

The National Football Head and Neck Injury Registry

Report and Conclusions 1978

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• The National Football Head and Neck Injury Registry has documented 1,129 injuries since 1971 that involved hospitalization for more than 72 hours, surgical intervention, fracture-dislocation, permanent paralysis, or death. Of this group of injuries, 550 were fracture-dislocations of the cervical spine, of which 176 were associated with permanent quadriplegia. It appears that during the last two decades, there has been a decrease in the incidence of direct fatalities, head injuries associated with intracranial hemorrhage, and injuries associated with death. Conversely, cervical spine injuries with fracture-dislocation and with permanent quadriplegia have increased. We believe that these observations are the result of the development of a protective helmet-face mask system that has effectively protected the head, and by so doing has allowed it to be used as a battering ram in tackling and blocking techniques, thus placing the cervical spine at risk of injury.

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DESPITE the contact nature of tackle football, the fatality and catastrophic injury rates have remained low.¹ It is questionable, however, whether the relatively low fatality and serious injury rates should be accepted simply because they compare favorably with other activities such as driving an automobile, auto racing, or motorcycling.

See also p 1480.

A more responsible approach to the calculated risks of athletic participation is to determine if an injury problem exists by epidemiologic documentation; identify possible etiologic variables; modify rules, equipment, or conduct of the activity so as to obviate the effect of such variables; and evaluate the effect of the implemented changes on the activity.

During the 1975 football season, 12 severe neck injuries occurred in the

states of Pennsylvania and New Jersey.² These injuries included one death, eight quadriplegias, and three cervical spine fractures without neurological involvement. Determination of the mechanism of injury responsible for the cervical spine fractures or dislocation resulting in quadriplegia was revealing. Six of the eight youngsters were rendered quadriplegic while playing defensive back and making a tackle. In each instance, the head and helmet were used as a battering ram while head tackling. More specifically, striking an opponent with the top or crown of the helmet in a high-impact situation was implicated as the responsible mechanism.

Evolution of protective coverings for the head has occurred during the past 70 years. As recently as 1905, protection was afforded by nothing more than a full head of hair. Current helmet-face mask protective systems—the bird cage attached to a polycarbonate shell with a variety of pneumatic, hydraulic, and web suspension systems—provide an extraordinary degree of protection to the head and face. As a result, coaches have developed playing techniques

that use the head and helmet as a battering ram in blocking, tackling, and butting.

Such techniques fail to account for the potential danger of injury to the cervical spine when the head is the primary point of contact in a high-impact situation. Other than the data collected by Schneider³ during the five-year period from 1959 through 1963, there has been no comprehensive study of this problem. The number of permanent quadriplegias observed in Pennsylvania and New Jersey in 1975 demonstrated the need for a central registry to document and analyze these injuries. To meet this need, the National Athletic Trainers Association and the Sports Medicine Center in Philadelphia established the National Football Head and Neck Injury Registry. Our data and observations were collected by the registry.

MATERIALS AND METHODS

The registry has collected data on head and neck injuries that occurred as a result of tackle football since the 1971 season. Criteria for inclusion in the registry were those injuries that required hospitalization for more than 72 hours, required surgical intervention, involved a fracture or dislocation, resulted in permanent paralysis, or resulted in death.

Information was obtained by several methods. Project descriptions and injury-report forms were mailed at the conclusion of the 1975, 1976, and 1977 seasons to the 39,000 members of the National Association of Secondary School Principals, 3,000 members of the National Athletic Trainers Association, and 3,000 members of the American College of Sports Medicine. In addition, a newspaper-clipping service was contracted each year to identify those head and neck injuries reported in the press. When an injury was reported, additional information was obtained from the responsible physician and coach.

Head and neck injuries sustained as a result of football from 1971 through and including the 1977 season are presented in four groups: (1) 1971 to 1975, (2) 1975, (3) 1976, and (4) 1977.

At the conclusion of the 1975 season, both the National Collegiate Athletic Association (NCAA) and the National Federation of State High School Athletic Associations adopted rule changes modifying the use of the head in playing techniques. Specifically, the NCAA Football Rules Committee implemented the following rule additions and modifications for the 1976 season: (1) No player shall intentionally strike a runner with the crown or

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top of the helmet. (2) Spearing is the deliberate use of the helmet in an attempt to punish an opponent. (3) No player shall deliberately use his helmet to butt or ram an opponent.

The National Alliance Football Rules Committee (high school) revised the rules governing butt-blocking and face-tackling to prohibit "technique involving a blow with the face mask, frontal area, or top of the helmet driven directly into an opponent as the primary point of contact either in close line play or in the open field."

Group 3 and group 4 data were recorded during the 1976 and 1977 seasons, respectively, and represent those injuries occurring after the aforementioned rule changes were implemented.

COMMENT

Consideration of severe head and neck injuries includes five values: (1) total direct fatalities, (2) intracranial hemorrhages, (3) intracranial hemorrhages resulting in death, (4) cervical fracture-dislocations, and (5) cervical spine fracture-dislocations with permanent quadriplegia. Available data allow a nonstatistical comparison of these five entities for two five-year periods: 1959 through 1963 and 1971 through 1975.

For the five years from 1959 through 1963, during which time 820,000 youths were exposed each year, the annual football fatality survey⁴ recorded 86 deaths as a direct result of football. During the period from 1971 through 1975, during which time 1,275,000 players were exposed annually, 77 deaths occurred. These figures represent a real reduction in the total number of direct fatalities when compared on an exposure basis.

Schneider³ reported 139 lesions in which intracranial hemorrhage was a component during the 1959 through 1963 period. Our registry has reported 72 similar lesions during the 1971 through 1975 period (Table 1). These figures suggest a decrease in injuries in which intracranial hemorrhage is a component.

Schneider³ reported 65 intracranial injuries that resulted in death during the period from 1959 through 1963. We have recorded 58 similar lesions that resulted in death between 1971 and 1975 (Table 1). When compared on an exposure basis, they represent a real decrease in reported deaths during the more recent five-year period.

From 1959 through 1963, Schneider³ reported 56 injuries to the cervical

	Group 1 1971-1975	Group 2 1975	Group 3 1976	Group 4 1977
Craniocerebral injuries				
Intracranial hemorrhage				
High school	60	18 (1.50)	18 (1.50)	9 (0.75)
College	5	2 (2.66)	1 (1.33)	1 (1.33)
Other	7	1	1	0
Total	72	21	20	10
Other lesions	91	56	80	54
Craniocerebral deaths				
High school	49	12 (1.09)	15 (1.25)	6 (0.5)
College	2	0	0	0
Other	7	1	0	0
Total	58	13	15	6
Cervical spine and spinal cord injuries				
Fractures or dislocations				
High school	182	68 (5.70)	95 (7.92)	65 (5.50)
College	64	23 (30.10)	20 (26.67)	16 (20.30)
Other	13	1	0	3
Total	259	92	115	84
Other lesions	54	30	58	38
Permanent quadriplegias				
High school	77	23 (1.90)	28 (2.23)	14 (1.16)
Colleges	18	4 (5.30)	7 (9.30)	3 (4.00)
Other	4	0	0	2
Total	99	27	35	19

*Numbers in parentheses are rates per 100,000 participants per season.

	Injuries Resulting in Quadriplegia, % (n=73)	Injuries Not Resulting in Quadriplegia, % (n=136)
Hyperflexion	10	11
Hyperextension	3	8
Vertical compression (spearing)	52	39
Knee or thigh to head	15	17
Collision, pileup, or ground contact	11	19
Tackled	7	7
Machine-related	3	0
Face mask acting as lever	0	0

spine involving fracture-dislocations. Our registry has recorded 259 similar lesions (Table 1). A statistical comparison cannot be made between these two figures. They are suggestive, however, of an increase in cervical spine fracture-dislocations during the more recent period.

Schneider³ reported 30 permanent quadriplegias during the 1959 through 1963 period. Our registry recorded 99 such lesions from 1971 through 1975 (Table 1). When compared on an exposure basis, they represent an increase in reported injuries resulting in quadriplegia during the more recent five-year period.

A change appears to have occurred in the frequency of severe head and neck injuries during the past 18 years. Specifically, the incidence of direct fatalities, head injuries associated with intracranial hemorrhage, and

head injuries associated with death have decreased. Conversely, cervical spine injuries with fracture-dislocations and with permanent quadriplegia have increased.

We attribute the apparent decrease in serious head injuries to the protective capabilities of the helmet-face mask unit as developed during the past two decades. Likewise, an increase in serious cervical spine injuries may be attributed to a helmet-face mask, which has encouraged the use of the head as the primary point of contact in blocking, tackling, and head butting.

Our data indicated that 52% of all cervical spine quadriplegia occurring from 1971 through 1975 was the result of spearing or rather direct compression, head-on type injuries where initial contact is made with the top or crown of the helmet (Table 2).

	Cervical Fracture-Dislocations Without Quadriplegia, 1971-1975		Permanent Cervical Quadriplegia, 1971-1975	
	High School (n=105)	College (n=46)	High School (n=77)	College (n=18)
Tackling, %	59	49	72	78
Tackled, %	15	24	14	22
Blocking, %	7	16	6	0
Drill, %	5	7	3	0
Collision pileup, %	12	4	3	0
Machine-related, %	2	0	2	0

	Cervical Fracture-Dislocations Without Quadriplegia		Permanent Cervical Quadriplegia	
	High School (n=89)	College (n=47)	High School (n=52)	College (n=15)
Defensive back, %	23	33	52	73
Linebacker, %	18	17	10	0
Specialty team, %	2	0	13	7
Offensive back, %	20	21	12	7
Defensive line, %	28	12	10	0
Offensive line, %	8	15	4	13

Of those cervical spine injuries resulting in quadriplegia between 1971 and 1975 at the high school level, 72% were a result of tackling. At the college level, 78% of the quadriplegia resulted from tackling (Table 3). With regard to position played at the high school level, 52% were defensive backs, 13% were on specialty teams, and 10% were linebackers. At the college level, 73% of those players rendered quadriplegic were defensive backs (Table 4). These figures clearly identify the defensive backs, linebackers, or specialty team members making a tackle while using the head as the initial point of contact as the persons at greatest risk to sustain a cervical spine injury resulting in quadriplegia.

The classic mechanism of injury responsible for fracture-dislocation of the cervical spine is that of accidental forced hyperflexion. The subject is an unsuspecting victim of some untoward circumstance. That is, an accidental fall, a dive into shallow water, an unsuspected blow to the head, or, in the case of the athlete, a poorly executed physical act in which the cervical spine is unwittingly forced into the extreme of motion, with resulting injury.

In the majority of these fracture-dislocations of the cervical spine documented in this registry, there are two major factors that differentiated them from the classic injury: the

circumstances surrounding the event were not accidental, and the mechanism of injury was not cervical spine hyperflexion.

In most injuries that resulted in quadriplegia, the subject was, of his own volition, executing a maneuver where the head was used as a battering ram; the initial point of contact was made with the top or crown of the helmet in a high-impact situation. Thus, rather than an accidental, untoward event, there occurs the deliberate implementation of a technique that places the cervical spine at risk of catastrophic injury.

When the cervical spine is forced beyond the extreme of motion and the applied force exceeds the elastic capabilities of the involved structures, injury will result. In the course of a contact activity such as tackle football, the cervical spine is repeatedly exposed to potentially injurious forces. Fortunately, however, forces exerted on the cervical spine are effectively dissipated by the elasticity of the intervertebral disk, the mobility of the spine itself, and the impact-absorbing capabilities of the cervical paravertebral musculature. However, in those instances when impact occurs with the position of the head, neck, and trunk such that the forces are transmitted along the axial alignment of the cervical spine obviating the impact-absorbing capacities of the disks, joints, and paravertebral

muscles, injury to the bony, disk, and ligamentous structures can occur.

Considering the alignment of the cervical spine from the lateral perspective with the neck in the neutral position, because of the normal cervical lordosis, the alignment of the spine is one of extension. With forward flexion of the neck, the cervical spine is, in fact, straightened. With impact exerted in line with the vertical axis of a straight spine, there occurs, in fact, the loading of a segmented column. When the force exceeds the energy-absorbing capacities of the involved structure, intervertebral disk space injury, ligamentous disruption, vertebral body fracture, or posterior element fracture can occur. When the maximum vertical compressive deformation is reached, cervical spine flexion or rotation occurs with subluxation or unilateral or bilateral facet dislocation.

The majority of cervical spine injuries with quadriplegia occurring in tackle football might result from purposeful vertical loading of the vertebral elements, with a previously unrecognized mechanism of injury occurring.

Biomechanical analysis of those injuries resulting in cervical spine fracture-dislocation has disclosed a previously unrecognized mechanism: nonaccidental loading of the straightened cervical spine reacting to maximum axial compressive deformation as a segmented column.

On the basis of observations and data offered by our study, we firmly believe that the increase in verified cervical spine injuries and permanent paralysis is due to the implementation of playing techniques that use the top or crown of the helmet as the primary point of contact in a high-impact situation.

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