
E20 Biomechanical Assessment of Various Punching Techniques

*Peter Hofer, MD**, Department of Forensic Medicine and Forensic Neuropsychiatry, Salzburg 5020, AUSTRIA; *Jiri Adamec*, Institute of Forensic Medicine, Munich 80336, GERMANY; *Stefan Pittner, PhD*, University of Salzburg, Salzburg, AUSTRIA; *Fabio Carlo Monticelli*, Interfaculty Department Forensic Pathology, Salzburg 5020, AUSTRIA; *Matthias Graw*, Institute of Forensic Medicine, Munich 80336, GERMANY; *Jutta Schoepfer*, Institute of Forensic Medicine, Munich 80336, GERMANY

Learning Overview: After attending this presentation, attendees will understand the injury risks associated with various punching techniques. In addition, attendees will learn the essential factors influencing the intensity of such blows and the basic physical quantities describing the punch efficacy.

Impact on the Forensic Science Community: The assessment of violent acts and the resulting injuries is an important competence for forensic medical experts. However, the literature on this subject is often limited to case reports and the basis of the expertise to a large extent subjective. This presentation will impact the forensic science community by providing quantitative data to base assessments of punches and further studies are planned.

Introduction: Punches are a common kind of body violence and are assessed on a regular basis in expert witness testimonies. Apart from the correspondence between the asserted assault and the documented injuries, questions are often raised on behalf of the punch intensity and other biomechanical aspects regarding the specific act of violence. There seems to be a general agreement that a strike with the palm of the hand is less than a fist punch, though robust biomechanical data to support this opinion are missing.

Fifty individuals (male and female) participated in the study, and the main anthropometric characteristics (height, weight, handedness, etc.) were recorded. Study participants performed three kinds of punches: with the fist, with the flat of the hand, and so-called “karate-chops.” As a target, a punching pad was fastened onto a KISTLER force plate (10kHz). In the course of the measurement session with each volunteer, three strikes of each kind were performed, both with the dominant and the non-dominant hand. The punch velocity was established by using a high speed Olympus® camera (2kHz). Afterward, the highest impulse (obtained by the integration of the force-time curve) was selected for further analysis. Also, the effective mass of the punches was computed (using the impulse and the punch velocity). Ultimately, the data underwent several statistical tests to identify significant differences between the outcomes of each individual.

Significant differences between the dominant and the non-dominant hand, as well as between male and female volunteers, were ascertained. The Friedman test showed significant differences among the different punch types for all the parameters on a 0.05 significance level. The post-hoc testing, according to the Nemenyi method, revealed that the fist punch parameters differed from the two other punch types in both the dominant and non-dominant hand. A significant difference between the palm strike and the karate chop was determined for the maximum force and the impulse of the dominant hand and for the impulse, velocity, and effective mass of the non-dominant hand. Also, a relationship between body height and impulse, and even more so between body weight and impulse, in all punching types was detected.

The presented data constitute a solid basis for the comparison of the most relevant physical parameters of different punching techniques and improves the understanding of punch and strike dynamics under various circumstances. A large-area contact leads to lower stresses in the affected tissues and thus a lower risk for contact injuries. The same amount of (maximum) force of a strike with the whole palm and finger area contacting the head leads to a significantly lower injury risk compared to a fist punch with the same force amplitude (with force being transmitted almost exclusively through the knuckles of the bases of the long fingers). It is known that the risk of an injury of a punch to a high degree depends on the assailant’s technical skills. It appears that the impact force and thus the injury risk is higher in skilled persons because of them being able to transfer more of the striking arm’s mass into the punch.

Biomechanics, Punching, Forensic Medicine