

# Clinical Summary

## Comparison of Rectilinear Biphasic Waveform Energy Versus Truncated Exponential Biphasic Waveform Energy for Transthoracic Cardioversion of Atrial Fibrillation

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### Purpose:

Randomized study to compare success of the Biphasic Truncated Exponential (BTE) and Biphasic Rectilinear (BRL) waveforms for conversion of atrial fibrillation (AF).

### Methods:

- 145 patients with AF were prospectively randomized to receive treatment with either a BTE or a BRL device.
- 74 patients received BTE shocks delivered with a LIFEPAK® 12 defibrillator with ADAPTIV™ biphasic technology using a step-up protocol of 50, 100, 150, 200, and 360 J. Seventy-one patients received BRL shocks with a biphasic Zoll M Series defibrillator using a step-up protocol of 50, 100, 150 and 200 J.
- If cardioversion was not successful, a crossover shock at the maximum energy setting of the other waveform was given.

### Results:

- “Success rates at 50, 100, 150, and 200 J were not significantly different” (see table).

Comparative Cumulative Success Rates of Cardioversion				
BTE Group		BRL Group		
Joules	Percent Success	Joules	Percent Success	P Value
50	54	50	61	0.43
100	84	100	79	0.45
150	92	150	93	0.81
200	97	200	97	0.97

- Two patients in the BTE group failed to convert at the maximum energy of 360 J. They also failed to convert in cross-over shocks by the BRL maximum energy of 200 J.
- Two patients in the BRL group failed to convert at the maximum energy of 200 J. Both patients were successfully converted in cross-over shocks by the BTE maximum energy of 360 J.

- No patients had more than first-degree burns and none required hemodynamic support after cardioversion.

### Conclusion:

- Joule for joule there is no significant difference in effectiveness of BTE (Medtronic) and BRL (Zoll) waveforms at energy settings up to 200 J.
- “Despite the limitations (of the present study), there may be clinical situations in which the truncated exponential device, which has significantly higher maximum energy output (360 vs. 200 J), can be used successfully when the rectilinear device cannot restore normal rhythm, such as obese patients with AF or patients in ventricular fibrillation who are refractory to defibrillation attempts.”

### Discussion Points:

1. This study, along with the Al Atawi<sup>1</sup> and Neal<sup>2</sup> studies, demonstrates that at the same energy settings, the Zoll and Medtronic biphasic waveforms have equivalent efficacy. The results of this study add to the growing body of clinical data that directly contradict competitor claims that: 1) “Joule for joule, Zoll’s biphasic shocks are more effective than Medtronic biphasic shocks”, and 2) “Medtronic devices escalate to 360 J only because they are less efficacious at lower energy levels.”
2. This study provides additional support for the benefit of biphasic energies greater than 200 J.
3. The crossover shock data from this study, in combination with that from the other two direct comparison AF studies, build a compelling case for selecting a defibrillator with the capacity to escalate beyond 200 J biphasic.

Across the three independent biphasic to biphasic comparison studies, Medtronic 360 J crossover shocks were successful after a failed 200 J Zoll shock in 5 of 7 (71%) patients, while all Zoll 200 J shocks were unsuccessful (5 total) when 360 J failed to cardiovert (see table).

(over)

	Kim et al (present study)	Al Atawi et al	Neal et al	Combined Results**
Medtronic 360 J after failed Zoll 200 J	2/2	3/5	N/A	5/7 (71%)
Zoll 200 J after failed Medtronic 360 J	0/2	0/2	0/1	0/5 (0%)

\*\* Statistically significant (Fishers exact test p=0.028)

**There are no published reports of a 200 J biphasic shock successfully cardioverting a patient after a failed 360 J biphasic LIFEPAK Medtronic shock.**

- The present study showed the relative ease of both biphasic waveforms in successfully cardioverting a random set of patients. However, there are known subsets of patients where successful conversion rates are much lower at 200 J. Khaykin et al<sup>3</sup> studied a population of “difficult-to-cardiovert” patients and found that with the same BTE waveform at 200 J, only 43% of the patients were cardioverted. Escalating to 360 J raised the success rate to 69%. What level of success could one expect for Zoll 200 J maximum energy shocks in this same group of difficult-to-cardiovert patients?
- Studies like this are much more difficult to conduct with patients in ventricular fibrillation (VF), particularly VF occurring during out-of-hospital cardiac arrest. However, these authors suggest that “patients in ventricular fibrillation who are refractory to defibrillation attempts” could benefit from energies above 200 J. Will some patients with out-of-hospital VF benefit from 360 J shocks? The exact percentage may never be definitively known, but data from AF studies like this and the Khaykin study, indicate that 200 J will not be sufficient to treat some patients. Although we cannot predict what size shock any given patient will need, we do know that difficult-to-cardiovert and difficult-to-defibrillate patients exist.

**References:**

- Al Atawi FO, Gurevitz, O, Ammash NM, Malouf JF, Bruce CJ, White RD, *et al*. Comparison of biphasic waveforms for the transthoracic conversion of atrial fibrillation: The Mayo Clinic Cardioversion Center Experience. *Circulation* 2003; 108: IV-647.
- Neal, S, Ngarmukos, T Lessard, D Rosenthal, L. *American Journal of Cardiology* 2003; 92(7):810-814. Comparison of the Efficacy and Safety of Two Biphasic Defibrillator Waveforms for the Conversion of Atrial Fibrillation to Sinus Rhythm.
- Khaykin Y, Newman D, Kowalewski M, Korley V, Dorian P. *Journal of Cardiovascular Electrophysiology* 2003; 14(8): 868-872. Biphasic versus monophasic cardioversion in shock-resistant atrial fibrillation: a randomized clinical trial.



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