# To compare methods used in our operating room for alleviating tourniquet pain

Muhammad Asghar Ali,[1] Shahla Siddiqui[2]

## Abstract

**Objective:** To compare the efficacy of different methods used to alleviate tourniquet pain in operating rooms as well as assess their effect on post-operative pain.

**Methods:** The study was conducted at the Aga Khan University Hospital, Karachi from June to August 2010. All patients who came for elective orthopaedic surgery in whom a tourniquet application was planned were included in the study. Information was collected through a pre-designed data form. Qualitative data was expressed as mean ± standard deviation, while qualitative data was presented as frequency and percentage.

**Results:** In the 106 patients studied, opioids were administered in 90 (85%) cases, paracetamol in 73 (69%) and non-steroidal anti-inflammatory drugs in 11 (10.4%) cases. Efficacy was determined by means of the effect on the blood pressure and heart rate of the patient before and after the drug administration. Intravenous paracetamol was found to be the most effective in reducing both blood pressure and heart rate ($p < 0.001$). The effect on post-operative pain was insignificant.

**Conclusions:** Intravenous paracetamol is a cost-effective and safe analgesic, especially when combined with a multi-modal regimen, and has potential effect on the alleviation of tourniquet pain.

**Keywords:** Tourniquet pain, Alleviation, Analgesia, Orthopaedic surgery. (JPMA 63: 432; 2013)

## Introduction

Pneumatic tourniquets are often used to reduce blood loss and to provide optimal operating conditions during extremity surgery.[1] Compression of the tissues under a tourniquet is associated with soft-tissue injuries involving muscle, artery, skin, and, most importantly, peripheral nerves.[2] The aetiology and neural pathways involved in tourniquet pain is complex.[3] Pain associated with nerve compression is mediated by unmyelinated, slow conducting C-fibres, which are normally inhibited by earlier-arriving fast impulses conducted by myelinated A$\delta$ fibres because mechanical compression appears to block the large A$\delta$ fibres more effectively.[4] In animal models, both neuro-physiological and pathological nerve fibre damage have been found to correlate with the degree of tourniquet pressure applied.[5] Severe tourniquet pain characterised by a gradual onset and dull aching sensation at the site of the tourniquet or distal extremity[6] pain conducted by both myelinated A$\delta$ fibres and small C-fibres, whereas the second visual analogue scale (VAS) score peak indicates the tourniquet pain conducted by C-fibres alone. Tourniquet ischaemia produces an increase in C-fibre action potential frequency resulting in the induction of central sensitisation.[7]

Many methods are used to reduce tourniquet pain intra-operatively such as use of regional anaesthesia,

[1]Senior Instructor, [2]Department of Anaesthesia, Aga Khan University, Karachi.
**Correspondence:** Muhammad Asghar Ali. Email: asghar.ashraf@aku.edu

intravenous (IV) opioids, non-steroidal anti-inflammatory drugs (NSAIDs), paracetamol, gabapentin, melatonin and clonidine. Pre-operative administration of a single oral dose of gabapentin (1.2g) provides a significant clinical benefit by decreasing tourniquet-related pain.[8] Pre-administration of low-dose ketamine (0.1mg/kg) has been shown to attenuate tourniquet pain.[9] Clonidine has been reported to depress nerve action potentials in C-fibres.[10] Melatonin is an effective pre-medication before intravenous regional anaesthesia (IVRA) since it reduced patient anxiety, decreased tourniquet-related pain, and improved peri-operative analgesia.[11] The addition of paracetamol during IVRA with lidocaine decreased tourniquet pain, increased anaesthesia quality, and decreased post-operative analgesic consumption.[12] So far the incidence of tourniquet pain and variance in treatment has not been studied in our setting.

The objectives of the study were to assess the frequencies of different agents used in our operating rooms (OR) to reduce tourniquet pain, and to evaluate their effectiveness as well as to observe the pain score in post-operative care unit.

## Patients and Methods

The study was conducted in the operating theatres and the recovery room of Aga Khan University Hospital, Karachi, from June to August 2010. After approval from the Research committee of the Anaesthesia Department, adult patients who were scheduled for any orthopaedic procedure in which a tourniquet was planned to be used

under general anaesthesia with control mode of ventilation were included. At the end of surgery, the drugs used during the procedure for tourniquet pain alleviation was noted in a data collection form. Tourniquet-induced hypertension was defined as more than 30% increase in either systolic or diastolic arterial pressure after tourniquet inflation within 1 hour from the baseline. In order to assess the effectiveness, the blood pressure and heart rate (HR) of the patients were also noted before and after the administration of this medication. Data was collected by the anaesthesia resident in the OR. In the recovery room, the patient's pain score was collected from the recovery room chart, indicating whether the pain was 'mild,' 'moderate' or 'not present.' All patients less 15 years of age were excluded. Elective patients were selected in an arbitrary manner from all ORs Monday to Friday during routine work hours. Emergency cases were excluded.

The data collection forms included the demographics of the patients such as age, gender, planned surgery and diagnosis as well as the tourniquet inflation pressure and time. Patient confidentiality was ensured by means of assigning a serial number to the data collection form and identifying the patient by means of the medical record number only. Specific questions were asked regarding the agent used for alleviating tourniquet pain. The choices included opiates, NSAIDS, paracetamol and others. The choices were not mutually exclusive and more than one choice could be selected if more than one agent was used. These choices stemmed from the usual practices in the Ors. An ethical review was not required due to the observational nature of this study.

## Results

A total of 106 forms were filled by elective orthopaedic cases. Tourniquet pain was treated in 100 (94.3%) patients.

Table: Demographic and clinical characteristics of patients.

| Variables | Statistics |
|---|---|
| Mean Age | 38±18 years |
| Mean Weight | 66.24±14 kg |
| Mean BMI | 26.5±14.27 kg/m$^2$ |
| Mean Tourniquet inflation time | 92.71±178 min |
| Mean Tourniquet inflation pressure | 283±146 mmHg |
| **Gender** | |
| Male | 64(60.4%) |
| Female | 42(39.6%) |
| **ASA Status** | |
| I | 49(46%) |
| II | 47(44.3%) |
| III | 09(8.5%) |
| IV | 01(0.9%) |

BMI: Body Mass Index.
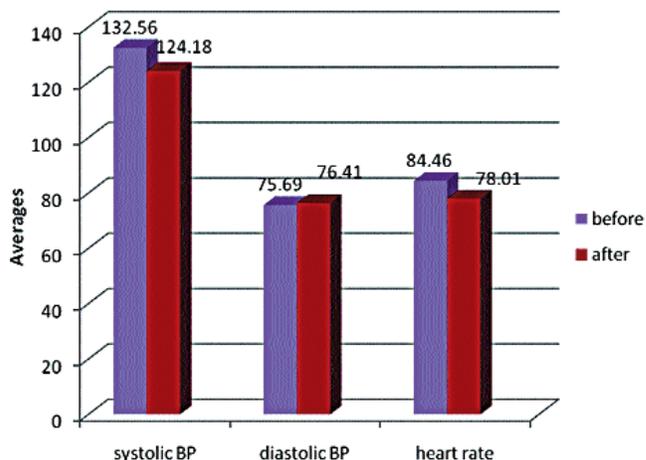


BP: Blood pressure.

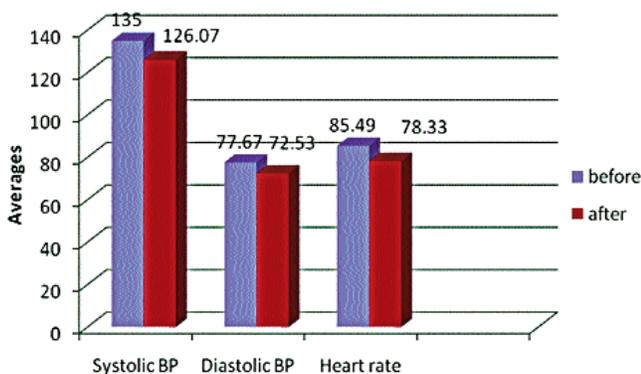**Figure-1:** Haemodynamic effect of opioids on tourniquet pain.
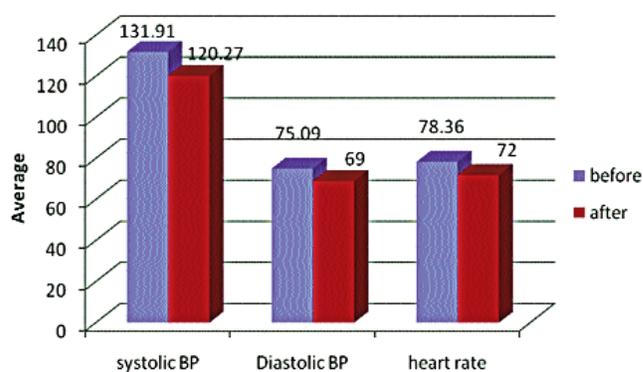


NSAIDs: Non-steroidal anti-inflammatory drugs.
BP: Blood pressure.

**Figure-2:** Haemodynamic effect of NSAIDS on tourniquet pain.

The average age was 38±18 years, and there were 64 (60%) males. The average height and body mass index (BMI) were 66.24±14kg and 26.51±14.27 respectively for males and females. As for the American Society of Anaesthesiologists (ASA) classification, 49(46%) patients in the study were ASA-I; 47 (44.3%) were ASA-II; 9(8.5%) were ASA-III; and 1 (0.9%) ASA-IV. The average tourniquet inflation time (Tt) and pressure (Tp) was 92.71±178mins and 283±146mmHg respectively (Table).

Opioids were used in 90 (85%) cases specifically for tourniquet pain. This was in addition to the induction analgesia. Pethidine was used in 76% (n=81) of the time in these cases in titrated doses. NSAIDs, such as ketorolac, was used in 11 (10.4%) and paracetamol was used in 73

**BP: Blood pressure.**

**Figure-3:** Haemodynamic effect of paracetamol on tourniquet pain.

(68.9%) cases. Agents could be used concurrently and 2 agents were used 30% (n=32) of the time. Usually these were a combination of opioids and NSAIDs, or NSAIDs and paracetamol.

Patients were also followed in the recovery room where the pain score assessed by the nurses and recorded on the charts were noted: 96 (90.6%) patients had mild pain; 8 (7.5%) had moderate pain; and 2 (1.9%) had no pain. The severity of the pain score in the recovery room, when compared to different agents used, was not significant; the p value of using opioids for tourniquet pain intra-operatively and in the recovery room score was 0.37; for NSAID it was 0.73; and for paracetamol it was 0.43.

The effectiveness of the 3 agents for tourniquet pain was judged by the effect on systolic blood pressure, diastolic blood pressure and heart rate (haemodynamics). The highest pressures and HR during tourniquet pain before treatment were recorded and compared to the lowest pressure immediately following the drug administration (Figure-1-3). The difference was significant in most cases, but the highest significance was noted with paracetamol (p < 0.001).

## Discussion

Tourniquet is used commonly in patients undergoing orthopaedic procedure under general anaesthesia to prevent excessive bleeding and to have a better surgical field. The application of tourniquet is painful and the intensity of this pain increases with the passage of time. The pain intensity correlates with rise in blood pressure and thus the term 'tourniquet-induced hypertension' has been defined, which states that, 'the rise in blood pressure above 30% from the baseline' is known as tourniquet-induced hypertension.[8] It is suggested that tourniquet

pain may arise from ischaemia of peripheral neurons or nociceptors distal to the tourniquet, or from nerve fibre activation directly under it, again because of ischaemia up to the extent that mechanical trauma and tissue ischaemia under or distal to the tourniquet lead to release of inflammatory mediators which in turn may cause tourniquet pain.

Effective pain management is an important component of post-surgical care. Many patients, however, continue to experience inadequate pain relief. Despite improvements in analgesic delivery, including patient-controlled analgesia (PCA) and sustained-release opioids, several recent surveys have found that up to 80% of patients report moderate to severe pain after surgery. The ideal analgesic treatment should provide rapid and effective pain relief, have a low incidence of adverse effects, and have minimal impact on major organ systems or no significant interaction with other pharmacologic agents.[13]

Non-opioid analgesics are commonly used alone or as adjuncts to opioid-based analgesia to treat moderate to severe pain. Peri-operative administration of acetaminophen and NSAIDs has been advocated to provide multimodal analgesia that decreases opioid dose requirements and may reduce associated adverse events while reducing post-surgical pain intensity.[13]

In our current cost-constrained environment, it has become essential to fast track most elective surgery patients. A substantial reason for delay in discharge is post-operative pain or even complications from analgesics given for intra operative tourniquet pain. Various methods have been described in literature, including IVRA or Bier's block, intra-thecal or epidural blocks, intravenous analgesics such as NSAIDs like ketorolac, ketamine and opioids.[14-16] However, paracetamol has not been studied extensively for tourniquet pain specifically. Studies suggest that intravenous paracetamol is a useful component of the multimodal analgesia model generally, especially after tourniquet surgery.[13] Paracetamol has been shown to be definitely a viable alternative to NSAIDs, especially because of the lower incidence of adverse effects, and should be the preferred choice in high-risk patients. Paracetamol should also be considered instead of NSAIDs for pain management after major orthopaedic surgery.[17] Others showed that the use of intravenous paracetamol in the Emergency Department is equivalent to NSAIDs given intravenously.[18]

Analgesic properties of intravenous paracetamol have been found to be similar to those of intravenous morphine in acute traumatic limb pain.[19] Single and

repeated doses of paracetamol can be used effectively as an alternative to morphine for the management of post-operative pain after mild to moderately painful surgery, with the added benefit of better tolerability.[20] Besides, paracetamol has a wider safety margin and is generally cheaper than the other agents.[21,22] In our operating rooms, opioids were followed by paracetamol as treatment of haemodynamic changes associated with tourniquet pain. However, the efficacy as judged by the drop in BP and HR was more significant for paracetamol when compared to opioids and NSAIDs.

In terms of limitation, consecutive patients could not be enrolled due to logistical issues as these forms were filled on a voluntary basis by the assigned anaesthesia teams. Hence, an incidence of tourniquet pain could not be accurately estimated during the study.

## Conclusion

Larger studies are recommended to investigate the comparative use of paracetamol and its effectiveness in alleviating tourniquet pain.

## References

1. Estebe JP, Le Naoures A, Chemaly L, Ecgfey C. Tourniquet pain in a volunteer study: effect of changes in cuff width and pressure. Anaesthesia 2000; 55: 21-6.
2. McLaren AC, Rorabeck CH. The pressure distribution under tourniquets. J Bone Joint Surg Am 1985; 67: 433-8.
3. Hodgson AJ. A proposed etiology for tourniquet-induced neuropathies. J Biomech Eng 1994; 116: 224-7.
4. Pedowitz RA. Tourniquet-induced neuromuscular injury. A recent review of rabbit and clinical experiments. Acta Orthop Scand Suppl 1991; 245: 1-33.
5. Hagenouw RR, Bridenbaugh PO, Van Eqmond J, Stuebing R. Tourniquet pain: a volunteer study. Anesth Analg 1986; 65: 1175-80.
6. MacIver MB, Tanelian DL. Activation of C fibres by metabolic perturbations associated with tourniquet ischemia. Anesthesiology 1992; 76: 617-23.
7. Turan A, White PF, Karamanlioglu B, Pamukcu Z. Premedication with gabapentin: the effect on tourniquet pain and quality of intravenous regional anesthesia. Anesth Analg 2007; 104: 97-101.
8. Takada M, Fukusaki M, Terao Y, Kanaide M, Yamashita K, Matsumoto S, et al. Preadministration of low-dose ketamine reduces tourniquet pain in healthy volunteers. J Anesth 2005; 19: 180-2.
9. Gaumann DM, Brunet PC, Jirounek P. Clonidine enhances the effects of lidocaine on C-fibre action potential. Anesth Analg 1992; 74: 719-25.
10. Mowafi HA, Ismail SA. Melatonin improves tourniquet tolerance and enhances postoperative analgesia in patients receiving intravenous regional anesthesia. Anesth Analg 2008; 107: 1422-6.
11. Ko MJ, Lee JH, Cheong SH, Shin CM, Kim YJ, Choe YK, et al. Comparison of the effects of acetaminophen to ketorolac when added to lidocaine for intravenous regional anesthesia.Korean J Anesthesiol 2010; 58: 357-61.
12. Reuben SS, Steinberq RB, Kreitzer JM, Duprat KM. Intravenous regional anesthesia using lidocaine and ketorolac. Anesth Analg 1995; 81: 110-3.
13. Memis D, Inal MT, Karalci G, Sezer A, Sut N. Intravenous paracetamol reduced the use of opioids, extubation time, and opioid-related adverse effects after major surgery in intensive care unit. J Crit Care 2010; 25: 458-62.
14. Celik M, Saricaoqlu F, Canbay O, Dal D, Uzumciqil A, Leblebicioqlu G, et al. Withdrawn the analgesic effect of paracetamol when added to lidocaine for intravenous regional anesthesia. Minerva Anestesiol 2009.
15. Remerand F, Letendre C, Baud A, Couvret C, Pourrat X, Farord L, et al. The early and delayed analgesic effects of ketamine after total hip arthroplasty: a prospective, randomized, controlled, double-blind study. Anesth Analg 2009; 109: 1963-71.
16. Benson M, Maranqou A, Russo MA, Durocher J, Collaku A, Starkey YY. Patient preference for sustained-release versus standard paracetamol (acetaminophen): a multicentre, randomized, open-label, two-way crossover study in subjects with knee osteoarthritis. J Int Med Res 2009; 37: 1321-35.
17. Hyllested M, Jones S, Pedersen JL, Kehlet H. Comparative effect of paracetamol, NSAIDs or their combination in postoperative pain management: a qualitative review. BJA 2002; 88: 199-214.
18. Todd KH, Funk KG, Funk JP, Bonacci R. Clinical significance of reported changes in painseverity. Ann Emerg Med 1996; 27: 485-9.
19. Craig M, Jeavons R, Probert J, Benger J. Randomised comparison of intravenous paracetamoland intravenous morphine for acute traumatic limb pain in the emergency department. Emerg Med J. Published online first: 2011. doi:10.1136/emj.2010.104687.
20. Van Aken H, Thys L, Veekman L, Buerkle H. Assessing analgesia in single and repeated administrations of propacetamol for postoperative pain: comparison with morphine after dental surgery. Anesth Analg 2004; 98: 159-65.
21. El-Radaideh KM. [Effect of pretreatment with lidocaine, intravenous paracetamol and lidocaine-fentanyl on propofol injection pain. Comparative study. Rev Bras Anestesiol 2007; 57: 32-8.
22. Nikles CJ, Yelland M, Del Mar C, Wilkinson D. The role of paracetamol in chronic pain: an evidence based approach. Am J Ther 2005; 12: 80-91.