



Engineering Sciences Section – 2008

C46 Efficacy of Full90 Performance Headgear™ in Soccer Related Impacts

Eric R. Miller, BSE*, PO Box 7337, Tempe, AZ 85281

Attendees of the presentation will have a greater understanding of the effectiveness of a common type of soccer headgear in reducing the potential for mild traumatic brain injury (MTBI).

The presentation will impact the forensic community by providing information on MTBI injury potential with and without headgear, possibly improving the diagnosis and treatment of soccer related MTBI.

Head injuries as a result of common impacts that occur during a soccer match are of high concern, especially to parents of youth soccer players. Head protection has recently been approved by U.S. Soccer and the National Federation of High Schools for use in all games at all age levels. This recent change in the interpretation of equipment rules has led to questions from parents regarding the effectiveness of headgear in preventing injury. The most easily found headgear is the Full90 Performance Headgear™, manufactured by Full90 Sports. However, aside from performance claims on the manufacturer's website, little to no data is available to the public to assess the efficacy of this model of headgear in mitigating head injuries that occur as a result of common impacts on a soccer field such as head-to-ball, head-to-head, head-to-elbow, head-to-ground, or head-to-goalpost.

The efficacy of three types of soccer headgear, including the Full90 Performance headgear, was investigated for head-to-ball and head-to-head impacts in a blinded study.¹ Ball-to-head impact speeds of 6.4-8.4 m/s and 10-30 m/s were used for volunteer and dummy testing. The authors concluded that none of the headgears tested reduced the impact response, most likely due to the very large deformation of the ball during impact.¹ Head-to-head impacts of 2-5 m/s conducted with Hybrid III dummies were found to provide a "measurable" improvement in the impact response, depending on impact speed and impact location.¹

The purpose of this study was to investigate the protective abilities of the Full90 Performance Headgear™ in head-to-goalpost, head-to-concentrated load, such as an elbow, and head-to-ground impacts. Thirty-eight head-drop tests were conducted using a 50th percentile male Hybrid III dummy head, equipped with a tri-axial accelerometer and tri-axial angular rate sensors at the head center of gravity. Indoor tests were conducted at 78°F. Figure 1 shows the headgear on the Hybrid III head.

Five sets of Full90 headgear were used, with each set of headgear impacted once at the forehead, bilateral temples and occiput for each of the following impact configurations: head-to-round goalpost, head-to-square goalpost, head-to-concentrated load, and head-to-ground. Impact speeds of 2.5 m/s and 3 m/s were used for the goalpost and concentrated load tests respectively. Head-to-ground tests were conducted with an impact speed of approximately 5 m/s, corresponding to a drop height of about 48 inches.

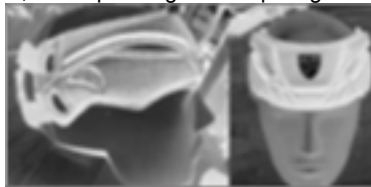


Figure 3: Full 90 Headgear on Hybrid III

A general trend of reduced values for HIC36 and average acceleration was seen, and thus only the data for HIC36 is presented in table 1 below, where HG designates an impact the headgear in place. However, rather than comparing percent reductions between headgear use and non-headgear use, it may be more useful to compare the head injury severity using the AIS injury scale.^{2,3}



Engineering Sciences Section – 2008

Table 1 Impact test data

	HIC	
	No HG	HG
Round Goal Post (2.5 m/s)		
Forehead	49.10	40.53
Temple	39.95	27.33
Occiput	56.80	51.07
Square Goal Post (2.5 m/s)		
Forehead	59.80	52.00
Temple	52.60	40.10
Occiput	74.80	40.90
Concentrated Load (3 m/s)		
Forehead	190.30	89.30
Temple	149.60	94.95
Occiput	219.70	158.50
Ground Impact (5 m/s)		
Forehead	551.90	525.25
Occiput	507.40	418.80

The abbreviated injury scale (AIS) was developed to aid in impact injury assessment. Examples of AIS head injuries are: AIS1 – scalp abrasions/ contusions; AIS2 – scalp laceration > 10 cm, unconscious < 1 hr without neurological deficit; AIS3 – cerebral contusion; AIS4 – subdural hematoma, open basilar skull fracture; AIS5 – diffuse axonal injury, penetrating brain injury, arterial laceration.⁴

The risk of suffering an AIS1-AIS5 category injury for each impact configuration is shown in table 2 below. The numbers in the table indicate the percent risk (0-100) of incurring an AIS injury of a certain level.

	AIS1	AIS2	AIS3	AIS4	AIS5
Round Goal Post (2.5 m/s)					
No HG Forehead	0.5	0.2	0.1	0.0	0.0
HG Forehead	0.2	0.1	0.0	0.0	0.0
No HG Temple	0.2	0.1	0.0	0.0	0.0
HG Temple	0.0	0.0	0.0	0.0	0.0
No HG Occiput	0.9	0.3	0.1	0.0	0.0
HG Occiput	0.6	0.2	0.1	0.0	0.0
Square Goal Post (2.5 m/s)					
No HG Forehead	1.1	0.4	0.1	0.0	0.0
HG Forehead	0.6	0.2	0.1	0.0	0.0
No HG Temple	0.7	0.2	0.1	0.0	0.0
HG Temple	0.2	0.1	0.0	0.0	0.0
No HG Occiput	2.3	0.8	0.3	0.1	0.0
HG Occiput	0.2	0.1	0.0	0.0	0.0
Concentrated Load (3 m/s)					
No HG Forehead	20.5	6.8	2.3	0.5	0.0
HG Forehead	3.9	1.3	0.5	0.1	0.0
No HG Temple	13.0	4.3	1.5	0.3	0.0
HG Temple	4.6	1.6	0.6	0.1	0.0
No HG Occiput	26.5	8.8	3.0	0.6	0.0
HG Occiput	14.5	4.8	1.7	0.4	0.0
Ground Impact (5 m/s)					
No HG Forehead	84.4	45.3	15.5	3.5	0.3
HG Forehead	81.7	41.7	14.0	3.1	0.3
No HG Occiput	79.6	39.3	13.0	2.9	0.2
HG Occiput	66.9	28.0	9.0	2.0	0.1



Engineering Sciences Section – 2008

As seen in the above table, use of the Full90 headgear decreases the risk of AIS3 or lower head injuries for impacts to the square goal post and concentrated loading configurations by nearly 50% or more. However, there was little to no effect for the round goal post and ground impact situations. In addition, there was little appreciable difference in AIS4+ injury risk across all testing.

The Full90 Headgear™ seems to be most useful in decreasing the risk of AIS3 or lower head injuries in certain loading situations. The most likely injuries to be prevented are the AIS1 and AIS2 scalp lacerations, contusions, abrasions, and minor penetrating wounds, but this may be due more to the use of an extra layer between the head and the contacting object than any protective properties of the headgear itself.

Parents, coaches, and others need to make informed decisions about the protection they wish to provide to the players on the field, regardless of age group. If the primary concern is reducing the number of relatively minor injuries such as abrasions and small cuts, than use of the Full90 headgear may be warranted. However, if the primary concern is reducing the risk from falls where the player is knocked down, either while in the air or while standing, and is unable to “break” their fall with ensuing head-to-ground contact, the Full90 Performance Headgear™ does not appear to be an effective safety device.

References:

1. Withnall C, Shewchenko N, Wonnacott M and Dvorak J,
2. “Effectiveness of Headgear in Football,” Br J Sports Med (2005) 39(Suppl 1):i40-i48. Ryan GA, Hendrie D and Mullan N, “Development of a Method of Estimating the Costs of Injuries Predicted by ANCAP Testing in Australia,” Proceedings of the Road Safety Research Policing