

## CARDIOPULMONARY RESUSCITATION IN PRONE POSITION DURING SURGICAL INTERVENTIONS

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### Background

Cardiopulmonary Resuscitation (CPR) was first introduced in 1960 by Kuowenhoven et al<sup>1</sup> along with chest compression and mouth-to-mouth ventilation and combined with ABC (airway, breathing, circulation) algorithm. Today, ABC has given its place to CAB (circulation, airway, breathing). In 2005, the European Resuscitation Council (ERC) recommended chest compressions to be started before ventilation<sup>2</sup>. However, in the same period the American Heart Association persisted its advice that two live saving breathes should be given to the patient prior to cardiac compression<sup>3</sup>. According to latest publications, CAB is the recommended method both by European and American guidelines<sup>4,5</sup>. The aim is to reduce the potential time without blood flow (*no flow time*) through continuous effective chest compressions.

The practice of CPR in the prone position was first proposed in 1989 by McNeil<sup>6</sup>. The first relevant case report on successful management of two patients having cardiac arrest after acute hypovolemia was published by Sun et al<sup>7</sup> in 1992. The application of CPR in the prone position was also supported by Steward in 2002<sup>8</sup>. Additionally, the first pilot study prone CPR was carried out in 2003, in which the patients that failed standard CPR for at least 30 minutes received 15 additional minutes of standard CPR and then prone CPR for 15 minutes<sup>9</sup>. The pilot study showed that CPR performed in the prone position generated higher systolic and mean arterial pressure during circulatory arrest compared to standard CPR. In 2001, Brown et al<sup>10</sup> published the first systematic review on CPR in the prone position. It was reported that 22 intubated inpatients received CPR in the prone position and 10 of those 22 cases could be discharged from the hospital.

Chest compression is one of the cornerstones of the basic life support algorithms. According to the 2010 American Heart Association (AHA) Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care, it may be reasonable for rescuers to provide CPR in the prone position if the patient cannot be placed in the supine position<sup>11</sup>. The latest AHA guideline did not review the recommendations in 2015<sup>12</sup>. According to the latest ERC guideline, major spinal surgery, hypovolemia, air embolism, wound irrigation with hydrogen peroxide, occluded venous return were identified as the risk factors for cardiac arrest in prone patients<sup>13</sup>. Besides it was concluded

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in the same guidelines that chest compression in the prone position can be achieved with or without sternal counter-pressure.

No flow time, on the other hand, may be the most important determinant of survival. Patients may be placed in the prone position for procedures like spinal surgery or neurosurgery. Prone position may be also preferred for improving oxygenation of the patients in ICU or in cases like acute respiratory distress syndrome. Cardiac arrest may develop while the patient is in the prone position. In this case, the time required for recruiting enough hospital personnel to place the patient back in the supine position safely may cause significant delays in starting CPR. Considering that safe rolling of the patient from prone to supine requires 4 to 6 hospital personnel, and such patients generally have invasive monitors, urinary catheters or tracheal tubes, the rolling process may require approximately 5-6 minutes<sup>14</sup>.

Additionally, turning the patient to supine position during cerebral or spinal surgery may result in neural damage. Studies suggest that as CPR in the prone position generates higher blood pressures than in the supine position, it is more advantageous compared to classical CRP<sup>9,10,15</sup>. McNeil<sup>6</sup> claimed that the thoracic pump model supported prone CPR more than the cardiac pump model. Mazer et al<sup>9</sup> achieved increased intrathoracic pressure and systolic blood pressure in 6 cases, whose circulation did not return despite 30 minutes of standard CPR, by applying rhythmic CPR in the prone position. During thoracic compressions in the prone position, the abdomen shifts less forward, and thus, the effectiveness of CPR efforts increases. Each anterior sternal compression presses the midriff inferior and in the meantime the abdominal structures change place anteriorly depending on the force of the compressions. In the prone CRP, however, abdomen is in contact with a solid surface and movement of abdominal structures is restricted. In this way, compressions become more effective. Also, as shunts decrease in the prone position, better oxygenation can be achieved. The prone method is also more advantageous in provision of ventilation support. In the prone position, patient's head is placed neutral and the forehead is supported with the arm under the head (Figure 1). The head is extended forward and

mandibula falls forward so that the tongue does not fall behind and the airway patency is protected<sup>16</sup>. This provides an advantage even if the patient is not intubated.

*Fig. 1*

*Prone CPR technique during spinal surgery*



Regurgitation of stomach content is also among major complications of standard CPR as well as nausea and aspiration pneumonia. In prone position, however, such complications are prevented, and there is minimum risk of aspiration. Additionally, the rescuer may be significantly more willing to imitate the rescue in the prone position compared to mouth-to-mouth ventilation. Even in cases of ventricular tachycardia or ventricular fibrillation, cardioversion can be successfully performed without the need to change the position of the patient. Successful electrical defibrillation has been reported in patients having spinal surgery in the prone position<sup>17</sup>. The time spent for re-positioning the patient may decrease the success rate of defibrillation.

As the pressure applied with both hands spreads to the posterior chest wall the McNeil method generates

less localized pressure than conventional CPR. On the other side, in the supine position the pressure is applied to a limited region of the sternum. As the posterior chest is more rigid, there is lower risk for development of traumatic injury as a result of spread of the applied power, thus, stronger compressions may be applied in the prone position with minimal risks yet without significant reductions in heart compressions. Both one-handed and two-handed techniques and two handed techniques of prone CPR have been described. In 2002, J.A. Steward<sup>8</sup> provided a detailed description of the prone CPR process. First, the patient is placed on a solid surface with the face facing down and the arms of the patient are positioned under the forearm. Thus, nasal bridge can stand freely on the elbow. Hands are placed on the back of the chest in a way that both hands are in one half. The chest is compressed forward 40

times per minute (Figure 1). This position allows neck extension and forward chin position which are often required.

Defibrillator pads are placed and can allow sufficient energy transmission throughout myocardium. The pads can be inserted in left mid-axillary area and left scapula. Alternatively, the pads may be inserted on right/left mid-axillary lines, in posterior of the left mid-axillary line or in inferior of right scapula<sup>18</sup>.

Effective chest compression may not be possible or effective during surgical interventions. We concluded that prone CPR is not a commonly performed technique, but when it is performed it provides great advance with serious reduction in no flow time.

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