

# Alternative Positions for Cardiopulmonary Resuscitation

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## Abstract

External cardiac compressions are the cornerstone of current life support protocols in case of cardiac arrests. Though supine body positioning is considered the optimum during managing such cases; others alternatives have also reported. The latter can be lifesaving in certain situations where supine positioning is either difficult or time consuming. The present article presents the available literature about cardiopulmonary resuscitation in prone, lateral and head up position.

## Keywords

Cardiopulmonary Resuscitation, Cardiac Arrest, Body Positioning

## 1. Introduction

Cardiopulmonary resuscitation (CPR), or the technique of “closed-chest cardiac massage” as first proposed by Kouwenhoven et al, is the cornerstone for management of cardiac arrest [1]. Over the years, the technique has been modified numerous times [2], yet the recommended position in which CPR is applied –supine position– remains the same for over 50 years.

The present article presents the proposed alternatives positions for CPR that have been reported in the literature, mainly in the last 15 years. The need for these alternatives emerged for the cases of cardiac arrest that supine positioning is impossible, difficult or time consuming.

## 2. Prone Position

The first time that prone or “reverse” CPR (P-CPR) is adopted in AHA and ERC Advance Life support (ALS) guidelines is 2005, yet it has not been reviewed since 2010 [3-5]. The idea however, was first presented in 1989 by McNeil [6], and even earlier for cases with chest injury, in 1983 by Dryden-Benz [7].

The studies on the subject are few: in 2001, Atkinson suggested that efficient CPR can be performed on a

mannequin in the prone position [8]. In 2003, the first pilot study on humans reported that P-CPR generates higher mean systolic blood pressure (SBP) and higher mean arterial pressure (MAP) during circulatory arrest than standard CPR [9]. Later, Wei et al<sup>10</sup>, confirmed the previous hemodynamic findings, and reported good respiratory support at the same time: mean tidal volumes of 399±110 ml were generated during external pressure on the back. P-CPR was therefore suggested as an alternative for out-of-hospital cardiac arrest.

Meanwhile, there were several published cases with good outcome after P-CPR (Table 1).

The vast majority of cases were intra-operative cardiac arrests, mostly young patients and with compression in the midline, two-thirds of the way up the torso between imaginary scapulae. A recent study defined the optimum landmark for P-CPR as the region which correlates with the largest left ventricular (LV) area. It reported that when the patient is positioned prone, the largest LV cross-sectional area is 0 to 2 vertebral segments below the inferior angle of the scapula in at least 86% of patients [20].

On the contrary, there are only case reports about the efficiency of defibrillation in prone position [21]. An evenly crucial question is when the patient is turned supine [22]. Finally, education process of P-CPR is also under evaluation. Should it be limited only to those how may encounter such conditions (e.g. neurosurgeons, anesthetists, intensivists),

only to medics or to P-CPR as part of CPR training in general? [23]

Possible advantages of P-CPR include: easier training, no need to be constantly alert for airway patency, less risk of aspiration pneumonia, no delay in onset of compressions, and increased willingness of bystander action than with mouth-to-mouth ventilation [24].

Clinical trials of CPR in hospitalized patients or out-of-

hospital victims are challenging because interventions must frequently be implemented at a short time frame: thus, legislative difficulties (e.g. obtaining consent) arise.

In any case, P-CPR could serve as alternative in selected cases, such as neurosurgical operations, Intensive Care Units' (ICU) patients in prone mechanical ventilations or in settings (prehospital) where turning is either difficult or time-consuming (e.g. cardiac arrest in narrow spaces)

**Table 1.** Case report of successful application of P-CPR (11 patients in total): OR- operation room/surgery.

No	Cases	Characteristics	Setting	Reference
1	2	Pediatric female (14yr) Adult male (34yr)	Neuro-OR, Emergency Posterior fossa craniectomy Neuro-OR, Emergency spinal surgery for C3 fracture	[11]
2	1	Adult female (34yr)	Neuro-OR, Cerebellar meningioma	[12]
3	1	Pediatric male (12yr)	Neuro-OR, spinal fusion	[13]
4	1	Pediatric male (6 month)	Neuro-OR, foramen magnum decompression	[14]
5	1	Adult male (48yr)	ICU, ARDS-prone ventilation	[15]
6	1	Adult male (43yr)	Neuro-OR, Lumbosacral spinal surgery	[16]
7	1	Adult male	Neuro-OR, Cerebellar hematoma	[17]
8	1	Adult female (77yr)	Neuro-OR, parietal-occipital meningioma	[18]
9	2	Pediatric male (14yr) Adult female (25yr)	Neuro-OR, Koch's spine correction Neuro-OR, lumbal spinal surgery	[19]

### 3. Lateral Position

While left-tilt position (27-30° left lateral) is a well known and recommended alternative position for CPR in cases of cardiac arrest in late pregnancy [4] (the other position, equally recommended, is lateral uterus displacement) [25], CPR in lateral position is seldom reported. The literature is consisted of an infant (4-month boy) case during OR positioning for anterior mediastinal mass [26], a pediatric case (6yr old boy) during craniotomy for right intraventricular tumor [27] and 5 adult cases (age range 35-61yrs old), all of them in OR [28-30].

The challenges are lack of validated guidelines on CPR in lateral position, difficulty in administering chest compression and placement of defibrillator paddles owing to thorax fixation devices. In one of the reports, chest compression was performed in this position by two rescuers; one from the chest and the other from the back, pushing simultaneously [28], while in other reports one person delivered chest compressions and a second one provided mechanical back support to allow uniform distribution of the compressive force [30-31]. In the latter cases, defibrillator paddles were placed at upper precordium and in left mid axillary line (recommended site is cardiac apex and right infraclavicular region [4]).

### 4. Head-up Position

Research about head-up CPR originated both from theoretical and practical challenges.

The first was based on the brain hemodynamics during CPR. The optimal chest compression during CPR should effectively improve brain perfusion without compromising intracranial pressure (ICP). Studies on animals revealed that head-up position may improve carotid flow during CPR [32].

In a similar study different head-up positions were tested (0°, 20°, 30°, 40° and 50°). ICP and cerebral flow improved linearly as the elevation increased. Thirty degrees appeared to have the best balance between decreased intracranial pressure (ICP), increased cerebral flow and aortic pressure [33].

Recently, a very interesting study on human cadavers reported a lower ICP and a higher cerebral perfusion pressure in the head-up position, regardless of the type of CPR being performed, except for standard CPR. In the same study, it was also noted that both the ICP lowered and the cerebral perfusion pressure increased with active compression decompression (ACD)-CPR vs. standard CPR [34]. In addition, it used cadaveric fluoroscopy to evaluate the effect of supraglottic airway devices on carotid flow<sup>35</sup>. Even in prolonged head-up CPR, cerebral perfusion pressure was maintained higher than standard CPR [36].

Practical challenges are the difficulties met when transporting a patient with out-of-hospital cardiac arrest e.g. how do we place such a patient in a narrow elevator?[36].

### 5. Future Perspectives

Considering the resuscitations' guidelines for minimal CPR interruptions [4], providing CPR in positions other than supine may be a useful alternative to think about; especially when "classical" CPR is not an easy option. The database available is very limited, thus the definite role of each body position in advanced life support protocols is still unclear.

However, as the CPR "physiology" is further studied [37] and more reports about body CPR position during are published, the answer may not be far.

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