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Estimation of optimal pediatric chest compression depth by using computed tomography

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Objective This study aimed to compare the optimal chest compression depth for infants and children with that of adults when the simulated compression depth was delivered according to the current guidelines.

Methods A total of 467 consecutive chest computed tomography scans (93 infants, 110 children, and 264 adults) were reviewed. The anteroposterior diameter and compressible diameter (CD) for infants and children were measured at the inter-nipple level and at the mid-lower half of the spine for adults. Compression ratio (CR) to CD was calculated at simulated 1/4, 1/3, and 1/2 antero-posterior compressions in infants and children, and simulated 5- and 6-cm compressions in adults.

Results In adults, the CRs to CD at simulated 5- and 6-cm compression depth were 41.7±0.16%, 50.0±7.3% respectively. In children and infants, the CRs to CD at 1/3 chest compression were 55.1±2.4% and 51.8±2.4%, respectively, and at 1/2 chest compression, CRs were 82.7±3.7% and 77.7±3.6%, respectively. The CRs to CD of 4-cm compression depth in infants and 5-cm compression depth in children were 74.4±10.9%, 62.5±8.7%, respectively. The CRs to CD for children and infants were significantly higher than in adults ($P<0.001$). The CR to CD of 4-cm compression depth in children was almost similar to that of 6-cm compression depth in adults (50.0± 6.9% vs. 50.0±7.3%, $P=0.985$).

Conclusion Current pediatric guidelines for compression depth are too deep compared to those in adults. We suggest using 1/3 of the anteroposterior chest diameter or about 4 cm in children and less than 4 cm in infants.

Keywords Chest compression; Pediatrics; Computed tomography

Capsule Summary

What is already known

Excessive chest compression may cause serious mechanical complications.

What is new in the current study

Current cardiopulmonary resuscitation guideline which recommend optimal depth in infants and children as over 1/3 depth of anteroposterior diameter seemed to be too deep comparing with the guideline of adults.

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INTRODUCTION

Closed-chest compression—a crucial factor during cardiopulmonary resuscitation (CPR)—is related to cardiac output and coronary perfusion pressure, and can directly affect a victim's survival. It has been well established in previous studies that proper chest compression is highly associated with high survival rates of cardiac arrest patients.[1-4] Too shallow compression depth can reduce cardiac output and coronary perfusion pressure, which can impede survival from sudden cardiac arrest. Since Kouwenhoven et al.[5] first introduced the closed-chest compression in 1960, the optimal rate and depth for chest compressions have been evaluated by numerous physicians. Based on evidence that deeper compression depths have shown better outcomes compared to shallower compression depths, the 2010 international CPR guidelines recommend that rescuers should perform chest compressions over 5 cm depth. Recently, Hellevuo et al.[6] reported that intra-organ injuries were more frequent among arrest patients by the rescuer group who performed too deep chest compressions compared to the rescuer group who performed less deep chest compressions. Excessively forceful chest compressions can cause various mechanical complications such as rib, sternal, or clavicular fractures; flail chest; lung damages to the pneumothorax, pneumomediastium, hemothorax; lung contusion; or abdominal injuries such as liver laceration or spleen injury.[7-12] In some cases, critical cardiovascular complications including coronary artery dissection ruptures, myocardial rupture, and aortic dissection were also reported.[13] Overall, cardiac injury from CPR is directly induced by too deep chest compressions; therefore, maintaining optimal compression depth during CPR is very important to prevent these deadly complications.

Some studies have investigated optimal compression depth to prevent serious complications from too deep compressions; however, there is a lack of evidence for optimal chest compression depth for infants and children CPR, therefore guidelines are not been well established for these populations.[14-16] Currently, most South Korean physicians perform CPR according to the American Heart Association (AHA) CPR guidelines and were trained in CPR in programs that were established from the AHA guidelines. The 2005 AHA guidelines recommend an optimal compression depth between 1/3 and 1/2 of the thoracic depth for infants and children.[17] The 2010 guidelines changed the optional depth guideline to over 1/3 of thorax depth for infants (approximately 4 cm) and children (approximately 5 cm).[18] Although the 2005 AHA guideline of 1/2 of thorax depth was dropped in the 2010 AHA guideline, this recent guideline still allows the 1/2 of thorax depth to be permeable compression depth because this guideline only mentioned the lower limit of optimal compression depth.

The purpose of this study was to evaluate the accuracy of the 2010 AHA guideline recommendation for correct compression depth for infants and children, and assess the optimal depth for infants and children by comparing the depth rate of adults and children with the computed tomography (CT) analysis.

METHODS

Study design

This retrospective study used radiographic data from 206 children aged 0 to 8 years who were tested by using chest CT between January 2010 and December 2013. Children with pectus excavatum, chest/lung hypoplasia (n = 3) were excluded resulting in a total of 203 children that were included in this study. In addition, 264 non-traumatic adult patients who were tested by using chest CT were enrolled in the study for the comparison.

The anteroposterior diameter (APD) of the thorax was measured by cross-section analysis of the chest CT. According to the 2010 AHA guidelines, APDs were measured below the spine across the nipple line in infants. For children, APDs were measured at the mid-lower portion of the spine.[18] In this study, the APD was measured by calculating the compressible diameter (CD; i.e., compressing diameter), defined as the distance from the skin to spine; and incompressible diameter (ICD; i.e., non-compressing diameter), defined as the distance from the spine to back separately (Fig. 1). Each 1/4, 1/3 and 1/2 of APD in the infant and children were measured from the CT first, and each compression ratio (CR)

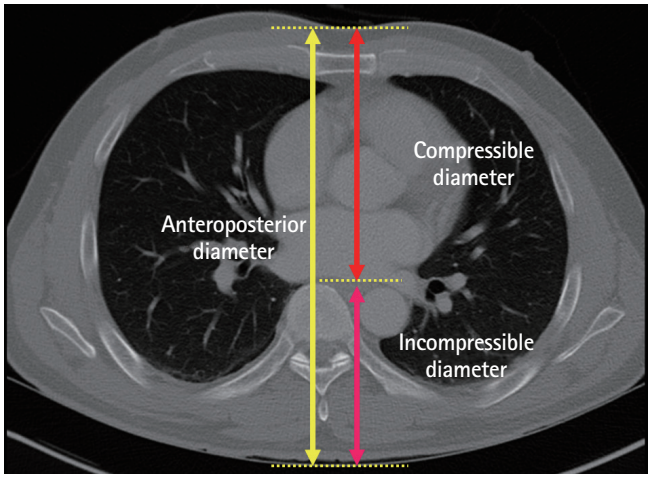

Fig. 1. Computed tomography scan demonstrating axial image at the mid sternal level and method for calculating compressible, incompressible diameter and antero-posterior diameter. We calculated the compressible diameter by measuring a line drawn perpendicularly from the skin anteriorly to the anterior vertebral body.

was calculated for the measured APD according to the 2010 AHA neonatal and children compression depth guideline, which is 4 and 5 cm, respectively. In adults, APD and CD were measured from the CT first, and then each CR was calculated according to the 2010 AHA adult compression depth guideline, which is 5 and 6 cm, respectively. CRs of adults were compared with those of infants and children. In addition, we analyzed the compression depth in infants and children, which were well matched with the CR of CD when adults compressed the chest with 5 to 6 cm depth. Compression depth values were sorted and found to be related to excessively decreased residual APD from the calculated residual CD.

Data analysis

Statistical analyses were performed using IBM SPSS Statistics ver. 21.0 (IBM Corp., Armonk, NY, USA). Normally distributed data were presented as mean and standard deviation, and the independent Student's t-tests was used to compare normally distributed data between the 2 groups, and one-way ANOVA was used among the 3 groups. An alpha level of 0.05 for this two-tailed test was considered statistically significant.

RESULTS

Baseline characteristics of subjects

Enrolled subjects (n=467) included 93 infants, 110 children, and 264 of adults. The mean age was approximately 4 months in the infants, 4.3 years in the children, and 41.5 years in the adults. The percentage of male subjects was 50.5%, 60.0%, and 58.7% in the infants, children, and adults, respectively (Table 1).

Table 1. General characteristics of the subjects

Group	No.	Male	Age (yr)
Infant (≤ 1 yr)	93	47 (50.5)	0.31 ± 0.34
Child (> 1 and ≤ 8 yr)	110	66 (60.0)	4.3 ± 2.1
Adult (≥ 18 yr)	264	155 (58.7)	41.5 ± 11.9

Values are presented as n (%) or mean ± standard deviation.

APD, CD, and CR in each study group

There was no significant difference in APD between the male and female infants (87.9 vs. 83.9 mm, P=0.243) (Table 2). There was no significant difference in CD between the male and female infants (56.4 ± 9.8 vs. 53.8 ± 8.0 mm, P=0.166). There was no significant difference in CR for APD between the male and female infants (64.4% vs. 64.5%, P=0.915). APD of children was larger in the male than in the female subjects (138.6 vs. 128.0 mm, P<0.001), and CD was larger in the male subjects (84.5 ± 11.1 vs. 77.1 ± 10.8 mm, P<0.001). However, there was no significant difference in CR for APD between the male and female children (61.0 ± 2.2% vs. 60.1 ± 2.6%, P=0.082). In adults, APD was significantly larger in the men than in women (212.2 vs. 199.1 mm, P<0.001) and CD was larger in the men (125.3 vs. 118.1 mm, P<0.001). However, there was no significant difference in CR for APD between the male and female adults (58.9% vs. 59.1%, P=0.527). There was a significant difference in APD and CD between both sexes in the children and adults, but there was no significant difference in CR for APD in all groups. Otherwise, there were significant differences in CR for APD among the infant, children, and adults. CR for APD was highest in the infant and lowest in the adults (P<0.001).

CR for 1/4, 1/3, 1/2 of APD in the infant and children

Table 3 shows the CD in each sex and age population under the assumption of chest compression with 1/4, 1/3, and 1/2 depth of APD in the infants an children. For compressions with 1/3 depth of APD in infants, its calculated depth was 29.3 mm in male and 28.0 mm in female infants. For compressions with 1/3 depth of

Table 2. APD and CD according to the subgroup

Group	Variable	Total[a]	Male	Female	P-value[b]
Infant	APD (mm)	85.9 ± 16.3	87.9 ± 17.0	83.9 ± 15.4	0.243
	CD (mm)	55.1 ± 9.0	56.4 ± 9.8	53.8 ± 8.0	0.166
	CD/APD (%)	64.4 ± 2.8	64.4 ± 2.4	64.5 ± 3.3	0.915
Child	APD (mm)	134.3 ± 16.8	138.6 ± 17.1	128.0 ± 14.3	< 0.001
	CD (mm)	81.5 ± 11.5	84.5 ± 11.1	77.1 ± 10.8	< 0.001
	CD/APD (%)	60.6 ± 2.6	61.0 ± 2.2	60.1 ± 2.6	0.082
Adult	APD (mm)	206.8 ± 22.5	212.2 ± 19.4	199.1 ± 24.3	< 0.001
	CD (mm)	122.3 ± 16.5	125.3 ± 14.8	118.1 ± 18.0	< 0.001
	CD/APD (%)	59.0 ± 2.9	58.9 ± 2.7	59.1 ± 3.1	0.527

Values are presented as mean ± standard deviation. CD/APD showed statistically significant difference between infant vs child, child vs adult, and infant vs adult (All P<0.001).

APD, anteroposterior diameter; CD, compressible diameter.

[a]Male and female. [b]Comparison between male and female using t-test.

Table 3. Compression diameter according to 1/4, 1/3, and 1/2 compression depth of APD in pediatric patients

Group	Compression depth (mm)	Total[a]	Male	Female	P-value[b]
Infant	1/4 of APD	21.5±4.1	22.0±4.3	21.0±3.9	0.243
	1/3 of APD	28.6±5.4	29.3±5.7	28.0±5.1	0.242
	1/2 of APD	43.0±8.1	43.9±8.5	41.9±7.7	0.243
Child	1/4 of APD	33.6±4.2	34.6±4.3	32.0±3.6	0.001
	1/3 of APD	44.8±5.6	46.2±5.7	42.7±4.7	0.001
	1/2 of APD	67.2±8.4	69.3±8.5	64.0±7.1	0.001

Values are presented as mean±standard deviation.
APD, anteroposterior diameter.
[a]Male and female. [b]Comparison between male and female using t-test.

Table 4. Compression ratios to the CDs according to 1/4, 1/3, and 1/2 compression depth of APD in pediatric patients

Group	Compression ratio (%)	Total[a]	Male	Female	P-value[b]
Infant	1/4 of APD to CD	38.9±1.8	38.9±1.5	38.9±2.1	0.978
	1/3 of APD to CD	51.8±2.4	51.8±2.0	51.8±2.7	0.991
	1/2 of APD to CD	77.7±3.6	77.7±2.9	77.7±4.1	0.994
Child	1/4 of APD to CD	41.3±1.8	41.1±1.5	41.7±2.2	0.067
	1/3 of APD to CD	55.1±2.4	54.8±2.0	55.6±2.9	0.067
	1/2 of APD to CD	82.7±3.7	82.1±3.0	83.4±4.4	0.068

Values are presented as mean±standard deviation.
CD, compressible diameter; APD, anteroposterior diameter.
[a]Male and female. [b]Comparison between male and female using t-test.

Table 5. Compression ratios to APD and CD of the several recommended compression depths according to groups

Group	Compression ratio (%)	Total[a]	Male	Female
Infant	4 cm to APD	48.1±8.0	47.1±8.2	49.1±7.6
	4 cm to CD	74.4±10.9	72.9±11.4	75.9±10.2
Child	5 cm to APD	37.8±4.5	36.6±4.4	39.5±4.1
	5 cm to CD	62.5±8.7	60.2±7.9	66.1±8.7
Adult	5 cm to APD	24.5±2.8	23.7±2.2	25.5±3.2
	5 cm to CD	41.7±6.1	40.5±4.9	43.4±7.1
	6 cm to APD	29.4±3.4	28.5±2.6	30.6±3.9
	6 cm to CD	50.0±7.3	48.6±5.9	52.1±8.5

Values are presented as mean±standard deviation.
APD, anteroposterior diameter; CD, compressible diameter.
[a]Male and female.

APD in the children, its calculated depth was 46.2 mm in male and 42.7 mm in female children. Table 4 shows the CRs in each calculated compression depth. In infants, the chest was compressed at 38.9% of CR in both sexes when compression depth was 1/4 of APD. When compression depth was 1/3 of APD, the chest was compressed at 51.8% of CR in both sexes. When compression depth was 1/2 of APD, the chest was compressed at 77.7% of CR in sexes.

In children, the chest was compressed at 41.3% of CR in both sexes when compression depth was 1/4 of APD. When compression depth was 1/3 of APD, the chest was compressed at 55.1% of CR in both sexes. When compression depth was 1/2 of APD, the chest was compressed at 82.7% of CR in both sexes.

Because CR for APD in children was smaller than that in infants (60.6% vs. 64.4%), higher CR was shown in the children.

CR for 4 cm of APD in the infant, 5 cm of APD in children, and 6 cm of APD in adults

When compression depth was 4 cm in the infant according to 2010 AHA guideline, the chest was compressed at 72.9% of CR in males and 75.9% of CR in females. When compression depth was 5 cm in children, the chest was compressed at 36.9% of APD in males and 39.5% of APD in females. CR was 60.2% of APD in males and 66.1% of APD in females (Table 5). Otherwise, when compression depth was 5 cm of the lowest limit for adults, the chest was compressed at 23.7% of APD in males and 25.5% of APD in females. CR was 40.5% of APD in adult males and 43.4% of APD in females. When compression depth was 6 cm of the highest limit for adults according to European Resuscitation Council guideline, the chest was compressed at 28.5% of APD in males and 30.6% of APD in females. CR was 48.6% of APD in adult males and 52.1% of APD in females. Therefore, CR was highest at 4 cm for infant, 5 cm for children, and 6 cm for adults and 5 cm of adults were followed.

Table 6. Comparison of the CRs between pediatrics and adult

Group	CR (%)	Mean±SD	Adult		P-value[a]
			CR of 6 cm to CD	CR of 5 cm to CD	
Infant	1/4 of APD to CD	38.9±1.8	-	41.7±6.1	<0.001
	1/3 of APD to CD	51.8±2.4	50.0±7.3	-	<0.001
	1/2 of APD to CD	77.7±3.6	50.0±7.3	-	<0.001
	4 cm to CD	74.4±10.9	50.0±7.3	-	<0.001
Child	1/4 of APD to CD	41.3±1.8	-	41.7±6.1	0.563
	1/3 of APD to CD	55.1±2.4	50.0±7.3	-	<0.001
	1/2 of APD to CD	82.7±3.7	50.0±7.3	-	<0.001
	5 cm to CD	62.5±8.7	50.0±7.3	-	<0.001
	4 cm to CD	50.0±6.9	50.0±7.3	-	0.985

CR, compression ratio; SD, standard deviation; CD, compressible diameter; APD, anteroposterior diameter.
[a]Comparison between infant or child and adult using t-test.

Comparisons of the CR among the infant, children, and adults (Table 6)

The CR of APD was compared with 1/4, 1/3, 1/2 depth of infants and children, 4 cm depth in infants, and 5 cm depth in children to that of 6 cm depth in adults. The CR of APD in 1/3 and 1/2 depth in infants and children was higher than that in 6 cm depth in adult ($P < 0.001$). The CR of APD in 4 cm depth in infants and 5 cm depth in children was higher than that in 6 cm depth in adults as well ($P < 0.001$). The CR in 1/2 depth in children is highest among all calculated CRs, and CR in 1/2 depth in infants, 4 cm depth in infants, 5 cm depth in children, 1/3 depth in children, 1/3 depth in infants, 6 cm depth in adults, and 5 cm depth in adults were followed in order. Otherwise there was no difference in CR of APD between the 5 cm depth and 1/4 depth in children (41.7% vs. 41.3%, $P = 0.563$).

Residual CD after compressions with 1/4, 1/3, 1/2, 4, and 5 cm of APD in the infants and children (Table 7)

When compression depth was 1/2 of APD in infant, residual CD was less than 1 cm in 10 (10.8%) patients, and others showed less 2 cm of residual CD. When compression depth was 1/3 and 1/4 of APD, all residual CDs were higher than 2 cm. However, when compression depth was 4 cm of APD in infants, residual CD was less than 1 cm in 35 (37.6%) patients. Too deep compressions may be delivered when a rescuer compresses the chest with 4 cm depth of APD according to the 2010 AHA guidelines in infants.

When the compression depth was 1/2 of APD in children, the residual CD was less than 1 cm in 19 (17.3%) patients, and 81 (73.6%) showed 1 to 2 cm of residual CD. When rescuers compressed the chest with 5 cm depth of APD in children according to the 2010 AHA guidelines, the residual CD was less than 1 cm in only 1 patient, but 19 showed 1 to 2 cm of residual CD.

Table 7. Residual compressible diameter according to compression depths

Group	Compression depth	Residual compressible diameter		
		Mean ± SD (mm)	< 1 cm, n (%)	1–2 cm, n (%)
Infant	1/4 of APD	33.6 ± 5.1	0	0
	1/3 of APD	26.4 ± 3.9	0	0
	1/2 of APD	12.1 ± 2.2	10 (10.8)	83 (89.2)
	4 cm	15.1 ± 9.0	35 (37.6)	31 (33.3)
Child	1/4 of APD	47.9 ± 7.6	0	0
	1/3 of APD	36.7 ± 6.4	0	0
	1/2 of APD	14.4 ± 4.2	19 (17.3)	81 (73.6)
	4 cm	41.5 ± 11.5	0	1 (0.9)
	5 cm	31.5 ± 11.5	1 (0.9)	19 (17.3)

APD, anteroposterior diameter; SD, standard deviation.

DISCUSSION

This study analyzed the real CDs and CRs in various recommendations for compression depth after dividing by compression possible diameter and compression impossible diameter using the chest CT. Some previous studies sought to determine the optimal chest compression depth. However, the study samples were too small and included mainly western populations, and did not consider the anatomical compression depth that could not be compressed.[15,16]

This study showed the approximate APD of chest and values of CRs in adults, children, and infants. There was no significant difference in the CR for total APD between males and females despite significant differences in APD and CRs between children and adults. This may be used as a guideline for comparing the corrected depth of chest compression between male and female subjects. There was a significant difference in the CR for APD among each population. The CR in children was similar to that in adults but smaller than that in infants; therefore, deeper chest compressions may be delivered in children than in infants if chest compressions are performed according to the guideline of constant CR for APD. Thoracic spine growth is faster in children compared to that in infants; therefore, CR for APD may be lower in children than in infants.

The 2010 AHA CPR guideline recommends that optimal chest compression depth should be over 5 cm, and 2010 European Resuscitation Council CPR guideline recommends that corrected compression depth is 5 to 6 cm.[19] According to the comparative results of the CR in children and infants with a CR of 6 cm depth of adults, CR of 1/2, 1/3, and 4 cm in infants and 1/2, 1/3, 5 cm in children were higher than that of adults with 6 cm compression depth. This demonstrated that deeper chest compressions were performed in infants and children than in adults. CR for CD was 74.4% in 4 cm compression depth in infants, and then this was similar with that of 1/2 depth in infants (77.7%) and higher than that of 6 cm depth in adults (50.0%). Approximately 1.5 times of compression depth in adults were delivered to the infants.

In comparison between adults and infants using the calculation of CR for CD, 1/3 depth of infant was matched well with 6 cm depth of adult. There was similar CR in both groups (51.8% vs. 50.0%), however statistically deeper compressions were delivered in 1/3 depth of infants than in adults with 6 cm depth.

In children, CR in 1/3 of depth was higher than in adults with 6 cm depth (55.1% vs. 50.0%). Relatively more forceful compressions were delivered in the children. In addition, CR in children with 5 cm depth was 62.5%. Approximately 1.2 times of compression depth in adults with 6 cm depth (62.5%) were delivered

in the children. If the 4 cm depth compared to the infant guideline was delivered in children, CR was matched well with that in 6 cm depth of adults (50.0%). The guideline of 4 cm depth in children seemed to be well correlated with the adult guidelines.

In this study, we defined that too deep compressions can cause mechanical injury as residual CD of lesser 2 cm after chest compressions, because the sum of the total thorax wall and total APD of heart was measured as 2 cm. Therefore, chest compressions, which can reduce residual CD by 2 cm may cause the cardiac contusions and possible impaired cardiac function after recovery of spontaneous circulations. This is because of the high possibility of direct collision between the anterior and posterior walls of the heart.

When the compression depth is 4 cm in infants, the mean residual CD was 15 mm and lesser than 2 cm of residual CD occurred in 71% among them. This means that chest compression with 4 cm depth in infants was too deep and may lead to a high risk of fatal internal organ damage. When the compression depth is 1/2 of APD in infants, lesser than 2 cm of residual CD occurred in most infants. Otherwise when compression depth is 5 cm in children, lesser than 2 cm of residual CD occurred in 20 (18.2%) of which, all were lesser than 2 years old, except in one child. This may be because some children have a body frame similar to that of infants. We could therefore consider that the infant guidelines may be more useful in children younger than 2 years. If the compression depth is 1/2 of APD in children, the residual CD was 2 cm less occurred in 99 (90.0%). This guideline may lead to a high risk of fatal internal organ damage in infants.

When the compression depth is 1/4 of APD in children and infants, CR for CD was lesser than that in adults with 6 cm depth, but similar to that in the adults with 5 cm depth (5 cm in adults vs. 1/4 of children vs. 1/4 of infants was 41.7% vs. 41.3% vs. 38.9%).

This result was well correlated with those of other previous studies, which demonstrated that 1/2 depth of APD seemed to be too deep.[15,16] The 2010 AHA guideline omitted guidance of 1/2 depth of APD in children and infants and recommended over 1/3 depth of APD as optimal compression depth guideline. However, there was a possibility that too deep compressions could be delivered by using the 1/3 depth guideline. In addition, the guideline of 4 cm depth in infants and 5 cm in children may cause internal organ injury.

According to the 2010 CPR guideline, the more forceful, faster, and over 1/3 depth, deeper chest compressions than 1/3 depth of APD may be delivered. Chest compressions with 1/2 depth of APD may be delivered in some small infants or children because there was scant difference between the 1/2 depth and 1/3 depth. Therefore, the current guideline of over 1/3 compression depth in children and infants may lead to too deep and forceful compression and fatal internal organ injury in some patients; this is because the guidelines did not consider variations in patients anatomy and the strength of the person providing compression. Some modification of guidelines for reliable compression depth in infant and children are needed in the future.

This study showed that 4 cm depth of children had similar CR with that in adult with 6 cm depth. We believed that the guideline of 4 cm depth in children seemed to be more suitable than previous guideline of 5 cm depth, and over 1/4 depth of APD may also be more suitable than 1/3 depth. Along with the case of children, too deep chest compressions were delivered according to the current 2010 guideline in infants. Guideline of 1/4 to 1/3 in infant seemed to be more suitable than the previous guideline of over 1/3 depth.

The study has limitations. First, this study was retrospectively performed in one university hospital. The sample size was small and study result may be limited to generalize the fact. Second, mainly patients were enrolled. Healthy subjects were not enrolled; relatively small sized subjects who were chronically or acutely ill were included. However, we excluded children with congenital chest anomalies and most children had mainly pneumonia or aortic disease, which may reduce the bias. Third, there was possible bias of measuring the diameter form variance of respirations. There was some difference in chest diameter between the inspiration and expiration. This difference may be small because of small tidal volume in infants and children. Fourth, the mean age of the infants was 4 months. Many small infants were included, the measured APD may be small.

The current 2010 CPR guideline, which recommends optimal depth in infants and children as over 1/3 depth of APD (4 cm in infants and 5 cm in children) seems to be too deep when compared to adult guidelines. Therefore, chest compressions under the 2010 guideline may cause fatal internal organ damage. Considering the adult guidelines, lesser than 1/3 depth of APD (4 cm) seemed to be more suitable in children and lesser than 1/3 depth of APD seemed to be more suitable in infants to avoid serious internal organ injury.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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