (mm)			
Preoperative	416.3±51.3	407.1±35.7	0.525*
Change in first day	16.4±21.2	21.9±16.4	0.174*
Change in second day	6.7±13.3	6.9±12.8	0.572*
Overall change	23.1±21.0	28.8±18.5	0.231
ROM (degrees)			
At discharge	84.9±10.0	85.3±10.4	0.640*
At 2 weeks	93.7±10.1	94.4±9.2	0.578*
At 6 weeks	105.6±12.0	106.3±10.9	0.753*
OKS at 6 weeks (points)	34.8±5.6	35.3±5.8	0.722
TUG at 6 weeks	16.5±7.5	17.6±11.4	0.769*

MRJB=modified Robert Jones bandage; NCD=non-compressive dressing; VAS=visual analogue pain score; ROM=range of motion; OKS=Oxford knee score; TUG=timed up-and-go test

* Mann-Whitney U test used for non-normally distributed data

from NCD. Baseline characteristics of the patients in both groups are shown in Table 1. There were no significant differences in amount of drained blood volume, maximal VAS scores at rest or during ambulation between the two types of dressing (Table 2). Comparison of the degree of swelling showed no significant change of KC one day after surgery. On day two, the MRJB group had a significantly larger change of KC compared with the NCD group (p=0.031). However, overall change of KC within 48 hours was comparable between the groups. No significant differences in the change of TC between the MRJB and NCD groups were observed (Table 2).

Assessment of postoperative ROM showed no significant differences between the two groups at discharge, two, or six weeks after surgery. The primary outcome in the present study, TUG at six weeks in the MRJB group was 16.5±7.5 scores, and in the NCD group was 17.6±11.4 scores (p=0.769). OKS at six weeks was also comparable between both groups (p=0.722) (Table 2). Complications following surgery were skin complications including five ecchymosis and one subcutaneous hematoma in six patients in the MRJB group and three ecchymosis and one subcutaneous hematoma in the NCD group (p=0.495). All patients had spontaneous recovery. No patients in the present study had blisters, peroneal nerve palsy, infection, or venous thromboembolism.

Discussion

To the best of the authors knowledge, the present study was the first that proves the efficacy of the MRJB in improving performance and functional outcome of patients after TKA. The important findings of the

present study are no significant differences between the MRJB and an NCD in either TUG or in OKS six weeks after TKA surgery. Based on Osteoarthritis Research Society International (OASRI) reports, TUG is one of the recommended performance-based tests for assessing physical function in people diagnosed with hip or knee osteoarthritis[13]. Currently, this test is commonly used with TKA patients[9,14,15]. TUG measures time in seconds taken to rise from a chair, walk three meters, turn, walk back to the chair, and then sit down. It can test the muscle strength, agility, and dynamic balance of a patient.

The secondary findings demonstrated that there were no significant differences in drained blood loss, maximal pain scores either at rest or during ambulation, TC, ROM at discharge, at two or six weeks after surgery, as well as and no significant differences in the incidence of complications. In terms of changes in KC after removing the dressing, the MRJB group had significantly more swelling than the NCD group. That difference might have been caused by the compressive effect of the MRJB. However, the tamponade effect was not great enough to significantly reduce the overall change of KC and TC. In addition, these two variables had wide standard deviation. A larger sample size would be required to prove these outcomes demonstrate any significant differences in KC and TC between the two bandage types.

Another randomized control trial, by Pinsornsak et al[4], similarly found no significant differences in blood loss, blood transfusion, pain score, thigh and leg circumference, or complications between using the MRJB and an NCD after TKA. However, those authors did not evaluate either postoperative ROM or functional outcome and performance. In a comparison with cryotherapy, Web et al[16] reported that the use of the MRJB had resulted in more pain, drained blood loss, and blood transfusion. Gibbons et al[17] also reported that the use of MRJB resulted in more drained blood loss, but found no difference in blood transfusion, pain, ROM, or complications. Smith et al[18] found no significant differences in drained blood loss, blood transfusion, pain, swelling, and ROM between using the MRJB and a cold dressing.

The present study has several limitations. First, only patients diagnosed as primary osteoarthritic knee and undergoing unilateral TKA were enrolled in the study, so the generalizability of our results to secondary osteoarthritis or bilateral TKA procedures is limited. Second, we did not include patients with bleeding or coagulation disorders. Third, to facilitate early ambulation, we applied the MRJB for only 24 hours postoperatively; longer use of the MRJB might have affected the results. Fourth, although we tried to control the application method of the MRJB, the pressure underneath the bandage was not directly measured, so the sub-bandage pressure could have varied in each patient. Measurement of sub-bandage pressure is not used in routine practice. Finally, the present study used a blood loss management protocol, which included administration of tranexamic acid and a three-hour interval drain clamping technique; a different protocol might have altered the outcomes.

Conclusion

The use of the MRJB does not improve either performance or functional outcome after primary unilateral TKA.

What is already known on this topic?

It has been proposed that the MRJB reduces bleeding, pain, tissue edema, effusion, and hemarthrosis after total knee arthroplasty.

What this study adds?

This study found no benefit from using the MRJB in terms of improved performance or functional outcome after primary total knee arthroplasty.

What are the implications for public health practice?

The authors do not recommend the routine application of the MRJB after unilateral primary total knee arthroplasty. However, the application of MRJB in particular patients, e.g., those with bleeding or coagulation disorders, might be considered.

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Authors' contributions

Ruangsomboon P and Pornrattanamaneewong C provided the research questions, conducted the data collection, analyzed the data and prepared the full manuscript. Chareancholvanich K and Narkbunnam R performed the TKA operations and reported the results. Wilairatana V reviewed the literature and analyzed the study data. All the authors have read and approved the final submitted manuscript.

Declarations

Ethics approval and consent to participate: The study was approved by the Siriraj Institutional Review Board, certificate of approval number Si 098/2016. The authors obtained consent to participate from all participants before randomization.

Consent for publication: All participants consented to the publication of any individual data.

Availability of data and materials: The datasets generated or analyzed as part of the current study are not publicly available due ethics committee requirements but may be requested from the corresponding author.

Conflicts of interest

The authors declare no conflict of interest.

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