

# Association of tourniquet utilization with blood loss, rehabilitation, and complications in Chinese obese patients undergoing total knee arthroplasty

## A retrospective study

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### Abstract

Obesity not only gives rise to more blood loss volume but also correlates with postoperative rehabilitation and complications in surgical patients. It is not clear at present whether tourniquet utilization is associated with blood loss, rehabilitation, and complications, and it is imperative to ascertain the tactics of utilizing tourniquet in obese patients undergoing total knee arthroplasty (TKA). The present study was designed to explore the association of tourniquet utilization with blood loss, rehabilitation, and complications, and ascertain the tactics of utilizing tourniquet in obese patients undergoing TKA.

A total of 130 patients from January 2014 to December 2014 were categorized into tourniquet group (n=94) and non-tourniquet group (n=36) based on whether the tourniquet was utilized or not during operation. Recorded data were as follows: total blood loss volume, intraoperative blood loss volume, hidden blood loss volume, blood transfusion volume, drainage volume, difference between hemoglobin value before operation and that on the fifth day after operation (5d Hb D-value), thigh swelling rate and visual analogue scale (VAS) score of motion pain, and Knee Society Score (KSS) score.

Mean age was  $65.27 \pm 7.43$  (49–82) years, and 15 patients (11.5%) were men. No significant difference in total blood loss volume, drainage volume, blood transfusion volume, and 5d Hb D-value was noted between the 2 groups ( $P > .05$  for all). Tourniquet group had significantly less intraoperative blood loss volume and significantly more hidden blood loss volume than the non-tourniquet group ( $P < .05$  for all). Tourniquet group had significantly higher thigh swelling rate and VAS score of motion pain on the third day after operation, and significantly lower KSS function score in the third week after operation than non-tourniquet group ( $P < .05$ ). No significant difference in KSS function score in the first year after operation was found between the 2 groups ( $P > .05$ ). No difference in postoperative complications was observed between the groups ( $P > .05$ ).

The current study demonstrated that the tourniquet is not associated with reduced blood loss and increased postoperative complications in obese patients undergoing TKA. Step-down postoperative rehabilitation related to tourniquet is short-term rather than long-term in obese patients undergoing TKA.

**Abbreviations:** 5d Hb D-value = the fifth day after operation, BMI = body mass index, KSS = Knee Society Score, NRG = nonrestrictive geometry, RPF = rotating platform flexion, SPSS = Statistical Package for Social Science, TKA = total knee arthroplasty, VAS = visual analogue scale.

**Keywords:** blood loss, knee arthroplasty, obesity, rehabilitation, tourniquet utilization

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ZL, DL, and GL contributed equally to this work.

Ethical approval was obtained from IRB authority and a written and oral informed consent before participating was given by participants before the initial assessment.

The authors report no conflicts of interest.

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## 1. Introduction

Obesity is a growing trend globally and poses a serious challenge to person's health. He et al<sup>[1]</sup> reported that obese populations in China have increased from 14 million in 1989 to 0.12 billion in 2009 in previous study. Obesity has an important effect on blood loss, rehabilitation, and complications of surgical operation. Previous studies revealed that obesity not only gives rise to more blood loss volume but also correlates with postoperative rehabilitation and complications in surgical patients.<sup>[2–4]</sup>

Total knee arthroplasty (TKA) is the recommended treatment for end-stage knee disease, and the tourniquet is regularly utilized in TKA to decrease blood loss.<sup>[4]</sup> However, the latter may influence postoperative rehabilitation and complications of patients undergoing TKA. Obese populations account for 44% to 55% of patients undergoing TKA, and this proportion is increasing year after year.<sup>[5,6]</sup> It is not clear at present whether tourniquet utilization is associated with blood loss, rehabilitation, and complications, and it is imperative to ascertain the tactics of utilizing tourniquet in obese patients undergoing TKA.

The present study was designed to explore the association of tourniquet utilization with blood loss, rehabilitation, and complications, and ascertain the tactics of utilizing tourniquet in obese patients undergoing TKA.

## 2. Methods

### 2.1. Study patients

A total of 130 patients in the Department of Joint Surgery were included in the current study from January 2014 to December 2014. Patients were eligible because of severe knee osteoarthritis undergoing unilateral TKA as the first time; and obesity [body mass index (BMI)  $\geq 30$  kg/m<sup>2</sup>]. Patients were excluded because of hemorrhagic disorders; peripheral nerve or vascular diseases; chronic liver or infectious diseases; damage of big blood vessel or ligament and other accidents during operation; operation time  $\geq 180$  minutes or therapy of intensive care unit after operation due to poor physical condition; and inability to cooperate with researchers because of mental illness or other reasons. Ethical approval was obtained from the ethics committee of Chinese PLA General Hospital and a written and oral informed consent before participating was given by participants before the initial assessment.

### 2.2. Study procedures

The research was a retrospective cohort study, and patients were grouped according to whether the tourniquet was utilized or not during the operation. Ninety-four patients were categorized into the tourniquet group and 36 patients were categorized into the non-tourniquet group. Tourniquet utilization lasted from the beginning of cutting bone to the end of binding up. Recorded data were as follows: total blood loss volume, intraoperative blood loss volume, hidden blood loss volume, blood transfusion volume, drainage volume, difference between hemoglobin value before operation and that on the fifth day after operation (5d Hb

D-value), thigh swelling rate and visual analogue scale (VAS) score of motion pain on the third day after operation, and Knee Society Score (KSS) function score in the third week and first year after operation. Blood pressure was recorded and kept less than 140 mm Hg of systolic blood pressure (SBP) or 90 mm Hg of diastolic blood pressure (DBP) after admission. Preprandial and postprandial blood glucose was recorded and 2-hour postprandial glucose was kept less than 10 mmol/L after admission. Preoperative long-term anticoagulation therapy was discontinued at least 1 week before the operation, and recovered 1 month after the operation. Rivaroxaban or low molecular weight heparin was utilized from 12 hours after the operation to 1 month after the operation.

### 2.3. Statistical analyses

All analyses were performed with Statistical Package for Social Science (SPSS) version 19.0 software (SPSS Inc, Chicago, IL), and a  $P$  value  $< .05$  was considered as statistically significant. Continuous variable with normal distribution was described with mean and standard deviation, and compared with Student  $t$  test. The continuous variable with abnormal distribution was described with median and interquartile range and compared with Mann-Whitney  $U$  test. The categorical variable was described with number and percentage and compared with Chi-square test.

## 3. Results

Mean age was  $65.27 \pm 7.43$  (49–82) years, and 15 patients (11.5%) were men. Table 1 summarized that no difference in baseline characteristics was seen between 2 groups ( $P > .05$  for all). As displayed in Table 2, no significant difference in total blood loss volume, drainage volume, blood transfusion volume, and 5d Hb D-value was noted between 2 groups ( $P > .05$  for all). Tourniquet group had significantly less intraoperative blood loss

**Table 1**

**Baseline characteristics of patients utilizing tourniquet or not.**

	Tourniquet group (n = 94)	Non-tourniquet group (n = 36)	P
Sex			.257
Men	9 (9.6%)	6 (16.7%)	
Women	85 (90.4%)	30 (83.3%)	
Age, y	65.34 $\pm$ 7.69	65.08 $\pm$ 6.81	.861
BMI, kg/m <sup>2</sup>	24.5 $\pm$ 2.7	25.0 $\pm$ 2.8	.265
KSS function score	46.10 $\pm$ 14.50	47.47 $\pm$ 14.94	.632
Hypertension	65 (69.1%)	25 (69.4%)	.974
Diabetes mellitus	14 (14.9%)	8 (22.2%)	.319
Cardiovascular diseases	8 (8.5%)	7 (19.4%)	.081
Cerebral infarction	5 (5.3%)	4 (11.1%)	.437
Preoperative long-term anticoagulation therapy	12 (12.8%)	10 (27.8%)	.075
Prosthetic types			.896
Gemini	40 (42.6%)	13 (36.1%)	
RPF	31 (33.0%)	15 (41.7%)	
NRG	6 (6.4%)	2 (5.6%)	
Vanguard	13 (13.8%)	4 (11.1%)	
Smith and Nephew	4 (4.3%)	2 (5.6%)	
Hemoglobin, g/L	132.28 $\pm$ 10.69	134.81 $\pm$ 11.22	.236
Operation time, min	112.82 $\pm$ 18.86	118.97 $\pm$ 22.69	.119
Postoperative anticoagulation therapy			.451
Rivaroxaban	59 (62.8%)	20 (55.6%)	
Low molecular weight heparin	35 (37.2%)	16 (44.4%)	

BMI = body mass index, KSS = Knee Society Score, NRG = Nonrestrictive geometry, RPF = rotating platform flexion.

**Table 2****Perioperative characteristics of patients utilizing tourniquet or not.**

Perioperative characteristics	Tourniquet group (n=94)	Non-tourniquet group (n=36)	P
Total blood loss volume, mL	890.53 ± 196.68	1028.64 ± 172.19	.002
Intraoperative blood loss volume, mL	203.16 ± 71.32	382.69 ± 85.96	<.001
Hidden blood loss volume, mL	629.39 ± 183.61	586.14 ± 187.54	.302
Blood transfusion volume, mL	595.13 ± 140.90	674.23 ± 80.61	.008
Drainage volume, mL	57.47 ± 56.45	61.35 ± 46.98	.456
Postoperative 1d Hb, g/L	124.28 ± 12.51	125.19 ± 14.49	.757
Postoperative 3d Hb, g/L	110.03 ± 13.61	112.23 ± 17.94	.511
Postoperative 5d Hb, g/L	109.63 ± 13.95	106.73 ± 13.08	.353
5d Hb D-value, g/L	23.29 ± 11.72	28.81 ± 11.56	.039
Postoperative 3d thigh swelling rate	7.44 ± 0.63	5.65 ± 0.91	<.001
Postoperative 3d VAS score	5.04 ± 0.88	4.36 ± 1.40	.016
Postoperative 3w KSS function score	51.97 ± 8.21	59.86 ± 7.22	<.001
Postoperative 1y KSS function score	90.27 ± 4.42	90.97 ± 4.44	.700
Anemia	3 (3.2%)	1 (2.8%)	1.000
Deep venous thrombosis	2 (2.1%)	1 (2.8%)	1.000
Intermuscular venous thrombosis	6 (6.4%)	2 (5.6%)	1.000

1d: on the first day; Hb: hemoglobin; 3d: on the third day; 5d: on the fifth day; 5dHb D-value: difference between hemoglobin value before operation and that on the fifth day after operation; 3w: in the third week; 1y: in the first year.

KSS = Knee Society Score, VAS = visual analgesic score.

volume and significantly more hidden blood loss volume compared with the non-tourniquet group ( $P < .05$  for all). Tourniquet group had significantly higher thigh swelling rate and VAS score of motion pain on the third day after the operation, and significantly lower KSS function score in the third week after the operation than non-tourniquet group ( $P < .05$  for all). No significant difference in KSS function score in the first year after the operation was found between 2 groups ( $P > .05$  for all). No difference in postoperative complications including anemia, deep venous thrombosis, and intermuscular venous thrombosis was observed between groups ( $P > .05$  for all), and there was no patient with the infection, prosthesis loosening, myocardial infarction, cerebral infarction, pulmonary embolism, and other postoperative complications in 2 groups.

#### 4. Discussion

TKA is the recommended therapy for end-stage knee disease, and there are more and more obese patients undergoing TKA.<sup>[5-7]</sup> Obesity changes the length and depth of operative incision, disturbs the anatomical position, increases the operative difficulty, and prolongs the operation time, leading to bleeding increase.<sup>[8-10]</sup> Prior studies have reminded us that obese patients have more blood loss volume.<sup>[2]</sup> The tourniquet is regularly utilized in TKA to decrease blood loss, and association of its utilization with blood loss is undefined. It is needful to ascertain the tactics of utilizing tourniquet in obese patients undergoing TKA. The current study found that no significant difference in total blood loss volume, drainage volume, blood transfusion volume, and 5d Hb D-value was noted between 2 groups. However, tourniquet group had significantly less intraoperative blood loss volume and significantly more hidden blood loss volume than the non-tourniquet group.

To high skilled surgeons performing TKA, the operative difficulty and operation time are not changed in obese patients. Moreover, elevated levels of blood lipids in obese patients raise up blood viscosity and slow down blood flow at the same time resulting in vascular function and structure abnormality by promoting atherosclerosis.

Postoperative rehabilitation may be difficult for obese patients on account of decreased physical ability and rehabilitation training. But Ayyar et al<sup>[11]</sup> and Dere et al<sup>[3]</sup> have advised that obesity has no adverse influence on postoperative rehabilitation of patients undergoing TKA. The problem about the effect of tourniquet utilization on postoperative rehabilitation is a more controversial issue in obese patients undergoing TKA. The current study confirmed that obese patients with tourniquet had more severe swelling and pain as well as weaker function in the short term, but alike function in the long term, in contrast to those without the tourniquet.

Due to the local complications often involving a wide range of subcutaneous fat, obesity is easy to result in dropsy, necrosis, and infection.<sup>[12]</sup> In prior studies, obesity is associated with an increased risk of infection and renovation rate in patients undergoing TKA.<sup>[4]</sup> Meanwhile, obesity leads to an increased risk of deep venous thrombosis and intermuscular venous thrombosis in patients undergoing TKA.<sup>[4]</sup> How the tourniquet affects the complications of TKA requires further study. The current study illustrated that there was no difference in postoperative complications, including anemia, deep venous thrombosis, and intermuscular venous thrombosis between obese patients undergoing TKA with and without the tourniquet. Moreover, there was no patient with the infection, prosthesis loosening, myocardial infarction, cerebral infarction, pulmonary embolism, and other postoperative complications in the current study.

#### 5. Conclusion

The current study demonstrated that the tourniquet is not associated with reduced blood loss and increased postoperative complications in obese patients undergoing TKA. Step-down postoperative rehabilitation related to tourniquet is short term rather than long term in obese patients undergoing TKA.

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