Effects of punching on load distribution inside a boxing glove - experimental assessment toward injury prevention

PhD proposal by Cristina-Ioana Vinescu
Department of Health Science and Technology, SMI,
Aalborg University, Aalborg, Denmark

July 30, 2016

Abstract

Along with head injuries, hand fractures are among the most common injuries suffered in boxing. Categorized as a combat sport, the increased level of danger results in high damages on the athletes body, thus situating boxing as the sport with the highest injury rate. Used as the outlet of force, a boxers hand gets injured regularly, but the reson behind why only some athlets are affected is still unclear. Few studies have been conducted on the injury mechanism resulted from a punching movement. The distribution of impact forces at the knuckles during a punch and the pressure patterns can be used to assess the injury risk of an athlete [3]. It has been demonstrated that the manner in which the punch is delivered affects the chances of getting injured. The present PhD project will investigate the effects of landing a punch on the hand structures by analyzing the pressure distributiom along the knucles while wearing boxing gloves. The results will provide the starting point for the biomechanical assessment, where the boxers upper extremity will be evaluated. The information regarding muscle activation, force achieved and pressure distribution around the knuckles will compute a biomechanical model. The results from this study may affect the way boxers train and also may be used to maximize their performance.

Scientific Content

Background

Barton et al 1997 [1] state that one quarter of all fractures concern the wrist joint or the hand, with injuries involving the carpus, metacarpals and phalanges being the most communally encountered in sport related activities. Depending on the practiced sport, the upper extremities are affected and injured in a different manner. The combat sports are viewed as having an elevated level of danger compared to other athletic sports [5]. Even though studies report that the most common injury in boxing is in the head and neck region [7][3] Pappas et al 2007 [5] finds that upper extremities injuries are almost three times more occurring than injuries in the head and face regions.

The "boxer's fracture" is a terminology applied to fractures located at the fifth metacarpal which are caused by punching with a closed fist[1]. This fracture is qualified as an intentional injury encountered mostly in fistfights or after punching a hard object[4]. The wrist and hand are divided in Loosemore et al 2015[3] in three distinct areas:

1. First area contains the thumb along with the scaphoid and the carpometarcarpal joints [3]
2. The second area contains the wrist and the carpal bones for the second to the fifth fingers [3]
3. The third area contains the metacarpal and phalanges bone for the second to the fifth fingers [3]

In Loosemore et al 2015 [3] it is also reported that 39% of upper extremity injuries are located in the thumb region, followed closely by 35% of the injuries in the wrist joint and 26% implicate the metacarpal bones. Only a third of the injuries located in the metacarpal region are fractures the rest are classified as soft tissue injuries. However, to all of the injuries a large amount the force was needed [3].

Smith et al 2000 [6]and Waliko et al 2005 [7] found a similar findings, where the mean peak force ranged between 4345N for heavy-weighted boxers to 2625N for middle-weighted boxers. The mean hand velocity was recorded at 9.14m/s though

no relation between the velocity and the peak force was discovered. However, the manner in which the punch was delivered, rigid wrist versus a flexed wrist, seem to affect the injury rates [7].

The force profiles combined with hand velocity and pressure distributions during a punching motion need to be analyzed and comprehended. Information regarding what impact force and the distribution of such forces are correlated with a high injury rate can provide vital information in regards to injury prevention methodologies. Consequently the present study aims at designing a method of analyzing the relationship between force profiles and injuries in the knuckles.

Research objectives

Junge et al 2009 [2] reviewed the injuries occurring in the Summer Olympic Games in 2008, boxing being the forth sport with 15% injury rate per athlete. The recovery time from injuries debilitate almost 8% of boxing athletes. It also records the highest injury rate in a competition, with 94,7% injuries, higher than hockey. However, it has the lowest rate of injuries during training [2]. Taking into consideration these facts, the costs for the recovery of boxers are also high.

The main aim of this PhD project is to investigate a boxer punch impact on the structures of the hand and wrist by means of biomechanical methodologies. To reach the proposed aim, the present study will incorporate the assessment of load distribution in the knuckles during punching with the muscle activity. Information is limited regarding the nature and the manner in which the impact forces, resulting from punching, differ from boxer to boxer. Moreover, data regarding specific force profiles that cause damage to the hand structures are still needed. Therefore, the present PhD study will provide the needed method of analyzing the distribution of pressure, forces and muscle activity during punching.

The current PhD study hypothesizes that by analyzing the impact forces, contact area of the knuckles and the boxer's technique, one can aim at achieving high impact forces while slightly changing it's punching technique in order to increase the total knuckles contact area. Achieving this optimum punch assumes that according to Loosemore et al 2015 [3]the risk of hand injuries can be lowered.

Key methods

1. Knuckle pressure distribution: A hand pressure system (Novel) will be attached on the knuckles and will collect data from each individual knuckle. The data will provide the information regarding the magnitude and distribution of the punch pressure and load between the knuckles and the contact surface.

2. Surface EMG: Surface EMG from the forearm and arm will be collected during a full force rear and lead punch.

3. Kinematics/ kinetics: Three dimensional force sensor will be placed inside a punching bag and will provide data about the kinematic outputs of the punch (force and moment). A 3D motion capture system will record the movement and with the kinematic data from the force sensor will provide the basis of a biomechanical model. Using specialized software (Anybody) kinematics and inverse dynamics will be rendered.

4. Intervention: Optimization of factors such as impact force, contact area and punching technique.

Bibliography

[1] Nicholas Barton. Sports injuries of the hand and wrist. *British journal of sports medicine*, 31(3):191, 1997.

[2] Astrid Junge, Lars Engebretsen, Margo L Mountjoy, Juan Manuel Alonso, Per AFH Renström, Mark John Aubry, and Jiri Dvorak. Sports injuries during the summer olympic games 2008. *The American journal of sports medicine*, 37(11):2165–2172, 2009.

[3] Mike Loosemore, Joseph Lightfoot, Jay Meswania, and Chris Beardsley. Unique method for analysing pressure distribution accross the knuckles during boxing. Technical report, PeerJ PrePrints, 2015.

[4] Sibel Mercan, Metin Uzun, Aygun Ertugrul, Irfan Ozturk, Basaran Demir, and Tevfik Sulun. Psychopathology and personality features in orthopedic patients with boxer's fractures. *General hospital psychiatry*, 27(1):13–17, 2005.

[5] Evangelos Pappas et al. Boxing, wrestling, and martial arts related injuries treated in emergency departments in the united states, 2002-2005. *Journal of sports science and medicine*, 6(Special Issue 2):58–61, 2007.

[6] MS Smith, RJ Dyson, T Hale, and L Janaway. Development of a boxing dynamometer and its punch force discrimination efficacy. *Journal of sports sciences*, 18(6):445–450, 2000.

[7] TJ Walilko, David C Viano, and Cynthia A Bir. Biomechanics of the head for olympic boxer punches to the face. *British journal of sports medicine*, 39(10):710–719, 2005.