THE EFFECTIVENESS OF TAEKWONDO HEADGEAR IN REDUCING IMPACT FORCE

By

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ABSTRAK

Taekwondo dikategorikan sebagai salah satu sukan yang mempunyai hubungan secara fizikal dangan pihak lawan, Sukan ini dikategorikan sebagai sukan yang lasak dan terdedah atau cenderung kepada kecederaan. Tendangan adalah teknik yang paling banyak digunakan di dalam perlawanan. Ia boleh menghasilkan daya impak yang sangat tinggi dan menyebabkan kecederaan. Banyak kaedah pencegahan telah diambil untuk mengurangkan risiko kecederaan termasuklah memakai penutup kepala. Ramai yang masih ragu-ragu tentang keberkesanan penutup kepala taekwondo dalam mengurangkan daya impak. Kajian ini dijalankan untuk meningkatkan pemahaman tentang cirri-ciri penutup kepala dalam mengurangkan daya impak. Objektif kajian ini adalah untuk mengkaji cirri-ciri penutup kepala yang dipilih dalam mengurangkan daya impak. Platform daya impak yang terhasil adalah daripada *"medicine ball"* yang dilepaskan pada ketinggian yang berbeza. Daya diukur tanpa mengunakan penutup kepala, menggunakan penutup kepala yang baru dan menggunakan penutup kepala yang terpakai. Penemuan awal menunjukkan bahawa penggunaan penutup kepala boleh mengurangkan sejumlah besar daya yang terhasil dari "medicine ball". Keputusaan yang didapati menunjukkan perbezaan daya yang signifikasi di antara tidak memakai penutup kepala dan memakai penutup kepala bagi setiap kawasan penutup kepala yang diuji.

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ABSTRACT

Taekwondo is categorized as a contact sports, it is rough and prone to injury. Kicking is the most used technique in the tournament. It can produce a very high impact force and causing an injury. Many prevention methods have been taken to reduce the risk of injury including wearing a headgear. Many still doubt about the effectiveness of headgear in reducing impact force. This study is conducted to improve the understanding about the properties of headgear in reducing impact force. The objective of the study is to examine the properties of a selected brand of taekwondo head gear in reducing impact force. A force platform is used to measure the impact force produced from releasing a medicine ball at different height. A force is measured without a headgear, with a new headgear and with a used headgear. Preliminary findings showed that using a headgear can reduce significant amount of impact force produced from a medicine ball. The result showed a significant amount of force reduction for a comparison between without headgear and with headgear for each of the tested area. The comparison between new and used showed a significant difference in the amount of force reduction for the big ear release and small ear release canal. It can be concluded that time is not affecting the frontal and occipital region of the headgear, but it is affecting the effectiveness of big ear-release canal and small ear-release canal. From this study, it can be concluded that there are internal properties of headgear in reducing impact force. It is effective in reducing impact force for a range of force applied.

Perbandingan di antara penutup kepala yang baru dan yang terpakai menunjukkan pengurangan daya yang signifikan bagi kawasan pelepasa telinga kecil (*small ear-release canal*) dan kawasan pelepasan teinga besar (*big ear-release canal*). Daripada kajian ini dapat disimpulkan bahawa masa tidak memberi kesan kepada kawasan hadapan dan belakang penutup kepala tetapi masa memberi kesan kepada kawasan pelepasan telinga kecil dan kawasan pelepasan telinga besar. Daripada kajian ini juga dapat disimpulkan terdapat cirri-ciri dalaman penutup kepala yang dapat mengurangkan daya impak. Ciri-ciri ini juga berkesan dalam mengurangkan daya impak yang tertetu yang dikenakan kepada penutup kepala yang diuji.

CHAPTER 1

INTRODUCTION

1.1 .1 TAEKWONDO

Sport taekwondo can be divided into sparring and poomsae events. From technical view, poomsae or hyeong is a series of fundamental movements, particularly defense and attack. Sparring or kyorugi is the act of practicing combat against a live opponent. The term martial art is applied widely to the different disciplines. Karate and taekwondo emphasize striking with feet and fists. Judo, jujitsu, and other similar styles emphasize grappling (wrestling type maneuvers), joint locks, and throwing techniques.

There are permitted and none permitted area that can be kicked in taekwondo. According to the rules and regulation of World Taekwondo Federation competition Taipei 2014, scoring targets for kicks are to the facial and body areas, scoring targets for hand strikes is to the body area only. The facial are includes the entire face and neck from the top of the forehead, in front of the ears, down to the collar bone while the body area includes the area covered by the chest protector from the collarbone to the navel for the front part and to the posterior axillary line on the side. Three points will be given for the kick to the head, and four points will be given for the turning kick to the head.

Start in 1977 and 1980 the rules for Taekwondo competition is three points for "knockdowns with a strong kick to the body" and "strong kick to the face" (World Taekwondo Federation Competition Rules and Interpretation, 2014). The definition of strong kick is very subjective because only strong kick judges can give point to the athlete.

Taekwondo athlete that involved in sparring is compulsory to wear headgear, mouth guard, chest guard, and arm and shin guard to prevent injuries. Headgear helps to prevent minor abrasions, lacerations, and contusions. It is controversial whether headgear can prevent serious injury such as concussion or intracranial injury (Kruk, 2014).

1.1.2 IMPACT FORCE

The definition of impact force is an impact of shock applied over a short period of time, when two or more bodies collide. In simple explanation is force resulting from the collision of two or more objects. Force can be influenced by energy. Energy is an ability or capacity to do work. The Formula for the impact force from a falling object is the mass of an object times by acceleration of gravitational pull (9.81 m/s/s) and multiply by the height of a falling object to reach the ground(F= m g h).

1.1.3 HEAD GEAR

Headgear for sports has been used for a long time. In the 1970 the US Government identified a high number of deaths and spinal cord injuries due to head-to-head impacts in American football (Kruk, 2014). However, the most important thing it helps to decrease the severity of head injuries in American football. It has similar objective when headgear was introduced in taekwondo in the 1980 (Bellinger, 2010). The main concern was the head injuries and the death due to athletes falling and hitting their head on the hardwood floor, concrete or by another impact force.

Based on the previous study, it showed that none of the approved model head gear has the ability in reducing impact force that might be causing severe injuries such as brain hemorrhages and skull fracture. There is none of headgear in any sport can prevent concussion but it supposes to reduce the impact force (Kruk, 2014) (Pieter, O'Sullivan, & Fife, Diminish Impact Attenuation Properties of Taekwondo and Boxing Headgear, 2014) (Fife, O'Sullivan, & Pieter, 2013).

Resent American Society for Testing and Material, impact attenuation standards provide a pass or fail criterion for low-energy (50 g) and high-energy (150 g) head impacts. According to recent study, all the tested taekwondo headgear were failed for both low-energy and high-energy impacts. Beside that magnitude differences for each location front, back, left and right were identified across all helmets that may represent influences of

headgear property characteristics such as stiffness and thickness (O'Sullivan, Fife, Pieter, & Shin, 2013).

1.1.4 HEAD INJURIES

Recently in August 2014, News about National Collegiate Athletic Associations reaches $75 million settlement in the concussion lawsuit. The news was about former American football athlete Adrian Arrington who claimed that he had suffered five concussions during his college career, the repeated trauma has caused him memory loss, migraine headaches, depression and seizures. He filed a personal injury claim against the National Collegiate Athletic Associations. Resulted from the claim, Arrington and three other former athletes would be paid $5,000 for being deposed as part of the lawsuit, while eight others would receive $2,500 for being named plaintiffs. The players' lawyers would receive $15 million and up to $750,000 for the expenses. The National Collegiate Athletic Associations also would contribute $5 million toward concussion related research, according to the settlement. National Collegiate Athletic Associations, schools also would have to follow certain procedures when their players suffer a head trauma. For example, an athlete would not be allowed to return to the competition on the day they have a concussion.

Total injuries rates in taekwondo competition for elite men varied from 20.6/1000 per athlete exposure to 139.5/1000 per athlete exposure. For elite women, the rates varied from 25.3/1000 per athlete exposure to 105.5/1000 per athlete exposure. About one-third of all injuries (29.6%) in the men were to the head and neck region. In women, 15.2% of

injuries were to the head and neck. Point estimates of rates of head injuries and concussions were found to be higher in taekwondo than in other contact sports such as football (soccer) and American gridiron football. 56.9% of all injuries in the men and 49.8% in the women were mostly caused by the turning kick (Pieter, Fife, & O'Sullivan, 2012).

1.2 SIGNIFICANT OF THE STUDY

There is none of the approved model head gear can prevent concussion (Kruk, 2014) (Pieter, O'Sullivan, & Fife, 2014) (O'Sullivan, Fife, Pieter, & Shin, 2013). Data about properties of the head gear in reducing impact force is not publicly available. Only one study in safety performance evaluation of taekwondo headgear was conducted in 2013 to compare different of headgear in reducing resultant linear acceleration of headgear model. Some of the coaches claimed that headgear is less convinced in preventing concussion (Petters, 2002). More study is needed to study the properties of headgear in reducing impact force. This study is conducted to understand the properties of headgear in reducing impact force for a specific area of the headgear. It also investigates different impact force applied to the headgear on the force platform. The force platform will be measured the force reduction by the headgear. In addition, these studies only investigate the force reduction by a specific area of the headgear. This study is needed to investigate the properties of the material used for headgear.

OBJECTIVE OF THE STUDY

Under such circumstances, our present study was done with the follow objective:

GENERAL

To examine the properties of a taekwondo headgear for a selected brand in reducing impact force.

SPECIFIC

i. To examine the frontal area of used and new taekwondo headgear in reducing of impact force.

ii. To examine the occipital area of used and new taekwondo headgear in reducing of impact force.

iii. To examine the small ear-release canal area of used and new taekwondo headgear in reducing of impact force.

iv. To examine the big ear-release canal area of used and new taekwondo headgear in reducing of impact force.

1.3 RESEARCH HYPOTHESIS

i. Ho : There is no significant difference in the amount of force reduction with and without used taekwondo headgear.

Ha : There is significant difference in the amount of force reduction with and without taekwondo headgear.

ii. Ho : There is no significant different in the amount of force reduction for the frontal area of taekwondo headgear.

Ha : There is significant in different in the amount of force reduction for the frontal area of taekwondo headgear.

iii. Ho : There is no significant different in the amount of force reduction for occipital area of taekwondo headgear.

Ha : There is significant in different in the amount of force reduction for the occipital area of taekwondo headgear.

iv. Ho : There is no significant different in the amount of force reduction for the small ear-release canal of taekwondo headgear.

Ha : There is significant in different in the amount of force reduction for the small ear-release canal area of taekwondo headgear.

v. Ho : There is no significant different in the amount of force reduction for the big ear-release canal area of taekwondo headgear.

Ha : There is significant in different in the amount of force reduction for the big ear-release canal area of taekwondo headgear.

CHAPTER 2

LITERATURE REVIEW

2.1 IMPACT FORCE

An injury was defined as any physical complaint caused by a transfer of energy that exceeds the body ability to maintain structural and functional integrity during competition or training session. Injuries are most commonly associated with the musculoskeletal system, which includes the muscles, bones, joints and their associated tissues, such as ligaments and tendons. Regardless of where the injury occurs within the body or the seriousness of the injury is commonly classified level one or two which is acute and chronic.

In terms of physics context, any person familiar with taekwondo is aware that its techniques, when correctly performed, are able to create devastating results such as injured an opponent. Five factors contribute to the generation of these results. They are reaction force, concentration, equilibrium, breath control and speed. They may be considered basic principles of taekwondo and all five must usually be present to optimize a technique (Him, 2007). Kazemie et al (2009) found that injuries in taekwondo associated with competitor experience level, age, gender, area in the body, and mechanism of injury sustained. All these factors contribute to the injury happen and depend on the person to execute the technique and force to an opponent.

According to Newton's third law, for every action force there is an equal and opposite reaction force. Force always comes in pair known as action-reaction force pair. When a car crashes into a wall with the force 1000 kg, the wall will return a force of 1000 kg. If an opponent is rushing towards an individual at high speed, then the individual throw the slightest blow at his opponent's head. All the reaction force will be turned back to the opponent. Then, the force acting on the opponent would be sum of the force from the slightest blow from the individual plus the force from the opponent's attack with high speed. The impacts when the two forces combined are quite impressive. Some reaction force is only effect the individual for example a punch with the right fist is aided by pulling back the left fist to the hip.

Concentration is the action or power of focusing all one's attention. By applying the impact force onto the smallest target area, it will concentrate the force and increase its effect. For example, the force of water coming out of a water hose is greater if the orifice is smaller. The blows in taekwondo are often concentrated onto the site of the open palm or to the crook of the fingers. Concentration is done in two ways, first is to concentrate every muscle of the body, particularly the bigger muscles around the hip and abdomen. Which theoretically are slower than the smaller muscles of other parts of the body towards the appropriate tool to be used at the proper time and the second way is to concentrate such mobilized muscles onto the opponent's vital spot. This is the reason why the hip and abdomen are jerked slightly before the hands and feet in any action, whether it is attack or defense.

Balance is the most important in any type of sports. In taekwondo, it deserves special consideration. By keeping the body always in equilibrium, that is, well balanced, a blow is more effective and deadly. Conversely, the unbalanced one is easily toppled. The stance should always be stable yet flexible, for both offensive and defensive movements. Equilibrium is classified into both dynamic and static stability. They are so closely inter-related that the maximum force can only be produced when the static stability is maintained through dynamic stability.

Controlled breathing not only affects on stamina and speed but can also condition a body to receive a blow and augment the power of a blow directed against an opponent. Through practice, breath stopped in the state of exhaling at the critical moment when a blow is landed against a pressure point on the body can prevent a loss of consciousness and stifle pain. A sharp exhaling of breath at the moment of impact and stopping the breath during the execution of a movement tense the abdomen to concentrate maximum effort on the delivery of the motion, while a slow inhaling helps the preparation of the next movement. An important rule to remember is never inhale while focusing a block or blow against an opponent. Not only will this impede movement but it will also result in a loss of power.

Mathematically, the maximum kinetic energy or force is obtained from maximum body weight and speed and it is all important that the body weight be increased during the execution of a blow. No doubt the maximum body weight is applied with the motion of turning the hip. The large abdominal muscles are twisted to provide additional body momentum. Thus the hip rotates in the same direction as that of the attacking or blocking

tool. Another way of increasing body weight is the utilization of a springing action of the knee joint. This is achieved by slightly raising the hip at the beginning of the motion and lowering the hip at the moment of impact to drop the body weight into the motion.

Speed is the most essential factor of force or power. Scientifically, force equals mass multiplied by acceleration according to formula ($F = ma$) or ($P = mv^2$). Where F= force, m=mass, a=acceleration, P= pressure, and v^2= velocity x velocity. According to the theory of kinetic energy, every object increases its weight as well as speed in a downward movement. This principle is applied to this particular art of self-defense. For this reason, at the moment of impact, the position of the hand normally becomes lower than the shoulder and the foot lower than the hip while the body is in the air.

Taekwondo uses strikes and blocks, however, it is emphasis on high kicks. In fact 80% of the competitive techniques used in taekwondo are kicks (Serina & Lieu, 1991). This situation cause increases in head impacts and possible concussions as a result of the rule changes between 2004 and 2011 (Koh & Yang, 2011). Especially turning kick is the common kick in a match will produce linear acceleration with a range 60.5-217.3g (Fife, Pieter, O'Sullivan, Cook, & Kaminski, 2011). While the Head Injury Criterion of the same kick was 128.4–1608.7. Head Injury Criterion refers to the risk of a person sustaining a head injury as a result of impact acceleration of the head. A Head Injury Criterion of 1000 is suggested to be life threatening (Pellman & Viano, 2006).

Risk of the head impact also depend on the technique demonstrates, for example swing like motions tend to produce the highest distal segment velocities, high resultant linear acceleration and head injury criterion . As the force imparted to the head is dependent on both the mass involved and the change in velocity, the effective mass in each of the techniques compared should be considered (WaliLko, Viano, & Bir, 2005). Examples of technique are the turning kick, the spinning hook kick, the spinning back kick and the hook punch. The clench axe kick technique was reported to be implicated in cerebral concussion in taekwondo because of linear acceleration from the kick is 33.3 ±11.1 g that exceed the uppercut in boxing 24.1±12.5 g (Fife, Pieter, O'Sullivan, Cook, & Kaminski, 2011).

Score point will be reward when athletes able to deliver sudden bursts of explosive and very powerful movements within a very short time period (Kazemi, Casella, & Perri, 2009). According Coral, Isaac and Manfred (2011) one of the faster kicks that allows athletes to score more points and is the most used kind of kick in taekwondo is the turning kick. This is because the measurement is based on reaction and execution time. It is also relate with weight. This is because taekwondo championships are organized according to weight categories. Category weight have a strong effect on kick performance especially reaction time (Isaac, Coral, Octavio, & Javier, 2012). However the impact force is similar if the execution distance is the same for all groups. Different performance time will result from different execution distances because the distance influences the kick performance (Kazemi, Casella, & Perri, 2009).

Sudden bursts of explosive produce by kicking to the head can cause death. This was reported by a reporter Jason Leopold (19991). The news about 25 year old Michael Richard Strube, a rock star collapsed and died after being kicked in the head by his opponent during a match Saturday evening at the Anaheim Convention Center. He was a second degree black belt who had studied the Korean martial art for about six years and take part in the eight annual United States Open Taekwondo Championship on Friday and Saturday. The competition is open to black belts only. In addition, the same accident occur in Singapore in July 2009 when a 17 year old boy, Vincent Tan, died after being kicked on the neck during a taekwondo competition organized by the Greenville Residents' Committee and the Singapore Taekwondo Gymnasium Singapore recently hosted the first ever Asian Youth Games ("AYG") 2009. His opponent kicked him in the neck and caused a main blood vessel to his brain to rupture. First aid was immediately administered to Tan, but he never gained consciousness, fell into a coma, and died in hospital (Lau, Suresh, Rajah, & Tann, 2009).

Previous findings were supporting the facts about the dangers of head and progression of the sport in the Olympic Games and other world-class events (O'Sullivan, Fife, & Pieter, 2014). Swing-like motion tends to produce highest distal segment velocity such as turning kick, the spinning hook kick and the spinning back kick. The force imparted to the head is dependent both on the mass involved and the change in velocity the average head blow to the head is 1.22 per minutes (Fife, O'Sullivan, & Pieter, 2013).

According to recent study (Sarah, Norman, Wagner, & Buz, 2008) this experiment situation almost same. An impact head is drop automatically to measure the impact force. Sample use in the study is place on the plate.

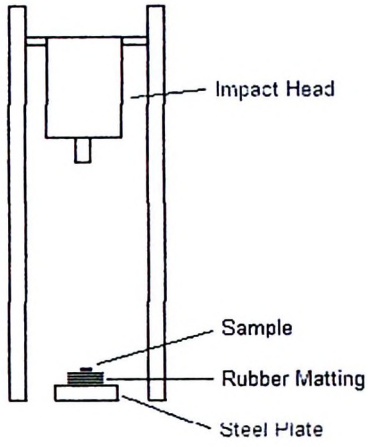

Figure 2.1 Instrumentation set-up for impact tests (Sarah, Norman, Wagner, & Buz, 2008)

2.2 HEADGEAR

The first headgear was introduced in 1985 and officially used in the 1987 World Taekwondo Federation in the World Championships in Barcelona, Spain. This safety precaution was taken because in 1983 World Taekwondo Championships reported on injuries two mandibular fractures and one fracture of the zygomatic bone (accompanied with a protruding eye ball) were observed. Although no protective headgear was used during the 1983 World Championships, it must be understood that the area of protection provided by taekwondo headgear does not cover the zygomatic bone.

In the study by P McCrory (2009), beside head gear can reduce concussion, mouth guards also have a definite role in preventing dental and oro-facial injury. Biomechanical study have shown a reduction in impact forces to the brain with the use of headgear and helmets, but these findings have not been translated to show a reduction in concussion incidence. Concussion is a type of traumatic brain injuries caused by a pump, a blow or a jolt to the head that can change the way your brain normally works (Concussion and Mild Traumatic Brain Injuries, 2014). Concussion can be fully recovered quickly. Age is the most influencing factor in the recovery process. It can be slower among older adults compared to young children, and teens. Individual who had a concussion in the past are also at risk of having another one. It also takes a longer time to recover, if the individual have another concussion. According to nonfatal traumatic brain injuries related to sports and recreation activities among persons aged less than or equal 19 years in United States, from 2001 until 2009, the emergency department reported all visits for sports and recreation--related injuries inactivity combat sport including martial art is 50,639 case out of 2,981 case are traumatic brain injuries (Gilchrist, Thomas, Xu, McGuire, Coronado, & Gilchrist, 2011).

Improved protection may also help reduce the chances of head and neck injuries However, to this date, only one report (O' Sullivan, Fife, Pieter, & Shin, 2013) on the safety performance of the official World Taekwondo Federation approved taekwondo headgear exists, indicating that none passed the standardized impact attenuation testing (i.e.,ASTM F-2397-04) (Pieter, Fife, & O' Sullivan, 2012). Headgear available in market is does not provide an adequate protection for severe head injuries as well as concussion.

According to Pieter, O'sullivan and Fife, 2014 taekwondo helmets have a limited lifespan. Thus, headgear should be changed after a certain period of use. Headgear get worse at attenuation impact after 30 or more impacts of low magnitude impacts 54 J (Kruk, 2014).

A few studies have demonstrated the efficacy of martial arts safety equipment in reducing force from a blow. Furthermore Moffitt and Lieu tested 14 commercial martial arts headgear for their impact attenuation properties to protect from head injury from a simulated blow or simulated fall onto the sparring surface. They conclude that the protective properties of the different headgear are variable (Moffitt & Liue, 1995). Thicker headgear is generally more protective, but all protection can be overcome with increased velocity of the simulated strikes. Eighty percent of competitive techniques used in taekwondo have been reported as kicks and these kicks have a high risk for injury potential (Serina & Lieu, 1991). The turning kick is reported to be the most frequently used kick in full contact taekwondo competition (Koh & Watkinson, 2002).

Taekwondo is a contact sport which involves both upper and lower extremities in striking situations. Like in other sports, injuries are a common incident which can occur during training or competition. Regardless to the protection equipments that are compulsory according to rules associated with other measures example groin guard, forearm guards, shin guards, hand protector sensing socks, a mouth guard and a head protector, the injuries rate in taekwondo is still remains high compared to other sports and to other martial arts such as karate, kung fu.

In 18th century, the first head gear is documented, during a game of American football between an army group and a navy group. It was introduced to protect the player's head by reducing the force of any impact to the head. Since then headgear or helmets have been used in many combat, racing and collision sports, such as boxing, taekwondo, motor cross, cycling, American football and ice hockey. Taekwondo is officially listed as a sport in Olympic Games in 2000 Olympic Sydney. Before gain admission to the Olympics, a variety of equipment modifications had to be introduced to meet the requirement for the safety standards of the International Olympic Committees. During the middle 1980s, shin guards, forearm guards, and headgear were gradually adopted as required safety devices. The safety devise is used to prevent injury. This is because it contains absorber to absorb the impact force produce during a kick.

Many martial arts participants never actually participate in tournament competition but there is still significant injury risk during training and practice. Taekwondo has been shown in martial arts to have the highest risk of injury and multiple injuries in the same athlete (Zetaruk, Violan, Zurakowski, & Micheli, 2005). Prevention is very important in the combat sports of martial arts. Taekwondo, which usually has highest injury rates, also is one of the only martial art forms that consistently require protective equipment (Zetaruk, Violan, Zurakowski, & Micheli, 2005). Competitors must wear headgear, chest protectors, groin protectors, shin pads, hand and foot padding, and mouth guards. The equipment often protects the offensive athlete, but is less effective in protecting the defensive athlete receiving the blows (Zemper & Pieter, 1989) (Waller, Feehan, Marshala, & Chalmers, 1994) (Birrer, Birrer, Son, & Stone, 1986).

Football experiences the same situation as taekwondo sport. During ball impacts in football, none of the headgear provided attenuation over the full range of impact speeds. Head responses with or without headgear were not significantly different and remained well below levels associated with mild traumatic brain injury. In head to head impact tests the headgear provided an overall 33% reduction in impact response. The football headgear models tested did not provide benefit during ball impact. This is probably because of the large amount of ball deformation relative to headband thickness. However, the headgear provided measurable benefit during head to head impacts (Withnall, Shewchenko, Wonnacott, & Dvorak, 2005).

Nowadays taekwondo getting develop. This can be seen from 80's when the corner judges use to mark the score on a piece of paper and hand it to the centre referee, then about 10 years ago judges pressing controllers and monitors showing the score and video replays, then about 4 years ago after the Olympics they trailed electronic body pads and these pads were used on the last Olympics. An electronic headgear was designed. The electronic head gear works in a similar fashion to the Protective Scoring Systems (PSS) already in use at WTF-sanctioned events where body shots are scored through a computerized system rather than at the judge's discretion. The electronic headgear system will only detect foot techniques to valid scoring areas of the headgear. The newly designed electronic headgear has been tested at the Trelleborg Open, The official test events of the Electronic Headgear will only comprise the junior categories of each competition, as it is not a WTF approved product yet and cannot be used in official competitions that are rewarded with ranking points. The tests are being carried out in order meet the WTF's aspirations of having the gear used at Rio 2016 as expressed by WTF President, Chungwon Choue (Paul, 2014). The

latest intervention of headgear taekwondo is face shields headgear. The function of face shield is to protect noses and eyes. Face shield made from a clear plastic as a material, because it is transparent and lighter than older style wire cages. The shields are attached to headgear with Velcro straps and sit off the face for ventilation.

2.3 INJURIES

The skull bone and brain tissue are the principal contents of the human head. The human skull lays eight areas from lateral view such as frontal, temporal, parietal occipital, zygomatic, mandible, maxilla and sphenoid bone. Skull does not loose strength with advancing age (Mosekilde & Mosekilde, 1986) (Yoganandan, Mykiebust, Cusick, Wilson, & Jr, 1988)(Yoganandan, Pintar, & Klienberger, 1998). This is because of the relatively larger proportion of the rigid cortical and the inner and outer tables. The thickness of the skull bone is various for all side. The temporal region is thinner compared to the parietal, occipital and frontal area (Yoganandan, Kumaresan, Voo, & Pintar, 1996). This is base on geometry of the temporal region is concave inwards (medially) and the parietal region is convex. In side impacts, both regions are often involved in absorbing external force. Despite geometrical differences, these regions are constitutionally identical.

Investigations are done to identify the high-magnitude head impacts in taekwondo. A previous report suggests a Head Injury Criteria 15 concussion threshold of more than 200 (Fife, Pieter, O'Sullivan, Cook, & Kaminski, 2011). The turning kick is of concern because it is the most common technique and most common cause of concussion in taekwondo. It has a high resultant head linear acceleration and Head Injury Criteria value is around 159.

It was observed that the predominant site of head impact was the temporal region. Similar results on the frequency of site of impact were found in rugby and Australian Rules Football (Fife, Pieter, O'Sullivan, Cook, & Kaminski, 2011).

Some times can be strange because some lesser trauma, with less energy, cause more severe injury. This can be explained by the force produce from the motion of the kick give influence. The rotational motions tend having serious injuries rather than linear acceleration or deceleration (Gennarelli & Thibault, 1982) (Duhaime, Gennarelli, Thibault, & Bruce, 1987). The turning kick and axe kick is the popular kick during fight and cause concussion (Koh & Cassidy, 2004) (Koh & Watkinson, 2002). Because the axe kick is typically aimed at the front of the head and reported to cause severe brain injury, that is, brain hemorrhage (Cohen, Margolin, Moscovici, Paldor, & Itsh, 2010). The turning kick use rotational from the hip, ankle and knee to execute it. This will increase the production of force.

True rotation of the brain within the skull will occur when the centre of rotation is internal to the skull (Wilkins, 1997). Example of the situation is when axial as in a blow to the side of the jaw, or possibly in an oblique strike by a car or in a rolling fall. The motion transferred from skull to brain via shear rather than compressive forces. The close veins are potentially stretched more and there is likely to be less damping by cerebrospinal fluid, so kinetic energy stored in the brain may be loss in tearing these vessels. Similar shearing forces may operate within the brain causing diffuse brain injury. Lesser true rotational forces are needed than linear forces to cause such injury. True rotation might be rare in simple falls but explain rare cases of severe injury.

Other sport that usually have concussion injury mention the same thing about headgear such as US Soccer Federation's Sports Medicine Committee finds no evidence that wearing headgear is beneficial to players, and is concerned that it might actually lead to more injuries. Headgear should not be a substitute for proper medical evaluation and treatment of concussions, and should not be used to hasten return to play after a concussion. Again, the Sports Medicine Committee is concerned that this headgear gives players a false sense of security. Further, members of the Sports Medicine Committee have also been informed that Fifa- Medical and Research Centre, Fédération Internationale de Football Association sports medicine committee, has concluded that this headgear does not tangibly improve safety for players.

Some studies showed, protective head gear equipment may reduce incidence of severe head and facial injury. As reported from the 6th World Taekwondo Championship, during a time where head gear, instep, shin, and gloves were not listed as mandatory equipment, 4% of competitors and 9 of 13 injuries admitted to the hospital casualty ward were located on the head and neck (Siana, Borum, & Kryger, 1986). Despite this promising report, recent longitudinal taekwondo injury data from Canada reports that the most common locations of injury treated during competition is the head and lower extremity, as has been confirmed by prior studies (Kazemi, Chudolinski, Turgeon, Simon, Ho, & Coombe, 2009). The turning kick has been determined to be involved in the majority of injuries sustained in competition (Beis, Pieter, & Abatzides, 2007). This may be due to the fact that the turning kick is the fastest kick (Del, Franchini, Del, & Pieter, 2011) compared to other taekwondo kicks and also the most frequently used kick in competition. The most common mechanism for injury in taekwondo during competition has been from defensive

kicks or offensive kicks (Kazemi, Chudolinski, Turgeon, Simon, Ho, & Coombe, 2009). The head and lower extremity are largely covered by protective equipment.

There are study on a baby doll model to measure acceleration is needed to cause brain injury by using accelerometer that implant in the doll (Brown & Minns, 1993). Base on the result for concussion only needs 9G can cause injury and for subdural hemorrhage about 285 G. 428 G is recoded when the model head impact on surface during shake. It has been said that packed earth can still causes 200 G deceleration after a 1.2 meter fall (Reichelderfer, Overbach, & Greensher, 1979). In kicking to the head there is kinetic energy produce. At impact some of this energy is dissipated as work of compressing the headgear as the kicking decelerates When wearing headgear which is soft surface. It absorbs more kinetic energy and less by the head.

CHAPTER 3

METHODOLOGY

3.1Study Design

This study involved a pre-post intervention design. It was designed to measure the force the force in three conditions: without headgear, with new headgear and used headgear. The test was repeated for four different sides of the headgear. Data was collected and analyzed using Quatro Jump software.

3.1.2 Inclusion Criteria

The selected headgear in this study must have fulfilled the following criteria:

I. Selected brand of new and used taekwondo head gear with same brand.

II. Both headgear are medium in size (Withnall, Shewchenko, Wonnacott, & Dvorak, 2005).

III. The used taekwondo headgear has been used for three years or more.