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Radial Nerve Palsy Following Pneumatic Tourniquet Use: A Case Series of Five Patients

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Abstract **Case Report**

Pneumatic tourniquets are widely used in upper-limb surgery to provide a bloodless operative field, but nerve injury remains a rare and potentially disabling complication. We report a series of five patients who developed postoperative radial nerve palsy after upper-limb surgery performed with a pneumatic tourniquet between January 2020 and December 2022. The mean age was 39 years and three patients were male. Surgical indications included two forearm malunions, one terrible triad of the elbow, one wrist malunion, and one recent forearm fracture. The tourniquet was inflated to 250 mmHg in all cases. Operative duration was less than 90 minutes in three patients, 100 minutes in one, and 105 minutes in one. All patients developed a high radial motor deficit; sensory impairment was present in three cases. Electromyography performed one month postoperatively showed neurapraxia with conduction disturbance in three patients and a more severe nerve injury pattern in two. All patients received vitamin supplementation and functional rehabilitation. Three patients recovered within four months and the remaining two by six months; wrist extension recovered before finger extension in every case. These observations highlight the need for individualized tourniquet pressure, appropriate cuff selection and positioning, minimization of inflation time, and early neurological assessment when postoperative weakness occurs.

Keywords: pneumatic tourniquet, radial nerve palsy, neurapraxia, upper-limb surgery, tourniquet-related nerve injury.

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INTRODUCTION

Upper-limb surgery often requires a clear, bloodless operative field because of the rich vascular supply and the need for precise visualization of neurovascular, tendon, and bony structures. Pneumatic tourniquets are therefore commonly used to temporarily occlude limb blood flow and facilitate surgery. Although modern tourniquet systems are generally safe, complications can include pain, skin injury, muscle injury, vascular events, and peripheral nerve injury [1,2].

Tourniquet-related nerve injury is uncommon but clinically important because it may result in transient or, rarely, persistent motor and sensory deficits. Mechanical compression, pressure gradients at the cuff edges, local ischemia, and ischemia-reperfusion phenomena have all been implicated in nerve dysfunction [2]. A systematic review of reported tourniquet-related nerve injuries found that most patients eventually achieved complete recovery, although recovery time was variable [3]. The purpose of this report is to describe the clinical profile, electrophysiological findings, management, and functional outcome of five patients who developed radial nerve palsy after pneumatic tourniquet use during upper-limb surgery.

CASE REPORT

This case series included five patients who underwent surgery for different upper-limb conditions between January 2020 and December 2022 and subsequently developed radial nerve palsy. Patients were included if they were older than 15 years, had complete medical records, and had more than one year of follow-up. Patients younger than 15 years and those with unusable or incomplete records were excluded.

The mean age of the patients was 39 years, and three of the five patients were male. The surgical indications were two forearm malunions, one terrible triad of the elbow, one wrist malunion, and one recent forearm fracture. Operative duration was less than 90 minutes in three patients, 100 minutes in one patient undergoing surgery for forearm malunion, and 105 minutes in one patient undergoing surgery for wrist

malunion. A pneumatic tourniquet pressure of 250 mmHg was used in all five cases.

Postoperatively, all patients presented with radial nerve palsy characterized by a high motor deficit. Sensory involvement was present in three patients, whereas sensation was preserved in two. Electromyography performed one month after surgery demonstrated a neurapraxic pattern with nerve-conduction disturbance in three cases and a more severe pattern of nerve injury in two. Vitamin supplementation and functional rehabilitation were initiated in all patients.

Three patients recovered within less than four months, while the remaining two recovered by six months. In all five patients, recovery of wrist extension preceded recovery of finger extension. No persistent motor deficit was reported after the recovery period described in the medical records.

Ethical approval and consent:

All clinical data were collected and analyzed in an anonymized manner. No information allowing direct or indirect identification of the patients was included in the manuscript, and patient confidentiality was strictly respected throughout the study.

DISCUSSION

Pneumatic tourniquets improve operative visualization, but their safety depends on pressure, cuff design, cuff position, and duration of inflation. Nerve injury is thought to result predominantly from mechanical compression and pressure gradients within the soft tissues, with local ischemia acting as an additional contributor [2]. Experimental human data have shown that focal nerve compression produces localized axonal depolarization followed by hyperpolarization after release, consistent with compression-induced focal ischemia [4]. Short periods of limb ischemia can also alter sensory conduction [5].

The radial nerve may be particularly vulnerable when a cuff is applied to the arm because of its close relationship to the humerus along the posterolateral aspect of the middle arm. In our series, all five patients developed radial nerve palsy, and three had associated sensory symptoms. The favorable evolution observed in all cases is consistent with the systematic review by Chang *et al.,* , in which most reported tourniquet-related nerve injuries ultimately recovered completely [3]. In our patients, recovery occurred within six months, and wrist extension returned before finger extension in every case.

A fixed inflation pressure of 250 mmHg was used in all five patients. Although 250 mmHg has traditionally been used in adult upper-limb surgery, contemporary evidence supports using the lowest pressure that reliably produces a bloodless field. Estebe and Estebe recommend basing inflation pressure on arterial occlusion pressure and using a limited safety margin rather than an arbitrary fixed pressure [6]. In a randomized trial of minor hand surgery, Kanchanathepsak *et al.,* showed that individualized pressure based on limb occlusion pressure significantly reduced tourniquet pressure compared with a standard 250 mmHg setting while maintaining an adequate surgical field [7]. More recently, a systematic review and meta-analysis of upper-limb surgery found that lower tourniquet pressures were able to provide satisfactory operative conditions across the included studies [9].

Current evidence-based recommendations emphasize preoperative assessment, selection of an appropriately sized cuff, protective padding, correct cuff placement, use of the minimum effective pressure, continuous monitoring, and minimization of inflation time [8]. Wider or contoured cuffs can also reduce the pressure required to achieve arterial occlusion [1]. These measures are particularly relevant because tourniquet-related nerve injury has been reported across a wide range of pressures and inflation times, and no single pressure or duration can be considered completely risk-free [3].

This series has several limitations. It includes only five patients and does not provide patient-specific systolic pressure, limb occlusion pressure, cuff width, cuff position, or exact tourniquet inflation time. These missing variables prevent determination of the relative contribution of pressure, duration, cuff geometry, and individual susceptibility. Nevertheless, the uniform occurrence of radial nerve palsy after a 250 mmHg upper-arm tourniquet and the subsequent complete recovery of all patients underline the importance of prevention, early neurological examination, electrophysiological assessment when clinically indicated, and structured rehabilitation.

CONCLUSION

Radial nerve palsy is a rare but potentially disabling complication of pneumatic tourniquet use in upper-limb surgery. In this five-patient series, all patients recovered within six months, with wrist extension preceding finger extension. Tourniquet safety should rely on appropriate cuff selection and positioning, protective padding, the lowest effective individualized inflation pressure, and limitation of inflation time. New postoperative motor or sensory deficits should prompt early neurological assessment and follow-up.

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