

89079_Auto_Edited.docx

Name of Journal: *World Journal of Orthopedics*

Manuscript NO: 89079

Manuscript Type: ORIGINAL ARTICLE

Prospective Study

Effect of Ankle Versus Thigh Tourniquets on Post-operative Pain in Foot and Ankle Surgery: A Prospective Study

Ashish Mishra, Ahmed Barakat, Jitendra Mangwani, Jakub Kazda, Sagar Tiwatane, Sana Mohammed Aamir Shaikh, Linzy Houchen-Wolloff, Vipul Kaushik

Abstract

1

BACKGROUND

Tourniquets are commonly used in elective extremity orthopaedic surgery to reduce blood loss, improve visualisation in the surgical field, and to potentially reduce surgical time. There is a lack of consensus in existing guidelines regarding the optimal tourniquet pressure, placement site, and duration of use. There is a paucity of data on the relationship between the site of a tourniquet and postoperative pain in foot and ankle surgery.

AIM

The purpose of this study was to explore the relationship between tourniquet site and intensity and duration of post-operative pain scores in patients undergoing elective foot and ankle surgery.

METHODS

Retrospective analysis of prospectively collected data on 201 patients who underwent foot and ankle surgery in a single institution was undertaken. Intraoperative tourniquet duration, tourniquet pressure and site, and postoperative pain scores using Visual

Analogue Score (VAS) were collected in immediate recovery, at six hours and at 24 h post-op. Scatter plots were used to analyse the data and to test for the statistical correlation between tourniquet pressure, duration, site, and pain scores using Pearson correlation coefficient.

1 RESULTS

All patients who underwent foot and ankle surgery had tourniquet pressure of 250 mmHg for ankle tourniquet and 300 mmHg for thigh. There was **1** no correlation between the site of the tourniquet and pain scores in recovery, at six hours and after 24 h. There was a weak correlation between tourniquet time and Visual Analogue Score immediately post-op ($r = 0.14$, $P = 0.04$) but not at six or 24 h post-operatively.

CONCLUSION

1 This study shows that there was no statistically significant correlation between tourniquet pressure, site and post-op pain in patients undergoing foot and ankle surgery. The choice of using a tourniquet is based on the surgeon's preference, with the goal of minimizing the duration of its application at the operative site.

INTRODUCTION

Tourniquets are frequently employed in orthopaedic procedures involving lower extremities [1]. Their primary purpose is to minimize blood loss, enhance surgical visibility, and streamline the surgical process [2]. Due to their ubiquity within the sphere of lower limb surgery, particularly foot and ankle, their use has been an interest of study to establish protocols and guidelines for their application. Nevertheless, the utilization of tourniquets has been linked to numerous local and systemic complications, one of which is postoperative pain [3].

The choice of tourniquet site and duration can significantly affect post-operative pain, and striking the right balance is essential [4]. The incidence of complications associated

with tourniquet usage increases proportionally with the duration of tourniquet application. This is linked to the hypoxic conditions induced by tourniquet inflation, thereby increasing the likelihood of consequential hypoxic and reperfusion damage to soft tissues [3].

In foot and ankle surgery, the usual placement of a tourniquet is it at the thigh, calf, or ankle. While thigh tourniquets are effective in minimizing intraoperative blood loss and maintaining a clear surgical field, they have been associated with a slightly higher risk of post-operative pain compared to ankle tourniquets [5]. The duration for which a tourniquet is inflated during surgery is another critical consideration. Prolonged tourniquet application has been associated with ischemic complications, muscle damage, and post-operative pain [6]. The challenge lies in finding the delicate balance between achieving adequate surgical conditions and minimizing tourniquet-associated complications. Other than minimising tourniquet duration and optimising occlusion pressure, the aim is to reduce the column of blood confined by the tourniquet use during surgery by utilising an effective, well-tolerated and as distal as possible.

We present the results of a comparative study investigating thigh *vs* ankle tourniquets applied for elective foot and ankle surgery in terms of effect on post-operative pain scores at different time points up to 24 h post-procedure. In addition, patient demographics such as age, gender, relevant medical conditions, and tourniquet time correlation to pain scores at those time points was also evaluated.

MATERIALS AND METHODS

The study was performed at the University Hospitals Leicester, United Kingdom. The study protocol was reviewed and accepted by University Hospitals Leicester as a service evaluation project ensuring compliance with regulatory and ethical guidance. 201 consecutive patients who had elective foot or ankle surgery under tourniquet (ankle and thigh) were included. The recruitment was performed as per the pre-set inclusion and exclusion criteria outlined in the study protocol. The inclusion criteria included patients who had their foot or ankle procedures under thigh or ankle tourniquets. All

trauma/fracture procedures were excluded as well as those with peripheral neuropathy or generalised pain disorders (e.g. fibromyalgia rheumatica). Patient demographics such as age, gender and relevant pre-existing medical conditions such as peripheral vascular disease, cardiac disease, severe hypertension, coagulopathies, diabetes and smoking status were collected. Patients were assigned to either ankle or thigh tourniquet groups in accordance with the surgeon's discretion. Recruited patients' operative details such as tourniquet site, occlusion pressure, and length of the operative procedure were recorded in the patient's operative records.

A standardised ankle tourniquets (Anetic Aid Ltd, Baildon, UK) were applied 10 cm above the ankle joint (586mm length x 106mm width) and thigh tourniquets (Anetic Aid Ltd, Baildon, UK) at mid-thigh (1074mm length x 129mm width). The tourniquet site was well padded in all patients with 3 rolls of 150mm width cotton roll (Softban Ltd, UK) and tourniquet site occluded with an impervious U-drape. All limbs were either exsanguinated or elevated before tourniquet inflation; a tourniquet pressure of 250 mmHg for ankle tourniquet and 300 mmHg for thigh was applied. Local anaesthetic depending on the length of the incision and procedure performed (10-20 mLs of 0.5% Levobupivacaine) was injected into the incision site before dressings were applied. Whilst in the recovery bay and as soon as the patient was fully awake and co-operative, visual analogue scores (VAS) were collected in the immediate post-operative, six hours, and 24 h after the operative procedure. Any tourniquet related complications (skin burn and post-tourniquet syndrome) were recorded. The analgesic plan for all the included patients in the first 24 h was standardised with Paracetamol 500 mg and Dihydrocodeine 30 mg prescribed per-orally every 4-6 h and Oromorph 10-20 ug prescribed as required unless patient's specific medical conditions or allergies precludes that.

Statistical analysis was performed using IBM SPSS software package version 20.0 (Armonk, NY: IBM Corp). The normality of variable distribution was assessed using the Kolmogorov-Smirnov test with mean, standard deviation (SD) and range used to describe normally distributed data. A Kruskal-Wallis test was employed in this study to

assess whether there is a statistically significant relationship between the placement of tourniquets at different sites (thigh or ankle) and the reported pain scores at immediate, six-hour, and 24-hour post-operative time points. Scatter plots were used to analyse the data and to test for the statistical correlation between tourniquet pressure, duration, site and pain scores using Pearson correlation coefficient. The significance of the obtained results was established at the 5% level ($p \leq 0.05$) and strong correlation considered for r values > 0.7 while weak correlation for those < 0.3 [7].

RESULTS

A total of 201 patients were included in our analysis over the 10 month recruitment period (January 2021 – October 2021). There were 116 (57%) males while the remainder 85 (43%) were females. The mean age was 59.4 years (range = 23 – 95 years, SD = 15.6) with no statistically significant difference between the ankle and the thigh tourniquet groups ($P = 0.4$). The medical records and conditions were available for all patients, with 89 (44%) having a relevant pre-existing medical condition presenting a potential risk factor influencing the outcomes of tourniquet use. The distribution of patient's demographics for the ankle and the thigh tourniquet groups is tabulated in **table 1**.

A total of 87 patients (43%) had an ankle tourniquet while 114 patients (57%) had a thigh tourniquet. The average tourniquet time was 73.7 minutes (range = 10 – 149 mins, SD = 28.7) with no statistical difference between the ankle and the thigh tourniquet groups ($P = 0.12$). There were two occurrences of tourniquet interruption after 120 minutes due to exceeding the recommended tourniquet time. Both of which happened in the thigh tourniquet group.

The mean immediate postoperative VAS was 3.9 (SD = 3.2, range = 0 – 10), mean six-hour VAS was 3.6 (SD = 2.6, range = 0 – 10), and mean 24-hour post-operative VAS was 5.8 (SD = 3.2, range = 0 – 10). Those patients who had a VAS of 10 at any time point were managed with elevation and escalated analgesia with resolution of their pain. None had any signs of compartment syndrome or concerning clinical findings. There were no reported tourniquet related complications for any of the included patients. Subsequent

subgroup analysis showed no statistically significant relationship between the 24 h VAS and the patient's age, gender or pre-existing medical conditions using multivariate regression analysis ($P = 0.35$, $P = 0.18$ and $P = 0.25$ respectively).

A paired t-test showed that there was a significantly higher mean VAS after 24 h as compared to the immediate post-operative ($t = 61.2$, $P < 0.0001$). We postulate that this is due to weaning off of the local anaesthetic effect, post-operative oedema, increasing patient activity level and peaking of the inflammatory response [8].

1 There was a very weak correlation between tourniquet time and recovery pain score, with the result just about statistically significant ($P = 0.04$). However, the size of the correlation coefficient is rather small ($r = 0.14$). On the other hand, there was no statistically significant correlation between tourniquet time and the six-hour pain score ($r = 0.09$, $P = 0.19$) or the 24-hour pain score ($r = 0.01$, $P = 0.81$) (Fig. 1).

As for the tourniquet site, Kruskal-Wallis analysis demonstrated no significant difference between immediate post-operative ($P = 0.69$), six-hour ($P = 0.45$) and 24 h ($P = 0.13$) pain scores as opposed to the tourniquet site (thigh *vs* ankle) (Fig. 2).

DISCUSSION

The use of tourniquet offers several potential benefits during foot and ankle surgery, including reducing operative time, minimizing blood loss, and thus improving visualisation. However, tourniquet use is associated with well-documented drawbacks, which encompass muscle ischemia, wound complications, neurovascular injuries, deep venous thrombosis [9-11]. The most common side effect remains to be post-operative pain at the tourniquet site [12]. Exploring the effect of tourniquet site and duration on post-operative pain has been investigated in our prospective study.

Mitigating tourniquet related post-operative pain can improve patient rehabilitation and engagement with physiotherapy as well as reducing morbidity and hospital stay. As for tourniquet duration, it has been recommended that tourniquet time should not exceed 120 minutes for foot and ankle surgery [13,14]. It has been demonstrated that

tourniquet-related complications increase as tourniquet time increases attributed to the hypoxic conditions and tissue ischaemia [15,16].

Although we observed no complications directly related to tourniquet use, we did identify a weak correlation between tourniquet duration and immediate post-operative pain scores, this correlation did not extend to the pain scores at six- or 24-hours post-operation. Other studies have observed similar relationship between tourniquet duration and post-operative pain with even better pain scores when not using a tourniquet. In a randomised trial by Dimnjakovic *et al.* assessing tourniquet *vs* no tourniquet in 50 consecutive ankle arthroscopy patients, they found less post-operative pain scores in the no tourniquet group [17]. A systematic review encompassing four studies that investigated tourniquet usage in lower limb surgery yielded consistent results. The findings supported the notion that surgical procedures performed without the use of a tourniquet resulted in a notably shorter hospital stay. Furthermore, these tourniquet-free surgeries were associated with reduced post-operative pain and complication rates, as compared to surgeries where tourniquets were utilized [18].

On the other hand, and contrary to other studies, there was no significant correlation between the choice of tourniquet site—whether at the thigh or the ankle—and the post-operative pain scores at the various time points we assessed. While extensive research exists regarding the immediate consequences of applying a tourniquet at a particular site, there is a notable paucity of high-quality data elucidating the comparative risk profiles associated with tourniquet use at one location *vs* another with only three comparative studies concerned with foot and ankle surgery available. For instance, a comparative study evaluated the impact of calf and ankle tourniquets on pain scores immediately and 30 minutes after deflation. The results revealed that despite the higher minimal occlusion pressure needed in the ankle tourniquet group, they demonstrated significantly better VAS than the calf tourniquets at the different evaluation time-points [19]. However, it is imperative to note that this conclusion was based on a laboratory experimental study on 63 healthy volunteers with VAS assessed to a maximum of 30 minutes after tourniquet removal. The other study was a retrospective analysis

comparing between using a thigh *vs* ankle tourniquet for calcaneal fracture surgery [20]. It included 42 patients and demonstrated significantly less foot pain in the ankle tourniquet group within two weeks after surgery and higher complications in the thigh tourniquet group. Finally, an RCT randomised 50 elective patients to thigh and ankle tourniquet groups showing significantly better pain scores for the ankle tourniquet group which was assessed for only a maximum of 30 minutes post-operatively [21].

There are limitations to our study as we did not assess foot and ankle functional scores due to the heterogeneity in the operative procedures included. Furthermore, the allocation of both groups was according to surgeon's preference and not randomized. However, the large cohort of patients assessed makes it one of the largest prospective studies assessing tourniquet use in elective foot and ankle surgeries to date.

CONCLUSION

In conclusion, the use of tourniquets, whatever ankle, or thigh locations, serves to meet the requirements of surgical field in foot and ankle surgeries. Tourniquet location does not have a significant bearing on post-operative pain levels however, minimising tourniquet duration does. Future high quality randomised trials are warranted to more reliably derive conclusions about the value of using tourniquets in foot and ankle surgery.

6%

SIMILARITY INDEX

PRIMARY SOURCES

1	physicianjnl.net Internet	133 words — 5%
2	Katherine C. Benedict, Somjade J. Songcharoen, Kristin L. Stephens, Anna L. Winter et al. "Comparison of inferior gluteal artery perforator flaps versus vertical rectus abdominis musculocutaneous flaps in the reconstruction of perineal wounds", Journal of Plastic, Reconstructive & Aesthetic Surgery, 2023 Crossref	16 words — 1%

EXCLUDE QUOTES ON
EXCLUDE BIBLIOGRAPHY ON

EXCLUDE SOURCES OFF
EXCLUDE MATCHES < 12 WORDS