91

A mechatronic bio-mimicking simulator to study various combinations of mechanical compressions during CPR.

Rashid Mazhar[1], Tahir Hamid[1], Ali Raza[2], Wasif Ali[3]
[1]Hamad medical corporation, Doha, Qatar. [2]University of Engineering & Technology, Lahore, Pakistan. [3]University of Engineering & Technology, Lahore, Pakistan

Abstract

Purpose of the study: Outcomes of various Automated cardio-pulmonary resuscitation (CPR) machines are largely at par with each other, and not superior to the manual CPR(1).

However, the results of all of these different methods stand in isolation. Their possible combinations have not been systematically studied, except in mathematical and electric circuit models(2,3).

We present a mechatronic bio-mimicking simulator which can study almost all possible, existing and novel, combinations of mechanical intervention during CPR.

Materials & methods: A fluid-filled, passive circulatory platform was created, comprising valved-conduits and chambers representing heart, lungs, splanchnic and lower limbs reservoirs.

The elastomeric composition, of the chambers were optimized to bio-mimic the required organ-compliances.

An exit conduit from its cardiac chamber, carried fluidic sensors recording Cardiac-out-put (COP) through a multi-channel acquisition board.

This platform was encased within a programmable electro-pneumatic, multi-effector, actuation system which was run with various combinations of in-vogue & novel thoracic and abdominal compressional sequences, with varied force, speed and timings.

Results: Three actuator configurations mimicking the actions of LUCAS™, Autopulse™ and Lifestick™ produced mean “aortic” pressure of 27.64±28.23, 18.32±19.38 & 15.96±21.24 mmHg, respectively, with corresponding flow rates of 6.02±2.65, 5.16±1.69 and 4.20±2.22 liters/minute.

A novel configuration of sustained abdominal compression followed by Thoracic compression and subsequent collective release, produced distinctly higher mean pressures of 44.46±40.81 mmHg (>60% higher than that with LUCAS configuration) with flowrates of 5.09±1.72 L/min.

Conclusion: The presented simulator provides a platform to test countless combinations/variations of existing and novel methods of CPR, to short-list the best-COP-producing methods, which could further be studied into animal and human studies.

The authors also propose a, “venous-backflow” theory of CPR-hemodynamics and its possible interventional implications.

1.West J Emerg Med.2021;22(4):810-819.

4.Circulation1999 Nov23;100(21):2146-52

5.Am J Emerg Med.1984Jul;2(4):299-308.