Guarding Our Children's Heads: Heading Safety in Soccer

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Heading skills in soccer are universally considered as both essential and good for the game. Does "good for the game," however, also mean "good for game participants?" Also, if the use of protective gear, such as mouth guards and head protection devices may prevent or at least lessen the severity of head injuries, should soccer officials, coaches, and players embrace such protective measures? In an attempt to answer the above questions let us first consider some of the relevant facts.

In its 1988 policy statement, the American Academy of Pediatrics defined soccer as a "contact/collision" sport and thus added it to the already contact-classified sports of football and hockey. This "upgrade" was no surprise to those familiar with hospital emergency room statistics that reveal soccer's high concussion rate per 1000 athlete exposures–a rate that equals football statistics (Tysvaer, Storli, & Bachen, 1989). A number of published studies in professional journals (e.g., "American Journal of Sports Medicine," "A Pediatric Perspective," "British Journal of Sports Medicine," "Journal of the American Medical Association," "Medicine and Science in Sports and Exercise," "Neurology," "Neuroradiology," and "Sports Medicine,") highlight the risks of head trauma in competitive soccer and point out the need to "develop and adopt methods of surveillance and prevention" to maximize player safety (Matser, J. T., et. al., 1998).

Causes of Head Injury in Soccer

Causes of acute head injuries in soccer include collisions with goal posts, head clashes between two or more players, blows to the head (resulting from illegal high kicking and/or low heading, elbows, knees, and other body parts), and to a far lesser extent, the game strategy of heading the ball. Tysvaer (1992) reported that head injuries account for 4 to up to 22 percent of all soccer related injuries. Extrapolating from available statistics on fatal soccer head injuries in the United States, one yearly death caused by trauma to the head in soccer may occur (Demarco & Reeves, 1994). Traumatic head injuries that result in severe damage or death cannot be dismissed because it presents an undeniable bad outcome. Since fatal accidents in soccer are relatively rare, the relevant question to the youth soccer parent/coach is "whether the act of heading during league practice and games presents a considerable risk for brain injury?" The available data on soccer-related head injuries was mostly derived from studies on highly competitive and very skilled amateur and professional adult soccer players (e.g., Jordan, et. al., 1996; Master, J. T., et. al., 1998; Muellar & Cantu, 1990). Studies and reports that address the relationship between heading and brain trauma in

youth sports have so far received little attention (Briscoe, 1985). To the skeptic, the answer to the question regarding the inherent risk in youth sport heading may not be as clear-cut and straight forward as it is to concerned parents, coaches, educators, athletic trainers, neurologists, orthopedic and brain surgeons, and pediatricians.

Research on Traumatic Brain Injury in Sports

Roberts, Caswell, Gould, & Deivert (2004) highlight a 3-year long report by Powell and Barber-Foss of 23,566 injuries in sports, of which 1296 (5.5%) were mild traumatic brain injuries (TBIs). While they acknowledge that TBIs account for a small percentage of all head injuries, they caution that repeated TBIs are the leading cause of sport-related fatalities. Head injuries often may not initially present alarming signs and symptoms. Therefore, the authors warn that a resumption of play prior to a full recovery from trauma to the head exposes the player to a possible second blow that could result in a potentially fatal condition called second-impact syndrome.

In a more recent report, Ives & Stred (2007) point out that repeated TBIs may result in post-traumatic hypopituitarism (PTHP), which is the failure of the pituitary gland to produce one or more of its hormones. The authors state that the purpose of their paper was “to raise awareness of the growing threat of sport-related PTHP in children and adolescents and to call for exercise and developmental neuroscientists to investigate PTHP.” They present the case of a 14-year old, previously healthy teenager that experienced four head traumas over a 3-month period, one resulting in a medically diagnosed concussion (mild TBI) suffered while playing soccer. Ives & Stred (2007) report that during the following year the athlete observed a decline in muscular strength and endurance, and a stoppage in growth. The authors cautioned that the diagnosis of hypopituitarism caused by TBI is especially difficult to identify in youth since the observed symptoms of delayed growth and belated manifestation of secondary sexual characteristics may be misconstrued as an expected variation within the normal developmental curb. In addition, they point out that signs of “fatigue and depression are often masked by trauma and postconcussion symptoms and may not appear until many months after the trauma incident.” Ives & Stred (2007) recommend that sports medicine professionals be trained “to recognize the possibility of pituitary disorders following concussion, and urge the development of screening tests (e.g., balance and posture, psychological, and neuropsychological) to identify cases of PTHP.”

Leitch & Hanson (2006) reported an unusual case of a 16-year old amateur soccer player that sustained a head injury while contesting an aerial ball. The trauma to the head resulted in two minutes of unconsciousness followed by dizziness for the next hour. Two days later, the player developed a profound left lower motor neuron facial nerve palsy. What originally may have appeared as a minor head injury was later found to have been a complex fracture of the left

petrous temporal bone, with fluid in the left middle ear and left mastoid. Clearly, even what initially may appear as an asymptomatic head injury should not be taken lightly.

Studies on Head-and-Neck Injuries in Soccer

Fuller, Junge, & Dvorak (2005) conducted a highly detailed case-control study of male and female soccer players that sustained head and neck injuries during 20 international FIFA tournaments from 1998 to 2004. Data about the nature of the head injuries was obtained through analysis of videotapes as well as medical reports provided by the team physicians. Out of a total 248 recorded head and neck injuries, 163 (66%) were selected for video sequencing analysis. Fuller, Junge, & Dvorak (2005) found that the most frequent head injuries were contusions (53 %), lacerations (20 %), and concussions (11 %). They reported that the incidence of all head and neck injuries was 12.8/1000 player hours for men and 11.5/1000 player hours for women. The most significant contributor to head and neck injury as compared to any other player action, according to the authors, was illegal play or "unfair use of the upper extremity" during aerial challenges . During the six year duration of the study only one report of a strained neck could be directly attributed to simply heading the ball (0.05 injuries/1000 player hours).

After an analysis of game videos of 62 cases of head impacts in soccer, Withnall, Shewchenko, Gittens, & Dvorak (2005), reported that elbow-to-head impacts, with collision velocity of 1.7-4.6 m/s, and lateral hand strikes, with collision velocity of 5.2-9.3 m/s, resulted in low risk of concussion (< 5 %) and severe neck injury (< 5 %), while head-to-head impacts, with collision velocity of 1.5-3.0 m/s, resulted in high concussion risk (up to 67 %) but low risk of severe neck injury (< 5 %). Simulations of head accelerations and contact with the ball via the use of the Head Impact Power index suggested little risk of concussion. However, despite a very low risk for neck injury, the authors warned that deliberate head-to-head collisions do pose "a high risk of concussion." The authors thus conclude that deliberate head-to-head impact "justifies a harsher position by regulatory bodies."

The Long-Term Effects of Head Injuries in Soccer

The renewed and growing concern among Pediatricians and Physical Educators (Frankl, 2000) stems from the findings of separate yet related research projects conducted in Norway (Sortland & Tysvaer, 1989; Tysvaer, 1992) and the United States (Barnes, B.C., et al., 1998; Jordan, 1996; Jordan, S.E. et. al., 1996). These studies focus on head injuries in soccer players that started playing and practicing heading as young children. The results of these studies indicate that the severity of attentional, concentrational, judgmental, and memory based deficits is positively related to reported amounts of heading during practice and games.

Based on available research on long- term effects of repetitive cumulative head injuries, Pediatrician Bernard Griesemer, M.D. (member of The American Academy of Pediatrics Sports Medicine Committee), stated that "Less is better..." when addressing the practice of heading skills in youth soccer leagues. It is important to note that Pediatricians caution about heading drills, that create numerous opportunities for head/ball contact and thus might be more conducive to a child's head injury than occasional contacts during a soccer game.

Skillfully Heading the Ball May Pose a Negligible Risk

A growing number of researchers, coaches, and players have come to the conclusion that the act of properly heading the ball results in a skillful play and not in trauma to the head (McCrath, 2000). For example, Pickett, Streight, Simpson, & Brison (2005) studied emergency room records (1996-2001) of head injury in 10-24 year-old soccer players. Of the total 1714 identified cases of soccer related injury, 235 (13.7 %) were diagnosed as head injuries. Results indicated that the primary causes of head injury were player-to-player contact (153/235; 65.1 %) and combined player-to-player and ball contact (62/235; 26.4 %). The rate of trauma to the head that resulted from heading the ball was low (4/62 or 6 %) while trauma resulting from attempted heading that involved head-to-head contact was significantly higher (15/153 or 9.8 %). An additional 39 cases of unspecified head-to-head trauma were also reported. The authors conclude that while deliberate heading of the ball rarely results in an injury, accidental and illegal contacts between players are a cause for concern and may thus justify preventive measures.

While the risk of head injury during soccer practice and games that results from collisions with goal posts, head clashes between two or more players, blows to the head (resulting from illegal high kicking and/or low heading, elbows, knees, and other body parts), is beyond dispute, the evidence of risk of acute head injury that results from the act of heading a ball is currently inconclusive.

Highly skilled players play longer during single games, play more games in any given season, and use their heading skills as a game strategy more often than less skilled players. As the level of competition increases so does the size, weight, pressure, and velocity of the game ball. The official ball sizes at the start of a soccer match (fifa.com, 2008) include the following categories:

Size 5: Ages 12 and up -- circumference: 68-70 centimeters or 28-29 inches; weight: 410-450 grams or 14-16 ounces; pressure: 0.6-1.1 atmospheres or 600-1,100 g/cm² at sea level or 8.5-15.6 lbs/sq. in; sphericity: maximum 2%; water uptake: not to exceed 20% of dry ball weight (Sphericity is a gauge of an object’s roundness. A soccer ball’s sphericity may deviate up to a maximum of 2% from a perfect sphere.).

Size 4: Ages 8 and 12 years -- circumference: 63.5 - 66.0 centimeters; weight: 350-390 grams; pressure: 0.6-1.1 atmospheres or 600-1,100 g/cm² at sea level

or 8.5-15.6 lbs/sq. in; sphericity: maximum 2%; water uptake: not to exceed 20% of dry ball weight).

Size 3: Under 8 years -- pressure: 0.6-1.1 atmospheres or 600-1,100 g/cm² at sea level or 8.5-15.6 lbs/sq. in; sphericity: maximum 2%; in 1994 Adidas Questra replaced leather by a synthetic material called Polyurethane (PU) that provides better water resistance (my-youth-soccer-guide.com, 2008).

Size 2 and 1: Mini or Skill Balls or Promotional soccer balls (typically manufactured out of PVC Plastic) – 7.0-8.5 lbs/sq. in; sphericity: maximum 2%; water uptake is negligent when a PVC Plastic ball is used.

Ball mass (related to ball weight) multiplied by a ball's velocity, or motion in a particular direction, equals to the ball's momentum. Advanced soccer players are often faced with a hard, fast moving ball that is "loaded with momentum" when heading. Those players use balls made out of leather or other approved materials (FIFA.com) that when played on wet surfaces may absorb moisture totaling up to an additional 20% of the original dry ball weight.

It would be reasonable to assume that when compared to the pros, youth play fewer and shorter games, are faced with a lighter, softer, slower moving ball, and head less frequently during practice and games. Despite the fact that children under eight-years-old rarely lift the ball during regular play on the field, throw-ins and even more so goalie kicks do, on occasion, result in heading opportunities. Those who dismiss the "dangers" of heading (e.g., McCrath, 2000) also tend to resist the implementation of some form of head protection gear. McCrath (2000) correctly raises concerns about the "idea of wearing a padded helmet to protect oneself (p. 5)." The use of any external "hard shell" type of helmet would indeed be counter productive and as pointed out by McCrath may result in more rather than less injuries. Instead of helmets it is suggested here that children use mouth guards and protective head bands. Until the time that mouth guards and head bands are regularly worn and are in use in large numbers it will be impossible to conduct controlled studies that are designed to evaluate the efficacy of these protective measures.

Still, examples from the not so distant past may shed some light on the "logic" behind the current overwhelming resistance to any form of mandatory head protection gear in soccer. Not too long ago, soccer players bitterly complained when required to wear the now globally accepted shin guards. Starting in 2006 youth club soccer teams, and since the fall of 2008 high school soccer teams are required to wear not just any shin guard, but shin guards that carry the NOSCAE stamp of approval that signifies that the shin guard meets a tough standard of shin protection. A voluntary use of mouth guards and head protection bands in various youth leagues may create an environment where a controlled comparison of the incidents of head trauma in those who do wear protection gear and those who do not may be feasible.

Should Adults Take Preemptive Protective Measures in the Case of Youth Soccer?

In the case of youth soccer, should the adults that organize those leagues wait until the verdict about the value of head protection gear is out or should they implement preventive measures now? Despite the fact that kids face smaller, lighter, and slower balls and are rarely engaged in heavy duty heading, several child specific factors should be considered in the decision process.

Developmentally, children are quite different from their adult counterparts. From birth to the age of 10 a child's body weight represent 5 percent and 50 percent, respectively, of an young adult's weight (Gabbard, 1992). The same child's brain, however, reaches 90 percent of its adult size by the age of three (Trevarthen, 1983), and reaches its full adult size at the age of six (Kessen, Haith, & Salapatek, 1970). A child's head is thus disproportionately heavy and large when contrasted with a child's total body weight. Does the above description mean "less risk" or should it be interpreted as "same risk" to brain injury resulting from heading in youth soccer leagues? Since the risk of brain damage resulting from heading at the professional level is well documented (Jordan, S.E., et. al., 1996; Master, J.T., et. al.), the recent and on-going trends of earlier start (soccer leagues for kids ages 3, 4, & 5) in youth soccer need to be examined. Also, as youth leagues are becoming more competitive, coaches tend to increase the number of weekly practices. Practice pre-season games are common place, as are post-season all-star games and various additional tournaments. Many little league participants also play soccer at school, and attend special soccer camp sessions throughout the school year and over the summer break. A logical conclusion based on the above presented scenario is that the more serious a child is about her/his soccer participation the more he/she is at risk of cumulative damage to the brain from heading and other soccer related trauma to the head. Instituting a requirement for some form of protective head gear and/or for the wearing of a mouth guard for competitive youth soccer should therefore be considered as a logical and sensible action. Our children's well-being is at stake here. Let us not wait for the perfectly conclusive data or for costly head injury litigation before we take preventive action. The old cliche "better safe than sorry" is a very appropriate one for addressing this issue. A possible positive side effect of head and/or mouth protection gear would be the curbing of the current trend of increase in sports injury litigation (Davis & McKelvey, 1998).

Should future data establish beyond reasonable doubt that heading in youth soccer is safe, still protection from head contact with goal posts, contact with ground, and contact with other players' heads, elbows, knees, etc...is enough reason to seriously consider head protection gear and/or the wearing of a mouth guard while playing this otherwise great and beautiful game.

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