

Cardiovascular monitoring and its consequences in oral surgery

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J. Thomas Lambrecht, Andreas Filippi, Jeannine Arrigoni

Department of Oral Surgery, Oral Radiology and Oral Medicine, University of Basel, Switzerland

Address for correspondence:

Prof. Dr. J. Th. Lambrecht, Department of Oral Surgery, Oral Radiology and Oral Medicine, University of Basel, Hebelstrasse 3, CH-4056 Basel, Switzerland.
E-mail: J-Thomas.Lambrecht@unibas.ch

ABSTRACT

Objective: Higher life expectancy has led to an increase of elderly patients in dental practices, thus also causing an increase in high-risk cardiovascular patients. **Study Design:** In all, 3012 patients had oral surgery with local anesthesia at the Department of Oral Surgery, Oral Radiology and Oral Medicine at the University of Basel. The Colin BP 306 compact monitor was used during these surgeries. The patient's heart rate, blood pressure, and oxygen saturation were routinely checked, both before and during the procedure. **Results:** The oral surgical procedure had to be discontinued 17 times, because the patient developed significantly elevated blood pressure. Twice, the procedure had to be discontinued due to cardiac arrhythmia. The average age of these 19 patients was 63.5 years. **Conclusions:** Pre- and intraoperative monitoring allows the dentist to identify patients with high-risk diagnostic findings and to reduce problematic cardiovascular situations.

Keywords: Blood pressure measurement, high-risk patient, hypertension, monitoring

INTRODUCTION

All dental practices now have more high-risk patients, due to an increased life expectancy and more polymorbid patients. Age, ethnicity, and sex all play a role in determining the risk factors for hypertension.^[1] If the patient has additional risk factors such as hypercholesterolemia, smoking, abnormal glucose tolerance, and/or left ventricular hypertrophy, hypertension becomes the main high-risk factor for cardiovascular complications.^[2] Based on estimates, untreated hypertension reduces a patient's life expectancy by 10–20 years, and even slight hypertension—untreated for 10 years—increases the risk of complications such as apoplectic or cardiac insult.

Monitoring the patient's pulse, blood pressure and oxygen saturation before and during the oral surgical procedure allows the surgeon to identify patients with high-risk diagnostic findings and makes it possible to avoid difficult situations. In addition, the increased safety factor leads to a more relaxed surgical atmosphere. There are instruments that are suitable for a physician's practice and that can take ECGs (i.e., during

intubation anesthesia), measure the patient's blood pressure, and his oxygen saturation level. Thus, a decrease in the patient's oxygen saturation level during local anesthesia with or without premedication before the first clinical symptoms manifest themselves can be detected.^[3,4] Preoperative blood pressure measurements enable a specific treatment and reduce potential complications that can occur throughout the daily routine of the dental practice. An example for this would be to inject local anesthesia to a hypotonic patient while he is laying down and to help him sit up slowly. If there is a problem, it is vitally important to be able to measure the patient's blood pressure to obtain some diagnostic findings. Especially for patients with circulation problems, and also in general, high blood pressure measurements can be an early warning sign for hypertension. A patient can have hypertension without having any symptoms. It increases the patient's morbidity and mortality risk and is usually discovered by chance.^[2] If the patient was already diagnosed with hypertension, taking the patient's blood pressure in the dental office is important to help monitor the therapy in progress. If the patient's medication is insufficient, the dentist needs to refer the patient to his primary care physician or internist. If the patient's blood pressure is not

taken, there are often anamnestic and/or clinical indicators concerning blood pressure deviations that then could be verified or excluded by taking the patient's blood pressure. If the patient has a somewhat elevated blood pressure before or during the procedure, the dentist should inform the patient about the results and advise him that there could be pathological causes for this and that he should have this checked out by his primary care physician or internist. The dentist himself should not diagnose "hypertension" based on individual momentary results.

The quantity of possible events in this context is not yet evaluated.

MATERIALS AND METHODS

In all, 3012 patients had oral surgery with local anesthesia at the Department of Oral Surgery, Oral Radiology and Oral Medicine at the University of Basel. All patients who had the procedure were included in this random survey without any type of selection. The clinic routinely uses the Colin BP 306 compact monitor (Colin Corporation, 2007-1, Hayashi, Komaki-City, Aichi, Japan; Figure 1). This device measures and displays the patient's heart rate, blood pressure, and oxygen saturation and can also perform a plethysmogram. In addition, it is possible to attach a temperature probe and an ECG (useful while intubation anesthesia). The device measures the patient's oxygen saturation and displays the plethysmogram by using a sensor that is attached like a clothes-pin to the patient's finger. The amount of oxygenated hemoglobin is determined based on the light absorption of the



Figure 1: Colin BP 306 compact monitor (Colin Corporation, Japan) with blood pressure cuff and finger clip

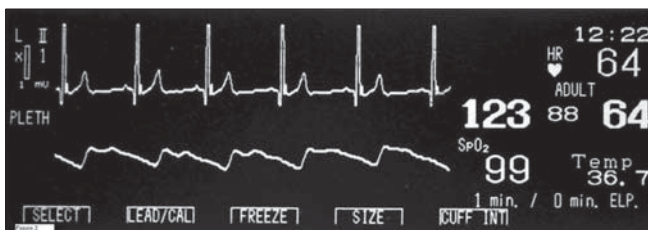


Figure 2: Monitor depiction. Left side: ECG (optional) and plethysmogram. Right side (top to bottom): time, heart rate (HR), systolic, mean and diastolic blood pressure, oxygen saturation (SpO₂) and body temperature (optional)

pulsing blood (pulse oximetry). It measures the blood pressure in an oscillometric manner. It indicates the systolic, diastolic, and the mean blood pressure [Figure 2]. It constantly monitors the patient's heart rate. It is possible to establish high and low critical values for the mentioned parameters. Should the measurements rise above or fall below these critical values, the device will sound alarm. All measurements that are taken during the procedure and their progression can be retrieved and printed out as tables or diagrams.

During all 3012 oral surgical procedures, the patient's blood pressure was taken before local anesthesia was administered and during the operation automatically every 15 min. An increased blood pressure leads to automatically repeated measurements in shorter intervals. In addition, the patient's oxygen saturation and heart rate were continually monitored. To evaluate the blood pressure measurement results, the classification of the National High Blood Pressure Education Program was used [Table 1].^[5] All patients who had one or more blood pressure measurements within hypertension categories 1, 2, or 3 before or during the procedure were registered.

If the operation was stopped due to pathological measurements, the researchers in addition to the patient's age and sex noted the body mass index (BMI: body weight in kg/[body height in m]²). A BMI between 18 and 24.9 represents a normal body weight. A BMI < 18 would mean that the patient is underweight, 25–29.9 overweight, and a BMI > 30 generally is interpreted as obesity.

RESULTS

During the evaluation period, 854 of the operated 3012 patients had one or more hypertension measurements within categories 1, 2, or 3 [Table 2]. In all, 122 of these patients experienced an increase in their blood pressure during the procedure; 423 patients experienced a blood pressure decrease during the procedure. A total of 309 patients had high blood pressure (category 2) that remained unchanged during the procedure. A total of 40 patients had one or more blood pressure measurements in hypertension (category 3) before or during the procedure.

In all, 17 procedures had to be discontinued because the patients (6 men and 11 women) developed intraoperative blood pressure measurements exceeding within 100 diastolic and 185 systolic [Table 3]. It was in each case decided to discontinue the procedure after the patient's blood pressure had been controlled repeatedly including consideration of the general clinical conditions. Two additional procedures (in two male patients) were discontinued due to arrhythmia. In all, 14 procedures had to be discontinued before the local anesthesia was administered, and 1 procedure was

Table 1: Blood pressure classification for adults in mm Hg (National High Blood Pressure Education Program, Glick 1998)

Category	Systolic blood pressure	Diastolic blood pressure
Optimal	<120	and <80
Normal	<130	and <85
"Still" normal	130–139	or 85–89
Hypertension grade 1	140–159	or 90–99
Hypertension grade 2	160–179	100–109
Hypertension grade 3	>180	>110

discontinued after the local anesthesia had been administered, but before the actual procedure started. Only two procedures had to be discontinued after the actual procedure had started.

All were referred to a cardiologist and received intensive physical examinations. The average age of these 19 patients was 63.5 years (median: 66, minimum: 21, maximum: 85). Seven patients already knew before the procedure that they were hypertensive and were taking medication. After the diagnostic findings that had been established at the Department of Oral Surgery, Oral Radiology and Oral Medicine, the attending physician changed the patients' antihypertensive therapy in four of seven cases. In five cases, the physicians excluded pathological hypertension; when repeating the procedure two of these patients were given a sedative before the procedure. Six hypertensive patients had a BMI < 25. The repeated procedure never had to be discontinued due to any alarming monitor parameters.

Table 2: Changes in blood pressure in 854 of 3012 patients with at least one hypertonic measurement (Classification as per Table 1)

Changes in blood pressure	Before operation	After operation	Number of patients
Increase	(Still) normal	Grade 1	67
	(Still) normal	Grade 2	4
	(Still) normal	Grade 3	1
	Grade 1	Grade 2	41
	Grade 1	Grade 3	2
	Grade 2	Grade 3	7
	Total: 122		
Decrease	Grade 1	(Still) normal	311
	Grade 2	(Still) normal	11
	Grade 2	Grade 1	83
	Grade 3	Grade 2	14
	Grade 3	(Still) normal	4
	Total: 423		
Continuously elevated	Grade 1	Grade 1	193
	Grade 2	Grade 2	104
	Grade 3	Grade 3	12
		Total: 309	

One patient, who was on antihypertensive medication that had been prescribed by her physician when the procedure was attempted a second time, had hypertension category 3, which led once more to a discontinuation of the procedure. Subsequently, the patient's physician adjusted her blood pressure medication. All other patients were able to undergo the second procedure without any problems or complications.

DISCUSSION

Arterial hypertension is a common condition, which is often not sufficiently diagnosed. Epidemiologically, it is assumed that 10% of the population in Europe and the United States, as well as every fifth person over the age of 50 suffers from high blood pressure.^[6] Often, the patient is not aware of his or her condition.^[5] Less than 50% of all hypertensive patients have a well adjusted blood pressure. The main reason for problems is that many patients fail to take their medication in accordance with their prescription. It is estimated that only one third of all patients take their antihypertensive medication on a regular basis.^[7] Patients who have not sufficiently been adjusted, or those who have not yet been diagnosed with hypertension, can be identified at the dental clinic by taking a thorough medical history, doing a clinical exam, and by measuring the patient's blood pressure.^[1] Every time the systolic blood pressure increases by 20 mm Hg, or the diastolic blood pressure increases by 10 mm Hg, the patient's risk regarding a cardiovascular incident doubles. In addition, a systolic blood pressure more than 140 mm Hg in patients more than 50 years of age is more important than the diastolic measurement. The patient's risk for a heart attack increases in a linear fashion, when the blood pressure exceeds 115/75 mm Hg^[8]; 80–90% of patients who have normal blood pressure measurements when they are between the ages of 55 and 65 will develop hypertension when they are between the ages of 80 and 85.^[5,8]

The main goal of a consistent medical hypertensive therapy is to adjust the blood pressure under 140/90 mm Hg. Especially patients suffering from diabetes mellitus or a kidney disease

Table 3: Detailed analysis of 17 patients whose intraoperative blood pressure measurements caused to discontinue the oral surgical procedure

Sex	Age	Aware of hypertonia	Antihypertensive drugs before first procedure	Blood pressure diastolic	Blood pressure systolic	When procedure was discontinued	BMI	Physician's diagnosis	Antihypertensive drugs after referral
Male	62	Yes	Beloc-Zok®	135	230	Before operation	23	Weak hypertonia	Adalat®
Female	66	Yes	Inhibace®	130	225	During operation	22.9	Hypertonia	Inhibace®
Female	85	No	∅	110	200	Before operation	18.1	No hypertonia	∅
Female	56	No	∅	100	195	Before operation	24	Hypertonia	Inhibace®, Dilatrend®
Female	56	Yes	Inhibace®, Dilatrend®	110	200	Before operation	24	Hypertonia	Norvasc®
Female	55	No	∅	100	190	Before operation	21.3	No hypertonia	Only during operation
Female	79	No	∅	110	185	Before operation	23.8	bypass-OP 2002	Sortis®, Marcoumar®
Male	60	No	∅	100	200	Before operation	22.2	No hypertonia	Only during operation
Male	74	No	∅	105	195	Before operation	26.8	Hypertonia	Diovan®
Male	48	No	∅	100	185	Before operation	23.2	Hypertonia	Korsor®
Male	68	No	∅	115	200	Before operation	27.2	Hypertonia	Norvasc®
Female	85	Yes	Atacand®	110	210	Before operation	27	Hypertonia	Atacand®
Female	74	Yes	Fluctal®	105	210	After local anesthesia	27	Hypertonia	Diovan®
Female	85	Yes	Cosaar®	105	200	Before operation	30.9	Hypertonia	Cosaar®
Female	82	No	∅	105	185	Before operation	17.1	Hypertonia	Beloc-Zok®
Female	76	No	∅	100	205	Before operation	26.7	Hypertonia	Norvasc®
Female	54	Yes	Concor®	105	200	During operation	18.4	Hypertonia	Reniten®

should have blood pressure measurements below that number.^[8] Only a small amount of hypertension patients are able to reach the desired blood pressure.^[9] Most of the patients need two or more medications to adjust their blood pressure. The most commonly used medication is a thiazide-type diuretic.^[8,10] If the patient's measurement differs by more than 10 mm Hg between the blood pressure measurements taken at the doctor's office and at home (white-coat hypertension), it would be advisable to conduct a 24-hr blood pressure test. White-coat hypertension could be a possible cause for resistance to treatment.^[11]

For the patients concerned, almost every oral surgical or just dental treatment represents a hyperadrenergic situation, which is intensified by fear and/or pain. With regards to oral surgical procedures, the patient's blood pressure increases particularly before local anesthesia is applied, during the subgingival debridement and while the tooth is removed.^[12] If there is already a preexisting condition or a respective predisposition, this hyperadrenergic situation can lead to an acute blood pressure increase or even a hypertensive crisis. This includes a high risk for an angina pectoris attack, a lung edema, a myocardial infarction, or cerebral bleeding. The most frequent symptoms are tachycardia, sweating, anxiety, stenocardia, headaches, and nausea. The best prophylaxis against a developing crisis is to cause the patient as little pain and stress as possible. This includes a gentle (possible after surface anesthesia) and effective local anesthesia, proceeding slowly and carefully, and establishing a calming and trust-building communication with the patients. In individual cases, it might become necessary to sedate the patient with medication (e.g., Valium®/Dormicum®). When providing dental services to hypertensive patients, it is important to make sure that they have taken their regular medication on the day of their dental visit. When administering some kind of sedative to help the patient relax, there is an 80% chance that the peripheral oxygen saturation declines during the procedure. Thus, it is particularly important to monitor premedicated patients during dental and oral surgical procedures in a pulse oximetric manner.^[3] Within the scope of this research, none of the patients' oxygen saturation fell under 90%; thus, it was never necessary for the dentist to intervene or even discontinue the procedure. High-risk cardiovascular patients should not be treated for longer than about 30 min if possible, because an incipient hypoxia often occurred after this amount of time. Patients, who had a BMI higher than 30, or who had been consuming nicotine for more than 30 pack-years, have an increased hypoxia risk when sedated.^[4]

In the past, the catecholamine adjuvants contained in dental local anesthesia have been overestimated as the cause for cardiovascular incidences, and the endogenous production of adrenaline was underestimated. It is more dangerous for the high-risk cardiovascular patient to produce endogenous adrenaline because he is not completely pain free than to receive a professionally applied local anesthesia with added adrenaline of 1:100,000 or 1:200,000.^[13-15] Added adrenaline in the amount of 1:100,000 increases the patient's heart rate and decreases his diastolic blood pressure. Adrenaline additives in local anesthesia are not contraindicated for hypertension patients, because the overall cardiovascular reaction is fairly insignificant.^[15,16] Adrenaline in higher concentrations, e.g., in locally applied hemostasis products (hemostatics) or in cords for gingival retraction, should be avoided with hypertension patients.^[1,7]

Should an incident occur, the first step would be to interrupt or terminate the treatment and to apply a calcium antagonist, such as 10 mg sublingual Nifedipine. It would also be advisable to nasally administer oxygen. If the patient is suffering from a severe hypertensive crisis and his general condition deteriorates significantly, an emergency service needs to be called.

Blood pressure associations and various authors have been requesting for years that dental practices routinely check every patient's blood pressure. Because many patients visit a dentist more frequently than a physician, it would be possible to reduce the high percentage of unrecognized hypertensive patients.^[16-20] There is, however, some resistance against this idea: Dentists in the United Kingdom, for example, do not want to be involved in screening for hypertension.^[8] They feel that a one-time-only blood pressure measurement does not suffice to diagnose hypertension, unless the measurements are excessively high.

In addition to recognizing hypertension, the dentist also needs to reduce the patient's stress and fear, avoid drug interferences and treat for side effects of the drugs. These side effects of anti-hypertensives also manifest themselves in oral tissue. Xerostomia, lichenoid reactions, and/or gingiva hyperplasia are very typical. Lichenoid reactions were observed when taking thiazides, Methyldopa, Propranolol, and Labetalol. All calcium antagonists (especially Nifedipine) can cause gingiva hyperplasia. In that case, the attending physician should change the patient's medication.^[2,21,22]

Taken into consideration that in only 17 patients of 3012 consequences were necessary regarding oral surgery one could question the necessity of the monitoring. "Patient safety first" should determine the base of our professional actions. It could be argued only to monitor patients at risk. Because hypertension is present without any symptoms in a large percentage of the population, almost every patient is at risk.

CONCLUSION

Cardiovascular high-risk patients should be identified as such, if possible before the beginning of the actual oral surgery. This means that the dentist needs to take a precise case history. If there is some ambiguity or an indication for possible blood pressure irregularities, it is urgently recommended to take the patient's blood pressure and to confer with the patient's attending physician. Pre- and intraoperative monitoring allows the dentist to identify high-risk diagnostic findings and to avoid difficult cardiovascular situations. It is essential that the entire staff of the dental practice have received emergency medical training and that the practice has developed an emergency procedure for treating hypertensive patients.

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