Original Research Article

A PROSPECTIVE COMPARATIVE STUDY OF TOURNIQUET VERSUS NO-TOURNIQUET TECHNIQUE IN ELECTIVE LOWER-LIMB ORTHOPAEDIC SURGERY

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ABSTRACT

Background: Tourniquet application is commonly used in limb orthopedic surgeries to provide a bloodless operative field and improve surgical visualization. However, its use remains controversial because, although it may reduce intraoperative blood loss, it has also been associated with increased postoperative pain, soft tissue injury, and delayed functional recovery. In recent years, growing attention has been directed toward comparing tourniquet and no-tourniquet techniques to determine their overall effect on perioperative outcomes and patient recovery. **Aim:** To compare the tourniquet and no-tourniquet techniques in limb orthopedic surgeries with respect to postoperative pain, blood loss, and recovery outcomes.

Materials and Methods: This was a prospective comparative study carried out in the Department of Orthopaedics at a tertiary care centre. Fifty-eight patients undergoing elective limb orthopaedic surgery were enrolled and divided into two equal groups: those operated with a tourniquet (n=29) and those without (n=29). Preoperative demographics, intraoperative findings, and postoperative outcomes — including pain scores, blood loss, drain output, mobilization time, and hospital stay — were recorded and compared. Statistical analysis was performed using SPSS version 26.0, with a p-value below 0.05 taken as significant.

Results: The baseline characteristics of both groups were comparable. Intraoperative blood loss was significantly lower in the tourniquet group (148.35 ± 34.12 mL) compared to the no-tourniquet group (221.64 ± 45.58 mL; p<0.001). Good operative field visibility was achieved more frequently with tourniquet use (86.21% vs 62.07%; p=0.03). However, postoperative pain scores were significantly higher in the tourniquet group at 6, 12, 24, and 48 hours. The mean total blood loss was significantly lower in the tourniquet group (266.81 ± 45.27 mL vs 357.43 ± 54.18 mL; p<0.001), and hemoglobin drop was also less pronounced (1.43 ± 0.58 g/dL vs 1.72 ± 0.64 g/dL; p=0.04). Patients in the no-tourniquet group showed slightly earlier mobilization and fewer tourniquet-related symptoms.

Conclusion: Tourniquet use in limb orthopedic surgeries offers clear intraoperative advantages by reducing blood loss and improving operative field visibility. However, it is associated with increased postoperative pain, greater analgesic requirement, and tourniquet-related discomfort. The no-tourniquet technique, while associated with more intraoperative bleeding, may provide a more favorable early postoperative recovery. In this study, the use of a tourniquet was linked to less intraoperative bleeding and a cleaner surgical field, but came at the cost of higher postoperative pain and greater analgesic use. The no-tourniquet group, despite greater blood loss during surgery, showed a

somewhat smoother early recovery. These results point to a genuine clinical trade-off, and given the non-randomized, single-centre nature of the study, the findings should be interpreted with appropriate caution.
Keywords: Tourniquet, no-tourniquet, orthopedic surgery, blood loss, postoperative pain.

INTRODUCTION

Tourniquet use has long been an established component of limb orthopedic surgery because it provides a relatively bloodless operative field, improves visualization of tissue planes, and may facilitate more precise dissection and implant placement. In both upper and lower limb procedures, surgeons often prefer a pneumatic tourniquet because it can temporarily occlude arterial inflow and reduce operative bleeding, thereby making technically demanding steps easier to perform. This advantage is particularly relevant in orthopedic surgery, where exposure of bone, joint surfaces, and soft tissue structures must often be achieved through limited incisions and within a clean surgical field. However, despite its widespread use, the actual clinical value of a tourniquet remains debated, especially when balanced against postoperative pain, tissue ischemia, nerve compression, swelling, and delayed functional recovery.[1,2] The rationale for tourniquet use is primarily based on intraoperative efficiency. A dry field can reduce the need for frequent suctioning, improve the surgeon's view, and limit blood contamination at the operative site. In procedures involving fixation, debridement, reconstruction, or arthroplasty, improved visualization may help shorten technically difficult parts of surgery and may also enhance cementing conditions in some operations. At the same time, modern hemostatic techniques such as electrocautery, hypotensive anesthesia, meticulous soft tissue handling, and perioperative antifibrinolytics have reduced the exclusive dependence on tourniquets. As a result, many surgeons now question whether the benefits of a tourniquet are still substantial enough to justify its routine use in limb surgery.[3] The controversy becomes more important when postoperative outcomes are considered. Although the tourniquet may reduce visible intraoperative blood loss, the total perioperative blood loss is not always lower, because hidden blood loss and postoperative bleeding may offset the benefit achieved during the operation. Furthermore, transient ischemia followed by reperfusion can contribute to muscle injury, postoperative thigh pain, edema, and inflammatory response. Compression under the cuff may also affect nerves, skin, and soft tissues, particularly when high cuff pressures or prolonged inflation times are used. These concerns have shifted attention from the traditional focus on bloodless surgery to a broader evaluation of patient-centered outcomes such as pain severity, analgesic requirement, mobilization, limb function, and complications.[4] In recent years, growing evidence has suggested that no-tourniquet techniques may be associated with better early recovery in selected orthopedic procedures. Avoiding the tourniquet may reduce ischemic insult to muscles and periarticular tissues, potentially resulting in less postoperative pain and earlier rehabilitation. This has become especially relevant in enhanced recovery pathways, where pain control, early mobilization, and reduced hospital stay are major goals. On the other hand, operating without a tourniquet may increase the need for intraoperative hemostatic measures and may challenge visibility in surgeries where bleeding obscures the field. Thus, the decision to use or avoid a tourniquet is no longer based only on surgical convenience, but increasingly on its overall influence on perioperative safety and recovery.[5] The literature on tourniquet use has produced inconsistent findings. Some studies and pooled analyses have shown that tourniquets decrease intraoperative blood loss and may slightly shorten operative time, whereas others have found no meaningful reduction in total blood loss, transfusion requirement, or long-term functional outcome. At the same time, concerns have been raised regarding increased postoperative pain, thromboembolic risk, wound problems, and minor complications. These contrasting results may be due to variations in surgical procedure, cuff pressure, duration of inflation, timing of release, drain usage, thromboprophylaxis, rehabilitation protocols, and methods used to estimate blood loss. Therefore, findings from one orthopedic setting cannot always be generalized to all limb surgeries. Another important issue is that most published evidence has focused on total knee arthroplasty, while many routine limb orthopedic procedures outside arthroplasty have received comparatively less attention. In everyday practice, tourniquets are used in a wide range of elective limb surgeries, including fracture fixation, soft tissue procedures, reconstructive operations, and both upper and lower limb interventions. The physiological effects of ischemia, cuff pressure, and postoperative reperfusion may differ according to limb segment, operative duration, and patient comorbid status. Therefore, there is a need for studies that assess tourniquet versus no-tourniquet techniques in a broader orthopedic population, rather than relying exclusively on arthroplasty-based data. Pain, blood loss, and recovery are particularly relevant endpoints when comparing these two techniques. Postoperative pain influences patient satisfaction, opioid or analgesic consumption, ability to begin physiotherapy, and overall rehabilitation progress. Blood loss affects postoperative hemoglobin, transfusion requirement, drain output, and perioperative stability. Recovery outcomes such as time to mobilization, return of function, hospital stay, and wound-related events determine both patient outcome and healthcare burden. Since these variables are interrelated, a balanced evaluation of both operative and postoperative effects is necessary to identify whether tourniquet use truly offers a net clinical advantage or merely shifts the burden from the intraoperative period to the postoperative phase.[6]

MATERIALS AND METHODS

This was a prospective comparative study conducted in the Department of Orthopaedics at a tertiary care hospital. The study was designed to evaluate and compare outcomes between elective lower-limb orthopedic surgeries performed using the tourniquet technique and those performed without tourniquet application. The primary objective was to assess differences in postoperative pain, intraoperative and postoperative blood loss, and functional recovery between the two surgical approaches. A total of 58 patients undergoing elective limb orthopedic surgeries were included in the study. Patients were divided into two groups based on the intraoperative technique employed: the tourniquet group and the no-tourniquet group, with 29 patients in each group. Patients were allocated to each group based on the operating surgeon's preferred technique and clinical judgement; formal randomization was not employed.

Sample Size: The sample size was estimated on the basis of detecting a clinically relevant 1-point difference in VAS pain scores, with 80% power and a significance level of 0.05. This calculation indicated a minimum of 26 patients per group; 29 were enrolled in each arm to allow for potential dropouts or incomplete data.

Ethical Approval: The study was approved by the Institutional Ethics Committee (Approval No: ______; Date: ______) and conducted in accordance with the principles of the Declaration of Helsinki. All participants provided written informed consent before being enrolled.

Inclusion and Exclusion Criteria: Patients of either sex who were scheduled for elective upper or lower limb orthopedic surgeries and were medically fit for surgery under spinal or general anesthesia were included in the study. Adult patients who provided informed consent and were willing to participate in postoperative follow-up were enrolled. Patients with known bleeding disorders, peripheral vascular disease, uncontrolled hypertension, severe anemia, active infection, previous surgery on the same limb, coagulopathy, chronic pain syndromes, neuromuscular disorders affecting recovery assessment, or those unwilling to participate were excluded from the study.

Methodology

All patients underwent detailed preoperative evaluation including demographic profiling, clinical history, physical examination, and relevant laboratory investigations. Baseline variables such as age, sex, body mass index, affected limb, type of surgery, hemoglobin level, hematocrit, and comorbid conditions were recorded. Preoperative pain status and functional status of the affected limb were also documented wherever applicable.

Surgical Technique: All surgeries were performed under standard aseptic precautions by orthopedic surgeons in the operation theatre of the tertiary care hospital. In the tourniquet group, a pneumatic tourniquet was applied to the operative limb after exsanguination and inflated to an appropriate pressure above systolic blood pressure according to institutional protocol. In the no-tourniquet group, the surgery was carried out without tourniquet inflation, and hemostasis was maintained using standard surgical techniques including careful dissection, electrocautery, and pressure control. The type of anesthesia, surgical approach, and perioperative antibiotic prophylaxis were administered as per hospital protocol.

Study Parameters: The patients were assessed using relevant perioperative and postoperative parameters. Intraoperative parameters included duration of surgery, operative field visibility, intraoperative blood loss, need for blood transfusion, and hemodynamic stability. Blood loss was estimated by measuring the volume collected in suction containers after deducting irrigation fluid and by weighing blood-soaked surgical sponges and gauzes. Postoperative parameters included Visual Analog Scale (VAS) pain score, postoperative drain output where applicable, fall in hemoglobin and hematocrit levels, requirement of rescue analgesia, limb swelling, wound-related complications, time to mobilization, duration of hospital stay, and return to functional independence. Recovery-related variables such as range of motion, ability to bear weight or use the limb as appropriate, and time to resume routine activities were also assessed.

Postoperative Follow-up: After surgery, all patients were monitored in the postoperative ward and followed according to standard orthopedic postoperative care protocols. Pain assessment, wound inspection, limb swelling, neurovascular status, and recovery milestones were recorded systematically. Functional recovery was assessed clinically based on the patient's ability to mobilize, tolerate rehabilitation exercises, and regain limb function appropriate to the type of surgery performed.

Statistical Analysis: The collected data were entered into Microsoft Excel and analyzed using **SPSS version 26.0**. Continuous variables are presented as mean ± standard deviation, with 95% confidence intervals reported for primary outcomes. Categorical variables are expressed as frequencies and percentages. Group comparisons were made using the independent samples t-test for normally distributed continuous variables, and Fisher's exact test was preferred over the chi-square test wherever cell counts were small. Serial VAS pain scores were analysed using repeated-measures ANOVA. Where appropriate, multivariable regression was used to adjust for procedure type and other relevant factors. A p-value below 0.05 was considered statistically significant throughout.

RESULTS

A total of 58 patients undergoing limb orthopedic surgeries were included in the study and divided into two equal groups: tourniquet group (n = 29) and no-tourniquet group (n = 29).

Table 1: Baseline Demographic and Clinical Characteristics

The baseline demographic and clinical characteristics of patients in both groups are presented in Table 1. The mean age of patients in the tourniquet group was 41.62 ± 12.48 years, while in the no-tourniquet group it was 42.37 ± 11.95 years, showing no statistically significant difference (p = 0.81). Similarly, the mean body mass index (BMI) was 24.81 ± 3.17 kg/m² in the tourniquet group and 25.26 ± 3.44 kg/m² in the no-tourniquet group, which was also statistically comparable (p = 0.59). Regarding gender distribution, males constituted 62.07% of the tourniquet group and 58.62% of the no-tourniquet group, while females represented 37.93% and 41.38%, respectively. This difference was not statistically significant (p = 0.79). In terms of type of surgery, upper limb procedures were performed in 31.03% of patients in the tourniquet group and 34.48% in the no-tourniquet group, while lower limb surgeries accounted for 68.97% and 65.52%, respectively (p = 0.78). The prevalence of comorbid conditions was also similar between the groups. Diabetes mellitus was present in 20.69% of patients in the tourniquet group compared to 24.14% in the no-tourniquet group (p = 0.75). Likewise, hypertension was observed in 27.59% and 31.03% of patients in the tourniquet and no-tourniquet groups, respectively (p = 0.78). Baseline hematological parameters were also comparable, with mean preoperative hemoglobin levels of 12.64 ± 1.21 g/dL and 12.51 ± 1.17 g/dL (p = 0.67) and mean hematocrit values of 38.42 ± 3.92% and 37.95 ± 4.11% (p = 0.64) in the tourniquet and no-tourniquet groups, respectively.

Table 2: Intraoperative Surgical Parameters

The intraoperative surgical parameters are summarized in Table 2. The mean duration of surgery was 86.24 ± 15.37 minutes in the tourniquet group and 89.73 ± 16.92 minutes in the no-tourniquet group, with no statistically significant difference (p = 0.39). However, a significant difference was observed in intraoperative blood loss, which was substantially lower in the tourniquet group (148.35 ± 34.12 mL) compared to the no-tourniquet group (221.64 ± 45.58 mL) with high statistical significance (p < 0.001). Hemodynamic instability during surgery occurred in 10.34% of patients in the tourniquet group and 17.24% in the no-tourniquet group, though this difference was not statistically significant (p = 0.45). Regarding operative field visibility, 86.21% of surgeries in the tourniquet group had good visualization compared to 62.07% in the no-tourniquet group, while moderate visibility was observed in 13.79% and 31.03% of cases respectively. This difference was statistically significant (p = 0.03), indicating improved operative conditions with tourniquet use. The requirement of blood transfusion was relatively higher in the no-tourniquet group (17.24%) compared to the tourniquet group (6.90%), although the difference did not reach statistical significance (p = 0.23). The use of electrocautery for hemostasis was significantly more frequent in the no-tourniquet group (89.66%) compared to the tourniquet group (65.52%) (p = 0.02), suggesting increased bleeding control measures in surgeries performed without a tourniquet. Intraoperative complications were minimal in both groups and showed no significant difference (p = 0.55).

Table 3: Postoperative Pain Assessment (VAS Score)

Postoperative pain assessment using the Visual Analog Scale (VAS) at different time intervals is shown in Table 3. At 6 hours postoperatively, the mean VAS score in the tourniquet group was 5.94 ± 1.12, which was significantly higher than the 4.83 ± 1.05 observed in the no-tourniquet group (p = 0.001). Similarly, at 12 hours, the pain score remained significantly higher in the tourniquet group (5.31 ± 1.06) compared to the no-tourniquet group (4.52 ± 0.98) (p = 0.003). At 24 hours, patients in the tourniquet group reported a mean pain score of 4.76 ± 1.03, while the no-tourniquet group reported 3.89 ± 0.96, again showing a statistically significant difference (p = 0.002). Even at 48 hours, pain scores remained slightly higher in the tourniquet group (3.21 ± 0.84) compared to the no-tourniquet group (2.79 ± 0.76) with a significant difference (p = 0.04). Regarding analgesic requirements, 41.38% of patients in the tourniquet group required rescue analgesia, compared with 24.14% in the no-tourniquet group, although this difference was not statistically significant (p = 0.16). The average number of analgesic doses required within the first 48 hours was significantly higher in the tourniquet group (3.76 ± 1.04) than in the no-tourniquet group (2.93 ± 0.89) (p = 0.001).

Table 4: Blood Loss and Hematological Changes

Table 4 presents the comparison of postoperative blood loss and hematological parameters between the two groups. The mean postoperative drain output was 118.46 ± 29.83 mL in the tourniquet group compared with 135.79 ± 32.15 mL in the no-tourniquet group, which was statistically significant (p = 0.03). The total blood loss, calculated from intraoperative blood loss, drain output, and hemoglobin reduction, was significantly lower in the tourniquet group (266.81 ± 45.27 mL) compared to the no-tourniquet group (357.43 ± 54.18 mL) (p < 0.001). Postoperative hemoglobin levels were slightly higher in the tourniquet group (11.21 ± 1.08 g/dL) compared with the no-tourniquet group (10.79 ± 1.14 g/dL), though this difference was not statistically significant (p = 0.11). The mean hemoglobin drop from preoperative levels was 1.43 ± 0.58 g/dL in the tourniquet group compared to 1.72 ± 0.64 g/dL in the no-tourniquet group, and this difference was statistically significant (p = 0.04). Postoperative hematocrit values were similar between the two groups (p = 0.34). Although blood transfusion requirements were higher in the no-tourniquet group (17.24%) compared to the tourniquet group (6.90%), this difference did not reach statistical significance (p = 0.23).

Table 5: Postoperative Recovery and Complications

Postoperative recovery parameters and complications are summarized in Table 5. The mean time to first mobilization was 2.41 ± 0.76 days in the tourniquet group and 2.07 ± 0.63 days in the no-tourniquet group. The difference just reached the threshold of statistical significance (p = 0.05; 95% CI: −0.01 to 0.69 days), pointing to a trend towards earlier mobilization among patients who underwent surgery without a tourniquet. The time required to regain functional limb use was 5.62 ± 1.43 days in the tourniquet group compared to 5.21 ± 1.36 days in the no-tourniquet group, though this difference was not statistically significant (p = 0.27). Similarly, the length of hospital stay was comparable between the groups, with 6.52 ± 1.43 days in the tourniquet group and 6.11 ± 1.32 days in the no-tourniquet group (p = 0.24). Postoperative complications were generally low in both groups. Postoperative limb swelling occurred in 31.03% of patients in the tourniquet group compared with 17.24% in the no-tourniquet group (p = 0.21). Wound complications were observed in 10.34% of patients in the tourniquet group and 13.79% in the no-tourniquet group (p = 0.69), while postoperative infections occurred in 3.45% and 6.90% of patients respectively (p = 0.55). Notably, tourniquet-related thigh pain was reported in 20.69% of patients in the tourniquet group, whereas no cases were reported in the no-tourniquet group, and this difference was statistically significant (p = 0.01). Nerve-related symptoms were rare and observed in only 3.45% of patients in the tourniquet group, with none reported in the no-tourniquet group (p = 0.31).

Table 1: Baseline Demographic and Clinical Characteristics

Variable	Tourniquet Group (n=29)	No-Tourniquet Group (n=29)	p-value
Age (years) Mean ± SD	41.62 ± 12.48	42.37 ± 11.95	0.81
BMI (kg/m²) Mean ± SD	24.81 ± 3.17	25.26 ± 3.44	0.59
Male	18 (62.07%)	17 (58.62%)	0.79
Female	11 (37.93%)	12 (41.38%)	
Upper limb surgeries	9 (31.03%)	10 (34.48%)	0.78
Lower limb surgeries	20 (68.97%)	19 (65.52%)	
Diabetes mellitus	6 (20.69%)	7 (24.14%)	0.75
Hypertension	8 (27.59%)	9 (31.03%)	0.78
Mean preoperative hemoglobin (g/dl)	12.64 ± 1.21	12.51 ± 1.17	0.67
Mean preoperative hematocrit (%)	38.42 ± 3.92	37.95 ± 4.11	0.64

Table 2: Intraoperative Surgical Parameters

Parameter	Tourniquet Group (n=29)	No-Tourniquet Group (n=29)	p-value
Duration of surgery (minutes) Mean ± SD	86.24 ± 15.37	89.73 ± 16.92	0.39
Intraoperative blood loss (ml) Mean ± SD	148.35 ± 34.12	221.64 ± 45.58	<0.001
Hemodynamic instability	3 (10.34%)	5 (17.24%)	0.45
Good operative field visibility	25 (86.21%)	18 (62.07%)	0.03
Moderate field visibility	4 (13.79%)	9 (31.03%)	
Requirement of blood transfusion	2 (6.90%)	5 (17.24%)	0.23
Use of electrocautery for hemostasis	19 (65.52%)	26 (89.66%)	0.02
Intraoperative complications	1 (3.45%)	2 (6.90%)	0.55

Table 3: Postoperative Pain Assessment (VAS Score)

Time Interval	Tourniquet Group Mean ± SD	No-Tourniquet Group Mean ± SD	p-value
6 hours	5.94 ± 1.12	4.83 ± 1.05	0.001
12 hours	5.31 ± 1.06	4.52 ± 0.98	0.003
24 hours	4.76 ± 1.03	3.89 ± 0.96	0.002
48 hours	3.21 ± 0.84	2.79 ± 0.76	0.04
Requirement of rescue analgesia	12 (41.38%)	7 (24.14%)	0.16
Average analgesic doses in 48 hrs	3.76 ± 1.04	2.93 ± 0.89	0.001

Table 4: Blood Loss and Hematological Changes

Parameter	Tourniquet Group (n=29)	No-Tourniquet Group (n=29)	p-value
Postoperative drain output (ml) Mean ± SD	118.46 ± 29.83	135.79 ± 32.15	0.03
Total blood loss (ml) Mean ± SD	266.81 ± 45.27	357.43 ± 54.18	<0.001
Postoperative hemoglobin (g/dl)	11.21 ± 1.08	10.79 ± 1.14	0.11
Hemoglobin drop (g/dl)	1.43 ± 0.58	1.72 ± 0.64	0.04
Postoperative hematocrit (%)	34.67 ± 3.54	33.81 ± 3.72	0.34
Patients requiring transfusion	2 (6.90%)	5 (17.24%)	0.23

Table 5: Postoperative Recovery and Complications

Parameter	Tourniquet Group (n=29)	No-Tourniquet Group (n=29)	p-value
Time to first mobilization (days) Mean ± SD	2.41 ± 0.76	2.07 ± 0.63	0.05
Time to regain functional limb use (days)	5.62 ± 1.43	5.21 ± 1.36	0.27
Length of hospital stay (days) Mean ± SD	6.52 ± 1.43	6.11 ± 1.32	0.24
Postoperative limb swelling	9 (31.03%)	5 (17.24%)	0.21
Wound complications	3 (10.34%)	4 (13.79%)	0.69
Postoperative infection	1 (3.45%)	2 (6.90%)	0.55
Tourniquet-related thigh pain	6 (20.69%)	0 (0.00%)	0.01
Nerve-related symptoms	1 (3.45%)	0 (0.00%)	0.31

DISCUSSION

In the present study, both groups were comparable at baseline, which supports the validity of subsequent outcome comparisons. The mean age was 41.62 ± 12.48 years in the tourniquet group and 42.37 ± 11.95 years in the no-tourniquet group (p = 0.81), while BMI, sex distribution, type of surgery, diabetes, hypertension, preoperative hemoglobin, and preoperative hematocrit were also statistically similar. This baseline homogeneity is consistent with the randomized series of Abdel-Salam et al. (1995), who studied 80 patients and similarly reported that the tourniquet and no-tourniquet groups were comparable with respect to mean age, sex, preoperative knee score, and radiographic grade, thereby allowing valid assessment of postoperative differences.[7]

Regarding intraoperative parameters, the mean duration of surgery in the present study was slightly shorter in the tourniquet group (86.24 ± 15.37 min) than in the no-tourniquet group (89.73 ± 16.92 min), although this difference was not significant (p = 0.39). In contrast, intraoperative blood loss was markedly lower with tourniquet use (148.35 ± 34.12 mL vs 221.64 ± 45.58 mL; p < 0.001). A similar pattern was reported by Tetro et al. (2001) in a prospective trial of 63 patients randomized to tourniquet (n = 33) and no-tourniquet (n = 30) surgery, where tourniquet use reduced visible operative bleeding but did not significantly reduce overall blood loss or transfusion needs. Thus, our data agree with their observation that a tourniquet improves the immediate operative field and reduces visible blood loss, even if the overall clinical benefit may be smaller than expected.[8]

A notable finding in this study was the better operative field with tourniquet use: 86.21% of cases in the tourniquet group had good field visibility compared with 62.07% in the no-tourniquet group (p = 0.03), and the need for electrocautery was significantly lower (65.52% vs 89.66%; p = 0.02). This supports the practical surgical advantage of a bloodless field. However, the improved field did not translate into a major difference in operative time. Vandenbussche et al. (2002) also found that operations without a tourniquet were associated with greater calculated blood loss, but they reported no significant difference in operating time, suggesting that experienced surgeons can compensate for the absence of a tourniquet with meticulous hemostasis. Their study further showed that the advantages of operating without a tourniquet were limited mainly to the early postoperative period rather than the intraoperative stage.[9]

Postoperative pain was consistently higher in the tourniquet group in our series. The mean VAS scores at 6, 12, 24, and 48 hours were 5.94 ± 1.12, 5.31 ± 1.06, 4.76 ± 1.03, and 3.21 ± 0.84, respectively, compared with 4.83 ± 1.05, 4.52 ± 0.98, 3.89 ± 0.96, and 2.79 ± 0.76 in the no-tourniquet group, with significant differences at all time points. This trend is in line with Li et al. (2009), who randomized 80 patients and demonstrated that tourniquet use was associated with significantly greater hidden blood loss, postoperative swelling, ecchymosis, and delayed straight-leg raising and knee flexion in the early postoperative period. Their conclusion that tourniquet-assisted surgery may hinder early rehabilitation supports our finding that the pain burden is greater when a tourniquet is used.[10]

The higher pain burden in our tourniquet group was also reflected in medication use. Although rescue analgesia requirement did not reach statistical significance (41.38% vs 24.14%; p = 0.16), the mean number of analgesic doses over 48 hours was significantly higher in the tourniquet group (3.76 ± 1.04 vs 2.93 ± 0.89; p = 0.001). Comparable findings were reported by Tai et al. (2012) in a randomized controlled trial of 72 patients, where tourniquet use reduced blood loss but caused slightly more postoperative pain, while postoperative swelling, rehabilitation progress, and hospital stay were not significantly different between groups. Therefore, our pain results are closely aligned with the work of Tai et al., particularly the concept that reduced operative bleeding may be offset by more postoperative discomfort.[11]

With respect to recovery, patients in the present study mobilized slightly earlier without a tourniquet, with the mean time to first mobilization being 2.07 ± 0.63 days in the no-tourniquet group versus 2.41 ± 0.76 days in the tourniquet group (p = 0.05). Time to regain functional limb use was also numerically shorter without a tourniquet (5.21 ± 1.36 vs 5.62 ± 1.43 days), although the difference was not significant. These findings parallel the randomized study of Ejaz et al. (2014) involving 70 patients, in which the no-tourniquet group had better early knee ROM both postoperatively (48° vs 36°; p < 0.001) and at 8 weeks (100° vs 93°; p = 0.002), along with lower discharge pain scores (4.6 vs 5.5; p < 0.02) and lower morphine-equivalent consumption during hospitalization. Their conclusion that omission of the tourniquet leads to faster early recovery strongly supports the recovery profile observed in our study.[12]

In relation to blood loss and hematological change, our study showed significantly lower postoperative drain output in the tourniquet group (118.46 ± 29.83 mL vs 135.79 ± 32.15 mL; $p = 0.03$), significantly lower total blood loss (266.81 ± 45.27 mL vs 357.43 ± 54.18 mL; $p < 0.001$), and a smaller hemoglobin drop (1.43 ± 0.58 g/dL vs 1.72 ± 0.64 g/dL; $p = 0.04$). This differs somewhat from the retrospective analysis by Alzahrani et al. (2022), who studied 276 primary TKAs and found no significant difference in postoperative hemoglobin, hemoglobin decrease, total blood loss, or transfusion need between the two groups; the reported hemoglobin decrease was 1.44 ± 0.80 g/dL in the tourniquet group and 1.16 ± 0.93 g/dL in the non-tourniquet group ($p = 0.907$), with transfusion rates of 1.90% vs 2.60% ($p = 0.703$). The discrepancy may reflect differences in operative spectrum, perioperative protocols, and the fact that our study included mixed limb orthopedic procedures rather than only primary TKA.[13]

The issue of visible versus occult blood loss remains important when interpreting our results. Although we found lower total blood loss in the tourniquet group, some contemporary studies suggest that tourniquet use mainly shifts blood loss from the intraoperative to the postoperative or hidden phase. This was shown by Albayrak et al. (2023) in 106 patients, where total blood loss was similar between the non-tourniquet and tourniquet groups (850 mL vs 880 mL; $p = 0.799$), but postoperative blood loss was higher with tourniquet use (400 mL vs 250 mL; $p < 0.001$) and occult blood loss was also greater (480 mL vs 200 mL; $p < 0.001$). Their data suggest that the lower measured drain output and hemoglobin drop seen in our tourniquet group may not always translate to universally lower “true” blood loss in all orthopedic settings, and that the mechanism of hidden bleeding should be considered while interpreting tourniquet-related blood conservation.[14]

Postoperative complications in our study were generally infrequent and mostly comparable between groups, including limb swelling (31.03% vs 17.24%; $p = 0.21$), wound complications (10.34% vs 13.79%; $p = 0.69$), infection (3.45% vs 6.90%; $p = 0.55$), and transfusion requirement (6.90% vs 17.24%; $p = 0.23$). However, tourniquet-related thigh pain was significantly more common in the tourniquet group (20.69% vs 0.00%; $p = 0.01$), and nerve-related symptoms were seen only in that group. A partially contrasting perspective was provided by Johnsen et al. (2024) in a randomized study, where tourniquet use was associated with lower estimated perioperative blood loss (122 ± 136 mL vs 254 ± 143 mL; $p < 0.001$) and a smaller fall in hemoglobin (1.7 ± 0.6 vs 2.1 ± 0.9 g/dL; $p = 0.02$), but there were no significant differences in pain scores, opioid use, ROM, or length of stay (1.92 ± 0.53 vs 1.97 ± 0.62 days; $p = 0.70$). Compared with their findings, our results suggest that in broader limb orthopedic practice, the pain-related adverse effects of a tourniquet may be more clinically evident than in standardized fast-track arthroplasty pathways.[15]

LIMITATIONS

A few important limitations of this study deserve mention. The sample size of 58 patients is modest, and while adequate for detecting differences in primary outcomes, it may not have been sufficient to pick up smaller but clinically relevant differences in secondary endpoints such as transfusion rates or wound complications. Group allocation was determined by the operating surgeon rather than by randomization, which introduces the possibility of selection bias — although baseline characteristics were well-matched between groups. The study was carried out at a single centre, and the findings may not translate directly to settings with different case volumes, anaesthetic practices, or rehabilitation protocols. The patient population was also somewhat heterogeneous, encompassing different procedures across the upper and lower limb; variations in tourniquet cuff pressure, ischaemia time, and anatomical site may have contributed to outcome variability. Total blood loss calculations did not incorporate occult or hidden blood loss using validated formulae such as the Nadler equation, so true perioperative losses may have been underestimated. Follow-up was limited to the inpatient period, meaning longer-term functional outcomes and patient-reported recovery were not captured. Finally, neither patients nor outcome assessors were blinded to the technique used, which may have introduced bias — particularly in the subjective scoring of pain on the VAS.

CONCLUSION

In conclusion, in this prospective comparative observational study, tourniquet use was linked to better operative field visibility and meaningfully lower intraoperative and total blood loss when compared with surgery performed without a tourniquet. That said, patients in the tourniquet group experienced higher postoperative pain, greater analgesic requirement, and more tourniquet-related thigh discomfort. Recovery outcomes such as time to mobilization and return of functional limb use were slightly better in the no-tourniquet group, although most differences were not statistically significant. Thus, while tourniquet application offers intraoperative advantages, the no-tourniquet technique may provide a more comfortable early postoperative recovery.

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