

A Comparison between Modified Robert Jones Bandage and Intermittent Cold Pack in Arthroscopic Anterior Cruciate Ligament Reconstruction: A Prospective Randomized Controlled Trial

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Background: Modified Robert Jones bandage and intermittent cold pack are commonly used for postoperative care in arthroscopic anterior cruciate ligament reconstruction (ACLR). However, no study has been done to compare the postoperative pain and functional outcome of both methods in ACLR.

Objective: To compare the postoperative pain and functional outcome of a modified Robert Jones bandage and intermittent cold pack in ACLR.

Material and Method: Forty patients scheduled for ACLR were included. Computer-generated randomization allocated patients into either modified Robert Jones bandage group (MRJ) or intermittent cold pack group (ICT). Visual analog scale and morphine usage were assessed postoperatively. Blinded assessors assessed functional outcome, knee swelling, and patient's satisfaction.

Results: There were 19 patients in each group. Two groups were well comparable for the prognostic variables. The postoperative VAS and total morphine usage in both groups were not statistically different. Postoperative knee swelling increment was significantly lower in ICT than MRJ group (p -value = 0.04). The patient's satisfaction and positive quadriceps set test were significantly higher in the ICT group than the MRJ group (p -value < 0.01).

Conclusion: Intermittent cold pack has not demonstrated the benefit of pain reduction or morphine usage when compared to the modified Robert Jones bandage, but it had significantly less knee swelling, a significantly higher patient's satisfaction and trend to have better functional outcome. We recommend intermittent cold pack for postoperative care in ACLR.

Keywords: Modified Robert Jones bandage, Cryotherapy, Intermittent cold pack

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Anterior cruciate ligament tear is a common injury that related to sport activity with high incidence⁽¹⁾. The gold standard treatment of young active patient who has sport activity is arthroscopic anterior cruciate ligament reconstruction (ACLR). It is the most common arthroscopic procedure of the knee. Postoperative pain, knee swelling, and reduction of the knee motion delay functional recovery and good surgical outcome in ACLR. Adequate postoperative pain control and minimal knee swelling lead to successful surgical outcome⁽²⁾. These conditions should be promoted in early postoperative rehabilitation program.

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One of the most common compressive dressings is the modified Robert Jones bandage that was introduced by Brodell et al in 1986⁽³⁾. This bandage is recommended for the soft tissue injury and postoperative knee surgery^(3,4). It is believed that increased intramuscular and intraarticular pressures are the mechanism of the reduction of tissue bleeding, edema, and postoperative pain^(5,6). The disadvantage of the modified Robert Jones bandage is the discomfort and being cumbersome because of its size. There are reports about the complications from the dressing being too tight such as peroneal nerve palsy, pressure ulcers, and blister. Although this bandage is widespread used for postoperative ACLR, there is lack of evidence of its benefits over the other methods.

Cryotherapy is found to be useful for soft tissue injury and postoperative knee surgery. Local vasoconstriction, decreasing tissue metabolism, and

slowing pain signals transmission are the mechanism of cryotherapy to reduce pain, inflammation, and tissue swelling^(7,8). The cryotherapy is divided into two types, continuous-flow, and intermittent. Continuous-flow cryotherapy with commercial cooling system in ACLR proved safe and effective⁽⁹⁻¹¹⁾. Konrath et al⁽¹²⁾ conducted a randomized control trial to study the result of intermittent cryotherapy with ice pack. It was as effective as the commercial cooling system in postoperative ACLR. It was the same in term of analgesic usage, postoperative range of motion, and length of hospital stay⁽¹²⁾. The advantage of the intermittent cryotherapy is low cost, comfortable, and reusable. To our knowledge, there is no study comparing the postoperative outcome between the modified Robert Jones bandage and intermittent cryotherapy in term of postoperative pain, functional outcome, knee swelling, and patient's satisfaction.

The objective of the study was to compare the postoperative pain and functional outcome of the compressive dressing with a modified Robert Jones bandage and the intermittent cryotherapy with intermittent cold pack in ACLR.

Material and Method

The Ethic Committee of Ramathibodi Hospital, Faculty of Medicine, Mahidol University, approved the present study. The inclusion criteria were patients who had anterior cruciate ligament injury and scheduled for unilateral primary arthroscopic ACLR in Ramathibodi Hospital between May 2010 and July 2012, and willing to enroll in the study. The patient who had other concomitant ligamentous injury, intraoperative complication, and contraindication for using anesthetics agents, spinal block, and cryotherapy were excluded. Forty patients were enrolled to prospective randomized comparative study.

Surgical treatment detail

All the patients were hospitalized one day before surgery. The anesthetic nurses trained the patients how to use the patient-controlled analgesia and evaluate postoperative pain by using visual analog scores (VAS). The operation was performed under spinal anesthesia with 0.5% isobaric bupivacaine without any intrathecal opioid. The well-trained orthopedics staffs performed the standard ACLR procedures using double hamstring graft. The three hundred fifty mmHg of standard tourniquet were used in all patients. Standard arthroscopic evaluation was performed using anterolateral and anteromedial

portal. Concomitant meniscus and cartilage injuries were evaluated and treated. The hamstrings graft was harvested through the oblique skin incision at anteromedial aspect of the proximal tibia. The femoral tunnel was created by transportal technique. Using cannulated reamer created the femoral and tibial tunnel. The sizes of the femoral and tibial tunnel depend on the size of the hamstring graft. The hamstring graft was passed through the tibial tunnel to femoral tunnel. Endo-button CL fixation system (Smith & Nephew, Adover, USA) was used to fix the graft at femoral tunnel, followed by fixing the graft at the tibial tunnel with Bio-intrafix ACL fixation system (Depuy Mitek, Raynham, USA). Graft tensioner was used during applied the Bio-intrafix ACL fixation system. The bleeding was carefully checked and stopped. The intraarticular fluid was squeezed out. The skin was closed without any closed suction drainage.

Intervention

STATA 11.0 program was used to generate blocked randomization and concealed with sealed envelopes. When the surgical procedure is complete, the assistant nurse opened the seal envelopes. The patients were assigned into two groups, modified Robert Jones bandage group (MRJ) and intermittent cold pack group (ICT). Immediately postoperative, MRJ group received a modified Robert Jones bandage using a cotton wool combined with elastic bandage from toe to groin, which remained in place for 48 hours (Fig. 1). Immediately postoperative ICT group received two frozen gel packs applying at the anterior aspect of the operated knee for 20 minutes and every four hours until 48 hours postoperative (Fig. 2). All the patients received the same postoperative care.



Fig. 1 The patient who received a modified Robert Jones bandage using a cotton wool combined with elastic bandage from toe to groin, which remained in place for 48 hours.



Fig. 2 The patient who received two frozen gel packs applying at the anterior aspect of the operated knee for 20 minutes and every 4 hours until 48 hours postoperative.

Data collection

Demographic data (age, sex, body mass index (BMI) and sport activity), intraoperative factors (operative time, surgeon, concomitants cartilage or meniscus injuries, other operative procedures), and preoperative VAS were collected. Knee circumference was measured at 5 centimeters above the upper border of the patella in centimeters. This was recorded before and 48 hour after the operation. All patients were prescribed morphine intravenous patient-controlled analgesia without continuous infusion (IV-PCA). Postoperative pain was measured as VAS and the amount of morphine usage via IV-PCA every eight hours for 48 hours postoperative. Quadriceps set test or Isometric Quadriceps contraction test was performed by contracting this muscle and pulling the patella upward. In the positive test, the patient should hold the contraction for five seconds and can repeat for three times. Straight leg raise test performed by lifting the patient's leg actively and hold for five seconds. The assessors informed the patient to extend and flex the knee actively at 48 hour postoperative. The plastic goniometer was used to measure the degree of the knee motion. Active knee flexion was the angle in degree that the patient can flex the knee actively. Limit knee extension was the angle in degree loss from full extension. Quadriceps set test, straight leg raise test and active knee range of motion were collected at 48 hours postoperative. These were functional outcome after ACLR for the present study. The knee swelling increments was defined as postoperative knee circumference subtracted with preoperative knee circumference in centimeter. Cold injury and compartmental syndrome and patient's satisfaction were also evaluated and collected. The assistant nurse who was blinded to the

result of allocation assessed the patient's satisfaction independently.

Statistical analysis

All analysis was performed using STATA version 11.0 (StataCorp College Station, Texas, USA), based on intention to treat analysis (Fig. 3). Continuous variables were presented as mean and standard deviation. Categorical data were showed as frequency and percentage. The outcomes within group according to time and the outcome between groups according to time were compared using repeated measurement analysis of variance (ANOVA) and post-hoc Scheffe's test. Significant level was set up as p -value <0.05 .

Sample size estimation

The sample size required for the present study was 19 patients in each group. The primary outcome was postoperative pain, which was evaluated using standardized VAS and total morphine usage. Our pilot study revealed the mean difference was 0.8 and standard deviation was 1.1. The sample size calculation based on a 2-side test with 80% power and alpha error of 0.05 using Stata 11.0 program.

Results

Forty patients were enrolled in the present study. One patient from each group withdrew from the study and included one patient that refused to participate in the study at postoperative period and one patient that did not receive the patient-controlled analgesia. There were 19 patients in each group (Fig. 3). The demographic data are reported in Table 1. The two groups were well comparable for the prognostic variables, including age, sex, preoperative VAS,

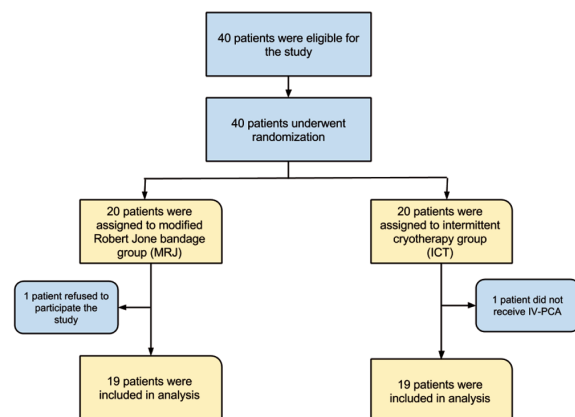


Fig. 3 Clinical trial diagram.

Table 1. Demographic data

	Modified Robert Jones bandage group (n = 20)	Intermittent cold pack group (n = 20)	p-value
Age (years), mean (SD)	25.10 (6.98)	29.55 (10.34)	0.12
Male, n (%)	18 (90)	18 (90)	1.00
BMI, mean (SD)	24.05 (3.72)	24.54 (2.38)	0.62
High sport activity, n (%)	17 (85)	15 (75)	0.82
Preoperative VAS, mean (SD)	0.20 (0.61)	0.55 (1.31)	0.29
Preoperative knee circumference (cm), mean (SD)	37.17 (1.77)	37.68 (2.50)	0.47
Surgeon, n (%)			0.30
CB	7 (35)	3 (15)	
CK	9 (45)	13 (65)	
NL	4 (20)	4 (20)	
Operating time (minute), mean (SD)	111.60 (39.88)	93.60 (19.31)	0.08
Repair meniscus, n (%)	7 (35)	7 (35)	1.00
Meniscectomy, n (%)	5 (25)	6 (30)	1.00

BMI = body mass index; VAS = visual analog score

operated surgeon, operating time, and concomitants surgical treatment.

The primary outcome of the present study was severity of the postoperative pain that measured from VAS and morphine usage in postoperative period. The VAS in both groups was highest at eight hour postoperative and gradually decreased. It was lowest at 48 hour postoperative. There was no statistical difference between groups (Fig. 4).

The total morphine usage was 51.7 mg in MRJ group and 45.65 mg in ICT group. There was no statistical difference (p -value = 0.44). The amount of morphine usage at 16 hours in MRJ group was higher than the ICT group significantly (p -value = 0.03). However, this was not statistically different between groups when controlled by time (Fig. 5). ANOVA revealed that VAS and total morphine usage significantly reduced according to time (p -value <0.001).

The functional outcome of the present study was evaluated using quadriceps set test, active straight leg, and range of motion of the knee. The percentage of patient who can perform successful three quadriceps contraction or positive result of the quadriceps set test was 45 and 95 in MRJ and ICT group respectively, which was statistically different (p -value <0.01). The percentage of patient who could perform active straight leg test was 30 and 55 in MRJ and ICT group respectively, but this was not statistically different (p -value = 0.20). The average degree of the active knee flexion was 46.25 and 51.78 degrees in MRJ and ICT group respectively, which was not statistically different (p -value = 0.46). The percentage of limited knee extension was 21.05

and 31.58 in MRJ and ICT group respectively, which was not statistically different (p -value = 0.71) (Table 2).

The knee circumference at 48 hour postoperative was not statistically different between

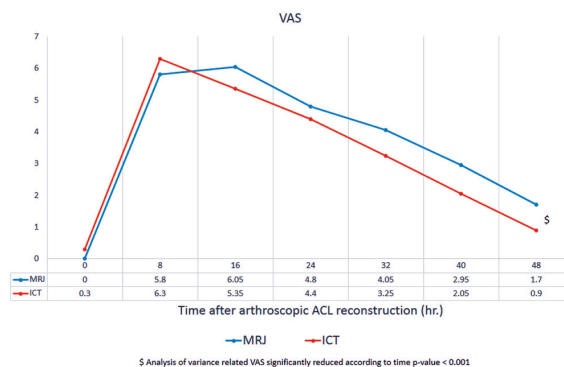


Fig. 4 The VAS score of MRJ and ICT group at postoperative period.

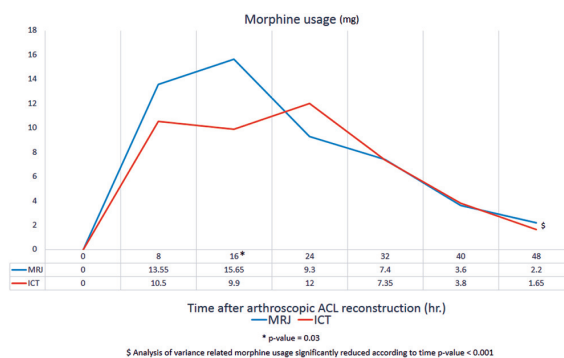


Fig. 5 The morphine usage of MRJ and ICT group at postoperative period.

groups (p -value = 0.7) but the knee swelling increments or the difference between preoperative and postoperative knee circumference was 2.98 and 2.19 centimeters in MRJ and ICT group respectively, which was statistically different (p -value = 0.04) (Table 3).

None of the patient had cold injury, compartmental syndrome, or postoperative complications. The percentage of patient's satisfaction was 35 and 100 in MRJ and ICT group respectively. It was statistically different (p -value <0.01) (Table 4).

Discussion

Cryotherapy is one of a pain-controlled treatment modality after orthopedic surgery procedures⁽¹³⁾. From the systematic review, cryotherapy is commonly used in arthroscopic assisted ACLR. It revealed significant pain reduction in 48 hour postoperative⁽¹⁴⁾. The complication of cryotherapy treatment was not different between patients receiving this treatment versus no treatment.

In ACLR, cryotherapy has been shown to decrease postoperative pain^(9,10,14,15). Although commercial continuous cryotherapy is commonly used, it increases the expense of the treatment and required special instruments. Woolf et al compared a continuous temperature-controlled cryotherapy device to a simple icing regimen after an outpatient knee arthroscopy. They found no significant difference in postoperative pain between groups⁽⁶⁾. The ice pack can decrease the skin and intraarticular temperature more than the

commercial continuous cryotherapy⁽¹⁶⁾. Therefore, intermittent cryotherapy had a favorable outcome as compared to commercial continuous cryotherapy⁽¹¹⁾. A bulky dressing using many layer gauzes can decrease the effective of cryotherapy whereas thin adhesive dressing would not⁽¹⁷⁾. The ICT group used thin dressing to improve the effectiveness of the intermittent cold pack. Therefore, it is necessary to stop bleeding meticulously before skin closure.

The present study revealed pain pattern in postoperative ACLR that was highest at 8 to 16 hours postoperative and gradually decreased. This followed the morphine usage. The VAS and morphine usage were statistically different between times (p -value = 0.05). The VAS score was below 3 at 40 to 48 hours while the morphine usage was decreased significantly. This pain pattern was comparable to the previous study of the cryotherapy in ACLR⁽¹⁸⁾.

Quadriceps set test, straight leg raise test, range of motion of the knee were the functional outcome. The patient, who can perform both tests, had a good clinical outcome⁽¹⁹⁾. The present study revealed that the ICT group had higher percentage of positive quadriceps set test than the MRJ group, which was statistically significant. Higher percentage of patient who can perform straight leg raise test was found in ICT group compared to MRJ group, but it was not statistically significant. The range of motion was not different either. Only the quadriceps set test was clearly better in the ICT group than in the MRJ group.

Table 2. Functional outcome at 48-hour postoperative

	Modified Robert Jones bandage group (n = 19)	Intermittent cold pack group (n = 19)	p -value
Positive quadriceps set test, n (%)	9 (47.36)	18 (94.73)	0.001
Active straight leg raise, n (%)	6 (31.58)	11 (57.89)	0.20
Active knee flexion (degrees), mean (SD)	46.25 (16.63)	51.78 (16.82)	0.46
Limited knee extension, n (%)	4 (21.05)	6 (31.58)	0.71

Table 3. Knee swelling at 48 hours postoperative

	Modified Robert Jones bandage group (n = 19)	Intermittent cold pack group (n = 19)	p -value
Postoperative knee circumference (cm), mean (SD)	40.15 (0.51)	39.86 (0.54)	0.70
Knee swelling increments (cm), mean (SD)	2.98 (0.99)	2.19 (1.39)	0.04

Table 4. Overall patient satisfaction

	Modified Robert Jones bandage group (n = 19)	Intermittent cold pack group (n = 19)	p -value
Patient's satisfaction (%)	7 (36.84)	19 (100)	<0.01

Although straight leg raise test was not statistically different, the percentage of positive test in ICT group was higher than in the MRJ group. These showed that the ICT group trend to have a better functional outcome.

Modified Jones bandage is recommended to be applied at the injured body part where swelling is expected⁽³⁾. It is believed to decrease knee swelling. However, a recent study showed that the postoperative swelling after total knee arthroplasty is not different when comparing the modified Jones bandage to no treatment⁽⁵⁾. In the present study, we demonstrated that knee swelling increments in MRJ group is higher than ICT group. Cryotherapy is one of the methods to reduce knee swelling in postoperative ACLR. The movement such as knee bending and ankle pump can decrease knee and leg swelling^(20,21). In the ICT group, the patient can easily move the operated knee at 48 hours postoperative. This help to reduce knee swelling.

The percentage of patient's satisfaction was 35 and 100 in MRJ and ICT group respectively. It was statistically significant. Unwieldy, heaviness sensation and itching were the main complaints of patient's in MRJ group. Comfort, pain reduction, and easily apply made the patient's satisfaction in ICT group.

The modified Robert Jones bandage has higher cost than the intermittent cold pack. Moreover, the ice pack can be reusable. The switch of routine postoperative pain management in ACLR to intermittent cold pack is recommended.

The strength of the present study was double-blinded randomized controlled with concealment and blinded outcome assessors. These methods reduced selection bias and measurement bias. The analysis was based on intention-to-treat fashion to assure the balance of prognostic factors after randomization.

The limitation of the present study set the trend a better functional outcome but was not statistically significant in straight leg raise test due to the small sample size. The sample size calculation depended on primary outcome, the postoperative pain using VAS. Therefore, the sample size was not enough for a secondary outcome such as the functional outcome.

Conclusion

Intermittent cold pack has demonstrated the benefit of pain reduction. The morphine usage remained equal to the modified Robert Jones' bandage. The intermittent cold pack had less knee swelling, higher patient's satisfaction, and trended to have better

functional outcome. We recommend intermittent cold pack for postoperative care for patient undergoing ACLR.

What is already known on this topic?

Modified Robert Jones bandage and intermittent cold pack are commonly used for postoperative care in arthroscopic ACLR. Both methods can reduce postoperative pain and knee swelling.

What this study adds?

Intermittent cold pack has demonstrated the benefit of pain reduction while morphine usage remained equal to the modified Robert Jones' bandage. However, it had less knee swelling, higher patient's satisfaction, and trended to have a better functional outcome.

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Potential conflicts of interest

None.

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การศึกษาเปรียบเทียบการใช้ *modified Robert Jones bandage* กับการใช้ความเย็นในการผ่าตัดส่องกล้องสร้างเอ็นแกนเข้าไขว้หน้า

ชูศักดิ์ กิจคุณาเสถียร, เฉลิมชัย ลิมิตเลาหพันธ์, ญัฐพร แสงเพชร, ประกาศิต ชนะสิทธิ์, เพชรา สุนทรฐิติ, ภัทรวัฒน์ วรรณรัตน์

ภูมิหลัง: *Modified Robert Jones bandage* และการใช้ความเย็น ได้รับความนิยมในการใช้ในการดูแลผู้ป่วยหลังผ่าตัดส่องกล้องสร้างเอ็นแกนเข้าไขว้หน้า แต่ยังไม่มีการศึกษาเปรียบเทียบผลการรักษาของทั้งสองวิธี ในแง่การลดอาการปวด บวม และการใช้งานของข้อเข่า หลังการผ่าตัดส่องกล้องสร้างเอ็นแกนเข้าไขว้หน้า

วัตถุประสงค์: เพื่อศึกษาเปรียบเทียบผลการรักษาของทั้งสองวิธี ในแง่การลดอาการปวด บวม และการใช้งานของข้อเข่า หลังการผ่าตัดส่องกล้องสร้างเอ็นแกนเข้าไขว้หน้า

วัสดุและวิธีการ: ผู้ป่วยจำนวน 40 ราย ที่ได้รับการผ่าตัดส่องกล้องสร้างเอ็นแกนเข้าไขว้หน้าเข้าร่วมการศึกษา และแบ่งกลุ่มโดยวิธีการสุ่ม ออกเป็น 2 กลุ่ม ได้แก่กลุ่มที่ได้รับ *modified Robert Jones bandage* และกลุ่มที่ใช้ความเย็น

ผลการศึกษา: พบว่าอาการปวดและปริมาณการใช้ยามอร์ฟินไม่แตกต่างกัน แต่ในกลุ่มที่ได้รับความเย็นจะมีภาวะเข่าบวมหลังผ่าตัดที่น้อยกว่า มีความพึงพอใจที่สูงกว่า และสามารถเกร็งกล้ามเนื้อต้นขาได้มากกว่าอย่างมีนัยสำคัญทางสถิติ

สรุป: จากการศึกษาจึงแนะนำให้ใช้ความเย็นในการดูแลผู้ป่วย ที่ได้รับการผ่าตัดส่องกล้องสร้างเอ็นแกนเข้าไขว้หน้า
