

# STRIKING DYNAMICS AND KINETIC PROPERTIES OF BOXING AND MMA GLOVES

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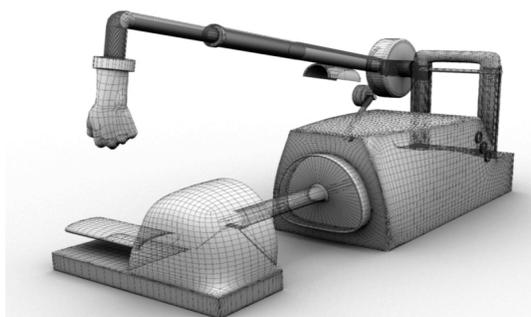
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## INTRODUCTION

Mixed martial arts (MMA) has recently grown in popularity. Furthermore, very little quantitative research has been performed to investigate striking dynamics and the kinetic parameters of devices used for both striking and receiving strikes. This investigation compared the strike dynamics of some sample boxing and MMA gloves in terms of peak force, time under load and patterns of force output given a constant energy input.

## METHODS

A repetitive impact tester was custom built and used to expose gloves to long-term (5 hour) repetitive impact tests with impact data collected every 30 minutes. The impact tester consisted of a pendulum arm falling under gravity to transmit a constant energy through the gloves mounted on a model fist, which impacted an instrumented anvil. Impacts were collected via a pancake force transducer (AMTI, Massachusetts, USA) sampled at 2160 Hz. Impact data was filtered using a 2<sup>nd</sup> order dual pass Butterworth filter with cutoff frequency set at 100 Hz, supported with residual analysis.



**Figure 1:** Representation of pendulum impact tester used during data collection.

## RESULTS

A general finding was that the MMA glove created a peak strike force that was approximately 5 times the peak force of a boxing glove and that this peak was achieved 4-5 times faster than the boxing glove (Figure 1).

A comparison of different model boxing gloves showed interesting outputs on the force-time plot, where a dual peak of force were observed given a single impact from the pendulum (Figure 2).

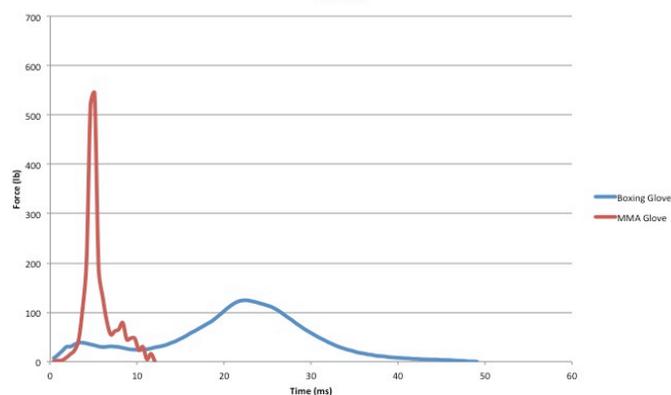
## DISCUSSION & CONCLUSIONS

The composition (density, stiffness, amount of padding) plays a role in the strike dynamics of the gloves. The MMA glove, 4 times lighter and much thinner than the boxing glove, created a more forceful and sharper strike than the boxing glove. The dual peak observed was speculated to be due to a non-homogenous composition where foams of varying densities

and thicknesses are layered in the boxing glove. Model 1 exhibited this dual peak pattern and as observed in Figure 3 the amplitude of peak force is much lower than Model 2, which exhibited a single peak. It is speculated that this initial peak was due to the outer (and more compliant) padding which bottoms out and reduces the amplitude of the second larger peak.

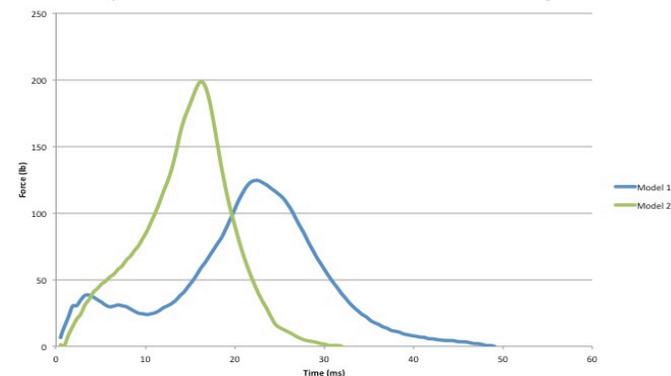
Given that the injury to tissue is dependent upon time of exposure strain rate, force magnitude; to name a few; this unique data will support discussion regarding issues of delivering force and energy versus protecting against applied force and energy.

**Comparison of Force-Time Plots Between 16 oz Boxing and 4 oz MMA Gloves**



**Figure 2:** Typical force-time histories comparing boxing and MMA gloves showing the difference in amplitude of peak force and time in which force is applied.

**Comparison of Force-Time Plots of Various Model 16 oz Boxing Gloves**



**Figure 3:** Comparison of 16 oz boxing gloves. The blue plot shows a single peak of force from the impact of the pendulum whereas the green plot shows two peaks of force.

## ACKNOWLEDGEMENT

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