

Impact of Prolonged Tourniquet Time on Wound Healing in Orthopaedic Surgeries: A Retrospective Cohort Study

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ABSTRACT

Introduction: Tourniquet application is routinely used in orthopaedic surgeries to reduce intraoperative blood loss and enhance surgical field visualisation. However, prolonged use of it may adversely affect tissue perfusion and delay wound healing.

Aim: To evaluate the association between tourniquet duration and wound healing in patients undergoing orthopaedic surgeries.

Materials and Methods: The present retrospective cohort study was conducted at Mahatma Gandhi Medical College and Research Institute, Pondicherry, India, over a period of six months involving 40 patients who underwent orthopaedic procedures involving tourniquet use. Participants were categorised into two groups based on tourniquet time: less than 120 minutes (n=23) and 120 minutes or more (n=17). Delayed wound healing was

defined as wound dehiscence requiring clinical intervention, delayed suture removal beyond postoperative day 12, or the presence of a surgical site infection confirmed clinically or microbiologically. Delayed wound healing incidences were compared between groups using Fisher's-exact test.

Results: A total of 40 patients were included in the study, of whom 7 were females and 33 were males. Delayed wound healing occurred in 4 out of 17 patients (23.5%) with tourniquet time ≥ 120 minutes, while none of the patients in the < 120 -minute group experienced delayed healing. The difference was statistically significant ($p=0.026$).

Conclusion: Prolonged tourniquet application of 120 minutes or more is significantly associated with delayed wound healing in orthopaedic surgeries. Careful consideration of tourniquet duration is warranted to minimise postoperative complications and support optimal healing.

Keywords: Bloodless surgical field, Intraoperative blood loss, Ischaemia, Transfusion related complications

INTRODUCTION

Tourniquet application is an indispensable technique in modern orthopaedic surgery, widely employed to establish a bloodless surgical field. [1,2]. By occluding arterial blood flow to the operative limb, tourniquets enhance visualisation of anatomical structures, improve surgical precision, and reduce intraoperative blood loss [3,4]. These benefits are particularly valuable in complex procedures such as joint arthroplasties, fracture fixations, and ligament reconstructions [2,5]. Additionally, the reduction in intraoperative blood loss minimises the need for blood transfusions, lowering the risk of transfusion related complications and improving overall patient safety [6,7].

However, the beneficial effects of tourniquets are not without consequences. Ischaemia, induced by the application of a tourniquet, deprives the tissues of oxygen and essential nutrients [8,9]. This oxygen deprivation triggers a cascade of metabolic disturbances, including the accumulation of anaerobic metabolites such as lactate and hydrogen ions [9]. If the ischemic period extends beyond a critical threshold, these metabolic changes can cause irreversible cellular injury [8,10]. Furthermore, the duration of Ischaemia is directly proportional to the extent of tissue damage, making prolonged tourniquet application a significant concern in clinical practice [7,10,11].

The reperfusion process further compounds the complications associated with tourniquet usage. When the tourniquet is released, the reintroduction of blood flow into the previously ischemic tissues generates oxidative stress and activates inflammatory pathways [12,13]. One of the most clinically significant complications arising from prolonged Ischaemia and reperfusion is delayed wound healing [13]. Delayed healing can manifest as persistent erythema, wound dehiscence, or surgical site infection, all of which can have profound implications for patient recovery [6,8]. These complications often necessitate additional medical or surgical interventions, leading to increased healthcare costs and prolonged hospital stays [6,10].

Given the potential for adverse outcomes, understanding the relationship between tourniquet duration and wound healing is essential [10,14]. Research has shown that extended ischemic times are associated with higher rates of wound complications [1,6]. However, the precise threshold beyond which the risks of tourniquet usage outweigh its benefits remains unclear. This lack of consensus highlights the need for further investigation to establish evidence based guidelines that can optimise tourniquet usage in orthopaedic surgery. With this background, the present study was conducted to evaluate the association between tourniquet duration and wound healing in patients undergoing orthopaedic surgery.

MATERIALS AND METHODS

The present retrospective cohort study was conducted from February to July 2024 in the Department of Orthopaedics at Mahatma Gandhi Medical College and Research Institute, Pondicherry, India. Approval was obtained from the Institutional Ethics Committee (MGMCR/Res/01/2023/91/IHEC/114). As this was a retrospective study utilising anonymised patient data, the requirement for individual informed consent was waived by the ethics committee. All patient information was kept confidential.

As this was a retrospective review of existing hospital records, a formal sample size calculation was not performed. Instead, a complete enumeration approach was adopted, wherein all eligible cases within the specified timeframe were included. A total of 40 patients who fulfilled the inclusion criteria were analysed.

Inclusion criteria: Patients who had undergone orthopaedic surgeries with tourniquet application and had complete documentation of both tourniquet time and postoperative wound healing outcomes.

Exclusion criteria: Patients with pre-existing skin conditions, infections near the surgical site, incomplete documentation, or inadequate follow-up were excluded.

Study Procedure

Data for the study were extracted from medical records. They included demographic details such as age and gender, surgical information including type and duration of procedure, recorded tourniquet application time, and documented wound healing status as noted in follow-up entries within the patient records. Standard tourniquet pressure was applied with a pneumatic tourniquet, employing an adult cuff size appropriate for the upper and lower limbs at the arm and thigh levels, respectively.

Based on the duration of tourniquet application, patients were categorized into two groups: those with tourniquet time less than 120 minutes and those with tourniquet time equal to or greater than 120 minutes [Table/Fig-1] [1]. The primary outcome of interest was delayed wound healing. This was defined as either wound dehiscence requiring clinical intervention or delayed suture removal beyond postoperative day 12, or the presence of a surgical site infection diagnosed either clinically or microbiologically [15].

Tourniquet time (minutes)	Frequency	Percentage (%)
<120 minutes	23	57.5%
≥120 minutes	17	42.5%
Total	40	100

[Table/Fig-1]: Distribution of participants according to tourniquet time.

STATISTICAL ANALYSIS

The collected data were entered into Microsoft Excel and exported to Jamovi Software V 2.3.28.0 for statistical analysis. Descriptive statistics were used to summarise the data: categorical variables were presented as frequencies and percentages, while continuous variables, after checking for normality, were summarised using means and standard deviations. A contingency table analysis was used to compare proportions between groups. Given the small sample size and expected cell frequencies, Fisher's-exact test was applied to assess statistical significance. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 40 participants were included in the study. The mean age was 40.38 years (SD=15.19), with an age range of 17 to 72 years [Table/Fig-2]. Of these, 33 participants (82.5%) were male, and 7 (17.5%) were female.

Age group (In years)	Frequency	Percentage (%)
15-24	7	17.5
25-34	8	20
35-44	9	22.5
45-54	8	20
55-64	5	12.5
≥65	3	7.5
Total	40	100

[Table/Fig-2]: Age-wise distribution of the participants.

Delayed wound healing was observed in 4 (10%) participants. Notably, all of these cases were in the group with tourniquet times ≥120 minutes. Delayed wound healing occurred in 2 out of 7 females (28.6%) and in 2 out of 33 males (6.1%). Although the proportion was higher in females, the association did not reach statistical significance (Fisher's-exact Test, p=0.134) [Table/Fig-3].

Case examples

Case 1: A 17-year-old male undergoing open reduction and plating for right distal radius (tourniquet time: 100 minutes) had routine wound healing with no gaping or discharge and suture removal at post-operative day 12.

Variables	Category	Delayed wound healing		p-value*	Odds ratio (95% CI)
		Yes n (%)	No n (%)		
Time code	<120 minutes	0 (0.0%)	23 (100%)	0.026	15.7 (0.782, 314) ^a
	≥120 minutes	4 (23.5%)	13 (76.5%)		
Gender	Female	2 (28.6%)	5 (71.4%)	0.134	0.161 (0.0183, 1.42)
	Male	2 (6.1%)	31 (93.9%)		
Age (in years)	< 40	0 (0.0%)	19 (100%)	0.108	10.0 (0.503, 200) ^a
	≥40	4 (19.0%)	17 (81.0%)		

[Table/Fig-3]: Association of tourniquet time, gender, and age with delayed wound healing.

*Fisher's-exact Test, ^aHaldane-Anscombe correction applied

Case 2: A 64-year-old female with achilles tendon rupture of left lower limb underwent Achilles tendon reconstruction with flexor hallucis longus augmentation (tourniquet time: 130 minutes) had delayed wound healing with wound dehiscence and underwent delayed suture removal at postoperative day 17.

Case 3: A 48-year-old male with a Trimalleolar fracture to the right lower limb underwent open reduction internal fixation with plates to the lateral and posterior malleolus and Cannulated Cancellous(CC) screws to the medial malleolus (tourniquet time: 140 minutes) had normal wound healing with no gaping or discharge and suture removal on postoperative day 12.

DISCUSSION

The present study demonstrated a statistically significant association between prolonged tourniquet time (≥120 minutes) and delayed wound healing in patients undergoing orthopaedic surgeries. These findings highlight the critical role of Ischaemia duration in influencing postoperative recovery. A prospective study by Horlocker TT et al., identified a 7.7% incidence of neurologic complications in total knee arthroplasty patients with a mean tourniquet time of 145±25 min. The risk increased 2.8-fold for every 30-minute rise in duration, supporting the detrimental impact of extended ischemic periods on tissue integrity [16]. Likewise, Butt U et al., reported a mean tourniquet time of 83 minutes (range 38-125 min) and found a significant association between longer tourniquet duration (P=0.03) and delayed cessation of wound oozing [3].

Contrarily, some studies suggest minimal or no association. A retrospective cohort study by Robertson C et al., (2022) examining hindfoot surgeries did not find a statistically significant difference in wound healing outcomes between groups with tourniquet time above and below 120 minutes [1]. However, methodological differences such as variability in surgical site vascularity, postoperative protocols, or sample characteristics may account for these contrasting results. Another critical consideration is the nature of reperfusion injury, which amplifies tissue insult rather than merely reversing Ischaemia. Studies by Newman RJ using magnetic resonance spectroscopy have confirmed the accumulation of anaerobic metabolites such as lactate and hydrogen ions during prolonged Ischaemia, which compromise cellular viability if not promptly resolved [8]. Reperfusion not only fails to reverse these changes fully but exacerbates tissue damage through oxidative and inflammatory pathways.

Clinical practice should thus aim to balance the benefits of a bloodless surgical field with the risks of extended tourniquet use. Strategies such as intermittent deflation, use of lower inflation pressures, and tourniquet application limited to critical surgical periods have shown promise in mitigating associated complications. Preoperative optimisation, such as managing diabetes, promoting smoking cessation, and ensuring adequate hydration, can enhance tissue resilience and support healing.

Limitation(s)

The present study's limitations include its retrospective nature and relatively small sample size, which may affect generalisability. Moreover, The authors did not account for confounding variables like

surgical technique, co-morbid conditions, or nutritional status, which could independently influence wound healing. Future research should include larger, randomised control trials and explore the molecular basis of Ischaemia-reperfusion injury in orthopaedic settings.

CONCLUSION(S)

In conclusion, there is some evidence to suggest that prolonged tourniquet application is a modifiable risk factor for delayed wound healing. Given the potential for preventable morbidity, orthopaedic surgeons must adhere to optimal tourniquet protocols and be vigilant about duration, especially in prolonged procedures.

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