Total Knee Arthroplasty with and without Tourniquet: Comparative study

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Research article

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Abstract

Background The use of tourniquet during complete knee arthroplasty (TKA) improves protection and reduces blood loss intraoperative. Turniquet use, however, may also have a negative impact after TKA on early recovery of muscle strength and lower extremity function. The purpose of this study was to demonstrate the effect of tourniquet use in TKA on surgery length, need for blood transfusion, and amount of postoperative blood drainage by suction drain, incidence of postoperative wound hematoma, postoperative thigh pain, and early mobilization.

Methods Seventy Patients are involved in this study and were divided into two groups; Group A (35) patients were treated with TKA with pneumatic thigh tourniquet. Group B (35) patients were treated with TKA without tourniquet. All patients were suffering from severe knee osteoarthritis and they failed to respond to conservative treatment so they are candidates for primary TKA. The two groups are matched related to age and gender. Selection of patients into two groups done randomly with regard of odd number for group A and even number for group B.

Results The results showed no significant difference regarding age, gender, postoperative DVT and wound hematoma between group A (when tourniquet was used) and group B (when tourniquet was not used) although we have 2 patients developed DVT and 3 patients had wound hematoma in group A but these are statistically not significant. Regarding post-operative VAS for thigh pain was significantly less in group B and this will result in early mobilization. Also there was significant difference in duration of surgery between two groups with less time in group A due to bloodless field of tourniquet while there was significantly more postoperative drainage amount of blood through the surgical drains in group A and significantly more amount of blood transfusion perioperatively in group B which explain that tourniquet can reduce the total amount of blood loss in TKA.

Conclusion There is significant effect of tourniquet in TKA on thigh pain postoperatively, which will effect postoperative mobilization and rehabilitation. Also the tourniquet can result in significant reduction in time of operation, total blood loss and amount of blood transfusion.

1. Background

The recommended treatment for end-stage knee disease is full knee arthroplasty (TKA), and the tourniquet is routinely used in TKA to prevent blood loss [1]. Nevertheless, postoperative recovery and complications of TKA patients can be affected by the latter [2]. A tourniquet's drawback is the morbidity resulting from its use, particularly in neuromuscular injuries that are secondary to ischemia in the neural and muscle tissues and direct damage to the nerve compression. In addition, in the perioperative period, the hemodynamic changes following inflation and deflation can depress cardiac function [3]. The length and demand for proper use of tourniquet remains controversial, and there are no strict guidelines. This defined a safe limit of (1–3) hours [4]. Using the tourniquet over two hours and pressures on the lower limbs greater than (350) mmHg increases the risk of compression and neuropraxia [5].

Application of a tourniquet during TKA was commonly used to enhance visualization of the operating area, decrease blood loss intraoperative [6,7] and improve the quality of cementation by providing a relatively bloodless operating field [8]. An evaluation of current practice practices by members of the American Association of Hip and Knee Surgeons showed that 95% of patients without vascular disease who had TKA had their tourniquet management procedures [9]. Many studies found numerous tourniquet-related drawbacks, including reduced early knee bending [10–12], increased coronary and cerebral microembolies, increased occurrence of deep venous thrombosis, increased risk of arterial thrombosis in subjects with preoperative vascular disease, risk of peripheral nerve damage, and tourniquet inflammation of the skin [13].

The purpose of this study was to demonstrate the effect of tourniquet use in TKA on surgery duration, need for blood transfusion, and amount of postoperative blood drainage through suction drain, incidence of postoperative wound hematoma and postoperative thigh pain, and early mobilization and risk of clinical DVT.

2. Materials And Methods

Study Design and patients

This study was a single center, prospective, randomized comparative controlled trial. Seventy Patients are involved in this study. This comparative study was started on March 2016 and ended on October 2018. All subjects who fulfilled the inclusion criteria were randomly divided into two groups; Group A (35) patients were treated with TKA with pneumatic thigh tourniquet. Group B (35) patients were treated with TKA without tourniquet. All patients were suffering from severe knee osteoarthritis and they failed to respond to conservative treatment so they are candidates for primary TKA. The two groups are matched related to age and gender. Selection of patients into two groups done randomly with regard of odd number for group A and even number for group B. All patients were followed for a period of two weeks until removal of skin sutures for the following parameters:

1. Amount of blood transfusion done at and after surgery.
2. Amount of blood drained postoperatively through suction drain.
3. Occurrence of postoperative wound hematoma.
4. VAS (Visual analogue score) for thigh pain at 1st day and (2) weeks postoperatively.
5. Clinical DVT.

Exclusion criteria included Hb less than 12; D.M**;** Blood dyscrasia**;** any evidence of infection by screening test ESR and CRP; and BMI more than 30.

Surgical technique:

Under general anesthesia or spinal anesthesia, tourniquet used in-group A and not used in-group B. Prophylactic antibiotic was used with induction of anesthesia in all patients. Patients were in supine

position with operating knee in flexion, midline incision was used in all patients in both groups, preparation of tibia and femur done then cemented prosthesis were inserted with cement then hemostasis secured and suction drain used in both groups and surgical wound closed in layers and dressing done.

Data Analysis

Statistical analysis was carried out using SPSS version 21 for Windows (SPSS, IBM Company, Chicago, USA). Categorical variables were presented as frequencies and percentages. Continuous variables were presented as (Means ± SD). Student t-test was used to compare means between two groups. Paired t-test was used to compare means for paired reading. Pearson's chi square (X2) and Fisher-exact tests were used to find the association between categorical variables. A p-value of ≤ 0.05 was considered as significant. In Figure (1), the mean differences of (VAS score for thigh pain) between two periods of assessments including (1st day post-operative and 2 weeks post-operative) for group A patients. There was significant reduction in VAS for thigh pain between these two periods.

3. Results

Seventy participants (47 women and 23 men) aged 49–84 years were recruited between March 10, 2016 and October 22, 2018. Thirty five patients were randomly allocated to each group.

Table (1) shows the mean differences of study variables including (age, duration of surgery and amount of drain) according to type of operation (Group A and Group B patients). There were significant differences between means of duration of surgery and amount of drain between these two groups.

Table 1: The mean differences of study variables between study groups including (Group A and Group B patients)

Study variables	Type of operation	N	Mean	SD	t-test	P-value
Age (years)	A	35	64.60	8.46	0.15	0.882
	B	35	64.28	9.10		
Duration of surgery (minutes)	A	35	80.00	7.07	**-19.47**	**< 0.001**
	B	35	115.14	7.99		
Drain (ml)	A	35	608.57	92.74	**6.37**	**< 0.001**
	B	35	456.42	106.47		

Figure (1) shows the mean differences of (VAS score for thigh pain) between two periods of assessments including (1st day post-operative and 2 weeks post-operative) for group A patients. There was significant reduction in VAS for thigh pain between these two periods.

Figure (2) shows the mean differences of (VAS score for thigh pain) between two periods of assessments including (1st day post-operative and 2 weeks post-operative) for group B patients. There was significant reduction in VAS for thigh pain between these two periods.

Table (2) shows the mean differences of (VAS score for thigh pain) between two groups of including (group A and Group B) 1st day postoperatively. There was significant reduction in VAS for thigh pain between these two groups.

Table 2: The mean differences of VAS score for thigh pain at 1st day postoperatively between two groups

Study variable	Groups	N	Mean	SD	t-test	P-value
VAS score	Group A	35	8.97	0.51	**65.98**	**< 0.001**
	Group B	35	1.83	0.38		

Table (3) shows the mean differences of (VAS score for thigh pain) between two groups of including (group A and Group B) 2 weeks postoperatively. There was significant reduction in VAS for thigh pain between these two groups.

Table 3: The mean differences of VAS score for thigh pain at 2 weeks postoperatively between two groups

Study variable	Periods	N	Mean	SD	t-test	P-value
VAS score	Group A	35	1.63	0.64	**14.92**	**< 0.001**
	Group B	35	0.00	0.00		

Table (4) shows the association between type of operation and study variables including (gender, blood transfusion, DVT and wound hematoma). There was significant association between type of operation and, blood transfusion to patients.

Table 4: Association between type of operation and study variables

Study variables	Type of operation		χ^2	P-value
	A	B		
Gender			0.065	0.799
Male	12 (34.3)	11 (31.4)		
Female	23 (65.7)	24 (68.6)		
Total	35 (100.0)	35 (100.0)		
Patient receive blood transfusion				**0.011* f**
Yes	28 (80.0)	35 (100.0)		
No	7 (20.0)	0 (0.0)		
Total	35 (100.0)	35 (100.0)		
Number of paints of blood that patient received				**< 0.001* f**
0	7 (20.0)	0 (0.0)		
1	26 (74.3)	3 (8.6)		
2	2 (5.7)	29 (82.8)		
3	0 (0.0)	3 (8.6)		
Total	35 (100.0)	35 (100.0)		
Patient developed DVT				0.493 f
Yes	2 (5.7)	0 (0.0)		
No	33 (94.3)	35 (100.0)		
Total	35 (100.0)	35 (100.0)		
Wound hematoma				0.239 f
Yes	3 (8.6)	0 (0.0)		
No	32 (91.4)	35 (100.0)		
Total	35 (100.0)	35 (100.0)		

*P value ≤ 0.05 was significant. f: Fisher-exact test.

4. Discussion

In our study, we found no significant difference between the two groups regarding age and gender (Table 1, Table 4) while there was significant deference between the two groups regarding duration of surgery with shorter duration in group A because of bloodless field that was provided by tourniquet (Table 1). Also there was significant difference between two groups regarding postoperative drainage tube (Table 1) with more blood drainage in group A because without tourniquet most of the bleeding vessels can be hemostased and can avoid postoperative bleeding and this can also explain why there was occurrence of wound hematoma in group A but not in group B although it was not significant statistically (Table 4).

In our study, we found significant difference in VAS of thigh pain between two groups and this explain how the tourniquet can affect the thigh muscle and subsequently thigh pain and this will limit postoperative mobilization and rehabilitation (Table 2, Table 3) with increased risk of DVT as in our study DVT occurred with group A but not in group B although it was not significant statistically (Table 4). We can see also there was significant difference in VAS of thigh pain at 1st postoperative day and after two weeks of surgery in both groups (Figure 1 and Figure 2). When we compare the results of VAS for thigh pain between the two groups in each period of assessment, there was significant difference and this explain the effect of tourniquet on thigh muscles and soft tissues and how it will be reflected as postoperative thigh pain (Table 2 and Table 3). Regarding blood transfusion for those patients, there was significant difference in amount of transfused blood between the two groups with more in group B because of bloodless field provided by tourniquet especially from bone cutting surfaces (Table 4).

Many researchers around the world [14–16] demonstrated a predominance of knee arthroplasties using a tourniquet. The pneumatic tourniquet is widely used in knee surgery, offering a bloodless surgical area, enhancing anatomical structure visualization, and the operating time [17].

Present pneumatic tourniquets are designed to minimize the occurrence of abnormalities, and prospective randomized clinical trials showed no significant deep-term deleterious effects in extreme surgery [18]. Moreover, tourniquet devices have reported local and systemic complications. Nerve and muscle are the two tissues that are at greatest risk during use of tourniquet [19]. The advantages of tourniquet use include better vision, decreased blood loss intraoperatively and cement fixation enhancement [20].

Silver *et al.* [21] reported that the adverse effects of tourniquet use included reduced early bending of the knee, increased perioperative pain, swelling of the postoperative limbs, complications of the wound and the development of cardiac and cerebral microembolies [22–23]. Some also recorded an increased incidence of deep venous thrombosis, arterial thrombosis in pre-operative vascular disease cases, and peripheral nerve injury [24–26]. The tourniquet prevents blood loss intraoperative, but cannot prevent postoperative blood loss or decrease blood loss overall [27,28].

The lost blood may leak into the soft tissue, resulting in swelling of the limbs that would lead to thigh pain, and additional swelling may impede regeneration of patients' early postoperative function and increase tension of the soft tissue [29]. Yoshida *et al.* [30] and Tai et al. [31] found that endovascular bleeding is reduced with application of tourniquet, but the use of tourniquet has no advantages with respect to postoperative bleeding, total blood loss or transfusion rates. It reported less intraoperative bleeding with use of tourniquet.

Conclusion

There is significant effect of tourniquet in TKA on thigh pain postoperatively, which will effect postoperative mobilization and rehabilitation. Also the tourniquet can result in significant reduction in time of operation, total blood loss and amount for blood transfusion.

Abbreviations

TKA: Total knee arthroplasty; DVT: Deep venous thrombosis; ESR: Erythrocyte sedimentation rate; CRP: C-reactive protein; BMI: Body mass index; DM: Diabetes Mellitus; VAS: Visual analogue scale.

Declarations

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Authors' contributions

S.A. Hamawandi was responsible for experiment design, conceptualization, supervision, data collection, and manuscript writing; H.I. Amin conducted data collection and data entry; A.K. Al-Humairi performed Statistical analysis and contributed to manuscript writing.

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Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

- **Ethics approval and consent to participate**

The protocol of this clinical study was reviewed and approved by the research ethics committee in Hawler Medical University. Consent to participate was obtained from all patients prior study conduction. The guarantee was given for confidentiality of their personal information.

- **Consent for publication**

This paper is approved by all authors for publication.

Competing interests

The authors declare that they have no competing interests.

References

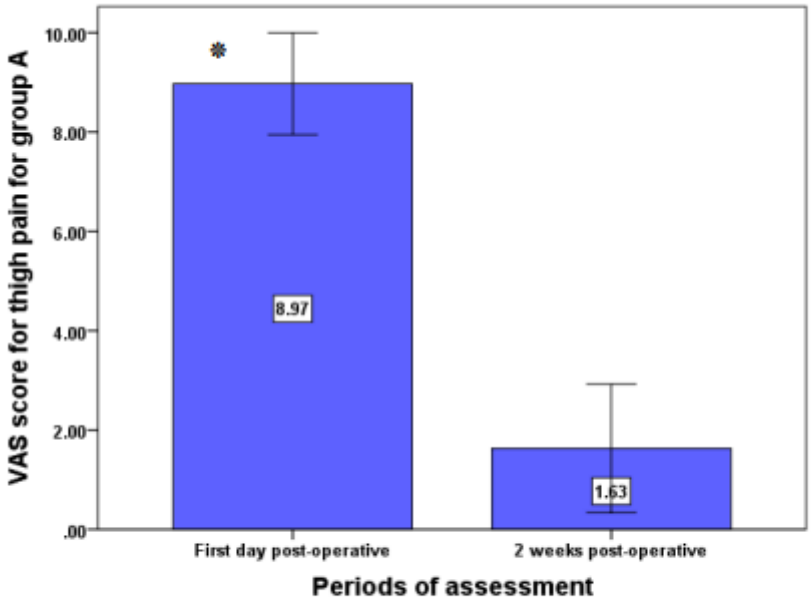
1. Kerkhoffs G, Servien E, Dunn W,Dahm D, Bramer JAM, Haverkamp D. The influence of obesity on the complication rate and outcome of total knee arthroplasty a meta-analysis and systematic literature review. J Bone Joint Surg. 2012; 94(20):1839–1844,.
2. Tetro AM, Rudan JF. The effects of a pneumatic tourniquet on blood loss in total knee arthroplasty. Can J Surg. 2001; 44:33–8.
3. Pedowitz RA Tourniquet-induced neuromuscular injury. A recent review of rabbit and clinical experimen Acta. Orthop. Scand. Suppl. 1991; 245: 1–33.
4. Sharma JP, Salhotra R. Tourniquets in orthopedic surgery. Ind J Orthop, 2012; 46(4): 377–83.
5. Berry DJ, Bozic KJ. Current practice patterns in primary hip and knee arthroplasty among members of the American Association of Hip and Knee Surgeons. J Arthroplasty, 2010; 25: 2–4,
6. Bin A, Razak HR, Tan HC. The use of pneumatic tourniquets is safe in Asians undergoing total knee arthroplasty without anticoagulation. Knee, 2014; 21:176–79.
7. Dennis DA, Kittelson AJ, Yang CC, Miner TM, Kim RH, Stevens-Lapsley JE. Does Tourniquet Use in TKA Affect Recovery of Lower Extremity Strength and Function? A Randomized Trial. Clin Orthop Related Res. 2016;474: 69-77.
8. Chen S, Li J, Peng H, J Zhou, H Fang, Zheng H. The influence of a half-course tourniquet strategy on peri-operative blood loss and early functional recovery in primary total knee arthroplasty. Int Orthop. 2014; 38:355–59.
9. Clarke MT, Longstaff L, Edwards D, Rushton N. Tourniquet-induced wound hypoxia after total knee replacement. J Bone Joint Surg. 2001; 83: 40–4.
10. Din R, Geddes T. Skin protection beneath the tourniquet. A prospective randomized trial. ANZ J Surg. 2004;74:721–22.
11. Ejaz A, Laursen AC, Kappel A, Laursen MB, Jakobsen T, Rasmussen S, et al. Faster recovery without the use of a tourniquet in total knee arthroplasty. Acta Orthopedica, 2014; 85(4): 422–26.
12. Feng L, Zhang XG, Yang QG, Wang G. Effects of tourniquet on cardiac function in total knee arthroplasty with trans-esophageal echocardiography. [in Chinese], Arch Orthop Trauma Surg. 2013;

127: 671–75.

13. Hirota K, Hashimoto H, Tsubo T, Ishihara H, Matsuki A. Quantification and comparison of pulmonary emboli formation after pneumatic tourniquet release in patients undergoing reconstruction of anterior cruciate ligament and total knee arthroplasty. Anesth Analgesia, 2002; 94(6):1633–38.
14. Horlocker TT, Hebl JR, Gali B, Jankowski CJ, Burkle CM, Berry DJ, et al. Anesthetic, patient, and surgical risk factors for neurologic complications after prolonged total tourniquet time during total knee arthroplasty. Anesth Analgesia, 2006; 102: 950–55.
15. Jarolem KL, Scott DF, Jaffe WL, Stein KS, Jaffe FF, Atik T. A comparison of blood loss and transfusion requirements in total knee arthroplasty with and without arterial tourniquet. Amer J Orthop. 1995; 24:906–09.
16. Olivecrona C, Blomfeldt R, Ponzer S, Stanford BR, Nilsson BY. Tourniquet cuff pressure and nerve injury in knee arthroplasty in a bloodless field: a neurophysiological study. Acta Orthopedica, 2013; 84:159– 64.
17. Olivecrona C, Ponzer S, Hamberg P, Blomfeldt R. Lower tourniquet cuff pressure reduces postoperative wound complications after total knee arthroplasty: a randomized controlled study of 164 patients. J Bone Joint Surg. 2012; 94: 2216–21.
18. Parmet JL, Berman AT, Horrow JC, Harding S, Rosenberg H. Thromboembolism coincident with tourniquet deflation during total knee arthroplasty. Lancet 1993; 341:1057–58.
19. 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 Analgesia 1998; 87: 439–44.
20. Parmet JL, Horrow JC, Singer R, Berman AT, Rosenberg H.. Echogenic emboli upon tourniquet release during total knee arthroplasty: pulmonary hemodynamic changes and embolic composition. Anesth Analgesia 1994;79: 940–45.
21. Silver R, de la Garza J, Rang M, Koreska J. Limb swelling after release of a tourniquet. Clin Orthop Related Res. 1986; 206: 86–9.
22. Smith DE, McGraw RW, Taylor DC, Masri BA. Arterial complications and total knee arthroplasty. J Amer Academy Orthop Surg. 2001; 9: 253–57.
23. Sulek CA, Davies LK, Enneking FK, Gearen PA, Lobato EB. Cerebral microembolism diagnosed by transcranial Doppler during total knee arthroplasty: correlation with transesophageal echocardiography. Anesthesiol. 1999; 91: 672–76.
24. Tai TW., Chang CW, Lai KA, Lin CJ, Yang CY. Effects of tourniquet use on blood loss and soft- tissue damage in total knee arthroplasty: a randomized controlled trial. J Bone Joint Surg. 2012; 94:2209–15.
25. Tai TW, Lin CJ, Jou IM, Chang CW, Lai KA, Yang CY. Tourniquet use in total knee arthroplasty: a meta-analysis. Knee Surg Sports Traumatol Arthrosc. 2011; 19(7): 1121–30.
26. Vandenbussche E. Duranthon LD. Couturier M. Pidhorz L. Augereau B. The effect of tourniquet use in total knee arthroplasty. Int Orthop. 2002; 26:306–09.

27. Verbeke G, Molenberghs G. Linear Mixed Models in Practice: An SAS-oriented Approach. New York, NY, USA: Springer, 1997.
28. Wakankar HM, Nicholl JE, Koka R, D'Arcy JC. The tourniquet in total knee arthroplasty. A prospective, randomised study. J Bone Joint Surg. 1999; 81: 30–3.
29. Worland RL, Arredondo J, Angles F, Lopez-Jimenez F, Jessup DE. Thigh pain following tourniquet application in simultaneous bilateral total knee replacement arthroplasty. J Arthroplasty, 1997; 12: 848– 52.
30. Yoshida Y, Mizner RL, Ramsey DK, Snyder-Mackler L. Examining outcomes from total knee arthroplasty and the relationship between quadriceps strength and knee function over time. Clin Biomechanics, 2008; 23(3): 320–28.
31. Tai TW, Lin CJ, Jou IM, Chang CW, Lai KA, Yang CY. Tourniquet use in total knee arthroplasty: a meta-analysis. Knee Surg Sports Traumatol Arthrosc. 2011; 19(7):1121–30.

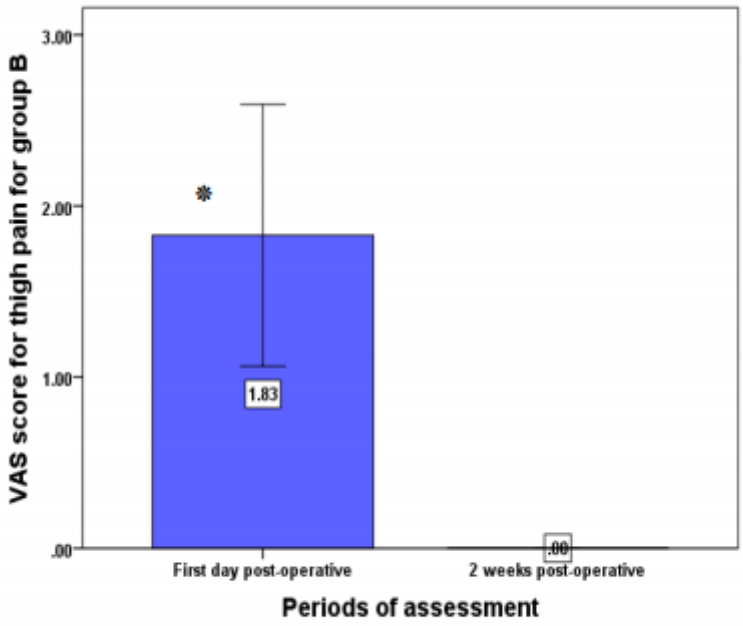
Figures



(Paired t-test=73.47, P=<0.001*).

Figure 1

The mean differences of VAS score for thigh pain between two periods of assessments for group A patients.



(Paired t-test=28.29, P=<0.001*).

Figure 2

The mean differences of VAS score for thigh pain between two periods of assessments for group B patients.