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Change in the Quality of the Chest Compression that is Practicable during Transport

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Abstract

Objectives: CPR during transportation has really important meaning for arrest patient. By that, authors of this paper consider many chest compression methods which can execute in ambulance during transportation. **Methods/Statistical Analysis:** This study was enforced from 15th of September 2015 to 19th of September 2015. Recruited subjects were executed randomly selected chest compression method without artificial respiration for 8 minutes as 2015 revised CPR guideline on practical manikin in private ambulance. To have same transportation condition, this research let only one driver to drive 4km distance from Namyeong elementary school in Busan Gangseo-gu with average 60~70km/hr for every subjects. **Findings:** Observed average number of appropriate chest compression during continuous chest compression during 8 minutes seemed to be increased by time past. Average execution ratio of appropriate chest compression depth was getting decreased from all three groups. Also there was no statistical significant difference among all timeslots except 4~6 minutes after initiating chest compression. For average execution ratio of Inappropriate relaxation of chest compression, chest compression with one hand seemed to have the most appropriate result among three groups and chest compression with knee shows the most inappropriate result among three groups. There was no significant difference among three groups for average execution of appropriate number of chest compression ($p>.05$). Also, there was no significant difference from each group for average execution of appropriate chest compression depth ($p>.05$). There was significant difference from 4 minutes to 6 minutes from three groups for average execution of inappropriate chest compression position ($p<.05$). there was significant difference among all time slots except period from start to 2 minutes ($p<.05$). **Improvements/Applications:** The results demonstrate that it is considerable to conduct the chest compression using the knee when transport takes time so that the quality of the pressure is very low.

Keywords: Arrest, Chest Compression, CPR (Cardio-Pulmonary Resuscitation), Knee Compression, Transportation

1. Introduction

Executing fast and high quality CPR (cardio-pulmonary resuscitation) is the most effective method than any other methods for patient with carcinoma before visiting hospital, thus CPR during transportation has really important meaning, as well as CPR at the site for carcinoma patients. Apparently, there are two methods to compression chest that can be executed by rescuer in ambulance. First one is one-hand CPR which executes chest compression with only one hand and another hand is holding installed facility in ambulance. Second method is two-hand CPR which execute chest compression with two hands by balancing with legs. However, both methods are difficult to have effective chest compression during transportation for carcinoma patients, because one-hand method has less pressure on chest since it is conducted by only one hand. Second-hand method cannot be conducted properly due to vibration of ambulance during transportation. By that, authors of this paper considers many chest compression methods which can execute in ambulance during transportation and made a hypothesis that chest compression method with using knees are effective on retaining compression depth as a new chest compression method which retain depth of compression and minimize obstacles such as vibration during transportation. Also, this paper figured out difference of conducting chest compression method

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with knee by dividing group with above CPR method and other CPR method.

For high quality CPR, it is recommended that rescuers change their position to compression patients test by every 2 minutes in recent announced CPR guideline[1]. However, transportation time that moves from the site to hospital averagely takes about 9 minutes and usually CPR conducted with skill of 1-person rescuer. Also, there are realistic issues such as number of rescuers[2], lack of Automated External compression machine and issue of using the machine[3-5]. Traffic situation which has to face during transportation is an obstacle towards effective CPR. It can be confirmed that the quality of CPR in ambulance during transportation is relatively lower than CPR at the site from researches which compared both situations[6]. As a result, it is really difficult to execute appropriate CPR during transportation due to vibration of ambulance, traffic and accumulated fatigue from width and gradient of road[6]. Especially, Shin and others claimed that retaining depth of CPR compression during transportation was not reached to standard of compression depth from AHA guide line since chest compression with all variable shows less than 5 cm from researches which studied CPR method in ambulance by targeting 890 rescuers who work in fire station in Gyeonggi province[7]. Also, for high recovery, it is studied that the unassisted (manual) CPR methods; the existing devices for CPR are discussed, their advantages and disadvantages are described[8]. And other studied that investigate the effects of rescuers' using a smartphone-band on the quality of chest compression[9].

2. Proposed Work

This study is a comparative experimental research that finds an effective pressing pose by comparing and analyses result of chest compression from pressing pose during transportation with manikin. Subjects of this study are 36 second year university students who were studying emergency rescue as same educational curriculum with firefighting and clinical practice in Busan D University to minimize technical difference among rescuers. All subjects were intended to join this experiment after enough explanation and understand. If they were not agreed to join the experiment and cannot execute chest compression shown in figure 1 due to their health condition, they were excluded as subjects. Also, they were able to stop the experiment anytime they want with personal reason or their will.

To minimize technical difference of chest compression, 36 research subjects were divided into 3 groups such as chest compression with one hand, chest compression with two hands and chest compression with knee by randomly assigned by using table of random numbers which has same probability to pick each 0 to 9.

Figure 1. The chest compression method using the knee.

During experiment, no feedback was provided to research subjects and skill reporting was executed for every 2 minutes to check changed values. Due to revised CPR guideline in 2015, effective chess compression was defined as number of chest compression was at least 100 times, depth of chest compression is minimum of 50mm (2 inches) and relaxation height of pressed chest which is on 20mm above of centre chest nipple line[1]. This study was enforced from 15th of September 2015 to 19th of September 2015. Recruited subjects were executed randomly selected chest compression method without artificial respiration for 8 minutes as 2015 revised CPR guideline on practical manikin (Resusci Anne simulator®, Laerdal® PC skill reporting system, Laerdal Medical, Stavanger, Norway) in private ambulance (Grand starex, Hyundai). To have same transportation condition, this research let only one driver to drive 4km distance from Namyeong elementary school in Busan Gangseo-gu with average 60~70km/hr for every subjects. 8 minutes chest compression experiment data of research subjects was combined by PC Skill Reporting System (Laerdal, Stavanger, Norway) which was installed in laptop. SPSS for Window 21.0 program (SPSS INC., Chicago, IL, USA) was used for data analysis. Statistical difference of each group was analyzed through one-way ANOVA and difference of change in each time slots are analysed by using one-way repeated ANOVA. Each statistical method has statistical significance for significance validation when p value is less than 0.05. If there is significant difference, Scheffe post-hoc test was executed.

3. Conclusion

As shown in Table 1, there were 19 males (52.77%) and 17 females (47.22%) out of 36 research subjects. Chest compression groups which was divided by the table of random number consisted of 11 people of chest compression with one hand (30.55%), 12 people of chest compression with two hands (33.33%) and 13 people of chest compression with knee (36.11%).

As shown in Table 2 and Figure 2, Observed average number of appropriate chest compression during continuous chest compression during 8 minutes seemed to be increased by time past. Chest compression with knee couldn't exceed average 100 times for every time slot. There was no statistical significance of three groups.

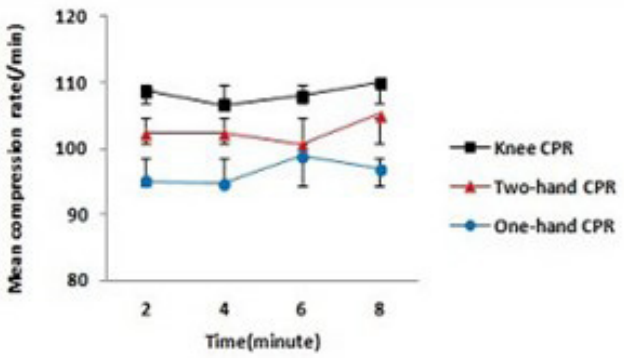

Figure 2. Time-serial estimated marginal means plots of mean chest compression rate results.

Table 1. Demographic characteristics of subjects

Variables		One-hand CPR (N=11)	Two-hand CPR (N=12)	Knee CPR (N=13)	p
Gender	male, N(%)	6 (54.6)	6 (50.0)	7 (53.9)	ns*
	Female, N(%)	5 (45.4)	6 (50.0)	6 (46.1)	ns*
Height (cm)		163.2 ±8.1	163.1 ±6.9	168.0 ±8.4	ns*
Weight (kg)		61.8 ± 6.4	56.1 ± 6.6	60.2 ±16.3	ns*

Table 2. Change in the quality of three chest compression methods among the second grader

Variables	Time (minute)	One hand CPR (N=11)	Two hand CPR (N=12)	Knee CPR (N=13)	F	p
Compression rate (/min)	0.0~2.0	108.64 ±16.99	102.42 ± 14.04	95.08 ± 23.39	1.33	.278
	2.1~4.0	106.64 ± 20.73	102.42 ± 16.05	94.69 ± 27.56	.69	.505
	4.1~6.0	108.00 ± 23.16	100.75 ± 18.85	99.00 ± 28.02	.07	.929
	6.1~8.0	110.00 ± 27.44	105.25 ± 13.63	96.69 ± 39.59	.06	.934
Compression depth (mm)	0.0~2.0	46.73 ± 10.47	50.75 ± 6.59	50.69 ± 6.00	1.00	.378
	2.1~4.0	43.45 ± 11.04	45.58 ± 8.03	48.23 ± 7.13	.89	.419
	4.1~6.0	42.36 ± 11.42	44.92 ± 7.34	49.23 ± 7.93	1.81	.179
	6.1~8.0	40.91 ± 14.01	43.83 ± 9.22	49.77 ± 8.73	2.14	.133
Proportion of incomplete compression position (%)	0.0~2.0	15.27 ± 38.82	15.50 ± 40.03	34.85 ± 39.53	1.00	.376
	2.1~4.0	28.00 ± 63.35	13.25 ± 19.16	49.85 ± 48.99	1.92	.163
	4.1~6.0	6.45 ± 20.75	13.25 ± 25.96	46.54 ± 54.80	3.92	.030*
	6.1~8.0	6.00 ± 13.79	28.00 ± 66.45	47.00 ± 41.74	2.31	.115
Proportion of incomplete recoil (%)	0.0~2.0	0.27 ± 0.64	0.58 ± 0.79	38.23 ± 72.84	3.16	.055
	2.1~4.0	0.73 ± 1.42	0.33 ± 0.65	30.77 ± 45.51	5.04	.012*
	4.1~6.0	0.18 ± 0.40	0.33 ± 0.65	41.46 ± 54.47	6.53	.004*
	6.1~8.0	0.27 ± 0.90	0.75 ± 1.05	71.69 ± 79.64	9.11	.001*

As shown in Table 2 and Figure 3, Average execution ratio of appropriate chest compression depth was getting decreased from all three groups. Chest compression with one hand seemed to have the most appropriate chest compression position, but chest compression with knee has the most inappropriate result among three groups.

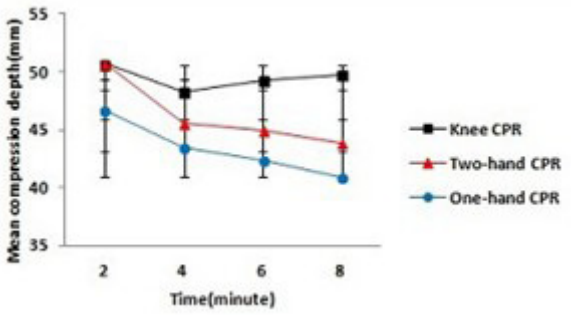

Figure 3. Time-serial estimated marginal means plots of mean chest compression depth results.

As shown in Table 2 and Figure 4, also there was no statistical significant difference among all time slots except 4~6 minutes after initiating chest compression. After validation, it was possible to find out that there was significant difference from the experiments from 4~ 6 minutes.

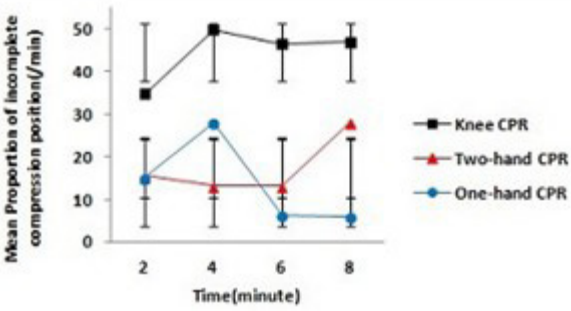

Figure 4. Time-serial estimated marginal means plots of mean chest compression incomplete position results.

As shown in Table 2 and Figure 5, for average execution ratio of Inappropriate relaxation of chest compression, chest compression with one hand seemed to have the most appropriate result among three groups and chest compression with knee shows the most inappropriate result among three groups. Also, it was possible to find out statistical difference in all timeslots except period between beginning and 2 minute.

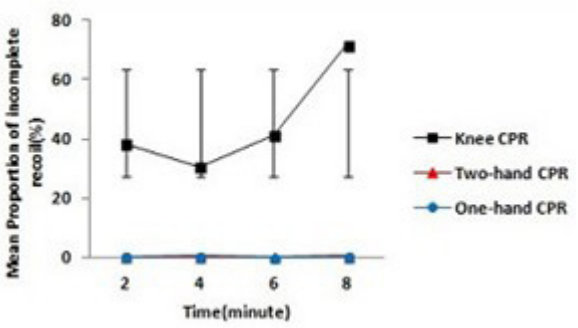

Figure 5. Time-serial estimated marginal means plots of mean chest compression incomplete recoil results.

After validation, there was significant difference in all experiment time apart from period between start of the experiment until 2 minutes. Variance analysis results of repeatedly measured three groups followed by execution of continuous 8 minute chest compression are listed below. There was no significant difference among three groups for average execution of appropriate number of chest compression ($p>.05$). Also, there was no significant difference from each group for average execution of appropriate chest compression depth ($p>.05$). There was significant difference from 4 minutes to 6 minutes from three groups for average execution of inappropriate chest compression position ($p<.05$). There was significant difference among all time slots except period from start to 2 minutes ($p<.05$). After validation, there was no significant difference in average execution of appropriate number of chest compression and appropriate chest compression depth among three groups ($p>.05$). There was significant difference from 4 minutes to 6 minutes among 3 groups for average execution of inappropriate chest compression position. Also, there was significant difference in all time slots except period from start to 2 minutes for average execution of inappropriate chest compression relaxation ($p<.05$).

This research is meaningful of first reporting that chest compression with knee shows negative result on all time slots for inappropriate chest relaxation except period between 0 and 2 minutes, as well as inappropriate chest compression position during 4~6 minutes even it doesn't show not much impact on depth and numbers of chest compression out of chest compression result which occurs during transportation through comparison between chest compression with one hand, chest compression with two hands and chest compression with

knee for 8 minute continuously on manikin. There was no statistical significance on result of average executed chest compression number for a minute from all three chest compression method which conducted by subjects, because it is believed that subjects have more experience on chest compression with one hand and two hands for more than 100 times chess compression in a minute with CPR practice on actual carcinoma patients during firefighting and clinical field. Therefore, they seemed to retain chest compression speed for the method of using knee. Through above, it is necessary to have continuous training on 100 times/min speed which is recommended by AHA guideline. The depth of chest compression was getting decreased by time past for all three group. It is same as the research result which was announced before. In [10]claimed that accuracy meaningfully decreases after 1 minute from chest compression in their research which is accuracy study by time consumption of cardiac massage[10]. In [11]argued that accuracy of chest compression start to decrease by time past in their research that impact of compression to ventilation ratio of 30:2 and 15:2 on fatigue and quality of CPR of 1-person rescuer[11]. In [12]recommended replacing chest compression rescuer by every 2 minutes for above preceded research in their research that quality change of chest compression by time flow of normal people's CPR[12]. They even recommended replacing rescuer earlier than 2 minutes if there are many number of rescuers. All of them can be confirmed from this research that depth of chest compression decreases by time. Especially, result from chest compression with one hand seemed to inappropriate from all three groups. It is possible to figure out the reason of above from research of Shin and others that more than 85% of 119 emergency crews use chest compression with two hands even they are getting injured since they know chest compression with two hands is more effective than chest compression with one hand on their research. However, it is still necessary to continue research on diverse methods of effective CPR in transporting ambulance since rescuers injury could be serious due to moving vehicles. Also, chest compression with depth was the most appropriate among three groups for depth of chest compression. The result shows that chest compression with knee keeps the most near to minimum depth 50 mm (2 inches) which is recommend by AHA guideline for total 8 minutes. From result of chest compression position, chest compression with one hand seemed to the most appropriate among three groups. This seemed to the most appropriate method to balance in moving ambulance by holding an object and conduct chest compression. This brings possibility of chest compression on appropriate position. On the other hand, chest compression with two hands shows the inappropriate result from all three groups due to change of chest compression position by movement of vehicle. Also, there were safety problems such as tilting phenomenon which rescuers tilted forward. The chest compression with knee show the most inappropriate result among three groups, because it is hard to keep chest compression position since pressure point itself was anatomically much larger than hands. Therefore, it must be hard to set accurate position again. From the result of chest relaxation after the chest compression, chest compression with one hand seemed to have the most appropriate result among three groups. Since the depth by chest compression with one hand is relatively lower than other methods, it is corresponding to the result. Chest compression with two hands seemed to have relatively inappropriate result compare with chest compression with one hand, but it was pretty fine since it did not exceed more than 1 cm. However, chest compression with one hand seemed to have the most inappropriate result, because some rescuers hit their head on the sealing of ambulance due to not enough height during conducting chest compression with knee pose. There were difficulties to conduct complete execution. Also, subjects were not familiar with chest compression with knee since the method is pretty new and not trained much. The limitations of this research is that it only researched university students who have major in emergency rescue, so it is hard to represent entire medical workers. It is not reflecting anatomical characteristics of chest which actual people have since strength requirements due to body type of patients by using manikin. Also, basic health of research subjects was not considered.

From comparison research that is to find out effective chest compression pose and figure out chest compression accuracy by poses such as chest compression with one hand, chest compression with two hands and chest compression with knee by using manikin, number of chest compression was increased by time past from three groups, but chest compression with knee couldn't exceed average 100 times per minutes. For the depth of chest compression, all three groups conducted lSess depth chest compression by time past, but chest compression

with knee seemed to retain depth of chest compression during entire experiment period. Also, chest compression with one hand showed the most appropriate result for inappropriate chest compression position and chest relaxation, but chest compression with knee showed the most inappropriate result.

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