

## Does tourniquet use affect wound healing in operatively treated ankle fractures?

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The aim of this study was to compare post-operative wound complications of tourniquet-assisted to non-tourniquet-assisted open reduction internal fixation (ORIF) of ankle fractures. The overall rate of complications after ankle fracture fixation varies between 5% and 40% depending on the population investigated; wound complications have been reported to occur FAA in 1.4% to 18.8% of patients. This study is a multi-institutional retrospective chart review of 300 operatively treated ankle fractures within the Northwell Health system. Data was collected from September 2016-September 2017. Out of 300 operatively treated ankle fractures, 70 patients fit the inclusion criteria. 22 out of 70 patients had their ankles fixed with assistance of a tourniquet, while 48 out of 70 had their ankles fixed without the assistance of a tourniquet. The decision to use or not use a tourniquet was purely based on surgeon preference and training. Wound complications were tracked in this cohort; wound complications were defined as those requiring dressing care for superficial wound dehiscence, oral antibiotics, requiring further surgical treatment, severe persistent (over 96 hours) edema and/or erythema, stitch abscess, and wound secretion. The overall prevalence of postoperative wound complications within our cohort was 18 out of 70 (25.7%). Seventeen out of the 18 patients that developed wound complications had their wounds heal with antibiotics and local wound care, and 1 patient (1.4%) developed deeper infection. Five patients within the tourniquet group developed minor wound complications (22.7%) and 12 out of 48 patients within the non-tourniquet group developed minor wound complications (25%). One patient in the non-tourniquet group (2%) developed a deep infection which further required a formal irrigation and debridement and removal of hardware. There was no statistically significant difference seen in postoperative wound complications among tourniquet-assisted and non-tourniquet assisted ORIF of ankle fractures.

**Keywords:** ankle fracture, tourniquet, surgical site infection

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Ankle fractures are a common injury, with a reported incidence of 184/100,000 person-years. Tourniquets are commonly employed during foot and ankle surgery [1]. The objective of a tourniquet is to optimize surgical field visualization, thereby limiting operative duration and improving technical precision

[2-6]. Their Utility is not benign. Reports of adverse events associated with the application of tourniquets during lower limb surgery include neuropraxia [8,9], vascular injury [9,10] post-operative swelling and joint stiffness [11,12], hyperemia on tourniquet deflation, increased postoperative pain [11-15], decreased

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muscle endurance and functional weakness. An increased incidence of deep vein thrombosis (DVT) and pulmonary embolism (PE) have also been associated with tourniquet use [7]. However there has been paucity of data in the foot and ankle literature regarding tourniquet use and postoperative wound complications. In addition to tourniquet related adverse outcomes, there are numerous established patient-related risk factors associated with postoperative wound complications. These include diabetes, a higher body mass index and smoking. Postoperative wound complications with deep infection may result in malunion or nonunion, amputation, sepsis, and increased mortality [16]. Besides the impact on postoperative outcome, the economic impact of postoperative wound complications should not be underestimated [17]. Infection at the operative site is one of the major reasons for readmission of orthopedic operative patients [18]. The incidence of wound complications is well documented for knee and hip surgery [19,20]. There is limited data on postoperative wound complications in patients who have undergone ankle ORIF and specifically its association with the utility of tourniquets.

## Materials and Methods

The medical records of three hundred operatively treated ankle fractures were retrospectively reviewed from September 2016 through September 2017. Out of the three hundred charts, seventy fit our inclusion and exclusion criteria. (Table 1). Twenty-two out of seventy patients had their ankles fixed with assistance of a tourniquet, while 48 out of 70 had their ankles fixed without the assistance of a tourniquet. The decision to use or not use a tourniquet was purely based on surgeon preference and training. There were 34 males and 36 females with an average age of 47. Fifty eight out of the seventy patients received preoperative antibiotics and two out of the seventy patients did not receive preoperative antibiotics, while there was no information on the remaining ten patients.

## Clinical Evaluation

These patients were seen postoperatively in the outpatient setting by their respective surgeons. Postoperative wound complications adapted from

Zgonis et al. were defined as the presence of at least 1 of the following findings including, superficial wound dehiscence, severe persistent (over 96 hours) edema and/or erythema, stitch abscess, and wound secretion[26]. Wound infection was classified following the guidelines of the Centers for Disease Control and Prevention for superficial incisional and deep incisional operative site infections [27].

## Results

In our cohort, 18 out of 70 patients (25.7%) developed wound complications. Five out of twenty-two patients (22.7%) in the tourniquet group required wound care such as antibiotics or silvadene dressings postoperatively. Twelve out of forty eight patients (25%) in the non-tourniquet group developed minor wound complications. One patient in the non-tourniquet group (2%) developed a deep infection, which further required a formal irrigation and debridement and removal of hardware.

## Discussion

Many studies have looked at the outcomes of operatively treated ankle fractures, and mostly good results follow surgical intervention. Wound complications are an important part of postoperative management of ankle fractures. They usually occur early in the postoperative period, however some deep infections may ultimately affect the long-term function of the ankle. Very few studies have specifically focused on wound complications for operatively treated ankle fractures and to our knowledge no study has looked at the association of tourniquet utilization and wound complication in surgically treated ankle fractures. SooHoo et al. performed an analysis of complications in all patients undergoing surgical treatment of ankle fractures in the state of California who required readmission or additional surgery on the ankle [25]. They reported that the rate of wound-related complications was 1.44%. Similarly in our entire cohort of seventy patients, 1.4 % of patients required return to the operating room for irrigation and debridement and removal of hardware for deep wound infections. SooHoo et al., however, did not review the rate of minor wound complications that did not require hospital readmission or further surgical treatment. In our cohort 25.7% of patients required antibiotics and

local wound care and there was no significant difference in the rate of wound complication with or without the use of a tourniquet.

The use of a tourniquet during surgery of the lower extremity is widespread. Although post-tourniquet syndrome is well established, its effects on wound complications are less understood. Use of tourniquet decreases blood flow in the tissues distal to its placement [23]. Reactive hyperemia and arterial dilatation follow even short periods of tissue ischemia, and edema results from reperfusion after thirty minutes to four hours of ischemia, thereby interfering with post-ischemic tissue nutrition. We believe that the reperfusion of the limb after tourniquet use may increase the tension exerted at the suture line, causing secondary ischemia of the sutured skin leading to higher wound complications [24]. Our hypothesis that use of a tourniquet will lead to higher rate of wound complications was rejected by the study. We acknowledge the small sample size of seventy patients as a limitation to our study; however this could be due to the fact many that many patients

followed up in other outpatient clinics where getting access to their charts were limited and others were lost to follow up. Furthermore, we used strict exclusion and inclusion criteria, in particular excluding revision surgery, prior surgery to same foot or ankle and hardware removal, to prevent any false positives. This could also have led to a smaller sample size. Future studies can be conducted to evaluate the optimal time to release the tourniquet to further minimize wound complications. Additional study should focus on identifying specific patient comorbidities that lead to increased wound complications like diabetes and smoking; thereby leading to better patient education and improved understanding of one's outcomes

**Conclusion**

In conclusion, our study showed that there was no significant difference in wound complications with or without the use of a tourniquet for operatively treated ankle fractures.

Inclusion Criteria	Exclusion Criteria
Simple lateral malleolus ankle fractures	Systemic infection at the time of surgery
Bimalleolar ankle fractures	Foot/Ankle ulcerations/blisters at the time of surgery
Trimalleolar ankle fractures	Vascular disease
Fractures requiring syndesmotic screw fixation	Revision surgery
Aseptic surgery	Prior history of Hardware removal from same ankle
All follow-ups in our outpatient clinic	History of DVT in same extremity
	Pilon Fractures, Open Fractures
	Skin condition on same extremity as ankle fracture

**Table 1** Inclusion and exclusion criteria for patient enrollment.

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