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Original article

Non-randomized controlled prospective study on perioperative levels of stress and dysautonomia during dental implant surgery



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ABSTRACT

Purpose: The purpose of this study was to compare pre- and postoperative autonomic activities and changes in salivary stress biomarkers between patients who received only local anesthesia and those who received local anesthesia together with intravenous sedation in dental implant surgery.

Methods: A total of 21 patients were enrolled in this non-randomized controlled prospective study; 7 subjects underwent implant surgery under local anesthesia with intravenous sedation and 14 subjects underwent surgery under only local anesthesia. Stress was evaluated by measuring salivary levels of chromogranin A (CgA) and a spectral analysis of heart rate variability (HRV) at baseline (on a day other than the day of surgery), 1 h preoperatively, and 1 h postoperatively. HRV analysis yields low- (LF) and high-frequency (HF) components, the LF/HF ratio, and the component coefficient of variance (CCV[HF]), which provide indices of sympathetic and parasympathetic regulatory activity.

Results: CgA levels were significantly higher ($p < 0.05$) at baseline in patients who received sedation than those who did not, but CgA levels did not differ prior to surgery. Also, the values of most parameters, including LF, HF, LF/HF (L/H), and CCV(HF), did not significantly differ between groups or among the three time points. Only Δ L/H and Δ CCV(HF) were significantly lower ($p < 0.05$) at 1 h preoperatively in patients who received sedation than those who received only local anesthesia.

Conclusions: CgA levels were high in both groups immediately before surgery, and thus CgA values immediately before surgery may not be a reliable indicator of the need for intravenous sedation. Also, spectral analysis of HRV, especially Δ L/H and Δ CCV(HF), could be useful for assessing tension and anxiety.

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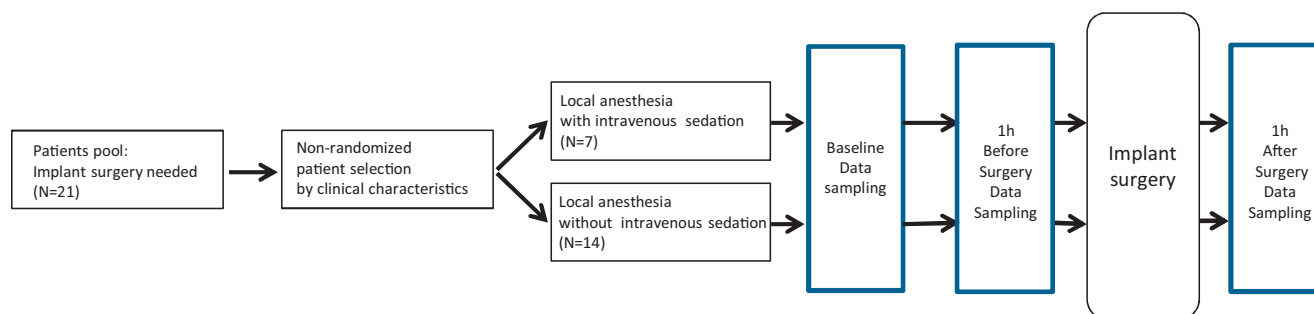


Fig. 1 – Study design. Orthostatic tolerance tests and measurement of salivary CgA levels were performed at baseline, 1 h before surgery and 1 h after surgery.

1. Introduction

Stress surrounding dental treatment is one of the most important factors that induce accidental systemic symptoms such as shock and acute elevation of blood pressure during procedures [1–3]. Systemic complications during dental treatment can be readily provoked by these psychological stresses, and most emergencies such as blood pressure elevation, tachycardia, and vasodepressor syncope are related to autonomic nervous disturbances [4]. These generally cause stress and fear, which may affect patient physiology and increase perioperative anxiety [5]. Previous studies have confirmed that patients experience anxiety not only before invasive treatments such as tooth extraction, but also before general dental treatments such as root canals and periodontal scaling [6,7]. In fact, invasive or uncomfortable procedures sometimes require intravenous sedation or general anesthesia [5,8].

As dental implant surgery can be very long, local anesthesia may be insufficient, and intravenous conscious sedation is an option [9]. Intravenous conscious sedation by the anesthetist is safe procedure and reduces the incidence of adverse events [10]. Consequently, intravenous sedation or general anesthesia is considered necessary for implant surgeries, particularly in patients who are highly susceptible to stress [11–13].

Stress may be evaluated by a variety of methods, including a self-administered questionnaire (SAQ) [5,6,14–16], statistical or dynamic analysis of electrophysiological signals of blood pressure and heart rate [17,18], and biochemical methods including measuring stress-related substances such as chromogranin A (CgA) and cortisol in blood or saliva samples [19–21]. The SAQ is employed most frequently, but it requires that subjects maintain reflective capability. In this respect, SAQ is not suitable for perioperative assessment of stress level with or without intravenous sedation. With regard to stress-related substances, levels vary markedly among individuals and throughout the circadian cycle [20,21] and lack a baseline. Therefore, it is difficult to identify patients susceptible to stress from surgery in advance of a procedure or to reliably evaluate stress before, during, or after dental treatment; there are also no guidelines on which patients should be intravenously sedated.

On the other hand, HRV is widely used as an index of autonomic nervous activity. In humans, cardiac pulsation fluctuates constantly, even at rest, and is determined by the

firing cycle of the sinus node. Sinus node firing is regulated by intracellular potassium (K^+) and calcium (Ca^{2+}) ion levels, which are adjusted by the autonomic nerves. Thus, autonomic nervous activity is assessable by frequency and time domain analyses of electrocardiogram data [22–27].

In this study, we attempted to identify biological distinctions between patients desiring intravenous sedation during implant placement and those who do not by evaluating salivary levels of the stress biomarker CgA and HRV immediately before, during, and after surgery.

2. Materials and methods

2.1. Subjects

A non-randomized controlled prospective study was performed with the approval of the Ethics Committee of Kyushu Dental University (No. 11-60). Twenty-one patients (15 females and 6 males; mean age, 61.4 years) were enrolled between August 2011 and August 2013 at Kyushu Dental University Hospital. Patients were given sufficient explanation of the study goals and signed a consent form. We excluded patients with certain criteria (severe diabetes, previous chemotherapy, previous irradiation of the head and neck region, progressive periodontitis, immunosuppression, human immunodeficiency virus infection), as well as those who had poor oral hygiene or were pregnant. Patients who needed bone grafting were also excluded. The differences between local anesthesia with and without intravenous sedation were explained to all patients before surgery, and the anesthetic methods were selected according to patient preference. In all, 7 patients received sedation during surgery and 14 received only local anesthesia.

Stress was evaluated by measuring salivary levels of the psychological stress biomarker CgA by immunoassay and by spectral analysis of heart rate variability (HRV) during orthostatic tolerance tests. HRV analysis yielded low- (LF) and high-frequency (HF) components, the L/H ratio, and the component coefficient of variance (CCV[HF]), providing indices of sympathetic and parasympathetic regulatory activity [28]. Orthostatic tolerance tests were performed and saliva was collected at baseline, 1 h preoperatively, and 1 h postoperatively (Fig. 1). Baseline data was measured between two to four weeks before surgery. According to our pilot study,

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