Bi-cruciate retaining (BCR) TKA reduces total blood loss when compared with Bi-cruciate stabilized (BCS) TKA

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INTRODUCTION: Total knee arthroplasty (TKA) effectively improves joint function and quality of life of patients but often leads to massive blood loss and requires efficient blood transfusion[1]. Reducing blood loss in TKA not only reduces the need for blood transfusion, but also reduces joint swelling and postoperative pain as well as increases the range of motion in early postoperative period [2]. In addition, compared with conventional TKA, bicruciate-retaining TKA (BCR-TKA) requires less bone resection, improves stability of the knee joint, physiological functions, and gait of walking [3]. Although some studies have examined the efficacy of BCR-TKA, none have focused on amount of blood loss. We hypothesized that compared to bicruciate-stabilized-TKA (BCS-TKA), BCR-TKA is more tissue-sparing and requires less bone resection, resulting in less postoperative blood loss. The purpose of this study was to compare the loss of blood volume and other clinical outcomes between BCS-TKA and BCR-TKA.

METHODS: This retrospective case-controlled study screened all patients operated between February 2017 and December 2020 at a single institution. This study included 97 patients who underwent an initial unilateral TKA. All study participants provided informed consent, and the study design was approved by the appropriate ethics review board. The patients were matched for sex, age, BMI and KL grade. A total of 78 patients (17 males, 61 females; average age 71.9 years) who underwent BCS-TKA (Journey II BCS, Smith and Nephew) comprised in the BCS group, and 19 patients (4 males, 15 females; average age 74.2 years) who underwent BCR-TKA (Journey II BCR, Smith and Nephew) were included in BCR group.
Hematocrit values were obtained from preoperative and postoperative blood sampling data. Blood loss was calculated consistent with height, weight, and gender (immediately after surgery, day 1, day 7, and total blood loss until day 7), and operation time. Range of motion at 7 and 14 days after surgery, presence or absence of blood transfusion, and postoperative complications were retrospectively compared between the BCS and BCR groups.
Baseline demographics are shown for all patients who underwent surgery performed by two experienced surgeons using similar instrumentation sets and surgical techniques. BCR TKA was indicated for patients with Kellgren-Laurence grades II–III, meniscal damage, and residual ACL and PCL. The parapatellar approach was used for the TKA. All patients underwent surgery using a tourniquet from the start to finish. Osteotomy was performed using modified measured resection, and implants were fixed with cement. At the time of wound closure, all the patients were injected with a cocktail of local anesthetics along with 10 ml tranexamic acid. No postoperative drains were used. After surgery, all the patients underwent a range of motion training and training related to full-weight walking from the next day.
The volume of perioperative bleeding was estimated based on the difference between preoperative hematocrit (Hct) and Hct determined postoperatively. The Nadler formula was used to calculate each patient's blood volume (PBV) as follows: PBV = (k1 × height [m]3) + (k2 × weight [kg]) + k3, where k1 = 0.3669, k2 = 0.03219, and k3 = 0.6041 for men; and k1 = 0.3561, k2 = 0.03308, and k3 = 0.1833 for women [13]. PBV multiplied by Hct yielded total volume of red blood cells for each patient. The estimated volume of blood loss was calculated from the change in Hct as follows: estimated volume of blood loss = PBV × (Hct pre-op – Hct post-op) [4].
Data were analyzed using R software (version 3.6.1, R Foundation for Statistical Computing, Vienna, Austria). Distributions of variables are presented as means ± standard deviations (SD) and ranges. Unpaired t-test, Fisher's exact test, and chi^2 test were used to assess the significance of any differences in categorical data between the two groups**.** Statistical significance was set at $p < 0.05$.

RESULTS: The mean blood loss (ml) immediately after surgery was 125.7 in the BCS group and 105.4 in the BCR group (p=0.94). On the first day, it was 57.9 in the BCS group and 43.5 in the BCR group (p=0.64). Total blood loss was 251.1 in the BCS group and 190.7 in the BCR group (p<0.05). Operation time (min) was 112.4 in the BCS group and 131.2 in the BCR group (p<0.05). Range of motion (extension-flexion) 7 days after surgery was: BCS group (4.2-95.5°), BCR group (3.2-99.2º) (p=0.44); 14 days after surgery: BCS group (1.5-112.2°), BCR group, (0.8-116.3º) (p=0.28). Blood transfusion was performed in two patients in the BCS group and one patient in the BCR group. No complications requiring reoperation were observed in either group (Table1).

DISCUSSION: Total blood loss up to 7 days postoperatively was significantly lower in the BCR group despite the longer operative time. We speculate that the reason for the BCR group having less blood loss than the BCS group may be related to the low amount of bone resection and high ability to preserve soft tissues such as the ACL and PCL in the BCR group. Since BCR-TKA can reduce the amount of blood loss, it is necessary to examine the long-term postoperative clinical results in the future.

SIGNIFICANCE/CLINICAL RELEVANCE: BCR TKA can reduce total blood loss and improve range of motion immediately after surgery when compared with BCS-TKA.

Table 1

		BCS-TKA (n=75)	BCR-TKA (n=17)	p value
OR time (min)		112.4	131.2	<0.05
Blood loss (ml)	postoperative	125.7	105.4	n.s.
	day1	57.9	43.5	n.s.
	day7	68.2	41.7	n.s.
	total	251.1	190.7	<0.05
Extension ROM (°)	day7	-4.2	-3.2	n.s.
	day14	95.5	99.2	n.s.
Flexion	day7	-1.5	-0.8	n.s.
	day14	112.2	116.3	n.s.
Complications		0	0	n.s.

References: [1] Gombotz H, et al. Transfusion 2014. [2] Lu Q, et al. Orthop Surg. 2018. [3] Lavoie F, et al. Knee Surg Sports Traumatol Arthrosc. 2023. [4] Bourke DL, et al. Anesthesiology. 1974.