

Original research - Orijinal araştırma

Complications of cardiopulmonary resuscitation

Yeniden canlandırma komplikasyonları

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Abstract

Aim. In 1960, Kouwenhoven observed that forceful chest compressions can produce arterial pulses. At following years cardiopulmonary resuscitation (CPR) continually advanced. Right now experts at the International Guidelines 2000 Conference strongly recommended development of in-school CPR programs as a primary educational strategy to ensure wide-spread learning of CPR. Rib and sternum fractures are frequent complications of CPR in adults. Fractures frequently occur at ribs, number 3-8 and between parasternal and axillary line; can be seen at the both sides but tends to be seen at the left side of the thorax. Fractures of rib 1 and 8-12 were very rare. Because of pliability of the ribs and costal cartilages, chest wall fractures are rare in children. This study was conducted to determine the incidence and effects of the complications of CPR. **Method.** The forensic records of 26912 deaths referred to Council of Forensic Medicine for autopsy in 1993–2002 were reviewed. Cases were included for analysis where the forensic case notes indicated there had been attempts at CPR, and no historical or physical evidence that trauma was the cause of death. We studied of autopsy findings on 602 eligible deaths that died after an attempt at CPR and without any other trauma. **Results.** Sternal and/or rib fracture stated in 97 (%16.1) of 602 cases. 433 (%71.9) of the 602 cases were male, and 169 (%28.1) female. Sixty-nine percent of the rib fractures were at the left side of the thorax. Seventy-one percent of these left sided fractures were found at the midclavicular line, 14% at the parasternal and 12% were found at the axillary line. In our study fractures were found frequently on the left 3.-4.-5. ribs at the midclavicular line. Sternal fractures were found in 29 (4.8%) of the cases. Liver injury was found in 4 (0.7%) cases. **Conclusion.** If CPR complications are not known sufficiently it may cause various problems, for both clinical and postmortem investigations. We have to know that CPR complications, can cause death itself, or it can be misinterpreted to be blunt trauma as a cause of death, and also we should keep in mind that it can be evaluated as medical malpractice.

Key words: Autopsy, Cardiopulmonary Resuscitation, Complications

Özet

Amaç. Kouwenhoven 1960 yılında güçlü göğüs masajının, kişide nabzın alınmasını sağladığını farketmiştir. İlerleyen yıllarda yeniden canlandırma (YC) önemli ve hızlı gelişim görülmüştür. 2000 yılında yapılan YC konferansına katılan uzmanlar öncelikle okullara eğitim ve YC'nin ge YC'nin öğrenimini sağlamak için, yeniden canlandırma dersleri konulmasını önermişlerdir. Kaburga ve sternum kırıkları, erişkinlerde YC'ye bağlı en sık rastlanan komplikasyonlardır. YC uygulanmasına bağlı kaburga kırıkları çoğunlukla 3-8. kaburgalarda, solda daha sık olmakla birlikte her iki tarafta ve parasternal ile aksiller hatlar arasında kalan bölgede oluşmaktadır. 1. ve 8.-12. kaburgalarda çok nadir olmaktadır. Çocuklarda kaburgaların ve kaburga kırıklarının esnekliği nedeniyle göğüs kafesi kırıkları nadirdir. Bu çalışmada yeniden canlandırma komplikasyonlarının sıklığının saptanması ve doğurduğu sonuçların irdelenmesi amaçlanmıştır. **Yöntem.** 1993-2002 yılları arasında Adli Tıp Kurumu Morg İhtisas Dairesi'nde otopsi yapılmış, 26912 olguya ait otopsi raporları incelenmiştir. Yeniden canlandırma uygulanmış, fakat vücudunda travma bulguları saptanmayan, ölüm nedeni travma olmayan olguların adli belgeleri incelenmiştir. Ölümünden önce YC uygulanmış ve başka bir travmaya maruz kalmamış 602 olgunun otopsi bulguları üzerinde çalışılmıştır. **Bulgular.** 602 olgunun 97'sinde (%16,1) sternum ve/veya kaburga kırığı tespit edilmiştir. 602 olgunun 433' unun (%71,9) erkek, 169' unun (%28,1)

kadın cinsiyetinde olduğu tespit edilmiştir. Kaburga kırıklarının %69'nun göğüs kafesinin solunda; bu kırıkların %71'nin midklaviküler hatta, %14'nün parasternal hatta ve %12'sinin aksiller hatta olduğu tespit edilmiştir. Çalışmamızda kaburga kırıklarının sol 3.-4.-5. kaburgalarda ve midklaviküler hatta, sırasıyla daha sık görüldüğü tespit edilmiştir. 29 (%4,8) olguda sternumda kırık, 4 olguda (%0,7) karaciğerde yaralanma tespit edilmiştir. **Sonuç.** YC komplikasyonları yeterince bilinmiyorsa hem klinik hem de ölüm sonrası incelemeler açısından çeşitli sorunlara yol açmaktadır. YC komplikasyonlarının tekbaşına ölüm nedeni olabileceği, yanlışlıkla ölüme etkili künt travma olarak yorumlanabileceği veya tıbbi uygulama hatası kapsamında değerlendirilebileceği göz önünde tutulmalıdır.

Anahtar sözcükler: Otopsi, yeniden canlandırma, komplikasyonlar

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Introduction

Cardiopulmonary resuscitation was first defined by Kouwenhoven and Jude and has become used in clinical practice since 1960s. In the following years, it has been used in ambulance services and in hospitals by educated staff and also by different persons in the population.

Complications of resuscitation can be classified as rib and sternum fractures due to a blunt trauma to thorax [3, 4], liver [5, 6], spleen [7] lung and heart injuries [8, 9], pneumonia due to ventilation by intubation [10], tracheal injury and finally gastric perforation and pneumoperitoneum [12, 13]. The most common complications are fractures in ribs and sternum and they can rarely lead to serious and mortal injuries such as pneumothorax and cardiac laceration [3, 14, 15]. We aimed to determine the incidence of CPR related complications and to investigate their effects.

Material and Method

Autopsy reports of the cases being examined between the times 1993-2002 in the Specialized Morgue Department of the Forensic Science Institute were investigated one by one. Cases without any history of trauma or without any evidence of trauma findings that were considered to be formed at the period prior to CPR were included in the study and their demographic characteristics, the type of the event, the localization of the lesion and its characteristics, their cause of death and arising problems were investigated. Chi-square test was used for evaluation.

Results

Reports of 26912 cases which underwent autopsy in the Forensic Science Institute between the time 1993-2002 were investigated and 602 cases in whom CPR was performed and had not any evidence of trauma prior to CPR were included in the study. The sex distribution of the cases revealed that the male cases are (433 cases, 71.9 %) 2.5 times more than the female ones (169 cases, 28.1%) in number. Sternum and or rib fractures were noted in 97 (16.1%) of 602 cases.

Age distribution of the cases showed that the cases were especially in the 10-59 age group and most of the cases were in the 20-29 age group.

The cause of death distribution of the cases revealed that the most popular reason for death was cardiovascular disease (213 cases, 35.4%) followed by poisoning (155 cases, 25.7%). We found a significant correlation between age and fracture formation. We found rib fracture in only three cases of the 122 cases belonging to the 0-19 age group. Also none of the patients in this group had a sternal fracture (Figure 1).

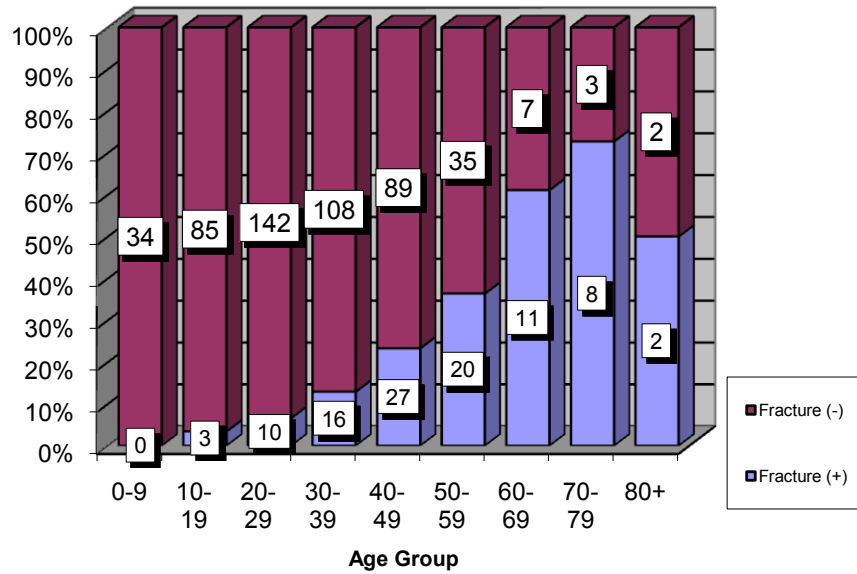


Figure 1: Distribution of bone fractures according to age groups. When the relation between bone fractures and age groups were investigated, we found that the probability of fracture formation increases significantly as age increases ($p=0.001$).

When the lines in which rib fractures occur were investigated, we found that they are usually formed in the left side of the ribcage and although common on the midclavicular line, they can also exist parasternally and at the anterior axillary line. In one case, two ribs were broken at more than two lines and the fractures were most common at the 4th left rib cage and at the midclavicular line when all fractures were considered (Figure 2).

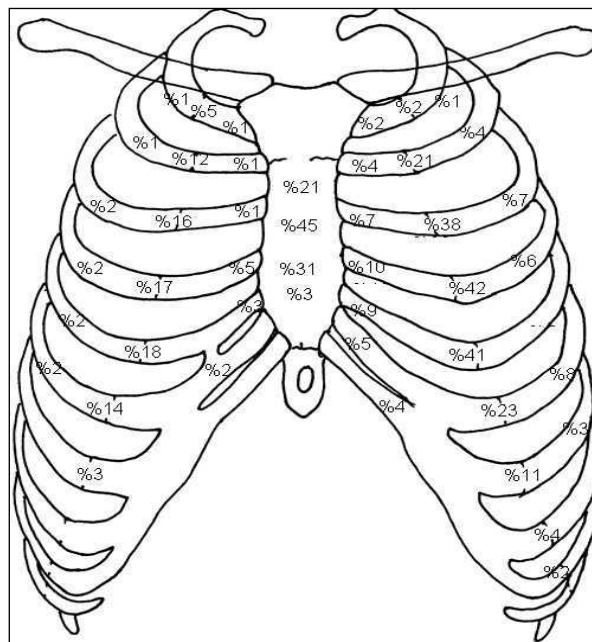


Figure 2: Distribution of fractures according to their localization in chest (Table 1).

Table 1. Distribution of fractures according to sex.

		Fracture		Total
		Present	Absent	
Male	n	77	356	433
	%	12.8	59.1	71.9
Female	n	20	149	169
	%	3.3	24.8	28.1
Total	n	97	505	602
	%	16.1	83.9	100

When the sternum fractures of the cases were investigated, we found that only 4.8% of the cases had sternal fracture and the fractures were most common at the third intercostal space (2.2%) (Table 2).

Table 2. Distribution of sternum fractures according to localizations.

Place of fracture	n	%
2nd Intercostal space	6	1.0
3rd Intercostal space	13	2.2
4th Intercostal space	9	1.5
5th Intercostal space	1	0.2
Total	29	4.8
Absent	573	95.2
Total	602	100

Traces of the defibrillator were found in the 85% of cases. They were most common on anterior chest wall, on sternum (53.7%), on left side of the chest as a second most common place and on anterior chest and left lateral place as the third most common place (Table 3).

Table 3. Distribution of the defibrillator traces.

Localization	n	%
Anterior	323	53.7
At left	88	14.6
At right	3	0.5
At left and right	13	2.2
At right and middle	7	1.2
At middle and left	78	13.0
None	90	15.0
Total	602	100

Five percent of the cases had hemorrhage and erosions on upper airways, 1.3% of cases had ecchymotic fractures at hyoid bone and at thyroidal cartilage (Table 4).

Gastric juice was seen at the airways in 4.6% of cases (Table 5).

Punctures in myocardium and pericardium were identified together with the existence of blood in pericardial space due to intracardiac injection in 9.1% of cases, there was pericardial rupture in one case, pleural puncture in one case, mediastinal hemorrhage in another case; subconjunctival bleeding in 5 (0.8%) cases, liver injury in 3 (0.5%) cases and liver injury together with abdominal bleeding in one case (Table 6).

Table 4. The distribution and frequency of lesions on neck organs, pharynx, esophagus, and upper air ways after resuscitation.

Lesion	n	%
None	561	93.2
Mucosal bleeding	30	5.0
Fracture of the hyoid or thyroidal cartilage	8	1.3
Bleeding at esophagus and or pharynx	3	0.5
Total	602	100

Table 5. Incidence and distribution of regurgitation.

Regurgitation	n	%
Gastric juice in trachea	17	2.8
In Trachea and main bronchi	11	1.8
None	574	95.3
Total	602	100

Table 6. Lesions identified in thorax and abdominal cavity.

Lesion	n	%
Puncture in heart, blood in pericardium	55	9.1
Rupture on the anterior face of the Pericardium	1	0.2
Pleural punctures	1	0.2
Mediastinal Hemorrhage	1	0.2
Liver injury	3	0.5
Liver injury and abdominal bleeding	1	0.2
None	539	89.5
Total	602	100

Discussion

Resuscitation can lead to findings of serious blunt trauma in a person after application. It has been shown in various studies that resuscitation carries the risk of cardiac and other lethal injuries [16-18]. The most common factor that increases mortality in a patient with thoracic trauma is resuscitation [19]. The prevalence of rib and/or sternum fractures after resuscitation varies between 16% and 75% and an average of 4 ribs are usually fractured [4, 9, 20-26].

Resuscitation in children seldom leads to rib fractures. While the fractures in the Shaken Baby Syndrome are usually located paravertebrally and seldom at the axillary line, fractures after resuscitation are located at the midclavicular and parasternal line [21, 24, 25, 27, 28]. Increased intrathoracic pressure after resuscitation can cause retinal bleeding [20, 21]. For this reason cases with a suspected diagnosis of Shaken Baby Syndrome should be carefully examined.

Rib fractures due to resuscitation are mostly located at the ribs 3-8, bilaterally being more common at the left side and at the region between the parasternal and axillary line [4, 26, and 29].

Sternal and/or rib fractures were identified in 16.1% of the cases. Rib fractures were located at the midclavicular line in 71%, at parasternal line in 14% and at anterior axillary line in 12% of the cases. In 2% of the cases, the ribs were found to be broken at more than one line. The average number of rib fractures per case were reported to be 4. The most common localization for rib fractures was the left side of the chest (69.3%) specifically the left 4th rib followed by the left 5th, left 3rd, left 6th and left 2nd ribs. 4.8% of the cases had sternal fractures which were located at the line of 3rd intercostal space in 44.8%, 4th intercostal space in 31%, 2nd intercostal space in 20.7%, 5th intercostal space in 3.5% of the cases. All of these results are in concordance with the studies similar to our study [3, 4, 14, 15, 18, 23-25].

433 of the 602 cases were male (71.9%) while 169 (28.1%) were female. The incidence of fracture formation in the resuscitated cases was found to be 11.8% among female and 17.8% among male cases. This finding can be explained by the higher mean age of the male cases (34±15, 4), than that of the female cases (29±16). But it is known that female hormones can increase the elasticity of the joint, connective tissue and joint capsule and fracture formation risk is low in females due to the elasticity of the costochondral joints [30]. When the 97 cases with fractures were examined, it was found that the sternum and/or rib fractures are most common after the age 50 (46.6%) and the fracture risk is the least between the ages 0-19 (2.5%). These findings are related with the loss of elasticity and increased fragility in ribs and sternum by increased age [31]. According to the

literature rib fractures are the least common complication of resuscitation in children. This low fracture incidence is due to the more flexible nature of ribs in children [32]. 47 of the 97 cases with sternum and/or rib fractures belonged to the age group 40-59 in our study. The most common reason of mortality was found to be cardiovascular diseases (50.3%) followed by poisoning (26.9%) in our study. 5.3% of the cases were identified to be died due to pass of electricity through their body. The incidence of fracture formation was found to be significant when both the age range (40-59) and the reasons for mortality were considered as a more persistent resuscitation is applied in cases of cardiovascular disease, poisoning and in deaths associated with pass of electricity through body. The slowness of the duration that leads to cardiopulmonary arrest is important for recognizing the condition of the case and for applicability of medical interventions. The causative agents were found to be carbon monoxide in 37.4%, methanol in 27.7% and drugs in 15.5% of cases died due to poisoning. Death occurs within hours in methanol and drug poisonings and as shown in this study usually the young and middle age group is affected. For this reason, considering also the persistent resuscitation used for these reasons, finding an increased incidence of sternum and rib fractures in these cases is significant. Regurgitation can occur in an unconscious patient or in a person in the agonal period after resuscitation in which procedure there is pressure difference between thorax and abdomen or due to a gastric dilation formed by wrong intubation. The prevalence of gastric juice aspiration due to regurgitation after resuscitation was reported to be 11.1% in one study and 12.4% in another [4, 33]. In this study we found gastric juice at trachea in 17 (2.8%) and at trachea and main bronchi in 11 (1.8%) cases. The difference in ratios of similar studies could not be explained. In recent studies it has been proven that resuscitation can cause or increase the prevalence of petechial bleedings in face, eye lids and conjunctiva [34]. Subconjunctival petechia was identified in 5 cases (0.8%) in our study. For this reason, resuscitation history or findings should be investigated and be interpreted in a person having critical findings such as petechial bleedings in face, eye lids and conjunctiva which could suggest mechanical asphyxia. Mucosal bleeding in the upper airways, pharynx, esophagus and in other neck organs were observed in 30 (5%) and esophageal and pharyngeal bleeding was observed in 3 (0.5%) of the total cases. These lesions were considered to be due to endotracheal intubation. Intubation traces found at esophagus should be evaluated by means of a medical application fault or as a link between death and resuscitation. There was pericardial rupture in one case, mediastinal hemorrhage in another case, liver injury in four cases of which one case experienced abdominal bleeding. Liver, spleen and gastric injuries occur due to fractures at lower ribs but are known to be a not common complication [7, 12]. Lesions formed due to resuscitation can seldom be lethal. These cases can be considered as blunt abdominal trauma if the medical history of the case is not sufficiently known. If death is established due to an internal organ injury due to resuscitation, a suspicion of medical malpractice can arise [9, 35]. Vertebral artery injury which can further lead to subarachnoidal hemorrhage can occur by hyperextension of the head during supplement of airway in the process of resuscitation [36]. This intervention can contribute to the death of a person when applied to a patient with cervical trauma and again medical malpractice can come up.

The clinician can meet with various problems regarding to both clinical and postmortem examinations if the complications of resuscitation are not sufficiently known. As a result it should be taken into consideration that complications of resuscitation can lead to death, they can be misinterpreted as blunt trauma which is also a factor in death and they can be considered as malpractice.

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