Emergency Medicine: Open Access
ISSN: 2165-7548
Ito et al., Emerg Med (Los Angel) 2015, 5:4
DOI: 10.4172/2165-7548.1000268
Research Article Open Access

The Effect of the Use of a Stabilizer and Different Height Settings on the Stability of the Dental Chair when Performing High-Quality Chest Compressions

Shinichi Ito*, **Noriko Karube, Jun Hirokawa, Saori Sako and Takeshi Yokoyama**

Department of Dental Anesthesiology, Faculty of Dental Science, Kyushu University, Japan

***Corresponding author:** Shinichi Ito, D.D.S., Ph.D., Department of Dental Anesthesiology, Faculty of Dental Science, Kyushu University, 3-1-1 Maidashi, Higashi-ku, Fukuoka 812-8582, Japan, Tel: +81 (92) 642-6480; Fax: +81 (92) 642-6481; E-mail: ito@dent.kyushu-u.ac.jp

Received date: June 04, 2015; **Accepted date:** June 26, 2015; **Published date:** July 03, 2015

Abstract

Background/Aim: In the case of sudden cardiopulmonary arrest (CPA) in a patient in a dental practice, dental professionals have to perform cardiopulmonary resuscitation (CPR) in the dental chair. However, not all dental chairs are stable enough for performing chest compressions, as some do not contain steady support under the backrest. We investigated methods for stabilizing the dental chair to increase the efficacy of chest compressions performed in the chair.

Materials and Methods: Chest compressions (with a depth of 5.0 to 6.0 cm) were performed on a CPR manikin that was laid on the backrest of a dental chair. The movement of the chest of the manikin and the displacement of the backrest caused by the chest compressions were recorded as video data, and the mean amplitude of the movement of the backrest at each compression depth was analyzed. We investigated the effect of three different height settings of the dental chair and the use of a round stool as a stabilizer under the backrest on the stability of the dental chair during CPR.

Results: Differences in the height settings of the dental chair did not significantly affect the vertical movement of the backrest caused by chest compressions. The mean amplitudes of the movements of the backrest with and without a stabilizer were 1.99±0.74 cm and 0.43±0.18 cm, respectively.

Conclusion: The placement of a round stool as a stabilizer under the backrest of a dental chair might increase the effectiveness of chest compressions.

Keywords: Cardiopulmonary resuscitation; Chest wall oscillation; Heart arrest; Dental care

Abbreviations

AHA: American Heart Association; CPA: Cardiopulmonary arrest; CPR: Cardiopulmonary resuscitation

Introduction

Various complications can arise during dental treatments. In severe cases, they might result in cardiopulmonary arrest (CPA) in the patient [1-7]. Dental professionals will then have to immediately start cardiopulmonary resuscitation (CPR) while the patient is still seated in the dental chair. Some studies have reported on useful tools (a bag-valve-mask device for ventilation, an automated external defibrillator, and emergency drugs) for treating CPA occurring in the dental practice [8-10]. Moreover, statistical analyses of medical emergencies in dental practices have been conducted [2,4,11]. However, only few reports on performing chest compressions in the dental chair have been published.

Effective chest compressions are the foundation of high-quality CPR [12,13]. However, many types of dental chairs are too unstable for performing chest compressions with an adequate depth because they do not contain steady support between the backrest of the chair and the floor. This instability of the dental chair may lead to insufficient compression depth or excessive fatigue in rescuers. Yokoyama et al. reported that effective chest compressions could be performed in a dental chair that was firmly fixed to the floor [14]. It has also been reported that the placement of a round stool under the dental chair stabilized the backrest and improved the effectiveness of chest compressions performed by rescuers [15]. However, these reports did not analyze the movement and instability of the dental chair when chest compressions with an adequate depth (as recommended in the 2010 International Consensus on CPR and Emergency Cardiovascular Care Science with Treatment Recommendations) are performed [16]. Therefore, the specific effect of the stabilizer on the stability of the dental chair during chest compressions remains unclear.

In this study, we investigated the effect of different seat heights and the use of a round stool as a stabilizer on the movements and stability of the dental chair during chest compressions.

Materials and Methods

Dental chair units

We used five different types of dental chair units in our study (Table 1). All dental chairs were installed in the dental treatment room at the Kyushu University Hospital.

Citation: Ito S, Karube N, Hirokawa J, Sako S, Yokoyama T (2015) The Effect of the Use of a Stabilizer and Different Height Settings on the Stability of the Dental Chair when Performing High-Quality Chest Compressions. Emerg Med (Los Angel) 5: 268. doi: 10.4172/2165-7548.1000268

Positioning of the manikin used for cardiopulmonary resuscitation in the dental chair

The CPR manikin (Resusci Anne Torso Basic; Laerdal Medical AS, Stavanger, Norway) was laid on the horizontal backrest of the dental chair. The upper end of the torso of the manikin was aligned with the top edge of the backrest (Figure 1B). The surface of the backrest under the lower half of the sternum of the manikin was levelled using a levelling instrument (LV16-55; Muratec-KDS, Kyoto, Japan).

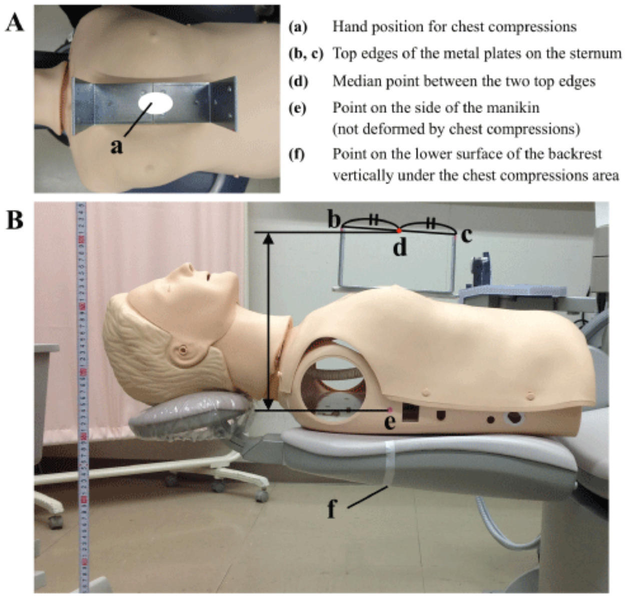

Figure 1: Setup of the manikin for measuring chest compression depth and movement of the backrest. (A) The hand position for the chest compressions (white ellipse; [a]) was the centre of the manikin's chest. The metal plates were attached in a U shape, centering on the hand position. (B) Chest compression depth was measured as the changes in the distance between (d) and (e). The displacement of the point on the lower surface of the backrest (f) was simultaneously measured with the vertical movements of the backrest caused by chest compressions.

Measurements of chest compression depth and displacement of the backrest

We used the center of the chest (the lower half of the sternum) as the hand position for chest compressions, as recommended in the European Resuscitation Council Guidelines for Resuscitation (2010) and the 2010 American Heart Association (AHA) Guidelines [12,17]. Firm metal plates that could not be deformed by chest compressions were used as indicators to measure chest compression depth. They were attached in a U-shape, centering on the hand position on the sternum (Figure 1A).

All chest compressions were performed by the first author who is an AHA-certified Basic Life Support instructor. The amplitude of the movement of the backrest of the dental chair by chest compression was determined as the average of 3 to 14 chest compressions. Figure 1B shows the points used for measuring chest compression depth and backrest movement resulting from chest compressions. The median point (d) between the two top edges of the metal plates on the sternum (b, c) was set as the indicator of the movement of the sternum. Chest compression depth was measured as the changes in the length between the steady point on the side of the manikin (e) and the median point (d). The displacement of the point (f) on the lower surface of the backrest (vertically under the area for chest compressions) was measured at the same time as the chest compression-induced vertical movements of the backrest.

Chest compressions of 5.0 to 6.0 cm were performed with and without a stabilizer, and the deformation of the manikin and the displacement of the backrest from its basal position were recorded with a camcorder (HDC-SD3; Panasonic, Osaka, Japan). Video data were transferred to a computer (iMac 11.1; Apple, Cupertino CA, USA) using iMovie '11 (Version 9.0.8; Apple, Cupertino CA, USA), and the movies were converted into still images using QuickTime Player 7 (Version 7.7.1; Apple, Cupertino CA, USA). The compression depth of the manikin and the amplitude (degree of instability) of the movement of the backrest were measured using the simultaneously captured ruler as a reference.

Use of a round stool as a stabilizer

To examine the effect of a stabilizer on chest compressions, a round stool with a hard seating surface (height, 46.0 cm; US-837H; Uchida Yoko, Tokyo, Japan) was placed under the backrest of the dental chair. The edge of the seating surface of the round stool was set to (vertically) touch the backrest under the area for chest compressions (Figure 2). Chest compressions (at the same seat height) were performed with and without the round stool as a stabilizer.

Figure 2: Placement of the round stool as a stabilizer. The edge of the seating surface of the round stool was set to (vertically) touch the backrest under the area for chest compressions.

Height adjustment of the dental chair

In order to examine the effect of different dental chair heights on the stability of the chair during chest compressions, three different height settings were tested. The lower limit of the seat height of each dental chair unit was considered the lowest position. Chest compressions were then performed at the lowest position of the dental chair as well as 10 cm and 20 cm higher than the lowest position.

Statistical analysis

Data are presented as mean±standard deviation. All data were tested with analysis of variance (ANOVA), followed by a paired Student's t-test for the comparison between two groups or a Tukey's honestly significant difference test for multiple comparisons. Probabilities less than 5% ($P<0.05$) were considered statistically significant. Analyses were carried out using the Kaleida Graph software in Japanese (Version 4.5.0; Synergy Software, Reading PA, USA).

Results

Effects of the stabilizer (round stool) on the movement of the dental chair

The vertical movements of the backrest of the dental chair induced by chest compressions were measured with and without the use of a round stool as a stabilizer. Chest compressions with a depth of 5.0 cm induced a downward shift of the backrest of 1.56 ± 0.57 cm without the stabilizer. Deeper compressions tended to result in a larger displacement of the backrest, and a compression depth of 6.0 cm caused a downward shift of 2.28 ± 0.90 cm. When the stabilizer was used, the displacement of the backrest caused by the chest compressions measured 0.37 ± 0.14 cm (using a compression depth of 5.0 cm) to 0.50 ± 0.20 cm (using compression depth of 6.0 cm). The round stool placed under the backrest as a stabilizer significantly reduced the amplitude of the displacement of the backrest at each compression depth (Figure 3).

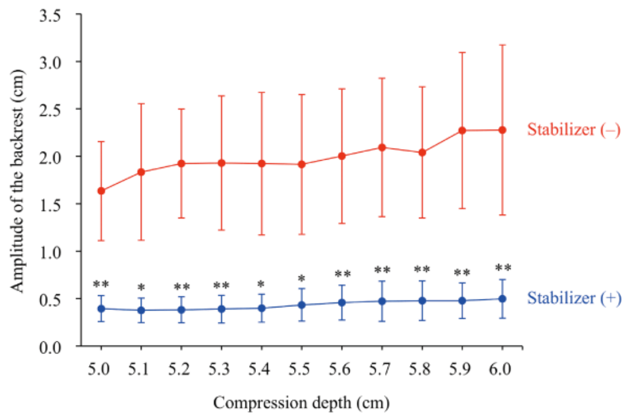

Figure 3: Effect of the stabilizer (round stool) on the vertical movements of the backrest caused by chest compressions. Results are expressed as mean ± standard deviation. Asterisks represent significant differences ($^{*}P<0.05$ and $^{**}P<0.01$).

Effect of dental chair height on the movement of the dental chair

We measured the vertical movements of the backrest caused by chest compressions when the dental chair was set to three different heights. We obtained similar results, irrespective of the dental chair unit that was used.

At the lowest position, chest compressions with depths of 5.0 cm and 6.0 cm induced downward shifts of the backrest of 1.50 ± 0.55 and 2.31 ± 0.57 cm, respectively. At the second height setting (10 cm higher than the lowest position), chest compressions depressed the backrest by 1.50±0.54 cm (using a compression depth of 5.0 cm) to 2.34 ± 0.64 cm (using compression depth of 6.0 cm). When the third height setting of the dental chair (20 cm higher than the lowest position) was used, chest compressions caused a downward shift of the backrest of 1.51 ± 0.54 cm (using a compression depth of 5.0 cm) to 2.33 ± 0.67 cm (using compression depth of 6.0 cm; Figure 4). We found no significant differences in the downward displacement of the backrest at each compression depth for the three different dental chair height settings.

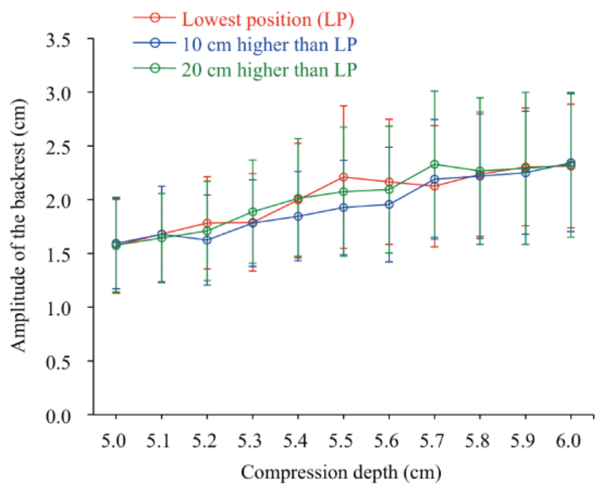

Figure 4: Effect of dental chair height on the vertical movement of the backrest caused by chest compressions. Chest compressions were performed at three different height settings of the dental chair. Data are expressed as mean ± standard deviation. LP, lowest position.

Discussion

In this study, we investigated the effect of different seat heights and the use of a round stool as a stabilizer on the movements and stability of the dental chair during chest compressions. We show that, although there was no significant effect of seat height on the stability of the dental chair, the use of a stabilizer (in the form of a round stool placed under the backrest of the chair) significantly reduced the amplitude of the dental chair's displacement of the backrest at each compression depth.

The prompt commencement of chest compressions is crucial during CPR [12,13]. In order to start chest compressions as quickly as possible, CPR should be performed on location (where the patient has the CPA). The efficacy of chest compressions that are performed in the dental chair vs. those that are performed on the floor during dental emergencies has been discussed [15,18]. The extra time required to move the patient from the dental chair to the floor should be taken into consideration. According to the principle of the immediate start of chest compressions, CPA occurring in the dental practice is preferably treated in the dental chair, without having to move the patient. Thus, ways to perform high-quality CPR in the dental chair must be developed.

Performing chest compressions with adequate depth and rate is crucial for providing high-quality CPR. During CPA in an adult, rescuers should push the adult chest at a rate of at least 100 compressions per minute with a compression depth of at least 5 cm [12,13,16,17]. Performing high-quality chest compressions is physically demanding and can exhaust the rescuer. In our study, chest compressions with an adequate depth could be performed in the dental chair without the use of a stabilizer; however, the backrest of the dental chair moved vertically during chest compressions, and the chest wall recoiled. The mean amplitude of the movement of the backrest caused by chest compression when no stabilizer was used was approximately 2 cm (Figures 3 and 4). During CPR in the dental chair, the vertical motion of the backrest induced by chest compressions might increase physical fatigue in the rescuer by causing an increased labor effort needed to push down the backrest. In addition, it is likely that having to use extra strength impedes performing chest compressions with an adequate depth. Hence, it is important to devise methods for executing efficient chest compressions in the dental chair.

In this study, we simultaneously measured chest compression depth (with a ruler) and the amplitude of the movement of the backrest (by video-captured moving images). A CPR manikin system that is capable of recording CPR performance is often used to measure chest compression depth [15,19,20]. However, the maximum chest compression depth measured by this manikin system is not always temporally synchronized with the maximum amplitude of the backrest. Thus, it is not easy to synchronize these two measured values. We suggest that the method that was used for assessing chest compression depth in this study facilitates synchronizing the two measurements (chest compression depth and the amplitude of the movement of the backrest).

The height of the dental chair seat likely affects the ease with which a rescuer can push the chest vertically, since the height of the rescuers also vary (i.e., it might be hard for a tall person to perform adequate chest compressions on a patient seated in a dental chair with a low height setting). Moreover, when chest compressions are performed, a higher seat position might cause a decreased stability of the dental chair. Thus, we assessed the effect of seat height on the vertical movements of the backrest induced by chest compressions. Our data show that differences in the height of the dental chair did not have a statistically significant effect on the vertical movement of the backrest caused by chest compressions (Figure 4). All types of dental chair units used in this study were composed of two parts, the seating part and the backrest. The seating part was firmly attached to the seat pedestal; thus, the higher position of the seat did not influence the stability of the seating part. The movement of the backrest seemed to be mainly caused by insufficient strength of the joint between the backrest and the seating part against the stress of chest compressions.

The round stool that was placed under the backrest of the dental chair significantly reduced the mean amplitude of the movement of the backrest caused by chest compressions with a depth of 5.0 to 6.0 cm (without the round stool, 1.99 ± 0.74 cm; with the round stool, 0.43 ± 0.18 cm; Figure 3). The round stabilizer is relatively fixed beneath the backrest under the area for chest compressions. The stabilizer must have sufficient strength to withstand the chest compression-induced vertical movements of the backrest. Moreover, it needs to have the appropriate height so that chest compressions can be performed easily. Many kinds of round stools with different heights are available. Therefore, it is important that a round stool of a size that is suitable for the dental staff potentially performing the chest compressions be chosen.

Our data indicate that a round stool with a hard seating surface has the suitable height for performing chest compressions and the sufficient strength to suppress the vertical movements of the backrest during chest compressions in the dental chair. However, it is important that the start of CPR should not be delayed, and chest compressions should not be interrupted in order to set a stabilizer. A round stool is relatively inexpensive and can be easily obtained. The usefulness of other types of stabilizers remains to be verified.

Conclusions

Our data show that the seat height of the dental chair does not affect the stability of the chair's backrest when performing chest compressions. On the other hand, the use of a round stool as a stabilizer significantly reduced the amplitude of the displacement of the backrest at each compression depth. Thus, using such a stabilizer might render chest compressions more effective.

Acknowledgements

This study was supported by the Academic Enrichment Fund allotted to the Department of Dental Anesthesiology, Faculty of Dental Science, Kyushu University. The funding body had no role in the study design, in the collection, analysis and interpretation of data; in the writing of the manuscript; and in the decision to submit the manuscript for publication.

References

1. Jevon P (2012) Defibrillation in the dental practice. Br Dent J 213: 233-235.
2. Müller MP, Hänsel M, Stehr SN, Weber S, Koch T (2008) A state-wide survey of medical emergency management in dental practices: incidence of emergencies and training experience. Emerg Med J 25: 296-300.
3. Chapman PJ, Penkeyman HW (2002) Successful defibrillation of a dental patient in cardiac arrest. Aust Dent J 47: 176-177.
4. Girdler NM, Smith DG (1999) Prevalence of emergency events in British dental practice and emergency management skills of British dentists. Resuscitation 41: 159-167.
5. Matsuura H (1989) Analysis of systemic complications and deaths during dental treatment in Japan. Anesth Prog 36: 223-225.
6. Haas DA (2006) Management of medical emergencies in the dental office: conditions in each country, the extent of treatment by the dentist. Anesth Prog 53: 20-24.
7. Hunter PL (1991) Cardiac arrest in the dental surgery. Br Dent J 170: 284.
8. Dietrich P, Graetz KW, Mutzbauer TS (2013) Evaluation of pressure-controlled ventilation concepts during cardiopulmonary resuscitation (CPR) in dental chairs. Oral Maxillofac Surg 17: 173-179.
9. Rosenberg M (2010) Preparing for medical emergencies: the essential drugs and equipment for the dental office. J Am Dent Assoc 141 Suppl 1: 14S-9S.

10. Laurent F, Augustin P, Zak C, Maman L, Segal N (2011) Preparedness of dental practices to treat cardiac arrest: availability of defibrillators. Resuscitation 82: 1468-1469.
11. Collange O, Bildstein A, Samin J, Schaeffer R, Mahoudeau G, et al. (2010) Prevalence of medical emergencies in dental practice. Resuscitation 81: 915-916.
12. Nolan JP, Soar J, Zideman DA, Biarent D, Bossaert LL, et al. (2010) European Resuscitation Council Guidelines for Resuscitation 2010 Section 1. Executive summary. Resuscitation 81: 1219-1276.
13. Travers AH, Rea TD, Bobrow BJ, Edelson DP, Berg RA, et al. (2010) Part 4: CPR overview: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 122: S676-684.
14. Yokoyama T, Yoshida K, Suwa K (2008) Efficacy of external cardiac compression in a dental chair. Resuscitation 79: 175-176.
15. Fujino H, Yokoyama T, Yoshida K, Suwa K (2010) Using a stool for stabilization of a dental chair when CPR is required. Resuscitation 81: 502.
16. Nolan JP, Hazinski MF, Billi JE, Bottiger BW, Bossaert L, et al. (2010) Part 1: Executive summary: 2010 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. Resuscitation 81S: e1-e25.
17. Berg RA, Hemphill R, Abella BS, Aufderheide TP, Cave DM, et al. (2010) Part 5: adult basic life support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 122: S685-705.
18. Laurent F, Segal N, Augustin P (2010) Chest compression: not as effective on dental chair as on the floor. Resuscitation 81: 1729.
19. Van Tulder R, Roth D, Havel C, Eisenburger P, Heidinger B, et al. (2014) "Push as hard as you can" instruction for telephone cardiopulmonary resuscitation: A randomized simulation study. J Emerg Med 46: 363-370.
20. Mirza M, Brown TB, Saini D, Pepper TL, Nandigam HK, et al. (2008) Instructions to "push as hard as you can" improve average chest compression depth in dispatcher-assisted cardiopulmonary resuscitation. Resuscitation 79: 97-102.