Clinical Summary

Study demonstrates that suboptimal pad placement can be overcome by using a 360 joule shock with a biphasic truncated exponential (BTE) waveform.

Esibov A, Chapman F, Melnick S, et al. Minor variations in electrode pad placement impact defibrillation success. *Prehospital Emergency Care*. Early online, September 15, 2015.

Purpose:

Shocks often fail to terminate VF in patients with cardiac arrest. Research has shown that pad position is inconsistent, among both professionals and lay-users.[1-5] This experimental study was designed to test the effect of small variations in anterolateral pad placement on shock success, and whether defibrillation shock dose could compensate for suboptimal pad placement.

Method:

This was a randomized experimental study. Three electrode pad positions were studied in random order on each of ten swine; the medial edges of the pads were placed 3%, 7% or 11% of the circumference from the midline of the sternum.

Three pad placements:

Inner	3% from midline sternum
Central	7% from midline sternum
Outer	11% from midline sternum

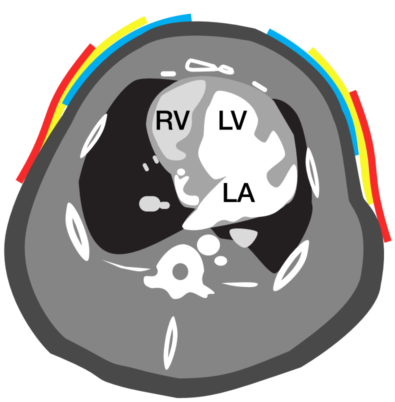


FIGURE 1. Axial view from CT scan of the thorax, with the right ventricle (RV), left ventricle (LV) and left atrium (LA) labeled. Radio-opaque markers were used to identify electrode pad locations.

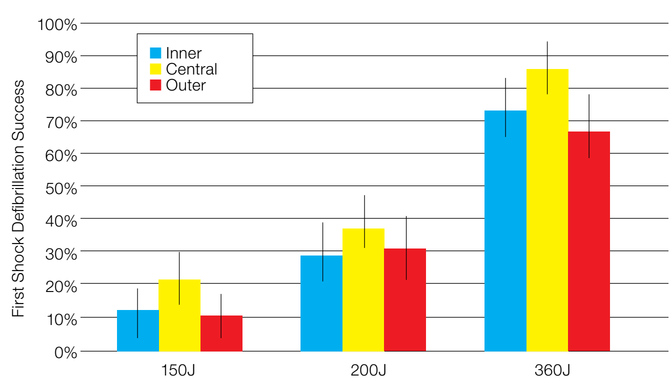
Three defibrillation therapies representing maximum AED and manual mode doses from two commercially-available defibrillators with biphasic truncated exponential waveform (BTE) were tested at each pad position.

- HeartStart® MRx from Philips® — 150J biphasic
- HeartStart MRx from Philips — 200J biphasic
- LIFEPAK® 15 device from Physio-Control — 360J biphasic

Three groups of 24 episodes (72 total) of induced short-duration VF were tested at each of the three pad positions. A 50-Ω resistor was added in with the pig to attain an impedance of about 90 Ω (typical human impedance), which causes the devices to deliver shocks with waveforms similar to those humans would receive.

Results:

- Defibrillation success varied significantly with pad position, with the Central position rendering more effective than the Outer position ($p = 0.02$).
- The defibrillator that delivered 360 joules resulted in higher first shock and two-shock cumulative success than did the defibrillator that delivered 150 joules or 200 joules ($p < 0.001$).
- Despite the use of similar peak currents (between the 200J and 360J waveforms), the defibrillator that delivered 360 joules resulted in higher shock success in each pad position.



Conclusions:

- Differences in electrode pad placement, which are well within user-to-user variation, significantly affected shock efficacy.
- Suboptimal pad placement was overcome by using a higher defibrillation shock dose with a BTE waveform.

Physio-Control Discussion Points:

- Shock success depends on a number of factors:
  - Vector of the shock (pad placement) and resulting current shunting (current going to areas other than the heart)
  - Location of the heart (axis deviation or degree of ventricular enlargement placing the myocardium in a suboptimal shock location)
  - Shock strength or size (e.g., more current)
  - Shock waveform (e.g., longer duration)

  } Two major determinants of energy (joules)
- The results from this experimental study show that even minor changes in pad placement (< 3 cm) can impact shock success.
- Using a defibrillator with an available 360J energy setting (BTE waveform) can be another way to mitigate poor shock success due to factors such as suboptimal pad placement.
- Despite the use of similar peak currents (between the 200J and 360J waveforms), the defibrillator that delivered 360 joules resulted in higher shock success in each pad position.
- In general, shocks to humans for cardiac arrest will result in higher success rates than observed in this study. The results indicate how human shock success rates with these therapies (pad position and shock dose) will relate to each other; the therapy with the highest success rate in this study can be expected to provide the highest in humans; the therapy with the lowest success rate in this study can be expected to provide the lowest in humans.
- One way to improve shock success is to place the electrode pads in optimal positions. In this study, all three pad positions on the swine visually appear to provide current pathways through the heart. Yet there were significant differences in defibrillation success rates between them. Human beings vary more in size and shape than swine. Therefore, optimal position likely varies even more in humans and there is no straightforward way to identify it. Even if rescuers could identify ideal pad position, consistently placing pads in those exact positions during resuscitation is impractical due to the rush and stress of the situation, and the infrequent and sporadic training of rescuers.
- The results from this study are similar to other published research on defibrillation energy, unrelated to pad placement, that show a statistically significant benefit in shock success when using defibrillation protocols (BTE waveform) that escalate to 360 joules vs. those that do not.[6-8]

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8. Walker R, Koster R, Sun C, et al. Defibrillation probability and impedance change between shocks during resuscitation from out-of-hospital cardiac arrest. *Resuscitation*. 2009;80:773-777.

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