The Bone Impactor: An Instrumented Device for Simulating Blunt- or Sharp-Force Trauma

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Introduction

Forensic scientists must interpret bony fracture patterns to determine the force required to create an injury [1]. Unfortunately, only a qualitative determination of force (mild, moderate, severe) is currently possible [1]. The Bone Impactor (Fig.1) is an instrumented machine developed to simulate blunt- and sharp-force trauma injuries while recording applied force and implement velocity. The data measured using this device will allow a more quantitative relationship between force and trauma to be established.

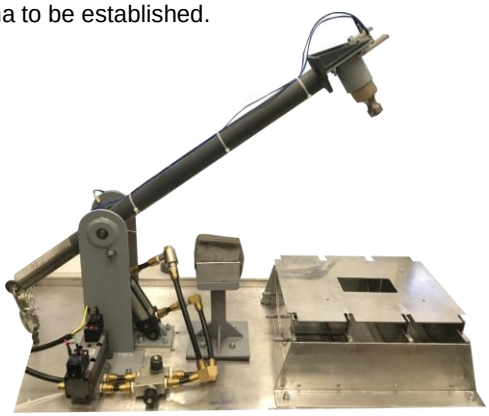

Fig. 1: Bone Impactor Machine

Design Objectives

The machine (Fig 1) has been designed to satisfy the following criteria:

- Tool motion follows an arc, similar to an overhand swing, at speeds comparable to those obtained in human trials [2].
- Interchangeable implements so that both blunt and sharp tools can be studied (Fig. 2).
- Record time histories of force and velocity throughout a test.

Fig. 2: Sharp and blunt interchangeable tools

Machine Overview

Tools are attached to a pivoting lever arm. A pneumatic actuator drives the arm so that the velocity can be adjusted by controlling the airflow. The maximum linear velocity at the tool is 6 m/s. Arm velocity is derived from the arm position, which is measured using a rotary encoder.

A uniaxial piezoelectric load cell, with a maximum compressive force of 4.4 kN, connects the tool to the end of the lever arm. The load cell was placed at the tool, rather than beneath the testing specimen, in order to provide a more direct measure of the force being imparted to the specimen. This design choice also reduced the mass supported by the load cell, which reduced inertial noise during impact.

A National Instruments Data Acquisition System, programmed with LabVIEW software, controls the Bone Impactor. The force and velocity time histories can be recorded at up to 20 kHz (Fig 3).

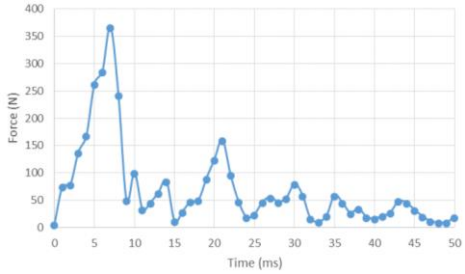

Fig. 3: Force-time history of blunt impact of ¾" wide x ¼" thick piece of pine

Conclusion

The Bone Impactor is capable of simulating overhand swings at up to 6 m/s, while recording force and velocity. The modular design also allows a variety of blunt and sharp tools to be studied. The device is currently undergoing validation tests. Once these tests have been completed, biological testing can begin. Future quantitative investigations of bony impact will allow forensic scientists to build relationships between force and fracture.

References

[1] Nolan G. Quantification of forces involved in stabbings (PhD thesis). University of Leicester; 2015.

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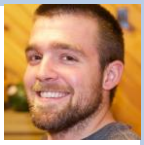
Further Information



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