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Effects of Standard and Half-Kneeling Cardiopulmonary Resuscitation

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Abstract

Background/Objectives*: The purpose of this paper is to suggest a position that complies with recent basic CPR guidelines emphasizing chest compression through comparison between standard cardiopulmonary resuscitation (CPR) and half-kneeling CPR.*

Methods/Statistical analysis*: Sixteen participants performed 30:2 conventional CPR and compression-only CPR in standard, kneeling on both side positions, and 30:2 conventional CPR and compression-only CPR in half-kneeling position, respectively four times each. 30:2 conventional CPR was performed 10 cycles and compression-only CPR was performed with 300 chest compressions. A short print out from the mannequin of four types of CPR were compared with one-way ANOVA. Independent sample t-test and two-way ANOVA was performed.*

Findings*: There was no statistically significant difference between standard CPR and half-kneeling CPR. However, incorrect pressure point and incomplete recoil were found in half-kneeling compression-only CPR. Half-kneeling compression-only CPR of the heavy group and small group showed incorrect pressure point and incomplete recoil.*

Improvements/Applications*: In half-kneeling compression-only CPR, there were incorrect pressure points and incomplete recoil when weights were heavier or smaller. In half-kneeling CPR training, chest pressure point and recoil must be mastered further.*

Keywords: *Basic CPR guidelines, Position, Compression-only, Kneeling on both sides, Cardiopulmonary resuscitation.*

1. INTRODUCTION

Recent changes in the American Heart Association Guidelines Update for Layperson Cardiopulmonary Resuscitation (CPR) show that chest compression quality is increased and simplifying the procedure centered on chest compression. As a result, it focuses on enhancing and activating the effect of pre-hospital basic CPR.

Carotid artery palpation by the public was omitted, and cardiac arrest was confirmed with no response and apnea. So chest compression should be performed immediately by observing respiration in agony frequently seen in adult cardiac arrest as apnea. The order was also changed from airway, breathing, circulation (ABC) to circulation, airway, breathing (CAB) with chest compression first. This is because adults have more cardiac arrest due to heart failure than death due to respiratory failure, so it is needed to send blood oxygen to the brain more quickly. It suggests chest compression with minimal downtime, and with artificial ventilation by mouth if trained or proficient. Chest compression is deep and accelerated and it emphasizes allowance of complete recoil between compressions after chest compression, avoiding leaning on patients[1].

However, if you perform enhanced chest compression (push hard and fast) with least two inches, no more than 6 cm, at speed of 100 to 120/minute, you will tire faster than the previous guided chest compression method and the possibility of leaning on patients increases. In previous studies, the heavier the body weight, the greater the height, and the higher BMI male was accurate at compression depth but incorrect at recoil[2]. Other studies reported that the hands-off technique of separating the compression point and the palm of the hand shows better recoil result than the standard method of maintaining contact. However, chest compression frequency was reduced due to separation[3]. In standard CPR position, which is kneeling on both sides position, sufficient recoil may be difficult due to limitation of center movement during chest compression. Compression-only CPR, which may be more tiring than conventional CPR, appears to incur incomplete recoil frequently. However, it is expected that incomplete recoil can be reduced in the half-kneeling CPR position where the center is easily moved by supporting the floor with one foot. In this study, we propose a position consistent basic CPR with enhanced chest compression by comparing standard cardiopulmonary resuscitation with half-kneeling CPR.

2. Materials And Methods

It CPR performance data scores were recorded by performance of 16 paramedic students who signed an informed consent with Resusci Anne SkillReporter™; Laerdal Medical, Stavanger, Norway. Students were free to think fully and agree to participate in this study (Figure 1). Students could withdraw their consent any time after the informed consent, during the investigation, or after the survey, and there would be no disadvantage assessed. Researchers described 30:2 conventional CPR and compression-only CPR of standard, kneeling on both sides and 30:2 conventional CPR and compression-only CPR of half-kneeling position to participants with reference to the 2015 American Heart Association Guidelines Update for Layperson Cardiopulmonary Resuscitation, but did not disclose the purpose of this study[4].

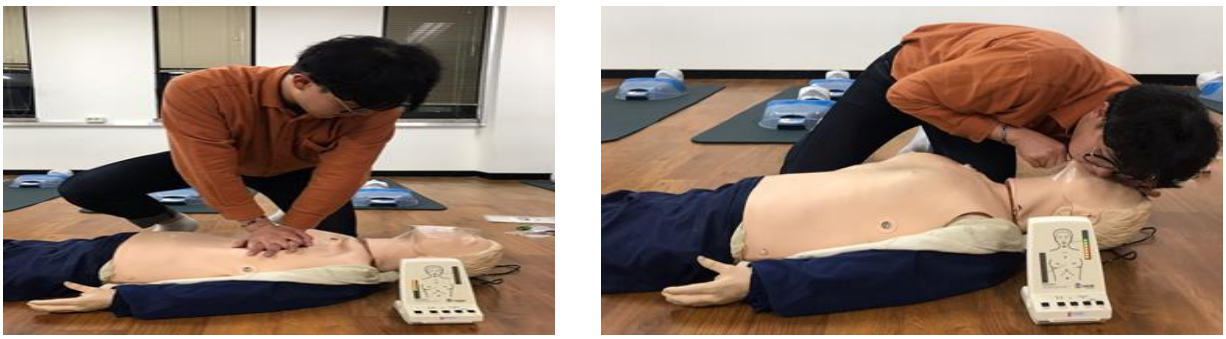

Figure 1. Standard and half-kneeling cardiopulmonary resuscitation position

To control the order effect that four CPR procedures could act as exercise or fatigue, participants were divided into four groups of four, with equal gender and grade, and the order of CPR was designed differently. Counterbalancing was applied so that the order effect appeared uniformly in CPR scores of all participants. Because students were familiar with the standard CPR method, they participated in this study after mastering the half-kneeling CPR at the same level as standard, kneeling on both sided CPR[5-6].

Because pre-arrival basic CPR is needed during four minutes of call receipt to arrival at the patient's side, in conventional CPR, 30 chest compressions and two mouth-to-face shield ventilation 10 cycles were performed and in compression-only CPR, 300 chest compressions were performed on the lab floor. Sixteen participants performed 30:2 conventional CPR and compression-only CPR in standard, kneeling on both sides, 30:2 conventional CPR and compression-only CPR in half-kneeling position four times, respectively. We obtained more 256 short print outs from the mannequin, 64 short print outs from the mannequin for each (Table 1).

Table 1. Comparison of half-kneeling and standard CPR

16 Participants * 4 times			
Standard		Half-kneeling	
Conventional	Compressions-only	Conventional	Compressions-only
10 cycles	300 compressions	10	300
64 printed out data	64	64	64
One-Way ANOVA, Two-Way ANOVA, *t*-test			

Collected data were determined as probability of a Type I error α=.05 (two-sided test) using the SPSS 18.0 for Windows (IBM Inc, New York, USA). When characteristics of CPR results output such as compression depth, chest compression rate, incorrect pressure point, incomplete recoil, compression correctness, ventilation volume, and ventilation correctness was discrete variable, it was arranged as frequency (%). When it was continuous variable, it was arranged as mean and standard deviation. One-way ANOVA and paired difference test were performed to compare results of standard cardiopulmonary resuscitation and half-kneeling CPR. Two-way ANOVA was performed to compare results of standard cardiopulmonary resuscitation and half-kneeling CPR according to body weight and height. Sixteen participants were divided into heavy group and light group according to weight. Participants were divided into tall group and small group according to height and they were analyzed.

3. RESULTS AND DISCUSSION

Table Participants totaled 16, eight males and eight females who were university freshman, sophomore, and junior students in the emergency medical service department. The average age was 21.1 years, average weight was 63.4 kg, average weight of the light group was 52.8 kg, and average weight of heavy group was 74.1 kg. Average height was 169.2 cm, and average height of the small group was 162.4 cm and average height of the tall group was 176.0 cm (Table 2).

Table 2. Participants' characteristics

Participants*(N=16)	
Age(year)	21.1(1.46)
Body weight(kg)	63.4(12.47)
Light	52.8(3.96)
Heavy	74.1(7.51)
Height(cm)	169.2(8.28)
Short	162.4(4.07)
Tall	176.0(4.93)
Gender	
Male	8
Female	8
Grade	
1st	5
2nd	5
3rd	6

Data are presented as mean(S.D.) or person

*Students enrolled in Department of Emergency Medical Services

**divided into two groups by body weight & height

One-way ANOVA was performed to analyze 30:2 conventional CPR and compression-only CPR of standard, kneeling on both sides, and 30:2 conventional CPR and compression-only CPR of half-kneeling position based on adult cardiopulmonary resuscitation mannequin-assessed skill data. As a result, there was no statistically significant difference. Compression depths were not significantly different, and compression-only CPR of the half-kneeling position was the fastest (123.7 per minute) in chest compression speed. Incorrect pressure point is equal to 8.4 on 30:2 conventional CPR and compression-only CPR of standard, kneeling on both sides. Incorrect pressure point was as low as 5.1 at 30:2 conventional CPR of half-kneeling position. However, the highest was 14.7 for compression-only CPR of half-kneeling position. Incomplete recoil was the smallest at 1.3 for compression-only CPR of standard, kneeling on both sides, but 8.2 for compression-only CPR of the half-kneeling position. Compression correctness was 88.1% at 30:2 conventional CPR of standard, kneeling on both sides, 87.9% at 30:2 conventional CPR of half-kneeling position, and 84.3% at compression-only CPR (Table 3). As a result of the paired difference test of the ventilation volume, both positions were within guideline range and ventilation correctness was slightly higher for the half-kneeling position at 59.7%. Therefore, the half-kneeling compression-only CPR showed incorrect pressure points and incomplete recoil.

Table 3. General comparison of mannequin-assessed skill

Manikin assessed scores*	Standard		Half-kneeling		*F* *T*	*P*
	Conventional	Compressions-only	Conventional	Compressions-only		
Compression depth(50-60mm)	55.4(3.49)	54.4(3.82)	55.0(3.81)	54.2(3.56)	1.62	.186

Compression rate(100-120/min)	120.0(8.11)	121.2(9.00)	121.4(9.16)	123.7(7.61)	2.12	.100
Incorrect pressure point(#)	8.4(23.73)	8.4(31.75)	5.1(8.76)	14.7(48.09)	1.26 1.05	.291** .374**
Incomplete recoil(#)	4.1(19.15)	1.3(5.94)	2.1(7.43)	8.2(34.55)	1.22 1.50	.304** .219**
Compression correctness(%)	88.1(16.93)	84.3(21.58)	87.9(17.41)	84.3(22.53)	0.74 0.74	.531** .529**
Ventilation volume(500-600mL)	543.0(81.00)	-	540.2(75.89)	-	0.23	.822
Ventilation correctness(%)	54.8(33.93)	-	59.7(33.07)	-	-1.01	.318

*by Resusci Anne SkillReporter™

Data are presented as mean(S.D.)

*by Resusci Anne SkillReporter™

**Welch and Brown-Forsythe by heterogeneity of variances

Two-way ANOVA was performed on 30:2 conventional CPR, compression-only CPR of standard, kneeling on both sides and half-kneeling position. Compression depth was deeper than 4-5 cm in the heavy group and chest compression per minute was faster in the light group of 30:2 conventional CPR and in the heavy group of compression-only CPR. Incorrect pressure point was the highest (17.9) at compression-only CPR of the half-kneeling position in the heavy group and the 11.5 in the light group of the same position. However, at 30:2 conventional CPR of the half-kneeling position, the light group was 6.3 at the lowest, and the heavy group was 3.9. Incomplete recoil was less than 1 in the light group, but the heavy group was more than 2.5-16.2. In compression correctness, the light group was as low as 74.5-81.6%, however the heavy group was as high as 89.4-96.8%. Ventilation volume was within range of the guideline in both groups and ventilation correctness was high in the heavy group. In summary, the half-kneeling compression-only CPR of the heavy group resulted in incorrect pressure points and incomplete recoil.

Table 4. Comparison of mannequin-assessed skill by body weight

Manikin assessed scores*	Body weight**	Standard		Half-kneeling		*F*	*P*
		Conventional	Compressions-only	Conventional	Compressions-only		
Compression depth(50-60mm)	Light	52.9(3.02)	51.9(3.27)	52.2(3.36)	52.2(3.52)	1.03	.378
	Heavy	58.0(1.44)	56.8(2.56)	57.8(1.25)	56.2(2.22)		
Compression rate(100-120/min)	Light	121.1(8.88)	119.3(7.85)	122.9(9.53)	122.8(6.65)	2.24	.084
	Heavy	118.9(7.25)	123.0(9.80)	119.9(8.67)	124.6(8.47)		
Incorrect pressure point(#)	Light	8.0(20.47)	7.6(23.83)	6.3(8.77)	11.5(34.01)	0.21	.892
	Heavy	8.8(26.92)	9.2(38.47)	3.9(8.72)	17.9(59.34)		

Incomplete recoil(#)	Light	0.1(0.39)	0.1(0.27)	0.9(3.71)	0.3(0.86)	1.64	.182
	Heavy	8.1(26.68)	2.5(8.29)	3.3(9.78)	16.2(47.92)		
Compression correctness(%)	Light	81.6(17.02)	74.5(23.35)	78.9(20.7)	79.3(21.26)	0.91	.439
	Heavy	94.7(14.27)	94.1(14.23)	96.8(4.58)	89.4(22.96)		
Ventilation volume(500-600mL)	Light	513.1(81.54)	-	521.9(92.51)	-	0.75	.388
	Heavy	572.8(69.62)	-	558.4(52.62)	-		
Ventilation correctness(%)	Light	45.8(35.32)	-	51.9(34.08)	-	0.05	.831
	Heavy	63.8(30.41)	-	67.5(30.59)	-		

Data are presented as mean(S.D.)

*by Resusci Anne SkillReporter™

**divided into two groups by body weight

Two-way ANOVA was performed to analyze 30:2 conventional CPR, compression-only CPR of standard, kneeling on both sides and 30:2 conventional CPR, compression-only CPR of half-kneeling position according to height. Incorrect pressure point was greater at 7.0-23.1 in the small group than in tall group, and compression-only CPR of the half-kneeling position was the greatest. In incomplete recoil, the small group was 2.2-16.3 and higher than the tall group, and compression-only CPR of half-kneeling position was the greatest. Compression correctness was also lower in the small group, 72.8-78.4% than in the tall group, 95.2-98.5%.

Table 5. Comparison of mannequin-assessed skill by height

Manikin assessed scores*	Body weight**	Standard		Half-kneeling		*F*	*P*
		Conventional	Compressions-only	Conventional	Compressions-only		
Compression depth(50-60mm)	Light	52.9(3.02)	51.9(3.27)	52.2(3.36)	52.2(3.52)	1.03	.378
	Heavy	58.0(1.44)	56.8(2.56)	57.8(1.25)	56.2(2.22)		
Compression rate(100-120/min)	Light	121.1(8.88)	119.3(7.85)	122.9(9.53)	122.8(6.65)	2.24	.084
	Heavy	118.9(7.25)	123.0(9.80)	119.9(8.67)	124.6(8.47)		
Incorrect pressure point(#)	Light	8.0(20.47)	7.6(23.83)	6.3(8.77)	11.5(34.01)	0.21	.892
	Heavy	8.8(26.92)	9.2(38.47)	3.9(8.72)	17.9(59.34)		
Incomplete recoil(#)	Light	0.1(0.39)	0.1(0.27)	0.9(3.71)	0.3(0.86)	1.64	.182
	Heavy	8.1(26.68)	2.5(8.29)	3.3(9.78)	16.2(47.92)		
Compression correctness(%)	Light	81.6(17.02)	74.5(23.35)	78.9(20.7)	79.3(21.26)	0.91	.439
	Heavy	94.7(14.27)	94.1(14.23)	96.8(4.58)	89.4(22.96)		
Ventilation volume(500-600mL)	Light	513.1(81.54)	-	521.9(92.51)	-	0.75	.388
	Heavy	572.8(69.62)	-	558.4(52.62)	-		
Ventilation correctness(%)	Light	45.8(35.32)	-	51.9(34.08)	-	0.05	.831
	Heavy	63.8(30.41)	-	67.5(30.59)	-		

Data are presented as mean(S.D.)

*by Resusci Anne SkillReporter™

**divided into two groups by body weight

Standard CPR and half-kneeling CPR analysis showed that there was no statistically significant difference in cardiopulmonary resuscitation skill between the two methods. Thus, half-kneeling CPR can be performed according to the situation, such as over-the-head CPR proven through research[7-9]. However, there were incorrect pressure points and incomplete recoil in half-kneeling compression-only CPR. In half-kneeling CPR with easy center movement, it was expected that the problem of recoil could be reduced. The reason for improper recoil was that the patient was leaned on by heavy weight and central movement after pressing was limited due to the short height.

In this study, recoil was incorrect in the short height, unlike the previous study in which recoil in the tall height was inaccurate, is interpreted as the result of the difference of CPR position and duration[10]. In a previous study in which CPR was performed for one minute, results were obtained in the alert state. In this study, data were obtained in a tired state during four minutes of half-kneeling CPR. Considering the actual situation, it is necessary to increase duration of CPR for four minutes. Thus, if you are 74 kg or more, and 162 cm or less, you will have to master chest compression position and recoil in half-kneeling CPR training. It is possible to induce enough recoil by applying the hands-off technique which slightly decrease the pressure point and the entire palm while keeping the number of chest compressions[11].

Preceding studies and this study support regression equations between compression depth and body weight to provide necessary weight estimates. There is a study in elementary school students who stated that weight should be more than 50 kg to maintain a compression depth of 38 mm (AHA Guidelines 2005) for two minutes[12]. College students should weigh more than 70 kg to maintain compression depth of 50 mm (AHA Guidelines 2015) for two minutes[13]. As a result, weight is an essential factor in maintaining adequate compression depth, but there is a difference of 20 kg in weight.

4. CONCLUSION

In this study, the fact that the light group weighing 52.8 kg, which maintained compression depth of 50-60 mm (AHA Guidelines 2015) for four minutes, supports the possibility of error. There was no mention of the recoil problem, so we obtained the same results as the study which showed that heavy body weight caused incomplete recoil. In half-kneeling compression-only CPR, there were incorrect pressure points and incomplete recoil when weights were heavier or smaller. In half-kneeling CPR training, chest pressure point and recoil must be mastered further.

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