Changes in Blood Pressure During Induction of Anesthesia and Oral and Maxillofacial Surgery by Type and Timing of Discontinuation of Antihypertensive Drugs

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The purpose of this study was to evaluate the effects of an antihypertensive drug class and the timing of discontinuation of antihypertensive therapy on blood pressure during oral and maxillofacial surgery for 129 patients on antihypertensive therapy receiving general anesthesia. Blood pressures at loss of response to stimulation and 5–15 minutes after intubation were significantly lower than those before induction, although the type of antihypertensive therapy did not affect changes in blood pressure. No significant correlation was observed between systolic blood pressure (SBP) on the ward and change in SBP during surgery, though patients with higher blood pressure on the ward tended to exhibit larger differences between SBP on the ward and the lowest SBP during surgery. Frequency of use of vasopressors during surgery was significantly higher in patients who discontinued antihypertensive therapy on the day before surgery than in those who continued antihypertensive therapy on the day of surgery. These findings suggest that appropriate preoperative antihypertensive therapy is important for minimizing change in blood pressure during surgery and preventing perioperative complications. Patients undergoing antihypertensive therapy should be carefully monitored perioperatively by observation for interactions between antihypertensive and anesthetic agents and minimizing interruption schedules for antihypertensive therapy.

Key Words: Antihypertensive drugs; General anesthesia; Oral and maxillofacial surgery.

Hypertension is one of the most common underlying diseases observed in patients undergoing dental treatment. During induction of general anesthesia, patients with hypertension may exhibit significant increases in heart rate and blood pressure, though the agents used for this often cause hypotension.¹ In Japan, many patients with hypertension are treated according to the guidelines for antihypertensive therapy,

which describe classifications of the severity of hypertension, timing of antihypertensive therapy, usage of antihypertensive agents, and targets for antihypertensive therapy to control blood pressure.² When such patients undergo general anesthesia, they typically continue their usual antihypertensive therapy up to the morning of their surgery.³ Since some antihypertensive agents are known to interact with anesthetic agents, care should be taken to determine when or if such antihypertensive agents are to be discontinued.

In this study, we retrospectively reviewed blood pressure before and during induction of anesthesia in patients receiving antihypertensive therapy to investigate the effects of different classes of antihypertensive

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Table 1. Types of Antihypertensive Therapy^a

Antihypertensive drugs	N
ARBs	15
ARBs+CCBs	17
CCBs	76
CCBs+ACE inhibitor, β-blockers, α-blockers	16
β-Blockers	5

^a ARB indicates angiotensin receptor blocker; CCB, calcium channel blocker; ACE, angiotensin converting enzyme.

medication on blood pressure during surgery. We also examined correlations of antihypertensive drug class and timing of discontinuation of antihypertensive therapy with change from baseline blood pressure and peak blood pressure during surgery.

SUBJECTS AND METHODS

This study involved 129 patients who had been receiving antihypertensive therapy and undergone oral and maxillofacial surgery under general anesthesia in the Osaka Dental University Hospital during the 3-year period from January 2003 to December 2005. Patients were classified into the following 5 groups by type of antihypertensive regimen described in their medical record: angiotensin receptor blockers (ARB) as monotherapy; calcium channel blockers (CCBs) as monotherapy; β-blockers as monotherapy; combination of ARB and CCBs; and combinations of CCBs, angiotensin converting enzyme (ACE) inhibitors, α-blockers, and β-blockers (Table 1). After excluding patients receiving β-blockers as monotherapy because of the small number of patients in this category, comparisons among the remaining 4 groups were made for blood pressure on the ward at admission and at time points from arrival in the operating room to 15 minutes after endotracheal intubation. In addition, correlations between baseline blood pressure and change in blood pressure during surgery were evaluated by plotting highest and lowest systolic blood pressure (SBP) during surgery against baseline SBP for each patient. Patients were also reviewed for the use of vasopressors during surgery to treat abrupt hypotension to determine the relationship between duration of suspension of antihypertensive therapy before surgery and incidence of hypotension during surgery.

Statistical Analysis

Changes in blood pressure during induction of anesthesia with various antihypertensive regimens were ex-

Figure 1. Change over time in arterial blood pressure during induction of anesthesia.

amined using repeated-measures ANOVA (StatView 4.0, Abacus Concepts Inc, Piscataway, NJ, USA) Relationships between baseline SBP on the ward and lowest and highest SBP during surgery were evaluated by determining Pearson's correlation coefficients (StatView 4.0). The relationship between use of vasopressors during surgery and timing of discontinuation of antihypertensive therapy was evaluated using the chi-square test for independence, with findings of $P < .05$ considered significant.

RESULTS

A total of 129 patients (74 males and 55 females) with a mean age of 65.0 ± 9.7 years was evaluated. The type of antihypertensive regimen was ARB as monotherapy in 15 patients, combination of ARB and Ca antagonist in 17 patients, CCB as monotherapy in 76 patients, and β-blocker as monotherapy in 5 patients. Sixteen patients received combined treatment with CCBs, angiotensin converting enzyme (ACE) inhibitors, α-blockers, and β-blockers.

There were no significant differences by type of antihypertensive agent in blood pressure on the ward; on arrival at the operating room; before or immediately after loss of response (LOR) to stimulation; or immediately or 5, 10, or 15 minutes after intubation. SBPs on the ward, on arrival in the operating room, and before LOR did not change significantly, while SBPs after LOR and 5, 10, and 15 minutes after intubation were significantly lower than those on the ward, on arrival at the operating room, and before LOR. SBPs immediately after intubation were significantly higher than those after LOR regardless of the type of antihypertensive regimen (Figure 1).

Figure 2. Correlation between preoperative arterial blood pressure on the ward and highest intraoperative arterial blood pressure.

No correlations were observed between SBP on the ward and highest SBP during surgery in patients who continued their regimen up to the evening before surgery or up to the morning of surgery ($Y = 136.3 + 0.117X$, $r = 0.086$). No effects of the timing of discontinuation of antihypertensive therapy on change in SBP were observed. In addition, there were no correlations between SBP on the ward and lowest SBP during surgery in patients who continued their regimen up to the evening before surgery or up to the morning of surgery ($Y = 78.6 + 0.108X$, $r = 0.152$). These findings indicate that lowest SBP during surgery is no higher in patients with higher ward SBP than in those with lower ward SBP regardless of the timing of discontinuation of antihypertensive therapy (Figures 2 and 3). During surgery, vasopressors were administered to 67% and 44% of the patients who received ARBs as monotherapy by the day before surgery and the morning of surgery, respectively. The corresponding figures were 20% and 8% for the patients who received a combination of ARB and Ca antagonist, 38% and 10% for those who received Ca antagonist as monotherapy, and 0% and 38% for those receiving multiple combination therapy with CCBs, ACE inhibitors, α -blockers, and β -blockers. The overall percentages of patients requiring vasopressors during surgery were 37% and 17% of those who continued their regimen up to the day before surgery and the morning of surgery, respectively ($P < .05$; Table 2).

DISCUSSION

Maintaining stable hemodynamics during surgery is the most important aspect of anesthesia in patients with hypertension, and it is believed that preoperative antihypertensive therapy decreases the incidence of

Figure 3. Correlation between preoperative blood pressure on the ward and lowest intraoperative blood pressure.

perioperative cardiovascular complications.^{4–6} However, it has also been reported that antihypertensive therapy, when maintained for a considerable length of time before surgery, does not affect changes in blood pressure during surgery.^{1,7} There is considerable uncertainty concerning the management of blood pressure during the perioperative period. In a study of the use of antihypertensive agents in Japan,⁸ 65% of the patients evaluated received monotherapy and 35% received more than one antihypertensive agent, and 78%, 23%, 16%, and 6% of the patients evaluated were treated with CCBs, ACE inhibitors, β -blockers, and ARBs, respectively. The guidelines for antihypertensive therapy in Europe and the United States recommend β -blockers for first-line use,⁹ while in Japan CCBs are often used as first-line therapy and combinations of a Ca antagonist with an ACE inhibitor or ARB are common.¹⁰ In the present study, 76% and 32% of the patients evaluated had received CCB monotherapy or a component of combined therapy, respectively, consistent with the high prevalence of use of CCBs noted in previous reports. Use of ARBs as monotherapy and combination of ARBs and CCBs was relatively common in the patients included our

Table 2. Use of Vasopressors During Surgery

	Evening Before Surgery (Cases)		Morning of Surgery (Cases)	
ARBs	4/6	67%	4/9	44%
ARB+CCBs	1/5	20%	1/12	8%
CCBs	6/16	38%	6/60	10%
CCBs+ACE inhibitors	0/3	0%	5/13	38%
Total	11/30	37%*	16/94	17%

* Significant difference from patients who took drugs up to the morning of surgery. $P < .05$.

study. It has been reported that ARBs may exert cardiovascular and renal protective effects¹¹ and prevent exacerbation of valvular disease.¹² The tendency toward an increase in the use of ARB-based regimens is thus expected to continue.

During induction of anesthesia, patients with hypertension may have problems with increases in heart rate and blood pressure caused by anesthesia from mechanical stimulation of the pharyngolarynx, and they are also at higher risk for hypotension than normotensive patients because of interaction between induction agents and antihypertensive agents. Although a comparison with normotensive patients could not be performed in this survey, our patients were maintained favorably on their antihypertensive therapy, remaining normotensive on the ward regardless of the type of antihypertensive therapy used. However, transient increases in systolic and diastolic blood pressure developed immediately after intubation regardless of the type of antihypertensive regimen. Blood pressures at LOR to stimulation and 5 and 15 minutes after intubation were lower than those on the ward and on arrival at the operating room. A transient increase in blood pressure during intubation can be controlled with opioids and intravenous administration of antihypertensive agents, but such drugs must be administered carefully to prevent hypotension after intubation.⁴

Although we could not evaluate the effects of anesthetics and methods of induction on hemodynamics, decreases in blood pressure persisted up to 15 minutes after intubation in the study. These findings suggest that antihypertensive therapy that had been continued before surgery was effective in preventing hypertension before entering the operating room, but careful monitoring is needed for changes in blood pressure during induction of anesthesia, especially immediately after intubation. On the other hand, the lowest SBP during surgery was substantially lower than ward SBP, and the difference between the lowest SBP during surgery and ward SBP tended to be large in patients with higher ward SBP. This indicates that antihypertensive therapy must be sufficient to minimize changes in blood pressure during surgery and prevent perioperative complications.

When patients receiving antihypertensive therapy undergo general anesthesia, anesthesiologists must carefully consider the timing of discontinuation of antihypertensives and possible interactions between antihypertensives and general anesthetics. It is common for patients to continue antihypertensive treatment up to the morning of surgery. However, some researchers have pointed out that hypotension during induction and the use of vasopressors are more prevalent among patients who have received ACE inhibitors or ARBs up

to the day of surgery than in patients who have stopped these drugs earlier and have suggested that patients not take ACE inhibitors and ARBs on the day of surgery.^{13,14} In the present study, the use of vasopressors during surgery was more prevalent in patients who continued antihypertensive therapy up to the morning of surgery than in patients who discontinued therapy the day before surgery, regardless of type of antihypertensive. Although we could not examine the acute effects of discontinuing CCBs and ARBs on hemodynamics, it is likely that use of intravenous antihypertensives to control hypertension during surgery may have resulted in excessive antihypertensive effects and caused hemodynamic instability in patients who had discontinued treatment with such drugs.

As noted in previous studies, patients who discontinued antihypertensive regimens including ACE inhibitors the day before surgery did not experience excessive hypotension during surgery, while many patients who continued such regimens up to the morning of surgery required vasopressors during surgery. Careful perioperative management is required for patients with hypertension, considering possible interactions between antihypertensives and anesthetics as well as the timing of discontinuing antihypertensive therapy.

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