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ORIGINAL RESEARCH

Transfer of male patients from the dental chair to the floor by female staff for cardiopulmonary resuscitation: a randomized study

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Abstract

Background: Despite the critical importance of emergency response, there are currently no dedicated resuscitation guidelines for managing cardiac arrest in dentistry. Existing international cardiopulmonary resuscitation (CPR) protocols, such as those from the American Heart Association (AHA) and the European Resuscitation Council (ERC), are designed for general life-threatening situations and may not be directly applicable in dental clinics. In cases of cardiac arrest in dental patients, it is often recommended to move the patient to the floor to facilitate effective chest compressions. However, most dental clinics in Japan have a limited staff, often predominantly female, with unique challenges in transferring patients, especially overweight male patients. These challenges include confined space, limited personnel, obstructive equipment, and the physical size of the patient. This study examined several factors that affect female staff members' ability to transfer male patients from a dental chair to the floor. **Methods**: A randomized crossover study was conducted involving four male and nine female rescuers using two types of dental chairs (with and without side tables). Variables such as the number of female rescuers, transfer time, changes in vital signs, and perceived fatigue were assessed. **Results**: Depending on patient size and chair type, a minimum of five female staff members and approximately 20 seconds were needed for a safe transfer. **Conclusions**: If the dental clinic does not have adequate staff and sufficient floor space, transferring the patient from the dental chair to the floor for CPR may not be a feasible or an effective procedure. **Clinical Trial Registration**: The study was registered retrospectively with UMIN Individual Case Data Sharing System (https://www.umin.ac.jp/) as UMIN000060182.

Keywords

Dentistry; Cardiopulmonary resuscitation (CPR); Chest compressions; Dental chair; Transfer; Female; Rating of Perceived Exertion (RPE) method

1. Introduction

With the aging of the population, dental patients are increasingly complicated by severe comorbidities. Today, there are approximately 190,000 dental clinics in the U.S. and 70,000 in Japan, treating large numbers of patients daily [1, 2]. Although medical risk management is emphasized, emergencies cannot always be prevented. Notably, no global guidelines currently exist for managing cardiac arrest specifically in dentistry. Therefore, ensuring the safety of dental patients during treatment is essential.

Cardiopulmonary arrest is one of the most serious emergencies in dentistry, necessitating immediate CPR. Approximately 80% of medical incidents occur when patients are seated in dental chairs, leading rescuers to consider moving them to the floor to improve the effectiveness of chest compressions. In other words, in many cases, when a patient experiences cardiac arrest, rescuers opt to transfer the patient to the floor for more effective chest compressions rather than performing CPR in the chair. Despite the critical nature of this decision, the issue of patient transportation during dental emergencies remains poorly understood and is often overlooked.

Dental clinics are special environments; dental chairs are large to enhance treatment efficiency for the dentist and comfort for the patient. Treatment equipment and X-ray units occupy much of the room, further limiting available space. These conditions pose several challenges to patient transport, including limited space and physical obstructions that hinder access to the patient.

In Japan, dental clinics typically operate with a small number of staff, and a very high percentage of them are female. If only female staff members are available to transport a male

patient with above-average body size, they may experience increased physical and emotional stress.

In this study, we designed a simulated dental clinic scenario in which a male patient in cardiac arrest was transferred from a dental chair to the floor by female staff members only. We examined the number of female rescuers required to transfer male patients of four different body sizes, the transfer times, physical load indicators (vital signs), and fatigue levels using the Rating of Perceived Exertion (RPE) method.

2. Materials and methods

2.1 Study design

This study employed an envelope-based lottery random sampling method in a controlled laboratory environment. We intentionally selected male participants for the patient role and female participants as staff (transporters) to simulate a realistic clinical scenario.

2.2 Participants

This study recruited four male and nine female volunteers, including dentists, nurses, and dental hygienists. Data collection was conducted between 9:00 and 13:00 from 10 to 15 January 2025. All participants were right-handed. Participants with cardiovascular disease, upper extremity impairments, spinal disorders, and other conditions deemed unsuitable for physical exertion were excluded. All participants wore standard surgical scrubs consisting of separate upper and lower garments.

2.3 Equipment and dental chairs

The Rating of Perceived Exertion (RPE) method is a subjective measure that correlates well with objective indicators, such as heart rate maximum (%HRmax), maximal oxygen consumption (%VO2max), and Lactate threshold. It is widely recognized as a simple, noninvasive, inexpensive, and reliable method of monitoring exercise intensity [3]. In this study, RPE was used to assess fatigue after the participants' exertion (Table 1). RPE procedures were thoroughly explained and practiced before the trial began, and data collection only commenced after participants demonstrated adequate understanding. Two different types of dental chairs at Kyushu University Hospital were used: Type 1: A chair with a side (work) table directly connected to the cuspidor unit on the left side of the patient, equipped with instruments for treatment assistance (Morita SIGNO TREFFERT®: MORITA, Osaka, Japan). It featured hand rests on both sides of the patient, each 20 cm above the seat. This is a common design in dental clinics. However, the side table obstructs access from the left, limiting rescuer positioning. Type 2: A chair without a side table (BELPORT NP®; TAKARA BELMONT, Osaka, Japan), allowing rescuers to approach from any direction. It featured a single 20 cm-high hand rest on the left side, as shown in Fig. 1.

Randomized assignment sheets were prepared, each specifying a combination of dental chair type (Type 1 or 2), male patient number (No. 1–4), and the number of female transporters (No. 2–9). Each sheet was sealed in an envelope to conceal its contents. In addition, sheets with female participants' personal numbers from 1 to 9 were placed in the box. First, the study director chose one envelope to determine the chair type, the male participant, and the number of transporters. Then, to select female transporters, these were randomly selected from the box. The designated male participant was then seated in the selected dental chair.

2.4 Research setting and measurement time, participants' (role of the rescuer) physical and fatigue level measurements

If the patient lying on the dental chair was too heavy, the strain on the female rescuers became excessive, increasing the risk of muscle soreness and injury. To ensure safety, a preliminary survey was conducted one week before the study period. For each male patient, a 30-second trial was conducted with two female rescuers while the patient was positioned horizontally. If transportation was deemed unfeasible, an additional rescuer was added, and the trial was repeated. Each measurement started with the minimum number of female rescuers expected to manage the transfer. To minimize the effects of participant fatigue, each trial on test days was separated by a rest period of at least 15 minutes, with no more than four trials conducted per participant per day. Blood pressure (BP) and heart rate (HR) were measured using a bedside monitor (BSM-1763 Life scope PT®; NIHON KOHDEN, Tokyo, Japan). Six identical bedside monitors were used to record vital signs for all rescuers simultaneously, immediately before and after the test.

(1) A board was placed between the rescuer and the patient, and the patient's body size remained unknown until measurements began.

(2) The male participant was seated on a dental chair with the backboard tilted at a 45° angle from the horizontal position and adjusted to its maximum height.

(3) One rescuer was positioned on the patient's right side (simulating the role of a dentist), while all other rescuers were positioned at the head side. The initial blood pressure and heart rates of all participants were measured.

(4) The height of the Type 1 and Type 2 dental chairs was lowered to their minimum positions (Type 1: 50 cm and Type 2: 53 cm), and the backrest was reclined to place the patient in a semi-horizontal position.

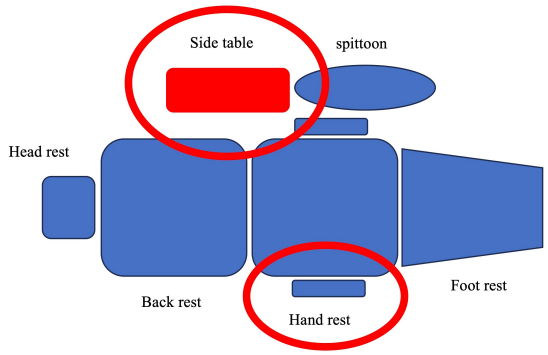
(5) Rescuers positioned themselves as they judged appropriate for patient transfer. The patient completely relaxed their body during the process.

(6) Rescuers inserted their arms under the patient and carried them by holding the arms directly, without grabbing the patient's clothing. The patient was lifted fully vertically, avoiding contact with the chair's hand rests and surrounding equipment. To perform lateral movement, the participants had to lift the patient vertically by at least the height of the dental chair (Type 1: 50 cm and Type 2: 53 cm at the lowest position), the chair thickness (Type 1: 35 cm, Type 2: 32 cm), and height of the hand rest (20 cm on Type 1 only). This resulted in a total lift height of approximately 110 cm for type 1 as indicated by yellow arrows. In contrast, type 2 lacked a right hand rest, reducing the lift height by approximately 90 cm, as shown in Fig. 2.

TABLE 1. Rating of perceived exertion (RPE) scale.

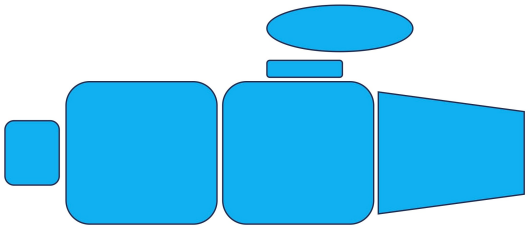
RPE scale	Rate of Perceived Exertion
10	Could Not Perform More Reps or Add Weight
9.5	Could Not Do More Reps, But Could Add Slightly More Weight
9	Could Do 1 More Rep
8.5	Could Definitely Do 1 More Rep, possibly 2
8	Could Do 2 More Rep
7.5	Could Definitely Do 2 More Rep, possibly 3
7	Could Do 3 More Rep
5–6	Could Do 4–6 More Rep
1–4	Very Light, Little to no Effort

Rep: repetition.



Type 1: With side a table and both side hand rests

Morita SIGNO TREFFERT®: MORITA. Osaka, Japan



Type 2: Without a side table and a right-hand rest

BELPORT NP®: TAKARA BELMONT. Osaka, Japan

FIGURE 1. Top view of two types of dental chairs with the backrest reclined. Each chair is divided into four sections: head, torso, waist, and legs, with the head positioned on the left and the feet on the right. The elongated circle on the left indicates the gargling (spittoon) area. Type 1: With a side table and hand rests on both sides, whereas Type 2 does not.

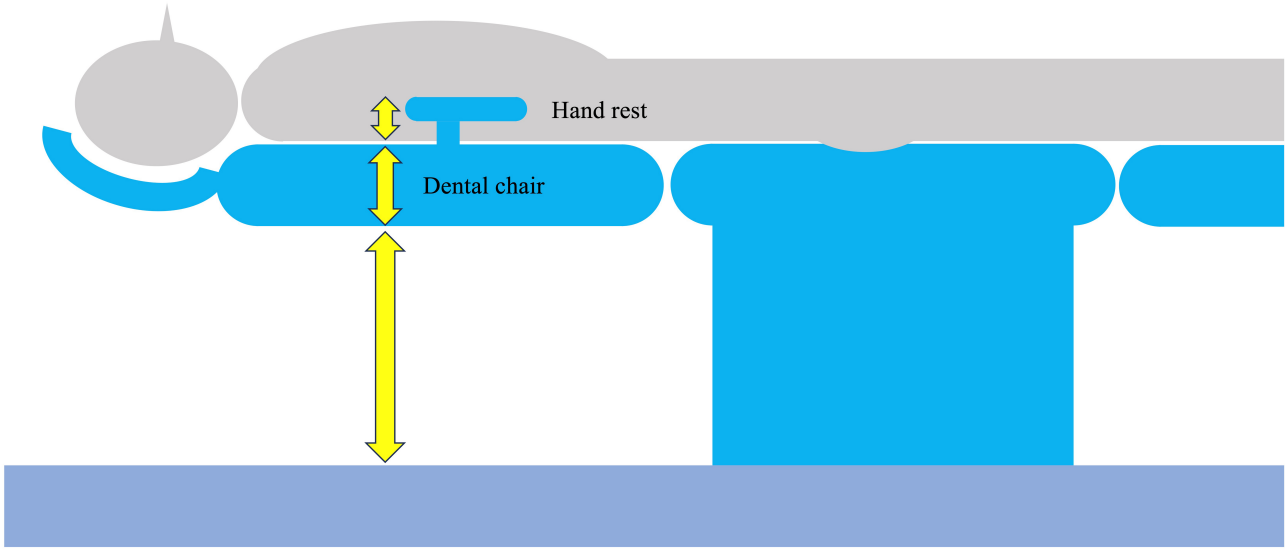


FIGURE 2. Side view of the dental chair during measurement. The patient was placed in a supine position with the backrest reclined. The head, supported by a head rest, is located on the left side. The lowest chair height was 50 cm for Type 1 and 53 cm for Type 2. Including the thickness of the chair (Type 1: 35 cm; Type 2: 32 cm) and the height of the hand rest (20 cm, present only on Type 1), the total vertical lift height reached approximately 110 cm, as indicated by yellow arrows. In contrast, Type 2, which lacked a hand rest, required a lift height of approximately 90 cm.

(7) The patient was then horizontally transferred to a designated location approximately 1 meter to the right of the dental chair and gently lowered to the floor. Afterward, participants' BP, HR, and RPE were measured. RPE was recorded only immediately after the trial and was used for statistical analysis.

(8) For each male patient, if all six transfers were completed successfully, the measurements were concluded without increasing the number of female rescuers.

2.5 Data and statistical analysis

All participants completed the tests in this study. Data collected from bedside monitors and the RPE assessments were exported to Microsoft Excel (Excel version 16.65; Microsoft 365 Corporation, Redmond, WA, USA).

Logistic regression analysis was performed to assess the factors influencing the successful transfer. Independent variables included the presence of the side table (with/without), male participants (patients), and the number of female participants. The distribution of data was assessed using the Shapiro-Wilk test, which confirmed that the data were not normally distributed. The Kruskal-Wallis test was used to compare the median values of each parameter across conditions. Differences in the number of participants were assessed using the Wilcoxon rank-sum test, and Cliff's Delta was used to estimate the effect size. For comparison of vital signs (BP, HR, *etc.*) and fatigue (measured using RPE methods) between conditions with and without a side table, median values were compared only for cases in which the transfer was completed. A significance level of $p < 0.05$ was applied for all statistical tests. Statistical analyses were performed using R software (version 4.3.2, released 2023-10-31; R Development Core Team: R: A Language and Environment for Statistical Computing, R Foundation for Statistical Computing, Vienna, Austria).

3. Results

3.1 Participant characteristics

Four male patients of different body sizes were assigned to the patient role; one classified as light (56 kg, 171 cm), one as medium (71 kg, 177 cm), one as heavy (82 kg, 178 cm), and one as robust (99 kg, 180 cm) (Table 2). Nine female participants served as dental staff, with a mean age of 38 $\pm$ 8 years, a mean height of 158 $\pm$ 3 cm, a mean weight of 54 $\pm$ 3 kg, and a mean body mass index (BMI) of 21 $\pm$ 1. These female participants were tasked with safely transferring the male patient from the dental chair to the floor. All measurements were completed without data exclusion.

3.2 Transfer success and the effect of dental chair configuration

Logistic regression analysis was conducted to evaluate factors influencing successful patient transfers. Concisely, odds ratios greater than 1 indicated a positive effect, while values less than 1 indicated a negative effect. The presence of the side table demonstrated a negative effect on transfer success (Table 3). When a side table was present, four female rescuers were required to transfer a 60 kg (173 cm) male patient, whereas five females were needed to transfer a male weighing 71 kg (177 cm), 82 kg (178 cm), or 99 kg (180 cm), as shown in Table 4. In contrast, when the side table was absent, two female rescuers were sufficient for a 60 kg (173 cm) male, and three females were needed for 71 kg (177 cm), 82 kg (178 cm), and 99 kg (180 cm) males (**Supplementary Tables 1**,**2**).

TABLE 2. Body size of male participants (role of a patient).

Male, No.	Weight (kg)	Height (cm)	BMI	Age (yr)
1 (Light)	56	171	19.15	51
2 (Medium)	71	177	24.22	37
3 (Heavy)	82	178	25.88	44
4 (Robust)	99	180	30.56	39

The standard Japanese body size (50–69 years old: 168.0 cm, 67.8 kg). BMI: body mass index.

Logistic regression analysis further revealed that successful transfer was significantly associated with the presence or absence of a side table (Odds Ratio: 3.071×10^{-6}, $p < 0.001$), the body size of the male participant (Odds Ratio: 2.561×10^{-3}, $p < 0.001$), and the number of female rescuers (Odds Ratio: 2932, $p < 0.001$).

3.3 Fatigue evaluation using RPE

Fatigue levels of the rescuers were assessed using the Rating of Perceived Exertion (RPE) method. Statistically significant differences in RPE scores were observed across varying group sizes: With side tables, significant differences were noted between groups with 2 versus 4 females for the 60 kg male, 3 versus 4 females for the 71 kg and 82 kg males, and 4 versus 5 females for the 99 kg male. Without side tables, significant differences were observed between groups with 2 versus 3 females for the 71 kg, 82 kg, and 99 kg males. In each case, successful transfers were consistently achieved in groups with a higher number of female rescuers, with all six trials completed successfully (6/6 success rate).

3.4 Time required for transfer

The time required to complete the patient transfer averaged approximately 20 seconds, depending on chair configuration and the number of rescuers.

4. Discussion

Cardiac arrest may occur unexpectedly in dental patients, and immediate initiation of chest compressions is essential for improving survival outcomes. However, in the absence of setting-specific global guidelines and an accurate understanding of the physical constraints of the dental clinic environment, rescuers may attempt to transport the patient to the floor to facilitate more effective chest compressions. This approach, however, is often impractical in real-world clinical settings.

In Japan, most dental clinics are small, with an average of 1.5 dentists, 1.3 dental hygienists, 0.4 clinic staff, and three

TABLE 3. Results of logistic regression analysis.

Predictor Variable	Odds Ratio	95% Confidence Interval	*p*-value
Presence of a side table (with/without)	0.0000031	(0.0000002–0.0086623)	<0.001
Male participants' body size	0.0256121	(0.0013664–0.1243610)	<0.001
Number of female participants	2932	(136–960,603)	<0.001

Presence of a side table with/without (1: With Side Table, 0: Without Side Table), Male participants' body size (1: 56 kg, 2: 71 kg, 3: 82 kg, 4: 99 kg), Number of female participants (2, 3, 4, 5).

TABLE 4. Transport success by body size and number of female staff, with or without side table.

A side table	Male's weight (kg), height (cm)														
	56 kg (171 cm)			71 kg (177 cm)				82 kg (178 cm)				99 kg (180 cm)			
Body Size Category	Light			Medium				Heavy				Robust			
Number of transfers (females)	2	3	4	2	3	4	5	2	3	4	5	2	3	4	5
With success of transport (times)	0/6	4/6	**6/6**		0/6	5/6	**6/6**			0/6	**6/6**			0/6	**6/6**
Without success of transport (times)	**6/6**			0/6	**6/6**			0/6	**6/6**			0/6	**6/6**		

Bold indicates the number of females that could safely transport males.

dental chairs per clinic [4]. Under these circumstances, staff availability and workspace are often limited. These constraints become apparent only when an emergency response is attempted. Even when transportation is carried out smoothly, the time required to transfer a patient from the dental chair to the floor may result in critical delays in the initiation of life-saving interventions.

Although the side table attached to the left side of the dental chair is useful for routine clinical procedures, especially for assistants, it becomes an obstacle during emergencies, as it prevents rescuers from accessing the patient from the left side. This limitation significantly complicates the process of patient transfer. In contrast, the table on the right side, connected to treatment instruments, allows greater freedom of movement and does not hinder rescue efforts during emergency procedures. Additionally, if the dental chair is equipped with hand rests, it increases the required lift height, adding to the physical burden and time delay.

The four male participants represented a stepwise increase in body size beyond the Japanese average (50–69 years old, 168.0 cm in height and 67.8 kg in weight). In addition, the female participants were healthy and exhibited similar physiques and athletic abilities. Their anthropometric characteristics closely aligned with the national average for Japanese females aged 30–49 years (158.0 cm in height and 54.8 kg in weight) [5], and thus were considered representative of a standardized population.

We indexed female staff members' performance by transport success or failure, the minimum number of rescuers required for a successful transfer, time taken, and the PRE score. With the development of technology, instruments for quantifying exercise have become widely used and are capable of providing detailed physiological data. However, such data can be highly complex, and there is no universally accepted single-value method to comprehensively present the physical workload. The RPE method remains widely accepted for its simplicity, cost-effectiveness, and correlation with objective markers like %HRmax, %VO2max, and Lactate threshold [3]. It has demonstrated validity, reliability, and consistency across ages and physical fitness levels, making it appropriate as a standalone tool for monitoring physical exertion [3]. In this study, we accurately assessed the condition of each participant. Although BP and HR were also measured, they provided limited insight due to the short and instantaneous nature of the physical activity involved. Notably, the number of rescuers had more influence on success than physiological strain.

In the clinical setting, additional time is often required for several responses, from the initial recognition of the patient's abnormal condition to the initiation of transfer. Moreover, the decision to request emergency medical services (EMS) from dental clinics is often delayed, resulting in response times that are significantly longer than those recommended in international CPR guidelines. In Japan, over 80% of medical accidents involving dental patients occur while the patient is seated in a dental chair [6]. Even in general hospitals (not limited to dental clinics), 67% of patients receive CPR on a mattress without moving from the bed [7]. When it is difficult to transfer a dental patient to the floor, performing chest compressions directly on the dental chair may be effective. However, dental chairs are not designed to withstand the strong external forces applied during chest compressions and are prone to instability. If the dental chair can be adequately stabilized to withstand the pressure, CPR can be initiated quickly. We have previously studied the effectiveness of chest compressions on a dental chair [8, 9]. The optimal method for stabilizing the dental chair during chest compressions is to place a stool under the reclining backrest. This method was recommended in the 2015 and 2021 European Resuscitation Council (ERC) guidelines [10, 11]. With this method, the efficiency of chest compressions was improved to be equivalent to that of a standard hospital bed [12]. This approach represents one of the most practical and feasible solutions within the specialized environment of dental clinics.

In future scenarios, improved patient transport techniques and dedicated rescue tools will be essential to ensure the safe transportation of dental patients, particularly in settings where

adequate space and manpower are not available. Additionally, standardized CPR protocols and regular staff training are essential in dental clinics.

This study has several limitations. First, the role of the male patients was played by dental professionals, rather than by general volunteers. Female participants were aware in advance that the "patient" would be transferred from the dental chair to the floor and understood the procedure. Therefore, the results may not fully reflect the realities of actual emergency situations. Furthermore, due to the limited number of female participants, their transport skills may have improved over time, potentially reducing the generalizability of the findings. Second, during real cardiac arrest, the patient's physiological condition differs significantly from that in a simulation study. Complete loss of muscle tone and consciousness would further complicate patient transfer. In this study, the patient's clothing was not grabbed, and no assistive devices were used to assist the lifting process. However, in real cases of cardiac arrest, muscle collapse makes the body more difficult to manage, and additional support may be required. Lastly, the instantaneous physical burden on female staff members could not be adequately assessed using conventional HR and BP measurements. Therefore, future research should incorporate more sensitive physiological indicators, such as electromyography (EMG), continuous BP and HR monitoring, and electrocardiography (ECG), as used in sports science, to more precisely evaluate physical effort.

Overall, this study suggests that safely transferring a patient from a dental chair to the floor is difficult in the absence of adequate staff and sufficient floor space. Attempting such transfers in all cases may cause delays and physical strain. Therefore, our first recommended approach is to perform CPR directly on a stabilized dental chair as the first-line approach. Transfer to the floor should be reserved for scenarios where sufficient staff and space are available.

5. Conclusions

The ability of female staff to safely transfer a male patient from a dental chair to the floor was significantly influenced by the presence of a side table, the body size of the patient, and the number of staff involved. Our findings suggest that three to five female rescuers are necessary for safe and effective transfers. In dental clinics with limited personnel or space, moving a male patient in cardiac arrest may not be feasible. In such cases, performing CPR directly on a stabilized dental chair is recommended.

ABBREVIATIONS

CPR, Cardiopulmonary resuscitation; RPE, Rating of Perceived Exertion; BP, Blood pressure; HR, heart rate; EMS, emergency medical services; ERC, European resuscitation council; AHA, American Heart Association; BSM, bedside monitor; BMI, body mass index; ECG, electrocardiography; %HRmax, heart rate maximum; %VO2max, maximal oxygen consumption.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analyzed in the current study are available from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTIONS

TH, RN and MK—designed the research study; performed the research. TH, TT—analyzed the data. TH, RN, TT and TY—wrote the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

All procedures in the study were performed with male participants (patient roles). We consulted the Institutional Review Board (IRB) of Kyushu University, which confirmed that no formal written waiver for ethical approval was required because of the design of the study. In addition, written consent was not obtained from any of the participants. Because all the participants in this study were in good health and there were no obstacles around the dental chairs, the risk of injury was minimal. But we have received verbal informed consent.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at https://oss.signavitae.com/mre-signavitae/article/2008468501948186624/attachment/Supplementary%20material.docx.

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