

Blade Angle Affects the Peak Force and Work Associated with Sharp-Force Trauma

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Introduction: Thoracic stabbing injuries are a common cause of death in Canada [1], and forensic investigators are required to interpret bone injuries to identify the amount of force required to make them. The magnitude of the force is typically described qualitatively as mild, moderate, or extreme. Recently, a custom pneumatic device was developed capable of simulating sharp force trauma and recording quantitative measures including peak force and work. The goal of this work is to identify whether force and work are significantly affected by the orientation of the knife blade relative to the rib.

Methods: Porcine side ribs were carefully defleshed and cut to a length of 105mm. Individual ribs were then placed, convex side up, into a holder which prevents the rib from rotating during impact. The holder was positioned to ensure the blade tip hit the center of the apex. Each rib was then impacted with a paring knife at 5m/s. The knife was perpendicular to the rib; however, the blade was angled at 0, 45, or 90° to the long axis of the rib. Force and angular displacement time histories were recorded for each test, from which peak force and work were calculated. One-way ANOVA and pair-wise t-tests were performed to evaluate whether average peak force and work were dependent on blade angle.

Results: A total of 24 ribs were impacted; however, two 0° tests were excluded because they did not hit the rib cleanly in the center of the cross section. Thus, there were 22 total tests at 0 (n=6), 45 (n=8), and 90° (n=8). Results are shown in Figure 1. The peak force increased with increasing angle: 132.9 ± 34.9 (0°), 349.3 ± 181.4 (45°), and 430.3 ± 298.6 N (90°). Work to failure was greatest at 45° (4.0 ± 0.7 J), followed by 0° (3.0 ± 1.8), then 90° (1.1 ± 0.5). ANOVA indicated that work was significantly affected by blade angle ($p=0.0001$), but peak force only had a trend toward significance ($p=0.052$). Pairwise t-tests indicated that the work in the 90° tests was significantly different from both 0 and 45° ($p<0.025$).

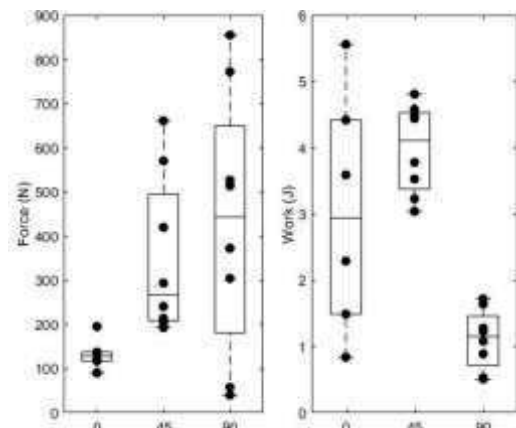


Figure 1: Boxplot and Scatter of Force and Work at the Different Angles

Discussion and Conclusions: Blade angle was found to have a significant effect on work; however, only a trend to significance was observed with peak force. These results suggest that forensic investigators need to consider blade angle as a factor when evaluating sharp-force trauma injuries.

References:

- [1] Government of Canada, S. C., 2018, "Homicide Victims, Primary Methods Used to Commit Homicide" [Online]. Available: <https://www150.statcan.gc.ca/t1/tb11/en/tv.action?pid=3510006901>.