

Comparison of Effects of Calcium Channel Blockers and Beta Blockers on Tourniquet-Induced Hypertension During Intravenous Regional Anesthesia

İntravenöz Rejyonel Anestezi Sırasında Turnike ile İndüklenen Hipertansiyon Üzerinde Kalsiyum Kanal Blokerleri ve Beta Blokerlerin Etkilerinin Karşılaştırılması

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ABSTRACT Objective: To investigate the efficacy of calcium channel and beta blockers for controlling tourniquet induced blood pressure increase in patients undergoing carpal tunnel operations with intravenous regional anesthesia (IVRA). **Material and Methods:** Files of patients who have been operated under IVRA in orthopedics clinics between January 2009 and January 2010 were retrospectively investigated. A total of 312 patients, 164 patients with carpal tunnel syndrome and 148 patients with trigger finger have been operated under IVRA. Out of 164 patients who have been operated due to carpal tunnel syndrome, 50 patients in which either calcium channel blockers or beta blockers were used for treatment of critical blood pressure increase after tourniquet inflation and in which whole data were obtained, were included to the study. The patients with systolic blood pressure above to 150 mmHg following tourniquet inflation and in which bolus dose of calcium channel blocker 10 mg (Group I) or beta blocker 0.5 mg/kg (Group II) have been administered by intravenous route constituted the study groups. The ages of the patients, onset of sensorial block, duration of sensorial block, surgery and tourniquet durations, and the tourniquet pressures were recorded from the patient files. **Results:** There was no difference between groups in terms of demographical variables and hemodynamic parameters ($p < 0.05$). The efficacy of both calcium channel and beta blockers for controlling tourniquet-induced hypertension were similar ($p < 0.05$). **Conclusion:** Although both calcium channel blockers and beta blockers were found to be equally effective in treatment of tourniquet-induced hypertension, there is need of large scale prospective studies in this subject.

Key Words: Hypertension; carpal tunnel syndrome; anesthesia, conduction

ÖZET Amaç: İntravenöz rejyonel anestezi (IVRA) ile karpal tünel operasyonu geçiren hastalarda turnike ile indüklenen kan basıncı artışı üzerine kalsiyum kanal bloker ve beta blokerlerin etkinliğinin araştırılmasıdır. **Gereç ve Yöntemler:** Üniversite Etik Komite onamı alındıktan sonra, Ocak 2009 ve Ocak 2010 tarihleri arasında ortopedi ameliyathanelerinde IVRA ile opere edilen karpal tünel sendromu hastalarının dosyaları retrospektif olarak incelendi. Karpal tünel nedeni ile opere edilen 164 hasta ve tetik parmak nedeni ile opere edilen 148 hasta olmak üzere toplam 312 hasta dosyası incelendi. Karpal tünel nedeni ile opere edilen 164 hasta içinden turnike sonrası kan basıncı artışı tedavisi amacıyla kalsiyum kanal blokeri veya beta bloker kullanılan ve dosya bilgilerine ulaşılan 50 hasta çalışmaya dahil edildi. Turnike şişirilmesi sonrası sistolik kan basıncı 150 mmHg üzerine çıkan ve bolus doz olarak 10 mg kalsiyum kanal blokeri verilen (Grup I) veya 0,5 mg/kg beta bloker (Grup II) verilen hastalar çalışma gruplarını oluşturdu. Hasta dosyalarından demografik veriler ve hemodinamik parametreler kaydedildi. **Bulgular:** Grupların demografik ve hemodinamik parametreleri arasında fark gözlenmedi ($p > 0,05$). Hem kalsiyum kanal blokeri hem de beta blokerlerinin turnike ile indüklenen kan basıncı artışı üzerindeki etkinliği benzer bulundu ($p > 0,05$). **Sonuç:** Her ne kadar turnike ile indüklenen kan basıncı artışı üzerinde kalsiyum kanal blokerleri ve beta blokerlerinin etkisi benzer bulunsada, bu konuda yapılacak daha geniş, prospektif çalışmaların gerekli olduğu düşüncesindeyiz.

Anahtar Kelimeler: Hipertansiyon; karpal tünel sendromu; anestezi, kondüksiyon

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Carpal tunnel syndrome (CTS) is a “median nerve entrapment neuropathy” that causes paresthesia, pain, and numbness in the area innervated by the median nerve. In addition to genetic and

environmental factors; diabetes, obesity, pregnancy, hypothyroidism, and overuse of hand are among the predisposing factors. Treatment is surgical cut of the transverse carpal ligament.^{1,2}

The most common anesthesia technique used in carpal tunnel procedures is intravenous regional anesthesia (IVRA). However, in recent years, together with the use of long-acting local anesthetics and direct visualization of the nerves with ultrasonography, peripheral nerve blocks have become more widely used in carpal tunnel operations. Nevertheless, IVRA, being a more affordable method compared to general anesthesia and brachial plexus block, is still the most preferred method in short surgical procedures of the hand and arm, by the clinicians who have not been educated on peripheral nerve block and ultrasonography.³

Intravenous regional anesthesia was first defined by August Karl Gustav Bier in 1908 and as it is a simple, easily applicable, reliable and cheap method, it was widely accepted in outpatient procedures. The most important disadvantage is systemic local anesthetic toxicity, slow onset of block, absence of muscle relaxation, tourniquet pain, and insufficient postoperative analgesia. However, the most significant unwanted effect is tourniquet pain.⁴

Several agents such as lornoxicam, paracetamol, ondansetron, ketamine, and nitroglycerine were added to local anesthetics as adjuvant agents to increase the quality of analgesia and to prevent tourniquet pain; their efficacy was also demonstrated.⁵⁻⁹

Although sedation of the patient is an effective method in the management of tourniquet pain that develops during the operation, high doses of benzodiazepines, remifentanyl, and propofol might produce unconscious sedation and respiratory arrest, thus creating problems in early discharge of the out-patient. In addition to sedation, reduction of the tourniquet pressure is also effective in the management of tourniquet pain. As the tourniquet pressure is adjusted to 150 mmHg above the systolic blood pressure during intravenous regional anesthesia, arterial blood pressure control is the most important factor in the reduction of tourniquet pressure. In routine anesthesia practice,

beta blockers, calcium channel blockers, and nitroglycerine are the most commonly used drugs for controlling blood pressure.^{1,2,4}

The aim of the current study is to investigate the efficacy of calcium channel blockers and beta blockers for controlling the tourniquet-induced blood pressure increase in patients undergoing carpal tunnel operations with IVRA.

MATERIAL AND METHODS

After obtaining approval from the University Research Ethics Committee (dated in 10.03.2014 and numbered as 04-130-14), the files of patients who were operated on under intravenous regional anesthesia (IVRA) in orthopedics clinics between January 2009 and January 2010 were retrospectively investigated. As the current study is a retrospective study, informed consent from patients could not be obtained. Personal information related to the patient were not shared. A total of 312 patients, 164 patients with carpal tunnel syndrome and 148 patients with trigger finger were operated on under IVRA. Out of 164 patients who were operated on due to carpal tunnel syndrome, 50 patients in which either calcium channel blockers or beta blockers were used for treatment of critical blood pressure increase after tourniquet inflation and in which whole data were obtained, were included in the study.

A total volume of 40 mL of prilocaine (Priloc, Vem İlaç, Türkiye) at a dose of 3 mg.kg⁻¹ was administered for IVRA. The patients in which systolic blood pressure increased to 150 mmHg and above following tourniquet inflation and in which a bolus dose of calcium channel blocker 10 mg (Diltizem, Mustafa Nevzat İlaç Sanayi Aş, Türkiye) (Group I) or beta blocker 0.5 mg.kg⁻¹ (Brevibloc, Eczacıbaşı İlaç Sanayi Aş, Türkiye) (Group II) were administered intravenously constituted the study groups. The systolic, diastolic, and mean blood pressure values and heart rate values at the beginning, after tourniquet inflation, following drug administration, and at the beginning of the surgery were recorded from the surgical files of the patients. The initial blood pressure value measured after tourniquet inflation was accepted as "blood

pressure at tourniquet inflation” and the following measurements with two-minute intervals were recorded from the patient files.

The ages of the patients, onset of sensorial block, duration of sensorial block, surgery and tourniquet durations, and the tourniquet pressures were recorded from the patient files.

STATISTICAL ANALYSIS

Statistical analysis was done with Statistical Package for the Social Sciences 15.0 (SPSS 15.0, SPSS Inc., Chicago, IL) software. The numerical variables were compared with independent samples t-test and expressed as “mean±standard deviation”. The non-numerical variables were compared with the chi-square test and expressed as percentages. The confidence interval was determined as 95% and p values smaller than 0.05 was accepted to be statistically significant.

RESULTS

There was no difference between groups in terms of age, tourniquet pressures, duration of tourniquet, sensorial block and surgery, and onset of sensorial block. The demographic characteristics of the patients were presented in Table 1.

In both groups, systolic and diastolic blood pressures and the heart rates decreased after sedation, increased following tourniquet inflation and decreased after bolus drug administration. However, there was no difference between groups in terms of the changes in systolic, diastolic blood pressure and heart rates in all measurement intervals (Figure 1-3). The decrease in blood

pressure continued until the completion of surgery and no additional drugs were required.

DISCUSSION

The current study demonstrated that both calcium channel blockers and beta blockers effectively decreased the tourniquet-induced blood pressure increase that develops in carpal tunnel procedures under IVRA and neither is superior to the other in terms of efficacy.

Hypertension is an independent risk factor for morbidity and mortality in all anesthesia procedures and “optimal values” are targeted during the perioperative period.¹⁰⁻¹³ During extremity surgeries, the surgical team generally use tourniquet in order to decrease the bleeding in the surgical field and to keep the surgical field dry. The use of a tourniquet during surgeries on extremities cause moderate to severe pain during regional anesthesia, in spite of sufficient anesthetic depth and is one of the reasons of hypertension during general anesthesia. Generally, independent of the anesthesia method, blood pressure increases to 30% of the basal values during tourniquet application. In a study including 500 patients, while the development of hypertension was 11% in the tourniquet group, it was 1% in the control group in which there was no tourniquet use.^{10,14} Although the mechanism of tourniquet-induced hypertension has not yet been precisely understood, some investigators suggest that central sensitization through activation of C fibers and N-methyl-D-Aspartic acid (NMDA) receptors might play a role in the development of tourniquet-induced hypertension.^{10,11}

TABLE 1: Demographical characteristics.

	Group 1 (calcium channel blocker)	Group 2 (beta blocker)	p
Age (year)	51.0±8.51	47.8±14.94	0.45
Duration of tourniquet (3 min)	39.0±6.67	39.24±4.90	0.07
Tourniquet pressure (3 mmHg)	362.0±21.79	366.0±23.80	0.22
Visual analogue scale	4.3±1.7	3.8±1.35	0.553
Duration of sensorial block (min)	44.04±11.02	43.52±7.25	0.308
Duration of surgery (min)	18.68±8.78	22.80±7.83	0.478
Onset of sensorial block (min)	4.12±1.50	4.68±1.97	0.345
Onset of surgery	14.76±7.08	12.44±5.69	0.524

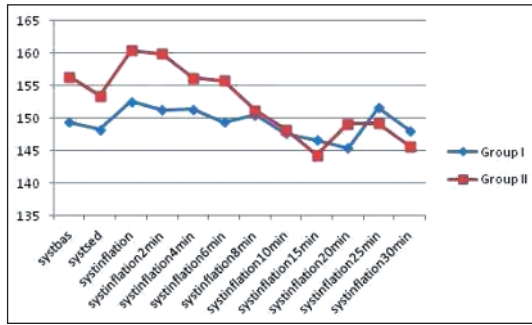


FIGURE 1: Intraoperative systolic blood pressure (Syst).

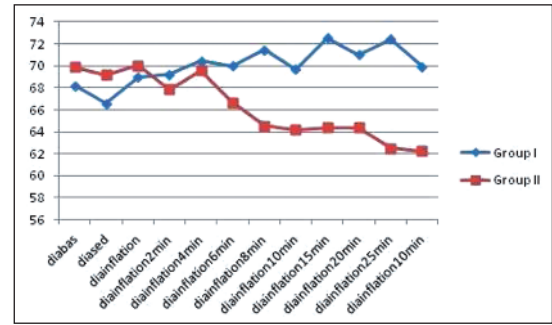


FIGURE 2: Intraoperative diastolic blood pressure (dia).

Carpal tunnel syndrome generally occurs in hypertensive females older than middle aged. Together with the tourniquet-induced hypertension that develops during surgery, this situation causes severe hypertension that necessitates treatment, anxiety, and severe tourniquet pain.¹⁰ Tourniquet-induced hypertension is difficult to treat and generally requires increased doses of antihypertensive agents. Furthermore it was reported that the arterial blood pressure increases 46 mmHg above the initial blood pressure values during ischemia.⁴

In our routine practice, sedation with benzodiazepines and opioids are administered prior to tourniquet inflation. In all patients included in the current study, routine sedation was done in all patients.

In a review of 20 years of experience including 1906 cases who had undergone IVRA, Brown et al. reported that no morbidity and mortality were observed.¹⁵

During intravenous regional anesthesia, hypertension is an important risk factor and an important cause of morbidity. In addition to the changing the response to analgesic agents and antihypertensive agents, hypertension also causes high tourniquet pressures and therefore it is thought as a contraindication for IVRA and even it may cause the delay of the surgical procedure.¹⁶

During lower extremity procedures, different agents such as dextromethorphan, clonidine, remifentanyl, and ketamine were used to prevent tourniquet-induced pain.^{11,17-19}

In a study that compared dextromethorphan and clonidine for blunting the tourniquet-induced

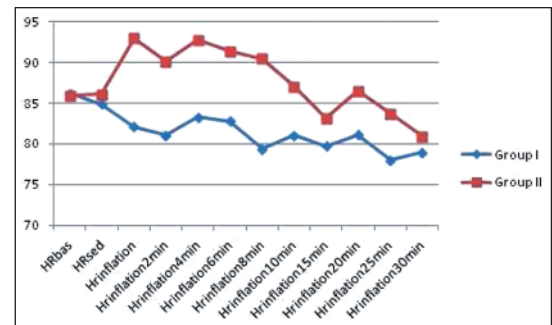


FIGURE 3: Intraoperative heart rate (HR).

cardiovascular response during lower extremity procedures under general anesthesia, it was demonstrated that preoperative oral clonidine significantly decreased systolic, diastolic, and mean arterial pressures.²⁰

The study of Park et al. demonstrated that preoperative low dose ketamine administration (0.1 mg.kg^{-1}) is effective in the treatment of tourniquet-induced hypertension for 60 minutes.¹⁴ In an experimental study, magnesium sulfate and ketamine were compared in the treatment of tourniquet-induced hypertension and they were found to be equally effective.²¹ Satsumae et al. demonstrated that the preoperative administration of low dose ketamine prevented arterial blood pressure increase and tourniquet pain.¹⁹

Lao et al. demonstrated that intravenous dexmedetomidine, which is a potent α -2 adrenoreceptor agonist with sedative, analgesic, and anxiolytic properties, decreased tourniquet-induced hypertension in 72 patients undergoing surgery under general anesthesia.²² In a similar study, Lu et al., also reported that preoperative dexmedetomidine $0.5 \text{ } \mu\text{g.kg}^{-1}$ prevented

tourniquet-induced hypertension during elective orthopedic procedures under general anesthesia.²³

Valli et al. reported that tourniquet-induced hypertension is more frequently seen in advanced age, in lower extremity surgeries and in surgeries with long duration. They reported that the incidence of tourniquet-induced hypertension is 2.7% during spinal anesthesia, 2.5% during brachial plexus blockade, and 19% during IVRA.²⁴ In spite of this high incidence, during the literature review, we could not find any study related to antihypertensive agents used for tourniquet-induced hypertension. The reason for this might be the relatively short duration of surgery and the tourniquet time and the thought that it may not cause any problems. However, hypertension observed during carpal tunnel procedures in female patients older than middle age, is a condition that should be treated not

only to decrease the tourniquet pressure and thus the tourniquet pain, but also to prevent cardiac morbidity and mortality in the patient. In our clinical practice, we prefer to decrease the tourniquet-induced hypertension and minimize the anxiety that develops due to the tourniquet pain.

The limitations of the current study is that it is a retrospective study and it includes small patient numbers. Further evaluation with prospective studies is needed.

In conclusion, we aimed to evaluate the effects of two different drugs for decreasing tourniquet-induced hypertension in the current study. Although both calcium channel blockers and beta blockers were found to be equally effective in treatment of tourniquet-induced hypertension, we believe that there is a need for large scale prospective studies on this subject.

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