Use of ketamine for reduction of tourniquet-induced hypertension

Ketamine Use for Prevention of Tourniquet-Induced Hypertension

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INTRODUCTION

- Tourniquet use can cause a dull pain, hypertension, and increased heart rate when utilized for longer periods of time, such as for more than 35 minutes.[1]
- Tourniquet-induced hypertension (TIH) has been defined as a 30% increase in systolic blood pressure (SBP) or diastolic blood pressure (DBP) from baseline.[1-4]
- TIH can occur in up to 11% of patients with tourniquet use.[2]
- TIH is often resistant to analgesia and increased depth of anesthesia.[3]
- NMDA receptor may be involved with tourniquet pain.[1]
- Ketamine is a NMDA antagonist.[1-4]
- Purpose statement: To investigate if the use of ketamine prior to tourniquet inflation can decrease the incidence of tourniquet hypertension.
- PICOT: In patients undergoing general anesthesia with intraoperative tourniquet use, can the use of intravenous ketamine prior to tourniquet placement in comparison to not administering ketamine affect the incidence of hypertension while the tourniquet is inflated during surgery?

METHODS

- Systematic review of EMBASE and PubMed
- Keywords: *tourniquet* and *hypertension*
- Limitations: English written publications
- 53 articles found on PubMed and 161 articles found on Embase
- Inclusion criteria: patients undergoing general anesthesia, tourniquet use, comparison to a control, test substances administered prior to tourniquet inflation, and blood pressure data collection
- 4 randomized controlled trials (RCTs) met inclusion criteria and were deemed best evidence.[1-4]
- IRB/IACUC approval does not apply to this evidence-based project.

Author, date	Sample, sample size, setting	Treatment groups	Results
Satsumae et al, 2001[1]	85 patients, lower limb surgery, ASA I-II, 14-68 years old General anesthesia Tourniquet on thigh inflated to 300 mmHg	Treatment administered at least 10 mins before tourniquet inflation 1.0 mg/kg ketamine IV bolus in 10 mL NS vs 0.25 mg/kg ketamine IV bolus in 10 mL NS vs 10 mL NS IV bolus	In the control group SBP was significantly increased at 40, 50, 60 min ($P < .05$) and DBP was significantly increased at 50 and 60 min ($P < .05$). Both ketamine groups did not have a significant change in SBP or DBP. Significantly less patients developed TIH in the large ketamine and small ketamine group compared to control ($P < .01$).
Park et al, 2007[2]	28 patients, lower limb surgery, ASA I, 18-60 years old General anesthesia 11 cm wide tourniquet on thigh inflated to 300 mmHg	Treatment administered 10 mins after induction 0.1 mg/kg ketamine in 10 mL of NS bolus vs 10 mL NS bolus	In the control group there was an increase in SBP 5 mins after tourniquet inflation and 35-60 min after tourniquet inflation ($P < .05$), but no significant increase in SBP in ketamine group. More participants developed TIH in the control group (28.6%) than the ketamine group (7.1%).
Ongaya et al, 2017[3]	46 patients, lower and upper limb surgery, ASA I-II, 18-80 years old General anesthesia Tourniquet utilized, but size and inflation pressure not disclosed	Treatment administered after induction 0.1 mg/kg ketamine bolus in 10 mL NS followed by 2 mcg/kg/min infusion vs 10 mL NS bolus followed by continuous NS infusion	SBP was higher in the control group after 60 min, but the results were not significantly different ($P = .866$). Tourniquet HTN was significantly higher in control group 26.08% versus 4.35% in the ketamine group ($P = .02$). No significant differences were present in DBP after 60 min.
Kim et al, 2022[4]	75 patients, lower limb surgery, ASA I-II, 18-75 years old General anesthesia 20 cm wide tourniquet on thigh inflated to 300 mmHg	Treatment administered 10 mins before inflation 1.5 mg/kg lidocaine bolus in 10 mL NS vs 0.2 mg/kg ketamine bolus in 10 mL NS vs 10 mL NS bolus	After 60 mins SBP was significantly higher in the control group than lidocaine or ketamine group ($P < .001$). TIH occurred significantly more ($P = .001$) in the control group (56%) than the lidocaine group (16%) or ketamine group (12%).

Table 1. Evidence Appraisal Table
Abbreviations: ASA- American Society of Anesthesiologists classification, DBP- diastolic blood pressure, HR- heart rate, HTN- hypertension, IV- intravenous, Min- minute, NS- normal saline, RCT- randomized controlled trial, SBP- systolic blood pressure, TIH- tourniquet-induced hypertension

QR code 1. Post-Presentation Quiz

QR code 2. References

REVIEW OF LITERATURE / CRITICAL APPRAISAL

- All 4 articles demonstrated decreased hypertension in the groups that received ketamine prior to tourniquet inflation when compared to a control.[1-4]
- Three articles collected data up to 60 minutes post tourniquet inflation[1,2,4] and 1 article collected data up to 120 minutes post tourniquet inflation.[3]
- Three articles investigated the use of a bolus of ketamine[1,2,4] and 1 article investigated the use of a bolus of ketamine followed by an infusion.[3]
- Ketamine doses utilized: 0.1 mg/kg, 0.2 mg/kg, 0.25 mg/kg, 1 mg/kg, or 0.1 mg/kg followed by 2 mcg/kg/min infusion[1-4]
- Treatment for hypertension varied between studies with studies utilizing different opioids, increased volatile anesthetics, or nicardipine.[1-4]
- There was difficulty ensuring similar level of anesthetic depth between groups. Bispectral index monitoring was only utilized in one article.[4] These limitations impair the comparability between studies and between patients.
- Articles excluded ASA III-V, those with ischemic heart disease, dementia, and vascular disease which limited applicability to some of the population requiring anesthesia services.[1-4]

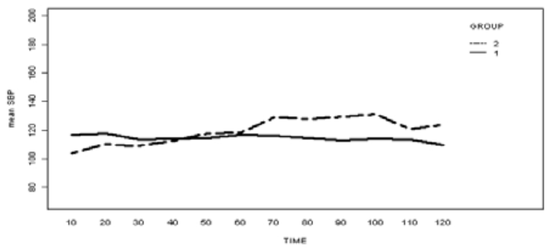

Figure 1. Change in mean SBP over time[3]
Group 1- ketamine group, Group 2- saline group
Abbreviation: SBP- systolic blood pressure

RECOMMENDATIONS FOR PRACTICE / CONCLUSIONS

- Ketamine administration can be used to prevent TIH.
- These studies support early ketamine administration, before signs of TIH.
- Additional studies are required to determine if ketamine can prevent TIH for longer periods of time.
- Further research including a more diverse population is necessary to determine if ketamine administration is effective in patients with a variety of comorbidities.
- A dose of 0.1-0.2 mg/kg can be utilized without dissociative effects.