Estimation of Optimal Chest Compression Depth based on Chest Computed Tomography in Thai Patients.

Nalinas KHUNKHLAI¹ Pakkaphon AIEMPAIBOONPHAN² Rathachai KAEWLAI³ Pinporn JENJITRANANT³ Krisna DISSANEEVATE⁴ Pairoj KHRUEKANCHANA²
¹Thai Resuscitation Council ²Depeartment of Emergency Medicine and Narenthorn EMS Centre, Rajavithi Hospital, Bangkok, THAILAND ³Department of Diagnostic and Therapeutic Radiology, Ramathibody Hospital, Mahidol University, Bangkok THAILAND ⁴Department of Radiology, Rajavithi hospital, Bangkok, THAILAND

BACKGROUND

Many studies evaluated chest internal diameters using radiological assessment to estimate the better chest compression depth and position during cardiopulmonary resuscitation but the results varied among ethnic groups. This study aimed to identify the chest compression depth across BMI groups in Thai patients when simulated compression depth was delivered in 1/2, 1/3, 1/4 of external chest (AP) antero-posterior diameter (EAPD) and 5-6 cm depth according to the current guidelines.

METHODS

A total of 421 consecutive chest computed tomography scans (male 50.8%) were reviewed across BMI groups (BMI under 18.5, 18.5-24.99, 25-29.99, and over 30 kg/m²). The external anteroposterior diameter (EAPD) were measured from the skin anteriorly at mid-lower half of sternum to the skin on the posterior thorax and will be used as an external marker for simulated chest compression.

TABLE 1 : CHARACTERISTIC OF STUDY POPULATION					
	BMI ≤18.5 (n=108)	BMI 18.5 - 24.99 (n=107)	BMI 25 - 29.99 (n=106)	BMI ≥30 (n=100)	p
Age (years)	59±15	59±5	58±14	53±14	
Gender : male %	55	55	53	51	
Height (cm)	161.4 ± 8.8	160.9 ± 9.7	161.0 ± 8.8	160.6 ± 11.1	0.92
Bodyweight (kg)	42.7 ± 6.4	55.9 ± 8.6	70.2 ± 8.6	86.2 ± 13.9	<0.001
External Chest AP Diameter (mm)	185.7 ± 19.4	204.5 ± 18.0	223.5 ± 17.6	239.5 ± 2.9	<0.001
Internal Chest AP Diameter (mm)	94.3 ± 15.3	103.3 ± 15.4	109.3 ± 13.1	113.3 ± 13.4	<0.001
Myocardial thickness (mm)	9.3 ± 2.5	9.3 ± 2.4	10.2 ± 2.7	10.6 ± 2.5	<0.001

TABLE 2 : RESIDUAL CHEST DEPTH AT EACH COMPRESSION LEVEL ACROSS BMIs					
	BMI ≤18.5 (n=108)	BMI 18.5 - 24.99 (n=107)	BMI 25 - 29.99 (n=106)	BMI ≥30 (n=100)	p
Compression 5 cm.(mm)	44.33 ± 15.32	53.34 ± 5.41	59.29 ± 13.10	63.25 ± 13.43	<0.001
Compression 6 cm.(mm)	34.33 ± 15.32	43.34 ± 5.41	49.29 ± 13.10	53.25 ± 13.43	<0.001
Compression 1/4 of EAPD (mm)	47.92 ± 11.34	52.21 ± 11.94	53.40 ± 9.77	53.38 ± 10.16	<0.001
Compression 1/3 of EAPD (mm)	32.45 ± 10.18	35.17 ± 0.95	34.77 ± 8.86	33.49 ± 9.6	0.16

The internal diameter (ID) were calculated from internal chest wall to surface of the cardiac wall. The Residual chest depth was calculated by ID minus simulated compression depth and targeted less than 20 mm. The patients in conditions which may alter thoracic or cardiac anatomy (COPD, Cor pulmonale, ventricular hypertrophy) were excluded.

RESULTS

421 patients (male 50.8%, age 57±14 years) equally in each BMIs. Mean height in male (166.53±0.92cm) and female (155.22±0.57cm.) were recorded but there's no different across BMIs in the same gender. The more patients' weight, the larger EAPD were identified (r 0.78). By simulated chest compression at lower half sternum, the compression depth at 1/3 of EAPD provided the best residual chest depth in all BMI groups (32.45±10.18 vs 35.17±10.95 vs 34.77±8.86 vs 33.42±9.60 mm. for BMI <18.5 vs 18.5-24.99 vs 25-29.99 vs over 30 kg/m² respectively; p=0.16). The cardiac ventricle were best exposed at sternoxiphoid junction area but there's possible intra-abdominal organ injury identified. (Liver 34% of cases).

CONCLUSIONS

The chest compression at 1/3 of EAPD depth could be the optimal compression depth in Thai population. The further clinical study may need to identify the association with survival outcomes.

Remark : The compression site which best direct expose and possible compress to left ventricular chamber is at xiphoid level. However, there are high possible intra-abdominal organ injuries such as liver and spleen expose in the view, from 3.3% to 33.9%.

REFERENCE : Cha KC, Kim YJ, Shin HJ, Cha YS, Kim H, Lee KH et al. Optimal position for external chest compression during cardiopulmonary resuscitation: an analysis based on chest CT in patients resuscitated from cardiac arrest. *Emerg Med J.* 2013 Aug;30(8):615-9., Donnelly PM, Yang TS, Peat JK, Woolcock AJ. What factors explain racial differences in lung volumes?. *Eur Respir J.* 1991;4(7):829-38., Lee SH, Kim DH, Kang TS, Kang C, Jeong JH, Kim SC, Kim DS. The uniform chest compression depth of 50 mm or greater recommended by current guidelines is not appropriate for all adults. *Am J Emerg Med.* 2015 Aug;33(8):1037-41. , H Matsukubo, I Matsura, N Endo, J Asayama, T Watanabe. Echocardiographic measurement of right ventricular wall thickness. A new application of subxiphoid echocardiography. *Circulation.* 2015;131(24):e535.

Copyright © 2017 Nalinas KHUNKHLAI MD FTCEP:
nkhunkhlai@thaicpr.org
Pakkaphon AIEMPAIBOONPHAN