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Resuscitation Cardiopulmonary in Patients with Morbid Obesity: Specific Considerations

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Abstract: Cardiopulmonary resuscitation (CPR) of an obese patient can be a problem even for the most experienced practitioner. Changes in anatomy, metabolism, cardiopulmonary reserve, ventilation, circulation, and pharmacokinetics of medications require special consideration. This article is dedicated to the most important components of the resuscitation of an obese patient, as it concerns performing indirect cardiac massage, defibrillation, ensuring the patency of the upper airways and ventilation, the pharmacokinetics of vasoactive substances. Materials and methods. The search in the electronic PubMed and others online sources was carried out using words key. Results and conclusions. Obesity causes significant anatomical and physiological changes that affect CPR. Medical professionals should take into account the particularities of cardiopulmonary resuscitation in patients with morbid obesity in other to increase the effectiveness of resuscitation in these patients.

Keywords: Morbid obesity, cardiopulmonary resuscitation, sudden death

INTRODUCTION

Acute cardiopulmonary failure (ACPF) remains the leading cause of death, both hospital and out of hospital, among adults worldwide. There are many etiological factors of ACPF, among which the diseases of the cardiovascular system is one of the leading causes.

Obesity is considered one of the main factors of risk of cardiovascular diseases and heart failure (HF), it increases the risk of development of cardiovascular disorders and sudden cardiac arrest [1-3]. Among the factors that lead to sudden cardiac death in overweight patient, the most common are arrhythmia due of structural changes in the myocardium, dilated cardiomyopathy, which causes prolongation of the duration of the QT interval, fibrillation a trial, ventricular tachycardia and ventricular fibrillation [4, 5].

Current recommendations European Council of Resuscitation do not support any changes in CPR procedures to patients with overweight: «There are no changes in the sequence of actions during the resuscitation of obese patients, but the performance of effective cardiopulmonary resuscitation (CPR) can be difficult» [6]. Our experience shows that CPR in a patient with morbid obesity can cause difficulties even for the most experienced professionals. Since there are currently no recommendations or separate national guidelines on performing CPR in obese patients, and there is also a limited data from foreign literature, there is need to analyze the possible impact of anatomical and path physiology of patients with morbid obesity and effectiveness ofCPR. CPR is a common in our hospital, especially in Emergency room, surgical theatres, ICUs, also in wards, anesthetists are called to carryout CPR.

The most important and essential components of CPR are the restoration of circulation and ensuring the patency of the airways. As our experience shows, these two components are the most difficult in the morbidly obese patient. Ensuring adequate circulation is achieved by reaching through compression of the chest during indirect cardiac massage, the effectiveness of which depends linearly on the speed, depth of chest compression and the location of the compression zone. Several studies have investigated the relationship between obesity and quality CPR. Edelson DP and his coauthors found that pathological obesity was associated with worse outcomes of indirect cardiac massage compared to subjects who did not suffer from obesity [7].

In patients with a body mass index (BMI) greater at 35 kg/m the anatomy of the thorax has certain differences with respect non obese patient due to the increase in the thickness of the subcutaneous adipose tissue layer (SAT) and the anteroposterior diameter [8]. It has been shown that high BMI and anteroposterior diameter of the thorax correlate with worse outcomes of CPR after cardiac arrest in the hospital [9].

From the point of view of physics, if the force of compression that is applied to patients with obesity and normal weight is the same, then the compression of the thorax in both cases must occur in the same magnitude $\Delta x = 5$ cm. However, in obese patients this will not ensure an equivalent compression of the heart due to the presence of damping properties of adipose tissue. In their study, Alkhoudi N and his co-authors demonstrated that in a patient with a fat layer of 2 cm on the anterior and posterior surfaces of the thorax to obtain an effective compression of the myocardium, analogous to that of a person without obesity, it will be necessary to perform an indirect cardiac massage with compressions 2 cm deeper, that is, compress the thorax not to 5, but to 7 cm. [10].

The relationship between pathological changes in the anatomical structure of the thorax, the thickness of the fat layer and the effectiveness of compression during CPR in morbidly obese patients. According to the study data, the average thickness of the fat layer in patients with an average BMI = 45.95 kg/m was36.5 mm on the anterior surface of the chest wall and 50.7 mm on the posterior. The authors of the study concluded that adipose tissue directly affects the effectiveness of indirect cardiac massage and the necessary chest compression depth, mathematically calculated, in this group of patients should be approximately 9 cm [10].

In addition to the frequency and depth of chest compression, in CPR in obese patients, it is important to determine the location of the compression zone. According to the current recommendations of the European Council of Resuscitation of 2020, for an effective indirect cardiac massage, the specialist's hands must be located in the center of the thorax, which is due to the maximum diameter of the left ventricle in this area [6]. If CPR is performed on an obese patient, the type of adipose tissue distribution should be taken into account: peripheral or central (abdominal shape). In turn, the central type of obesity according to the distribution of SAT can be intra- and extra visceral. From the point of view of the type of obesity, the characteristics of the performance of indirect cardiac massage refer to the central intravisceral type of SAT distribution because with this form of obesity intra-abdominal pressure increases, especially in the supine position. There is a displacement of the diaphragm, which leads to a change in the maximum diameter of the left ventricle in this area.

In their study, Heekyung Lee and his coauthors, using CT, determined that the optimal point of compression in morbidly obese patients is displaced 2 cm upwards compared to patients who have a normal body weight [11].

In addition, due to the increase in intra-abdominal pressure, in morbidly obese patients in the supine position, inferior vena cava syndrome may occur, which leads to a decrease in cardiac output. Therefore, CPR in morbidly obese patients should be performed in a position on the left side at an angle of 15- 30 degrees, similarly to women pregnant [12].

Characteristics of ensuring the patency of the upper airways and ventilation. Obesity is associated with several important anatomical changes of the upper airways that affect the patency and pulmonary ventilation. First of all, it is the excess of par pharyngeal tissue and the increase in neck circumference due to the deposition of adipose tissue, which combine with increased resistance in the airways and collapse of the upper airways. The presence of such pathological changes significantly hinders the process of ventilation with a mask [13].

Despite the impact of BMI on difficult intubation is less clear and the studies give contradictory results [14, 15], in an emergency situation, tracheal intubation in a patient with obesity can be significantly complicated not only by anatomical peculiarities, but also by the impossibility of providing the patient with the “Ramped-position” or «Semi recumbent position» necessary for a successful intubation (Fig. 1). That is why the currently existing algorithms to ensure adequate passage of air emphasize use of modern oral or nasal supraglottic ventilation devices for ventilation [16].

Fig.1. “Ramped-position” and “Semi recumbent position” for intubation of a patient with obesity [25].Ventilation of patients with morbid obesity during CPR does not differ from patients with normal weight.

As mentioned above, patients with morbid obesity often suffers from dilated cardiomyopathy, which increases the risk of defibrillation rhythms. It is known that the main condition for a successful electrical defibrillation is an adequate level of electrical discharge, which must reach the myocardium. Since patients with obesity have a higher transthoracic impedance than patients with normal body weight, it is assumed that this fact may negatively affect the success of defibrillation [17].

In their study, M. Zelinka and his co-authors attempted to determine the effect of transthoracic impedance in patients with obesity on the discharge energy when using biphasic defibrillators. The researchers concluded that the high transthoracic impedance led to a critical reduction in discharge energy [18]. But a later study by Ogunnaike B.O and his co-authors found no significant difference in the rate of successful defibrillation with restoration of cardiac activity after the initial discharge in patients with both normal weight and overweight [19].

Optimal discharge energy levels in patients with obesity is currently unknown, so its recommended values still remain unchanged: 150-360 Jo. The European Resuscitation Council recommends performing the first defibrillation with a 150 Joules discharge, all subsequent ones with the maximum energy available to the defibrillator [6].

Vascular access and monitoring of hemodynamics parameters. Obesity is always associated with complicated peripheral and central venous access [20].Today, ultrasound navigation largely solves the problem of identifying peripheral and central venous structures and has unconditional advantages from a safety position [21], but in resuscitation conditions, it is not always possible.

Since providing both peripherals, both central access of people with obesity may require a significant amount of time, which is categorically unacceptable in a CPR situation, the question arises of finding an alternative way to administer medications in this group of patients. The answer to this question was given by a recent study by Kehrl T and his coauthors, according to which, an alternative to vascular access in patients with obesity may be the intraosseous route of drug administration. Depending on the BMI and the availability of palpation of the tibial tuberosity for puncture of the proximal part of the tibia, it is proposed to use a 25 mm or 45 mm long needle for intraosseous access [22].

An alternative way to administer medications, may also be sublingual, but we did not find data indicating the effectiveness.

Dosage medications are determined by many factors. Perhaps the most important is the lipophilicity of the drugs. In general, when drugs have high lipophilicity, they spread rapidly to peripheral tissues and should be dosed based on total body mass. Unlike this, when drugs are hydrophilic, the volume of distribution is lower, therefore, the dose should be based on the ideal or corrected mass of the body. An additional factor that affects the dosage of drugs is renal function. If drugs are excreted by the kidneys, they should be dosed based on actual creatinine clearance, not calculated [24].In the context of CPR in patients with obesity, special attention should be paid to the pharmacokinetics and pharmacodynamics of cardiovascular drugs. b-adrenergic receptor blockers, lidocaine, amiodarone, calcium channel blockers, dioxin are relatively hydrophilic, and changes its volume of distribution with increasing BMI. Since its volume of distribution is relatively invariable, it is recommended to calculate the dose based on ideal body weight.

Weight-based and weightless vasoactive drug dosing strategies, such as noradrenaline, adrenaline, and dobutamine, demonstrated similar efficacy in achieving clinically significant results in terms of hemodynamic and mortality indicators. Therefore, vasoactive drugs do not require dose adjustment in patients with obesity [25].

DISCUSSION AND CONCLUSIONS

Obesity causes anatomical and physiological changes that significantly affect resuscitation measures. Taking into account the concomitant pathology and the numerous technical difficulties of CPR in patients with morbid obesity, it may give the impression that this group of patients has no chance of being successfully resuscitated. However, as a result of a series of studies, quite unexpected data were obtained, which today are known as the «obesity paradox: «overweight patients body weight compared to patients without obesity, have a more favorable prognosis, both in the short and long term in the post resuscitation» [26]. On the one hand, this may be due to the fact that patients with morbid obesity remain in hypoxia and hypercapnia for a fairly long time during their lives and are somewhat adapted to these conditions. However, to consider obesity as a protective factor in critical conditions, more solid bases and research are needed.

As mentioned above, there is still no national unified protocol for CPR in patients with concomitant obesity and foreign recommendations are of a limited nature. However, health professionals should take into account the above characteristics of CPR in patients with morbid obesity to increase the effectiveness of resuscitation measures in this group of patients.

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