



ORIGINAL ARTICLE

Preoperative dexmedetomidine prevents tourniquet-induced hypertension in orthopedic operation during general anesthesia

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Abstract This study was a double-blinded randomized control trial designed to investigate the hemodynamic effects of dexmedetomidine on prolonged tourniquet inflation. Thirty-seven patients scheduled for elective orthopedic surgery of the lower limb under general anesthesia were recruited. They were randomly assigned to receive intravenous dexmedetomidine (DEX, 0.5 µg/kg; $n = 18$) or normal saline (CON; $n = 19$) before tourniquet inflation. Arterial blood pressure and heart rate were recorded every 10 minutes until 60 minutes after the start of tourniquet inflation and again immediately after deflation. In the DEX group, arterial pressure was not significantly changed, but in the CON group arterial pressure was significantly increased at 40, 50, and 60 minutes after the start of tourniquet inflation. Development of more than 30% increase in arterial pressure during tourniquet inflation was more frequent in the CON group than in the DEX group. Preoperative intravenous dexmedetomidine could therefore prevent tourniquet-induced hypertension in patients undergoing general anesthesia. Copyright © 2012, Kaohsiung Medical University. Published by Elsevier Taiwan LLC. All rights reserved.

Introduction

Tourniquets are widely used in orthopedic surgery of the extremities to reduce surgical bleeding, but prolonged

inflation is also associated with severe pain which, in turn, is often accompanied by a progressive increase in systemic arterial pressure [1,2]. Tourniquet-induced hypertension (TIH) is generally defined as a progressive increase of more than 30% in arterial blood pressure after tourniquet inflation under general anesthesia [3,4]. The onset of TIH is delayed, and its treatment is difficult and often ineffective, even with increased doses of anesthetics and antihypertensive drugs [4]. Clonidine [5], ketamine [6], magnesium

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[7], and stellate ganglion block [8] have been used prophylactically to prevent TIH. Although the mechanism of TIH is unknown, the autonomic nervous system is involved [1]. Dexmedetomidine is a potent α_2 -adrenoceptor agonist with eight times higher affinity for the α_2 -adrenoceptor than clonidine, and it has shown sedative, analgesic, and anxiolytic effects after intravenous administration [9]. Dexmedetomidine attenuates hyperadrenergic responses and therefore may be of therapeutic or prophylactic value for TIH.

In this study, we investigated the effect of preoperative intravenous dexmedetomidine on arterial blood pressure and heart rate in patients undergoing general anesthesia for orthopedic surgery of the lower limbs with a tourniquet.

Methods

This study was randomized, double-blinded, and placebo-controlled. After approval was obtained from the ethics committee of the Third Affiliated Hospital of Anhui Medical University and written informed consent was received from each patient, 37 ASA (American Society of Anesthesiologists) physical status class I and II patients scheduled for orthopedic operation requiring tourniquet inflation of the lower limbs under general anesthesia were enrolled. Patients with known contraindications to dexmedetomidine; who had ischemic heart disease, hypertension, kidney dysfunction, or diabetes mellitus; and with expected tourniquet inflation time shorter than 60 minutes were excluded.

All patients received intramuscular phenobarbital (0.5 mg) 30 minutes before induction of anesthesia. Patients in the dexmedetomidine group (DEX; $n = 18$) received intravenous dexmedetomidine (0.5 $\mu\text{g/kg}$) diluted in 10 mL normal saline infused over 10 minutes, immediately before induction of anesthesia. Patients in the control group (CON; $n = 19$) received the same volume of normal saline infused over the same period. The infusions were prepared by a nurse anesthetist not involved with the case according to a computer-generated sequence. Anesthesia was induced with fentanyl (2–4 $\mu\text{g/kg}$) and propofol (2 mg/kg), and vecuronium (0.1 mg/kg) was given intravenously to facilitate intubation of the trachea. Arterial pressure before induction of anesthesia was measured noninvasively. After anesthesia induction, a radial artery catheter was inserted for invasive blood pressure measurements. Anesthesia was maintained with propofol (75 $\mu\text{g/kg/min}$) and remifentanyl (0.1 $\mu\text{g/kg/min}$). Muscle paralysis was maintained with vecuronium. Tidal volume was adjusted to keep the end-tidal CO_2 concentration 35–45 mmHg. After skin incision, the tourniquet was inflated to a pressure of 300 mmHg. If systolic arterial pressure exceeded 180 mmHg despite increased doses of propofol and remifentanyl, an additional bolus of nitroglycerol was given intravenously.

Blood pressure and heart rate were recorded at 0, 10, 20, 30, 40, 50, and 60 minutes after the start of tourniquet inflation and immediately after tourniquet deflation. The number of patients who developed TIH, as defined by an increase in arterial blood pressure greater than 30% of the baseline value, was recorded. The patients were extubated at the end of surgery after reversal with atropine (0.5 mg) and neostigmine (1 mg).

Statistical analysis was performed using the SPSS 10.0 program (SPSS Inc., Chicago, IL, USA). All data are presented

as mean $\pm$ standard deviation. Demographic data for the patients were compared among the groups using one-way analysis of variance with the *post hoc* Scheffé test. The hemodynamic changes were compared with the baseline values and among the groups by using two-way repeated-measures analysis of variance with Tukey's *post hoc* test. The χ^2 test was used to compare the number of patients with TIH. Statistical differences were considered significant if the *p* value was less than 0.05.

Results

There were no statistically significant differences between the groups with respect to the patients' demographic characteristics, dose of propofol and remifentanyl, time for duration of tourniquet inflation, and anesthesia (Table 1).

In the DEX group, systolic and diastolic arterial pressures were not changed during the study period, but in the CON group, systolic arterial pressure and diastolic arterial pressure were significantly increased at 40, 50, and 60 minutes after the start of tourniquet inflation. In all patients, the heart rate did not change significantly during tourniquet inflation, but there was a significant increase immediately after deflation in the CON group (Fig. 1). The CON group had a greater percentage of patients who developed TIH when compared with the DEX group.

Discussion

The results from this study showed that preoperative intravenous dexmedetomidine significantly prevented a systemic arterial pressure increase during prolonged tourniquet inflation in patients under general anesthesia.

Perioperative hypertension may be associated with serious cardiac complications [10–12]. Furthermore, the level of hypertension is correlated with the occurrence of postoperative silent myocardial ischemia [12]. The intraoperative hypertension induced by prolonged tourniquet inflation of the lower limbs is often unresponsive to increased doses of anesthetics and antihypertensive drugs

Table 1 Demographic data, dose of propofol and remifentanyl, duration of tourniquet inflation, and anesthesia.

Variable	CON ($n = 19$)	DEX ($n = 18$)
Age (y)	37 $\pm$ 11	40 $\pm$ 12
Sex (m/f)	11/8	12/6
Height (cm)	173 $\pm$ 5	170 $\pm$ 7
Weight (kg)	70 $\pm$ 8	67 $\pm$ 11
Tourniquet (min)	67 $\pm$ 6	69 $\pm$ 7
Propofol dose (mg)	407 $\pm$ 49	387 $\pm$ 32
Remifentanyl dose (μg)	1062 $\pm$ 288	983 $\pm$ 168
Duration of anesthesia (min)	96 $\pm$ 18	104 $\pm$ 18

Values are presented as mean $\pm$ SD. There were no significant differences between groups.

CON = group receiving normal saline; DEX = group receiving dexmedetomidine; Tourniquet = duration of tourniquet inflation.

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