

# EVALUATION OF INJURY CRITERIA FOR PREDICTING COMMOTIO CORDIS

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## INTRODUCTION

Commotio Cordis (CC) is defined as sudden cardiac death (SCD) due to blunt thoracic impact without any observable thoracic or cardiac damage. It is the second leading cause of death in youth sports, taking the lives of 85% of those afflicted (Link, 2005).

Research has provided substantial insight into the pathophysiologic mechanism of CC. It can result from a chest wall impact that occurs in a 10-30 ms vulnerable window during cardiac repolarization, corresponding to the upstroke of the T wave on the ECG. Rapid rise of left ventricular (LV) pressure following impacts directly over the heart results in SCD due to induction of ventricular fibrillation (VF) mediated through resultant myocardial stretch and activation of stretch-sensitive ion channels. Survival is most dependent on institution of early resuscitation including cardiac defibrillation. However, even early resuscitation cannot revive all those affected (Maron, 2005).

The need to identify the most appropriate injury criterion for CC is the next critical step. Currently the only reliable method to test the efficacy of chest protectors in preventing CC is in an animal model. This method requires a large number of animals in order to achieve statistical significance. The goal of the current study is to investigate two

possible injury criteria: force and LV pressure. The hope is one of these criteria will be an effective injury criterion for predicting induction of VF from blunt, thoracic impacts.

## METHODS

Twelve anesthetized swine ranging from 21 to 45 kgs were impacted using a free flight projectile according to the protocol established by Link et al. (2001). The impacts were timed to occur during the vulnerable period of the cardiac cycle (10-30 ms before the T-wave peak) and aimed directly over the LV. A lacrosse ball attached to an aluminum shaft instrumented with an Endevco 7270 20K accelerometer (Figure 1) was used as the impact projectile. This system provided accurate impact locations, consistent velocities, and a site for mounting the accelerometer.



**Figure 1:** Impact Projectile

Intracardiac pressures were recorded with a Millar Mikrotip catheter placed into the LV via the femoral artery, and the data was collected at 1 KHz using

AD Instruments PCLab Chart software. Accelerometer data was collected at 10 KHz using a TDAS data acquisition system (DTS, Inc) and was filtered using a CFC1000 filter within Diadem (National Instruments).

Specimens were impacted at velocities from 13.4 to 26.8 m/s. The acceleration and pressure data were recorded for each impact along with the incidence of VF. A biphasic defibrillator was used to restore sinus rhythm if VF was induced. Testing continued once normal cardiac physiology was restored.

The Animal Research Committee of the Tufts-New England Medical Center reviewed and approved the protocol.

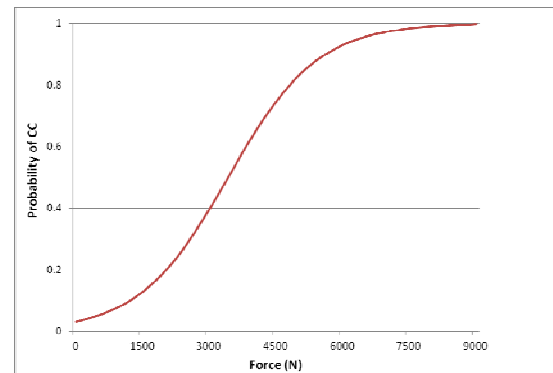
## RESULTS AND DISCUSSIONS

Logistic regression analysis was performed independently for both LV pressure and peak force with incidence of VF as the dependant variable (SPSS v15.0). Both peak LVP and peak force predicted the incidence of VF. However, peak force was a more accurate predictor compared to LVP (Table 1). Figure 2 represents the injury risk curve for the predictive levels of CC in terms of level of force.

This study represents the first prospective investigation into the validation of impact force as an injury criterion to predict the incidence of CC. Previous research has indicated that other criteria, such as the viscous criterion and peak chest compression, might also have significant predictive abilities (Bir, 1999). Future research could compare these variables to peak force to determine the most appropriate criterion.

**Table 1:** Statistical Results of Logistic Regression Analysis

	$\alpha$	B	X <sup>2</sup>	p	R <sup>2</sup>
<b>LVP</b>	-2.25	.003	9.5	.002	.096
<b>Force</b>	-3.43	.001	22.3	< .001	.270



**Figure 2:** Logistic regression graph for peak impact force

## CONCLUSIONS

This study shows that peak impact force has the ability to predict the occurrence of CC more reliably than peak LV pressure. Further research is required to identify the most appropriate predictors of CC for blunt thoracic impacts. These data will be critical in the future design of a reliable mechanical model of CC.

## REFERENCES

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