H25 Propeller Impacts: Injury Mechanics and Bone Trauma

Anne M. Kroman, MA, University of Tennessee, Department of Anthropology, 250 South Stadium Hall, Knoxville, TN 37996; Tyler A. Kress, PhD, BEST Engineering, 2312 Craig Cove Road, Knoxville, TN 37919; and David J. Porta, PhD, Bellarmine University, Department of Biology, 2001 Newburg Road, Louisville, KY 40205*

After attending this presentation, attendees will gain an understanding of the mechanics of injury in propeller impacts to the human body as they relate to speed of impact and propeller design.

This presentation will impact the forensic community and/or humanity by increasing the understanding of the correlation between impact speed and resultant fracture patterns, and the correlation between propeller design and soft and osseous tissue damages.

Numerous swimmers are injured or killed every year due to impact from boat outboard motor propeller strikes. Even boats traveling at relatively low speeds can create large amounts of soft tissue and bone damage. These wounds often bear characteristic patterning of longitudinal impact zones in both bone and soft tissue; useful to both forensic pathologists and anthropologists in determining cause and manner of death. While propeller impacts are fairly easily recognized, the exact injury mechanics have received comparatively little attention. Differences in propeller design, boat velocity, and motor rpm influence the resultant injury patterns – leading to conflicting opinions in the forensic community over the "classification" of propeller impact as either blunt or sharp trauma.

Injury mechanics associated with propeller impacts were investigated, as well as the differences created by *speed* and a *propeller alternative design*. Ten cadaveric specimens were used for the testing (4 human and 6 porcine). Two tests were conducted per specimen, resulting in a total of 20 tests. The human tests were conducted at speeds of approximately 5 to 7.4mph (with increasing propeller spinning speeds respectively). The porcine tests were conducted at speeds of approximately 1, 5, 7.4, and 15 mph (with propeller spinning speeds increasing respectively again). Two different propeller designs were examined in testing. One was a standard propeller design, with three blades of aluminum. The other was a "ring-style propeller" – a propeller in which all the tips of the three blades are joined together by an aluminum ring.

The human cadavers (recently deceased) were frozen post-mortem as "fresh specimens" (i.e. no preservatives were used) until thawed at the time of the tests. Specimens were refrigerated until a few hours before testing. Just prior to testing, each human specimen was fitted with swim attire and a mask. Porcine cadaver specimens were euthanized shortly before testing. Testing was performed in a unique facility at The University at Buffalo, part of the State University of New York system. The Center for Research and Education in Special Environments (CRESE) provides a controlled environment that allows for safety, privacy, and repeatability such that real-world boating accidents could be simulated as closely as possible. The facility houses a toroidal pool that is 8' wide, 8' deep, and 200' in circumference. The water was maintained at 73 degrees F throughout the testing. A large centrifuge is located at the center of the pool and a platform is suspended over the pool from the centrifuge arm. An outboard boat motor was mounted to the platform. Instrumentation allowed for inputting and recording of motor travel speed and RPM. The motor was towed at 5 or 7.4 mph around the pool to the impact site for the human tests. The motor was towed at 1, 5, 7.4, and 15 mph around the pool to the impact site for the porcine tests.

Each of the tests was recorded with standard and high speed video (1,000 f/s). The high speed video was essential in understanding the mechanics of the injury and the interaction between the cadaver and the boat propeller. A difference was seen between the standard propeller and the ring style propeller in how the body was engaged by the blades.

Post-test dissection showed classic multiple parallel lacerations and numerous vertebral, rib, and skull fractures for the standard prop tests. At these low speeds the standard prop gives rise to incisive, sharp-force injuries that affect both soft and osseous tissues (skull, face, ribs, scapula, and vertebra). The standard prop, in longitudinal impacts at just under 8 mph, produced life-threatening injuries. The ring-style propeller imparts more of a scooping-like blunt trauma that, at worst, results in large lacerations and avulsions that appear, in the four human cadavers, to only affect the superficial tissues. That is, at these low speeds, the ring-style propeller seems to kind of "bite" or "scoop" the superficial skin and fatty layers while primarily scooting/pushing along the muscles and bones, whereas the standard prop penetrates deeper and into the muscles and bones.

The injury mechanisms behind propeller strikes are complicated, as are most violent impacts to the human skeleton. However, controlled experimental testing can provide an increased understanding of the effects of speed of impact, as well as propeller design. Testing showed that both of these variables do

 ** Presenting Author*

influence the injuries to soft tissue, and the fracture patterns in bone.

Bone Trauma, Experimental Testing, Propeller Impact