Factors Pertaining to Head Injuries in Taekwondo

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Introduction

Taekwondo, literally meaning “way of the fist and foot”, originated in Korea several thousand years ago as means of self-defense. The meaning of the word does not imply a lifestyle of violence or aggression, but rather, a systemic fighting method and art form that transcends simple physical techniques. Discipline and respect are emphasized in the *dojang* (training studio) and students are taught to bow humbly to their instructors before and after training. The hands and feet are used both offensively and defensively through kicking, punching, and blocking techniques. Despite its traditional origins and training methods, taekwondo has quickly evolved into its current state as an Olympic sport practiced throughout the world. In modern times, it has rapidly developed beyond the traditional model of martial art, with increasingly less emphasis on philosophical thinking and greater emphasis on physical fitness and athleticism.

International level competitions have been taking place since at least 1973, with the first international Taekwondo World Championships in Seoul, Korea.[1] Since its introduction as a demonstration sport in the 1988 Olympic Games, it has gained tremendous popular appeal throughout the world. The 2004

Olympic Games in Athens marked the first year for taekwondo as an official medaling sport, bringing together more than 120 athletes representing 60 different countries to participate in sparring.[2]

Taekwondo is a high impact sport, with a high risk of injury resulting from the practice and implementation of kicks, punches and blocks. Athletes are required to wear shin, instep, and forearm pads, all worn under the *dobok*, or uniform, as well as a chest guard, helmet, and a single or double sided mouth guard (Figure 1). Additionally, men are required to wear a groin protector or cup. Referees are required to check each article of padding to ensure they are properly fitted before the start of a contest.

Figure 1: A taekwondo competitor in full competition gear.

Scoring is highly subjective and determined by corner referees, who tally points (either by hand or by electronic tallying system) based on both power and technique; for an athlete to score, they must implement a powerful, unguarded strike to the predetermined scoring area, which includes both the torso and head. The recently expanded scoring area does not include the spine or neck due to the high risk of permanent or life threatening injuries that may result from strong impacts to those areas.

The intention of this article is to provide further insight in determining the main causes and possible prevention of common injuries in taekwondo with a

particular emphasis in understanding factors that lead to head injuries. A recent study by Burke suggests that while head injuries account for more than half of the injuries during competition, injury rates for taekwondo generally compare favorably to other mainstream competitive sports.[3] An alternate study by Kazemi and Pieter suggests that lower body contusions and sprains are the most common source of injury as opposed to injuries to the head and neck.[4] Many factors can be attributed to injury rates during competition, and the discrepancy in data can be attributed differences in experience, gender, age, and weight class of the competitors, as well as differences in tournament rules and regulations.

This analysis of taekwondo tournament regulations, injuries, and practice will include my personal experiences as a competitor, class instructor, committee head for the UC Open Taekwondo Championships, referee, and point scorer. I am a second degree black belt and a member of the UC Berkeley Taekwondo Team, as well an instructor for introductory and intermediate courses. The studies presented in his paper chronicled injuries using written surveys and injury reports presented by medical staff or through the analysis of video recordings taken at the time of injury. Having witnessed many injuries, knockouts, and technical knockouts during my ten years of taekwondo experience, I hope to provide a new perspective in the discussion of head injuries that previous researchers may not have access to in their analysis of taekwondo competitions.

Scoring Zones, the Striking Implement, and Existing Safety Measures

The kicks and punches developed in taekwondo are meant for self-defense; their original intentions are meant to injure or immobilize an opponent into submission or defeat. As a sport, a careful balance must be struck between demonstrating the technique and athleticism of the participant while maintaining the safety of competitors. Though safety regulations and padding prevent the majority of injuries, the nature of the techniques used for scoring are still meant to injure opposing players, an aspect of the sport that can be downplayed but never completely removed from competition. The sport of taekwondo has been developing for more than thirty years on the international level, as have corresponding safety measures to prevent athletic injuries.

The scoring zone, according to current rules of USA Taekwondo, the national governing body presiding over taekwondo competitions in the United States, states, "Attack by fist and foot techniques on areas covered by the trunk protector are permitted. However, such attacks shall not be made on the part of the spine," and to the head, "This area is the face excluding the back of the head, and attack by foot techniques only is permitted".[5] The trunk includes the space between the armpit and the pelvis, while the face includes everything above the collarbones with the exception to the back of the head. The expansion of the scoring zone, introduced only in recent years to include the flank or dorsal aspect of the ribcage, was originally limited to the front and sides of the trunk protector, and athletes are now expected to guard

almost all aspects of their upper body during a match. In an adult black belt division match, a clean strike to the body counts as one point, while a blow to the head counts as two points.[6]

Though hand techniques to the facial region are strictly prohibited, the current rules are unclear regarding kicks aimed toward the throat. Under these rules, a successful kick to the side or front of the throat is technically legal and can be counted as a head kick. The spine and back of the head are explicitly prohibited from being attacked, but what about the back of the neck? The back of the neck, comprised of the vital cervical vertebrae, remains vulnerable to attack under these rules. This type of attack is generally considered dangerous and unsportsmanlike, but is not explicitly discussed in the rules, presenting a major safety hazard for competitors. It should be noted that referees can give warnings for repeated or violent attacks directed towards the neck region, but such warnings are at their discretion and not part of the official rules.

Though taekwondo involves both hand and foot techniques, the primary scoring implement is the foot, used most often in roundhouse kicks and axe kicks directed to the head. Hand techniques can also be scored, but are rarely performed because they are less effective and prohibited to make contact with the head. Additionally, hand techniques require a much closer range of attack compared to kicks, and leading with a punch without properly blocking can easily cause an athlete to be scored on. In the early history of taekwondo competitions, there was said to be a high rate of fatal or debilitating injury associated with hand techniques such as the backfist, that were aimed at the

temple, which is now protected by a helmet. Today, these techniques are discouraged through the penalty system by a full point deduction, or *gam-jeom*, for hand attacks to the head.[7] Under current rules, hand attacks can only be performed with a closed fist, and hand strikes are only allowed to make contact with padded areas of the body.

Though head contact is inherently encouraged due to point scoring conventions by senior division black belt rules, it is discouraged for junior competitors under the age of eighteen and for non-black belt, intermediate level competitors (color belts). Light contact is allowed in junior and color belt divisions but a knockout results in immediate disqualification of the attacker. Senior black belts have very different rules; they are awarded twice as many points for head attacks and an automatic win by knockout, thereby making the risk of head injury among senior level fighters significantly higher. The drastic difference in rules is tied to the legal implications and liabilities involved in fighting sports, as well as the importance of ensuring the safety and long-term development of junior competitors.

The helmet is the most important piece of equipment as it protects the brain case, the ears, and the insertion of the jawbones. It does not, however, protect the region of the face below the forehead line or any structures anterior to the ears. A mouth guard is required, and at the very least, must protect the upper teeth. The lack of protection around vulnerable areas such as the neck, throat, and face leaves them especially susceptible to attack, and attempts to injure opposing players are prevented by referees through a system of warnings and point deductions followed by

the disqualification of an offending player for multiple infractions. Aside from the existing rules, the players' protection is also reinforced by high density rubber floor mats that increase traction and absorb the shock of a fall.

Different scoring rules are sometimes applied to each division based on age, gender, and weight to enhance the safety of the players as well. USA Taekwondo rules typically divide competitors into eight weight divisions, though weight divisions are often grouped together for smaller tournaments or events in which competitors fight as part of a team. While some tournaments may emphasize higher safety standards by using eight weight divisions, others may combine weight classes in order to ensure that every competitor has a match.

The referee also acts as a safety check by ensuring beforehand that all players are wearing the proper equipment and by managing a match to preventing dangerous or illegal techniques from being performed. The referee controls the pace of the match by stopping and starting clock in the event of injury or equipment failure. In addition, players are not allowed to attack falling opponents and are kept within the boundaries of the ring by the referee, who is responsible for calling a break in the match when such events occur. The players' safety is largely dependent on the referee's ability to prevent injury by enforcing the rules of contact and ending the match at the appropriate time. Injury time outs are generally given for hard blows to the body or head, and if a player can no longer compete at the end of a slow, standing eight-count, the match is over.[8] In the event of an injury, only the referee can call a medical time out, and

medical staff should always be on hand to respond to such incidences. If a competitor is seriously injured, it is the referee's decision whether or not to stop the match prematurely in order to ensure the safety of the players.

Effectiveness of Safety Standards

A 2003 study by Burke et al. examined the effectiveness of different safety measures in recent taekwondo competitions compared to injury data in competitions from the 1988 US Olympic Team Trials. This retrospective study used data from the United States Tae Kwon Do Alliance national and regional tournaments, which included 2,498 competitors over the course of two competitions, to analyze injury rates based on the cause and location of injuries. The United States Tae Kwon Do Alliance has different regulations for padding and contact, which include higher safety standards than other regulating organizations. The tournaments required foam pads which covered a larger surface area on both the hands and feet, in addition to the standard full body padding. The rules for contact were also modified: there was either zero or limited head contact in the competitions, and no forceful kicks were allowed to the face. Differences between weight, age, and gender are not included in the study, and the data categorizes injuries in terms of their location.

The resulting data (see Table 1) showed that even with the change to stricter rules, contusions to the head and neck were still the leading causes of injuries that required medical attention. Nearly half of the overall injuries could be attributed to head and neck,

especially to the face.[9] This figure was followed by injuries to the lower limbs, and trunk. The rate of head injuries seems especially high until it is taken into consideration that Burke's study had a pool of 2,498 competitors. With all injuries combined, Burke et al. found that under the new rules, the injury rate was reduced to 0.4 per thousand competitors, as opposed to the 1988 US Olympic Team Trials, in which the rates of injury per competitor varied between 12.7 per hundred and 25 per thousand in earlier studies.[10] The Burke study shows that increased safety measures that discourage head contact and provide further padding to the striking implements can have a significant effect in limiting the number of overall injuries during a competition. Burke notes, however, that differences in the study groups under comparison may have skewed these results, as the Olympic Team Trials represent elite participants who are nationally and internationally ranked, as opposed to players who may have little to no competition experience and may be more or less liable to injury.

Table 1: Frequency of Traumatic Injury by Location.[11]

Rank	Location	Count
1.	Head and Neck	16
2.	Lower Extremity	8
3.	Trunk	5
4.	Upper Extremity	3
5.	Groin	1

Gender Differences and Injury

Differences in gender may also be a factor leading to head trauma. A study by Kazemi and Pieter reflects

a much higher injury rate at the advanced level compared to Burke's study, with an overall injury rate of 79.9 per thousand athlete exposures for men and 25.3 per thousand athlete exposures for women.[12] In Kazemi and Pieter's study, the gender of injured athletes was noted alongside the location and cause of injuries.

The data was tabulated using virtually the same method as the Burke's study, by implementing a prospective approach to analyze competition data of different injuries at the Canadian National Taekwondo Championships. Injuries were defined by the NCAA definition of time-loss from competition, and the Colorado classification for concussions[13] was used to determine the level of head injury based on loss of consciousness, confusion, and post-traumatic amnesia. The data revealed that while lower body contusions were most common type of injury in both men and women, men had a higher rate of injury to the head and neck, and were more than three times as likely to be injured during a competition.[14]

The authors offered few explanations for the cause of rate differences between men and women, but suggested that more research was needed to improve both competition rules and padding for competitors. The tournament that Kazemi draws data from also meets different safety standards compared to previous studies and has a minimum requirement that all competitors are at least 16 years of age and ranked as black belts. Considering the level and age of the competitors, head contact was encouraged as well as victory by knockout, so it would be expected that injury rates at this tournament are higher than those at other competitions studied.

The gender differences in taekwondo sparring competitions can potentially be attributed to a number of social and psychological differences, though little research has been done specifically with taekwondo to account for the gender difference in injuries. Do men and women kick differently? Dynamic spin kicks often result in head injuries, but do men use these techniques more than women? Anatomical and physiological differences may also account for this gap. Due to differences in bone density, overall body mass and the angle between the femur and tibia (Q-angle), men and women participating in taekwondo may be subjected to numerous different risk factors. Before any conclusions can be drawn, more research needs to be done chronicling the causes of injury resulting from gender differences, differences in techniques used by men and women, and potentially the social or psychological differences that occur while competing. A careful assessment of gender differences and their sociological implications across cultures should also be considered, as taekwondo is an international sport and these studies are mainly conducted in the United States and Korea.

Age Differences and Injury

The age of competitors may also be a factor in determining what types of injuries a competitor is likely to incur during a competition. Since rules vary not only with rank, but also with age, there are more precautions taken to ensure the safety of junior competitors. Junior competitors are generally discouraged from head contact, with no additional points scored for head shots, and penalties for

intermediate (color) belt junior competitors who attempt to kick to the head. Junior competitors are also more carefully protected by tournament rules because of the implications of long-term damage that can effect the overall growth and cognitive function of the athlete.

A 1997 study by Pieter and Zemper focused on the injury rates of children during three major taekwondo competitions: the Unofficial Junior World Championships in 1989, and the United States National Junior Taekwondo Championships in 1989 and 1990. The study used a prospective design, which involved reporting injuries on check-mark forms after they occurred. The study had one of the largest pools of participants, with 3,341 boys and 917 girls participating in all three competitions combined.[15] Injuries were defined as any incident that required medical treatment or evaluation at the tournament site.

The study by Pieter and Zemper concluded that even though injury rates for children were generally lower compared to senior competitors (95.07 per thousand athlete exposures vs. 105.45 per thousand) the risk of injury for per minute of competition time was higher than that of seniors. This statistic makes sense because junior athletes generally have shorter rounds (two minutes, as opposed to three) and fewer rounds per match. Junior athletes also tend to have smaller competition brackets based on their age category and weight, lending to fewer fights over the course of a competition day. Senior black belts, unlike juniors, are not grouped by age, so their brackets are substantially larger. Additionally, the authors of the study found that even though the chance of getting

injured between boys and girls were essentially the same, boys were more likely to be injured to the head and neck than girls (21.42 per thousand, vs. 16.91 per thousand).

Concussions and Head Trauma

If the majority of the aforementioned studies found that head injuries were only the second most common type of injury and not the first, what makes them more significant than injuries to the lower body? Simply stated, lower body injuries are expected to occur more frequently because they are the primary striking implement in taekwondo competitions and taken less seriously than a head injury. The area most frequently scored on is actually the body, not the head, yet injuries to the body are much less common. A kick to the head, in comparison to the body, has a much more devastating effect on an athlete and has more potential to cause a serious injury or knock out during a match.

A 2004 study by Koh and Watkinson utilized a combination of video footage, statistical data collection, and athlete interviews directly after a head trauma to determine the circumstances leading up to such injuries. A total of 1,009 head blows were scrutinized by observers to determine the situations that lead up to head injury, the severity of injury, and the occurrence of concussions. The researchers found that more than half of the total head blows were the result of a completely unguarded attack, and that "99% of the cases did not involve attempting or preparing evasive manoeuvres at the time of head impact… the majority of athletes were not trained to block

effectively, particularly against a kick to the head".[16] The study concluded that more effective headgear needed to be developed by equipment manufacturers, with a corresponding strong recommendation for the development of more effective blocking skills among athletes.

The study also suggests, that "athletes should practice blocking skills in concert with the offensive/defensive movement". This suggestion also includes blocking while attacking or evading the attack. Figure 2 depicts an example of blocking while attacking. Note that the competitor is holding both arms in a position to guard either the head or the body while attacking with a roundhouse kick.

Moving out of the line of attack is actually safer than guarding because of the lack of contact, but many athletes are inclined to only do one or the other—moving without guarding, or guarding without moving. The guard of taekwondo athletes is generally held lower compared to boxers or judokas, who primarily use hand techniques in their sports. Since most points are scored to the body and a kick to the head allows greater response time due to distancing, a taekwondo athlete is usually only guarding attacks to the trunk. A combination of blocking and evasion should be used in guarding attacks because the two types of technique can be done simultaneously.

Figure 2: Blocking while attacking.

Discussion

Given the high impact and collision nature of the sport, nearly all the studies mentioned previously found that injuries to the lower leg were most common among taekwondo practitioners. Since the foot is the main scoring implement, collisions between athletes' shins and misplaced blocks are expected. The figures of high injury rates to the lower leg showed little variation with age or gender, but had a direct

correlation in Burke's study to the enforcement of new regulations that required less heavy contact,[17] as well as the use of padding that had more coverage over the foot.

Head injuries were the second most common type of injury recorded. The biggest influence over head injuries were regulations that discouraged or prohibited attacks to the head by allowing only one point score for a clean head shot, such as in Pieter and Zemper's study, in which children had a separate set of rules from adults for scoring. The idea of having no head contact for children participating in taekwondo tournaments was encouraged by both Pieter and Zemper's study and Burke's study as better safety measures for preventing serious injury.

The study by Pieter and Zemper also suggested that athletes work more on developing blocking techniques before competition, which agrees strongly with Koh's finding that a high percentage of athletes who sustained head trauma did so as the result of failure to properly guard an attack. The lack of an athlete's ability to successfully block an attack to a vital area of their body suggests poor training that should require more emphasis on defensive maneuvers and evasion.

The traditional blocks taekwondo practitioners learn throughout their training simply do not apply effectively to sparring competitions. A "down block" used to guard the lower body from kicking attack is usually taught in a front stance, which increases the stability and power of the block but reduces the ability of the athlete to move dynamically, making them vulnerable to subsequent attacks. A body block or even a high block guarding the face is rarely used in the context it is taught. The application of such

techniques to sparring is limited by the speed and agility of the athlete. More effective sparring blocks, however, do use modified combinations of the traditional blocks, and are generally used to block the entire side of the body including the head. Figure 3 shows an athlete demonstrating a common guarding technique that covers both the body and the head simultaneously. Both arms can be used to guard either side of the body and the use of an open hand is meant to maximize the blocking area.

Though age and gender factor into the likelihood of head injury, young children show little distinction across genders, possibly due to the physiological similarity between boy and girls before puberty. Head injury in young boys was found to be more likely than young girls in Pieter and Zemper's study, coinciding with findings in the Kazemi and Pieter study that found disparities between men and women, though neither author was able to indicate the causality of such incidences. A young child's head also accounts for a greater percentage of their body mass, potentially increasing the risk of head injury, though no studies have correlated relative head volume with head injury.

In all studies of head injuries that resulted from taekwondo competitions, none continued to track participants after the date of injury, so very little data beyond the immediate severity of the injury, such as a head trauma resulting in deliriousness or black out, was available for study. The long-term damage attributed to head traumas were not recorded, but could be a potential topic for future research, as some traumatic injuries may be diagnosed after the fact due to the slow onset of conditions such as subdural hematomas and venous bleeding.

Figure 3: A common defensive position.

Since concussions occur in many sports, the suggested prevention methods are essentially the same. A 2001 study by Powell of the general causes and risks of concussion in sports found that head injuries could be prevented, yet not completely eliminated from sports by further evaluation of the biomechanical factors that contribute to each individual sport. Powell's findings included eliminating inherent hazards in the environment, technological

advances in equipment research, and enforcement of rules or regulations that minimized the risk of injury.[18] The study also suggests that "coaches must continue to review the up-to-date techniques for teaching appropriate skills that facilitate player performance and, at the same time, provide consistent protection from injury".[19] Powell's suggestions for injury prevention agree strongly with Burke, Koh, and Pieter and Zemper's findings of matching adequate training with minimizing environmental hazards in the playing field.

Conclusion

Taekwondo injuries resulting from head trauma, even in the presence of rules that prohibit head contact, are inevitable and can only be minimized, not eliminated from taekwondo competition. The results proving that contusions to the lower leg in all studies are the most common form of injury is no surprise, as most of the scoring in taekwondo is accomplished by striking or kicking from the lower body. Competitive taekwondo competitions would benefit greatly by further research into new preventative measures that aimed at limiting head contact while developing more effective defensive training techniques for practitioners.

The effect of gender as a factor in sustaining injuries remains a potential topic for future research. Few authors noted differences in the way men and women kick or strategize their attacks. Since anatomical, as well as psychological differences between genders vary greatly, it is possible that men and women function differently on a biomechanical

level or simply use different kinds of techniques. Men's weight classes are also significantly heavier than those of women, by up to twenty-five pounds in the heavyweight division,[20] so the momentum behind a head kick from a man may be substantially higher than that from a woman in the same weight category for their respective gender. There may also be a correlation between body mass, gender, and head injuries, but more data is needed to determine if any real conclusions can be made from this assumption.

In my personal experience with taekwondo competitions, the greatest improvement in preventing head injuries has been focusing on learning how to effectively block attacks to the head. Since traditional blocking methods are rarely used during sparring competitions, students get few opportunities to learn the application of their techniques. The safest and most effective way to teach students to block their upper body involves using foam paddles and other "safe" striking equipment in a dynamic environment to improve both reaction speed and blocking technique. Even though taekwondo is the "way of the fist and foot", collisions between the head and foot are neither necessary nor completely preventable. At the very least, greater emphasis needs to be placed on developing effective defensive strategies that cover an athlete's scoring areas as well as their unprotected vital areas.

References

Bailes, J., Hudson, V. "Classification of Sport-Related Head Trauma: A Spectrum of Mild to Severe Injury". *Journal of Athletic Training*. v. 36, no. 3, 2001, pp. 236-243.

Burke, D.T., Bryant, S., Schneider, J.C., Kim, H.J., and Levin, G. "Effect of Implementation of Safety Measures in Tae Kwon Do Competition." *British Journal of Sports Medicine*, v. 37, no. 5, 2003, pp.401–404.

Kazemi, M. and Pieter, W. "Injuries at Canadian National Taekwondo Championships: a prospective study." *BMC Musculoskeletal Disorders*, v. 5, no. 22, July, 2004.

Koh, J., Watkinson, J., and Yoon, Y.J. "Video Analysis of Head Blows Leading to Concussion in Competition Taekwondo." *Brain Injury*, v. 18, no. 12, December, 2004, pp. 1287–1296.

Pieter, W. and Zemper, E.D. "Injury Rates in Children Participating in Taekwondo Competition." *The Journal of Trauma: Injury, Infection, and Critical Care*, v. 43, no. 1, 1997, pp. 89–95.

Powell, J.W. "Cerebral Concussion: Causes, Effects, and Risks in Sports." *Journal of Athletic Training*, v. 36, no. 3, July–September, 2001, pp. 307–311.

USA Taekwondo – Competition Rules.
Available at http://usa-taekwondo.us/100.htm
Last updated February 8, 2006.
Accessed February 26, 2007.

World Taekwondo Federation – History.
Available at http://wtf.org/site/about_wtf/history.htm.
Last updated July 25, 2006. Accessed February 26, 2007.

[1] World Taekwondo Federation History.
[2] Ibidem.
[3] Burke et al., p. 403.
[4] Kazemi and Pieter, p. 3.
[5] USAT Competition Rules, p. 14.
[6] Ibidem, p. 16.
[7] Ibidem, p. 18.
[8] Ibidem, p. 26.
[9] Burke et al., p. 402-403.
[10] Ibidem, p. 403.
[11] Adapted from Burke et al, p. 403.
[12] Kazemi and Pieter, p. 6.
[13] Bailes, p. 241.
[14] Ibidem.
[15] Pieter and Zemper, 1997, p. 89-95.
[16] Koh and Watkinson, p. 1295.
[17] Burke et al., p. 403.
[18] Powell, p. 308.
[19] Ibidem, p. 309.
[20] USAT Competition Rules, p. 12.