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Mini Review

Historical Review of The Development, Technique, Safety, and Efficacy of Interposed Abdominal Compression Cardiopulmonary Resuscitation as a Promising Adjunct with Standard CPR

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Interposed abdominal compression cardiopulmonary resuscitation, henceforth referred to as IAC-CPR, is an adjunct to standard CPR (S-CPR) according to American Heart Association (AHA) guidelines since 1992. Compared to other CPR adjuncts like high-frequency CPR, Active Compression Decompression CPR (ACD-CPR), vest CPR, mechanical (piston) CPR, Simultaneous Compression Decompression CPR (SCD-CPR), Phased Thoracic Abdominal Compression Decompression CPR (PTACD), and invasive CPR, IAC-CPR is widely accepted to be the least expensive, simplest, and most studied adjunct. IAC-CPR incorporates additional manual rhythmic compression of the region between the umbilicus and xiphoid process of the abdomen during the relaxation, or diastolic, phase of standard CPR (S-CPR) [1]. IAC-CPR is believed efficacious by increasing venous return to the heart through IVC compression while simultaneously providing aortic counterpressure, ultimately increasing coronary perfusion [2]. It is an oft-forgotten method of resuscitation - despite the AHA acknowledging its efficacy compared to traditional CPR, its technical difficulty as well as resource demand limits its feasibility in a critical situation. The technique itself requires 3 medical personnel trained in its use, one for airway, one for chest wall and the other for abdominal compressions. As if the demand on the number of medical staff needed weren't enough, IAC-CPR also requires precise compression timing and depth for appropriate success.

Thus, the question clearly arises: why even bother? It may seem foolish to devote additional manpower and training for something that is rarely used to begin with. With that in mind, this mini-review will serve to provide a brief overview of past and present literature surrounding its promise as well as any implications this may have on the future deliverance of CPR in the Basic Life Support (BLS) protocol.

IAC-CPR first garnered attention following Ralston and associates small animal study in 1982 in which the technique improved arterial pressure, perfusion, and cardiac output compared to S-CPR in dog models [2]. The study aimed to explore further results from the 1967 Harris and associates study [3] showing positive outcomes with continuous compression of the abdomen during CPR, which increased carotid blood flow by ⅔. The Harris and associates study proposed IAC-CPR benefit through a mechanism of reducing blood flow to the intestines and lower extremities and shunting to more vital organs like the brain and heart. Additionally, compression of the abdominal aorta increases diastolic pressure, favoring retrograde blood flow through coronary and brain circulation. However, the study had limited utility as it differed in technique from modern IAC-CPR, with constant, not alternating, pressure being applied to the umbilicus. Upper abdominal pressure was also not recommended as 2 of the 6 dog models developed liver lacerations. A subsequent study by Redding in 1971 [4] again found improved carotid circulation and survival with continuous pressure in animal models, via blood pressure cuff around the abdomen, with no difference in liver laceration incidence between this technique and traditional CPR. Ralston and associates thus believed liver lacerations occurred in part due to the inability of the liver to recede if constant abdominal pressure is applied [2]. These initial studies ultimately sparked further interest in IAC-CPR and its benefits for future studies.

In the late 1980s and early 1990s, research was conducted on IAC-CPR's effects on cardiac output, perfusion, and overall efficacy. A small randomized prospective study found a strong association between higher cardiac output and IAC-CPR [5]. The study of 33 patients used end tidal PCO2 (ETPCO2) as a parameter in comparison of IAC-CPR to S-CPR. Patients were initially given either IAC-CPR (16) or S-CPR (17) and switched to the other technique after 20 minutes of resuscitation. On average, ETPCO2 was 17.1 mm Hg in patients receiving IAC-CPR compared to 9.6 mm Hg receiving S-CPR, with a difference of 78% (P=.001). ROSC was also higher in the IAC-CPR group at 30% compared to 6%, although not significant (P=.07). This study found promising results, however possible confounding bias exists as 6 of the 16 patients who initially received IAC-CPR were successfully resuscitated compared to 3 of 17 in the S-CPR group before 20 minutes when the techniques were switched. In 1992, Sack and coworkers conducted a randomized controlled trial of 103 patients comparing IAC-CPR to S-CPR, with abdominal compressions set at a rate of 80/min to 100/min [6]. The three endpoints were return of spontaneous circulation (ROSC), 24 hour survival post-CPR, and survival to hospital discharge. The study found significantly greater ROSC in the IAC-CPR group compared to control, at 51% to 27% respectively (P=.007) and greater rate of survival to hospital discharge at 25% to 7% respectively (P=.02). Of note 17% vs 6% respectively survived to hospital discharge and were neurologically intact, although these results were not significant. These studies further supported IAC-CPR improving survival following in-hospital cardiac arrest and built a strong foundation for holistic analyses of results.

Evidence-based review of data prior to 2003 of pre-hospital and in-hospital resuscitations including studies mentioned previously found strong benefit in IAC-CPR in achieving ROSC compared to S-CPR (P<.01). Exclusive focus on in- hospital practice found even higher statistical significance (P<.001) [7]. Analysis of animal and mechanical models found generally 50-100% improvement in circulation and coronary perfusion with IAC-CPR.

IAC-CPR has also been observed to potentially have a wider range of applicability. One case report by McClung and Anshus noted particular efficacy in a patient with chest wall deformities. The patient in question demonstrated full neurologic recovery whereas initial use of traditional CPR had been failing, suggesting that IAC-CPR may outperform standard CPR in patients with both normal and abnormal anatomy during in-hospital arrests [8].

On top of efficacy and versatility, studies have shown an improved safety profile as well. In their review of canine models and human models, Sack et. al found multiple safety benefits and next to no disadvantages of using IAC- CPR. Observed potential upsides include improved venous return, decreased incidence of gastric insufflation, and prevention of negative effects of vagal reflex activation prior to intubation. There has also been no observation of increased rates of emesis or aspiration of gastric contents. One may reasonably assume that abdominal trauma is of great concern as well, given that traditional CPR is known to cause significant thoracic trauma - however, there were 0 cases of abdominal trauma noted in over 200 subjects across 8 separate trials [9].

In summary, IAC-CPR has a wide host of benefits in its use compared to its traditional counterpart for in-hospital arrests - there is a growing body of evidence behind its efficacy and its wide range of usability. It continues to remain limited by its sheer technical difficulty and resource requirement, as there is currently a lack of suitable solutions to address these shortcomings. We believe that the promising nature of this technique warrants further study and, indeed, would not be surprised to see its use grow in popularity over the coming years.

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Conflict of Interest

No conflict of interest.

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