Primary total knee arthroplasty with or without the use of tourniquet

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Introduction
Total knee arthroplasty (TKA) may be the only effective treatment available to reduce pain and restore joint mobility and function in case of advanced osteoarthritis of the knee. The major benefit of TKA with the use of tourniquet is operating in a bloodless field. A possible secondary benefit is a better cement bone interface for fixation. However, the use of tourniquet in TKA is associated with multiple risk factors both local and systemic.
The aim of this work
To compare between the use or nonuse of tourniquet on patients operated for TKA.
Patients and methods
This study included 30 TKA in 30 patients. The comparison was made between 15 TKA done with the use of tourniquet in 15 patients (group A) and 15 TKA done without the use of tourniquet in the next consecutive 15 patients (group B). Full preoperative assessment including clinical, laboratorial, and radiological examination with routine investigations was done for every patient. The intraoperative blood loss and the need for and amount of blood transfusion were estimated. Immediate postoperative assessment included the estimation of hemoglobin level, blood loss, and need for and amount of blood transfusion. The 3-month postoperative evaluation included the pain by visual analog scale, range of knee flexion, and time to straight leg raising.
Results
There was no major operative complication during the procedures. Intraoperative blood loss was higher in group B (1273.3±430.1 ml), and postoperative blood loss was higher in group A (623.3±161.0 ml). Overall, 60% of group B patients had increased need for blood transfusion. Moreover, 26.7% of patients in group A compared with 6.7% of patients in group B had severe postoperative pain on the visual analog scale. The mean time to straight leg raising was 6.67±1.18 weeks in group A and 4.73±0.70 weeks in group B. The mean range of knee flexion was 118.33±5.56° in group A and 124.80±3.91° in group B after 3 months.
Conclusion
TKA done without the use of tourniquet is accompanied by more intraoperative blood loss and increased need for both intraoperative and postoperative blood transfusion. TKA without the use of tourniquet accelerates the recovery of knee flexion range and shortens the time for straight leg raising.

Keywords:
blood loss, total knee arthroplasty, tourniquet

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Introduction

The use of tourniquet is an integral part of a large number of routine orthopedic operations including total knee arthroplasty (TKA) [1]. The major benefit of TKA with the use of tourniquet is operating in a bloodless field. A possible secondary benefit is a better cement bone interface for fixation. However, the use of tourniquet in TKA is associated with multiple risk factors both local and systemic, including nerve damage, altered hemodynamic with limb exsanguinations and reactive hyperemia with tourniquet release, and delay in recovery of muscle or nerve function. It is also associated with increased risk of deep vein thrombosis (DVT) owing to direct trauma to vessel walls leading to a greater risk for large venous emboli propagation as well as vascular insult with higher risk in atherosclerosis and calcified arteries and an increase in wound healing problems [2,3].

Total knee replacement done without the use of tourniquet has the obvious benefit of reducing the risk of all the aforementioned complications. On the contrary, it is expected that TKA done without the use of tourniquet will be associated with increased blood loss which could have a negative effect on the surgical exposure, the cement mantle, and the hemoglobin

level, with its secondary effects on the clinical results such as wound healing and rate of infection [4–9].

Aim of the work

The aim of this work is to compare the results of the use or nonuse of tourniquet on patients operated for TKA.

Patients and methods

Patients

This study included 30 consecutive patients who presented to our hospital to undergo TKA. The comparison was made between the first 15 consecutive TKA done with the use of tourniquet in 15 patients (group A) and 15 TKA done without the use of tourniquet in the next consecutive 15 patients (group B). Institutional review board approval was granted from Alexandria Faculty of Medicine ethical committee and informed consent was obtained from all study participants.

The exclusion criteria included patients with previous injury or surgery to the same knee, severe varicosities, or peripheral vascular disease, which are contraindications for tourniquet application.

Age

The mean age of the patients in group A and group B was 68.13±4.64 and 69.07±2.89 years old, respectively.

Sex

In group A, 12 (80%) patients were females and three (20%) patients were males. In group B, 11 (73.3%) patients were females and four (26.7%) patients were males.

Occupation

In group A, 13 (86.7%) patients were retired pensioners and two (13.3%) patients were housewives.
In group B, seven (46.7%) patients were retired pensioners and eight (53.3%) patients were housewives.

Side affected

In group A, the operation was done on the right side in nine knees and on the left side in six knees. In group B, surgery was on the right side in eight knees and on the left side in seven knees.

Methods

Preoperative evaluation

(1) Patients were examined for detection of any associated medical or orthopedic diseases.
(2) An informed consent was taken from every patient involved in the study.

Routine laboratory investigations were done including preoperative hemoglobin level as well as routine radiological evaluation.

Intraoperative evaluation

(1) In group A, the tourniquet was inflated throughout the surgery. In group B, the tourniquet was inflated above systolic pressure (300 mmHg) before cementation and deflated again before wound closure.
(2) The surgical approach used was the medial parapatellar approach through a midline skin incision.
(3) Amount of blood loss collected by suction device is considered together with the number of soaked gauzes and the amount of normal saline used for intraoperative irrigation.
(4) Need and amount of blood transfusion.

Postoperative care

(1) Postoperative hemoglobin level on the next day of surgery.
(2) All patients received subcutaneous low molecular weight heparin (LMWH) 1 day after operation until hospital leave.
(3) The patients were mobilized day one postoperatively and discharged home when mobilizing safely. The same standardized physiotherapy protocol was undertaken in all patients postoperatively in the form of active and passive range-of-motion exercises without the use of continuous passive motion.
(4) Postoperative blood loss collected by an intra-articular drain on low suction inserted before wound closure and removed 48 h postoperatively.
(5) Need for and amount of blood transfusion was recorded.
(6) Postoperative pain was assessed (measured by visual analog scale) during hospital stay. Each patient is asked 24 h postoperatively to describe his pain intensity by a number from 1 to 10: from 1 to 3 is mild pain, from 4 to 7 is moderate pain, and from 8 to 10 is severe pain.
(7) Time to straight leg raising was recorded.
(8) Knee flexion range 3 months after surgery was assessed.
(9) Wound healing problems were documented.

Table 1 Comparison between the two studied groups according to blood loss

Blood loss (ml)	With tourniquet (group A) (*N*=15)	Without tourniquet (group B) (*N*=15)	*Z*	*P*
Intraoperative				
Minimum–maximum	100.0–700.0	600.0–2400.0		
Mean±SD	332.7±196.2	1273.3±430.1	4.588*	<0.001*
Median	250.0	1200.0		
Postoperative				
Minimum–maximum	350.0–920.0	280.0–1200.0		
Mean±SD	623.3±161.0	467.3±223.9	2.886*	0.004*
Median	620.0	400.0		
^{Z}P	0.003*	0.001*		

Z, *Z* for Mann–Whitney test. ^{Z}P, *P* value for Wilcoxon's signed ranks test for comparing between preoperative and postoperative results. *Statistically significant at *P* value less than equal to 0.05.

Table 2 Comparison between the two studied groups according to time to straight leg raising

	With tourniquet (group A) (*N*=15) [*n* (%)]	Without tourniquet (group B) (*N*=15) [*n* (%)]	Test of significance	*P*
Time to straight leg raising (weeks)				
4–6	8 (53.3)	15 (100.0)	χ^2=9.130*	0.006*
>6	7 (46.7)	0 (0.0)		
Minimum–maximum	4.0–8.0	4.0–6.0		
Mean±SD	6.67±1.18	4.73±0.70	*t*=5.467*	<0.001*
Median	6.0	5.0		

χ^2, χ^2 test; *t*, Student's *t* test. *Statistically significant at *P* value less than or equal to 0.05.

(10) Neurovascular complications, for example, deep vein thrombosis (DVT) were documented. We used Duplex ultrasonography to diagnose DVT postoperatively based on clinical suspicion.

Results

In group A, the mean intraoperative blood loss was 332.7±196.2 ml, whereas in group B, it was 1273.3±430.1 ml. The difference was statistically significant. Postoperatively, the mean blood loss in group A was 623.3±161.0 ml and in group B was 467.3±223.9 ml. The difference was statistically significant
(Table 1).

In group A, three patients needed intraoperative blood transfusion of one unit, whereas in group B, four patients needed intraoperative blood transfusion of 1 U and five patients needed for 2 U intraoperatively. The difference was statistically significant.

In group A (*n*=15), seven (46.7%) patients had mild postoperative pain, four (26.7%) patients had moderate pain, and four (26.7%) patients had severe pain. In group B (*n*=15), eight (53.3%) patients had mild postoperative pain, six (40.0%) patients had moderate pain, and only one (6.7%) patient had severe pain. The difference was statistically significant.

Figure 1

Incomplete straight leg raising in a 65-year-old male patient 6 weeks after his TKA done with tourniquet. TKA, total knee arthroplasty.

In group A, eight (53.3%) patients achieved straight leg raising within 4–6 weeks and seven (47.7%) patients took more than 6 weeks to achieve straight leg raising. In group B, 15 (100%) patients achieved straight leg raising within 4–6 weeks. The mean time for straight leg raising in group A and group B was 6.67±1.18 and 4.73±0.70 weeks, respectively. The difference was statistically significant (Table 2 and Figs 1, 2).

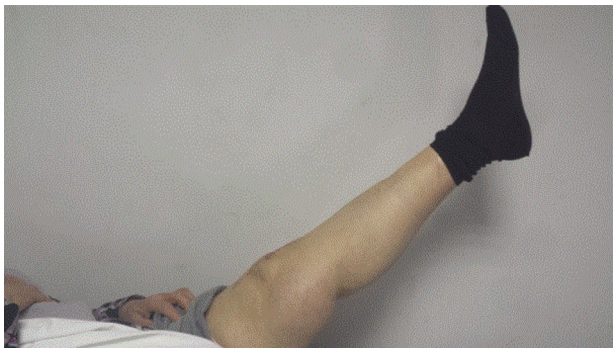
The mean knee flexion 3 months postoperatively in group A and group B was 118.33±5.56° and 124.80

Table 3 Comparison between the two studied groups according to knee flexion range

	With tourniquet (group A) (*N*=15)	Without tourniquet (group B) (*N*=15)	*t*	*P*
Knee flexion range				
Minimum–maximum	110.0–130.0	115.0–130.0		
Mean±SD	118.33±5.56	124.80±3.91	3.682*	0.001*
Median	115.0	125.0		

t, Student's *t* test. *Statistically significant at *P* value less than or equal to 0.05.

Figure 2



Full straight leg raising in a 60-year-old female patient 6 weeks after her TKA done without tourniquet. TKA, total knee arthroplasty.

Figure 3

Flexion range of 110° in the same patient of Fig. 1.

±3.91°. The difference was statistically significant (Table 3 and Figs 3, 4).

Discussion

Few studies have aimed at reducing the intraoperative and postoperative blood loss. In 1993, Liu and colleagues in their study observed that postoperative blood loss is lower in TKA after using a cemented press-fit condylar prosthesis and a femoral intramedullary plug [10]. Page *et al.* [11] studied the effect of tourniquet release and blood loss and concluded that blood loss was lower with intraoperative tourniquet release and hemostasis with

Figure 4

Flexion range of 120° in the same patient of Fig. 2.

diathermy. Some authors recommend the use of transexamic acid, a fibrinolytic inhibitor, during the knee arthroplasty to reduce intraoperative and postoperative blood loss [12,13].

In the study of Abdel-Salam and Eyres [14] and Vandenbussche *et al.* [15], the tourniquet was released after the application of the dressings, whereas in the study of Tetro and Rudan [16], deflation was after cementation but before wound closure. Abbas *et al.* [4] found no statistical significance in intraoperative blood loss whether the tourniquet was deflated before closure after cementation or after closure and dressing application.

In our study, the tourniquet was inflated in group A until skin closure, but in group B, it was inflated just before cementation and deflated before wound closure. We found that intraoperative blood loss was much more in group B, with a mean intraoperative blood loss in group A of 332.7±196.2 ml, whereas in group B, it was 1273.3±430.1 ml. The difference was statistically significant. Postoperatively, the blood loss was more in group A with a mean blood loss of 623.3±161.0 ml and in group B was 467.3±223.9 ml. The difference was statistically significant.

Some studies have related the postoperative blood loss to the type of drain used. They compared suction drainage with nonsuction drainage and concluded that the nonsuction drainage had a lower blood loss compared with suction drainage, although not statistically significant [15–19].

Overall, 60% of patients (nine of 15) in group B needed blood transfusion intraoperatively to compensate for the iatrogenic blood loss: five of them needed 2 U and four patients needed only 1 U. In group B, only 20% of patients needed blood transfusion and all of them needed only 1 U.

The use of blood transfusion in our study has been low compared with many reported studies [12,20,21]. This could be explained mainly owing to the use of the hemoglobin level of 9 g/dl as a threshold for transfusion as well as owing to the amount of perioperative blood loss being on the lower side, which may be related to the use of a cemented prosthesis and an intramedullary femoral plug [11,22]. Many recent studies have addressed the prevalence of clinically inappropriate over-transfusion and shown a widening acceptance of lower hematocrit and hemoglobin levels in patients who are otherwise stable [12,13,23].

Postoperatively, two (13.3%) patients in each group needed blood transfusion as their postoperative hemoglobin has dropped to below 9 g/dl.

Regarding the intensity of postoperative pain, it was lower in the nontourniquet group on the visual analog scale than that of the tourniquet group. We found that postoperative pain was well tolerated in the nontourniquet group.

Of 15 patients in both groups, four (26.7%) patients in group A and only one (6.7%) patient in group B had experienced severe pain. Most patients in both groups had mild to moderate pain. In group A, seven patients had mild pain and four had moderate pain, whereas in group B, eight patients had mild pain and six patients had moderate pain. These results were statistically significant and showed that the postoperative pain was more when using a tourniquet.

Our results agree with the results of Abdel-Salam and Eyres [14] who found high pain score in the tourniquet group. Barwell [24] in another study noticed that pain was significantly reduced by early tourniquet release with hemostasis before the quadriceps mechanism and the wound are closed.

Liu *et al*. [10] and Vandenbussche *et al*. [15] also found that the patients without tourniquet inflation during TKA had less pain as measured by the visual analog pain score. On the contrary, Wakankar *et al*. [1] found no difference in pain in both groups in their study.

We found that patients who underwent TKA without tourniquet took less time for full straight leg raising. In group B, all patients had achieved straight leg raising in 4–6 weeks after surgery. In the tourniquet group, eight patients did it in the same interval of time as group B, whereas the rest 7 needed more than 6 weeks to achieve straight leg raising.

Barwell [24] in his study found that patients without tourniquet had achieved earlier straight leg raising. Many authors had similar results to ours, such as Ledin *et al*. [25] and Saunders *et al*. [26] who found that the nonuse of tourniquet accelerates achievement of straight leg raising.

We found that the recovery of knee flexion 3 months after surgery was better in the nontourniquet group, with a mean of 124.80±3.91°, than in the tourniquet group, with a mean of 118.33±5.56°. Abdel-Salam and Eyres [14] observed that the recovery of knee function in the postoperative period was distinctly better in patients in whom a tourniquet had not been used with a mean of more than 110° compared with 95° in the tourniquet group. They stated that the use of a tourniquet causes some temporary loss of flexibility in the compressed thigh muscles.Wakankar *et al*. [1], Liu *et al*. [10], Vandenbussche *et al*. [15], and Esler [27] observed the same results as ours and concluded that recovery of knee flexion range after TKR done without tourniquet is achieved earlier, although there was no significant difference in the mean range of knee flexion achieved postoperatively between the two groups.

There has been no major postoperative complications in both groups such as wound infection or DVT. One patient in group A showed postoperative wound blisters, whereas another one in group B showed persistent wound oozing for 3 weeks. Some authors have reported that wound healing problems after TKR are lower when done without a tourniquet [1,10,15,27,28].

Conclusion

We concluded that TKA done without the use of tourniquet is accompanied by more intraoperative blood loss and increased need for both intraoperative and postoperative blood transfusion. The amount of

postoperative blood loss is more in TKA done with tourniquet compared with TKA done without tourniquet. Our study suggests tourniquet use in TKA results in more postoperative pain scores in the initial postoperative period. Moreover, we found that TKA done with a tourniquet will delay patients' early postoperative rehabilitation exercises considering that TKA done without the use of tourniquet accelerates the recovery of knee flexion range and shortens the time for straight leg raising.

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Conflicts of interest
There are no conflicts of interest.

References

1 Wakankar HM, Nicholl JE, Koka R, D'Arcy JC. The tourniquet in TKA, a prospective randomized study. J Bone Joint Surg Br 1999; 81-B:30–33.

2 Richard E. Total knee arthroplasty without the use of tourniquet. Semin Arthroplasty 2011 22:176–178.

3 Parvizi J, Diaz-Ledezma C. Total knee replacement with the use of a tourniquet :more pros than cons. Bone Joint J 2013; 95-B:133–134.

4 Abbas K, Raza H, Umer M, Hafeez K. Effect of early release of tourniquet in total knee arthroplasty. J Coll Physician Surg [Pak] 2013; 23:562–565.

5 Parmet JL, Horrow JC, Berman AT, Miller F, Pharo G, Collins L. The incidence of large venous emboli during total knee arthroplasty without pneumatic tourniquet use. Anesth Analg 1998; 87:439–444.

6 Canale TS, James H. Complication of total knee arthroplasty. In Canale TS, James H. Campbell's operative orthopaedics. 11th ed. Philadelphia, PA: Mosby Elsevier 2008; 6:572–581.

7 Olivecrona C, Lapidus LJ, Benson L, Blomfeldt R. Tourniquet time affects postoperative complications after knee arthroplasty. Int Orthop 2013; 37:827–832.

8 Unver B, Karatosun V, Tuncali B. Effects of tourniquet pressure on rehabilitation outcomes in patients undergoing total knee arthroplasty. Orthop Nurs 2013; 32:217–222.

9 Zhang W. The effects of a tourniquet used in total knee arthroplasty: a meta-analysis. J Orthop Surg Res 2014; 9:13.

10 Liu D. Effects of tourniquet use on quadriceps function and pain in total knee arthroplasty. J Arthro 2014; 26:207–213.

11 Page MH, Shepard BD, Harrison JM. Reduction of blood loss in knee arthroplasty. Aust NZJ Surg 1984; 54:141–144.

12 Keating EM, Meding JB, Faris PM, Ritter MA. Predictors of transfusion risk in elective knee surgery. Clin Orthop 1998; 357:50–59.

13 Han CD, Shin DE. Postoperative blood salvage and reinfusion after total joint arthroplasty. J Arthroplasty 1997; 12:511–516.

14 Abdel-Salam A, Eyres KS. Effects of tourniquet during total knee arthroplasty: a prospective randomised study. J Bone Joint Surg Br 1995; 77-B:250–253.

15 Vandenbussche E, Duranthon LD, Couturier M, Podhorz L, Augereau B. The effect of tourniquet use in total knee arthroplasty. Int Orthop 2002; 26:306–309.

16 Tetro AM, Rudan JF. The effects of a pneumatic tourniquet on blood loss in total knee arthroplasty. Can J Surg 2001; 44:33–38.

17 Fukuda A, Hasegawa M, Kato K, Shi D, Sudo A, Uchida A. Effect of tourniquet application on deep vein thrombosis after total knee arthroplasty. Arch Orthop Trauma Surg 2007; 127:671–675.

18 Keating EM, Ritter MA. Transfusion options in total joint arthroplasty. J Arthroplasty 2002; 17:125–128.

19 Kourtzis N, Pafilas D, Kasimatis G. Blood saving protocol in elective total knee arthroplasty. J Bone Joint Surg Am 2004; 187-A:261–267.

20 Reilly TJ, Ivan AG, William P, Maureen R. The use of postoperative suction drainage in total knee arthroplasty. Clin Orthop 1986; 208:238–252.

21 Walker RH. Transfusion risks. J Clin Pathol 1987; 88:371–374.

22 Mylod AG, France MP, Muser DE, Parsons JR. Perioperative blood loss associated with total knee arthroplasty. J Bone Joint Surg Br 1990; 72-B:1010–1012.

23 Manner PA, Rubash HE, Herndon JH. Future trends in transfusion. Clin Orthop 1998; 357:101–115.

24 Barwell J. The effects of early tourniquet release during total knee arthroplasty. J Bone Joint Surg Br 1997; 2-B:225–226.

25 Ledin H, Aspenberg P, Good L. Tourniquet use in total knee replacement does not improve fixation, but appears to reduce final range of motion. Acta Orthop 2012; 83:499–503.

26 Saunders KC, Louis DL, Weingarden SI, Waylonis GW. Effect of tourniquet time on postoperative quadriceps function. Clin Ortho 1979; 143:194–199.

27 Esler CAN. The use of a closed-suction drain in total knee arthroplasty. J Bone Joint Surg Br 2003; 85-B:215–217.

28 Klenerman L, Charabarti R, Mackie I, Brozovic M, Stirling Y. Changes in haemostatic system after application of a tourniquet. Lancet 1997; 1:970–972.