

ANNUAL SURVEY OF CATASTROPHIC FOOTBALL INJURIES

1977 - 2010

Frederick O. Mueller, Ph.D.
Department of Exercise & Sport Science
University of North Carolina
Chapel Hill, NC 27599-8700

Robert C. Cantu, M.D.
Chairman, Department of Surgery
Chief, Neurosurgical Service
Emerson Hospital
Concord, MA 01742

Research Funded by a Grant from the
NATIONAL COLLEGIATE ATHLETIC ASSOCIATION
NATIONAL FEDERATION OF STATE HIGH SCHOOL ASSOCIATIONS
AMERICAN FOOTBALL COACHES ASSOCIATION

World Wide Web (WWW.UNC.EDU/DEPTS/NCCSI)

CATASTROPHIC FOOTBALL INJURIES

INTRODUCTION

In 1977 the National Collegiate Athletic Association initiated funding for the First Annual Survey of Catastrophic Football Injuries. Frederick O. Mueller, Ph.D., and Carl S. Blyth, Ph.D., both professors in the Department of Exercise and Sport Science at the University of North Carolina at Chapel Hill were selected to conduct the research. The research is now being conducted as part of the National Center for Catastrophic Sports Injury Research, University of North Carolina at Chapel Hill, Frederick O. Mueller, Director and Robert C. Cantu, Medical Director.

The Annual Survey of Catastrophic Football Injuries was part of a concerted effort put forth by many individuals and research organizations to reduce the steady increase of football head and neck injuries taking place during the 1960's and 1970's. The primary purpose of the research was and is to make the game of football a safer sport.

DATA COLLECTION

Since 1977 and the initiation of this research, catastrophic injuries were defined as football injuries which resulted in brain or spinal cord injury or skull or spine fracture. It should be noted that all cases involved some disability at the time of the injury. Neurological recovery is either complete or incomplete (quadriplegia or paraplegia). Yearly follow-up is not done, thus neurological status (complete or incomplete recovery) refers to when the athlete is entered into the registry which is usually two to three months after injury. Injuries, which result in death, are not included in this report.

Data were compiled with the assistance of high school and college coaches, athletic directors, school administrators, physicians, athletic trainers, executive officers of state and national athletic organizations, sporting goods dealers and manufacturers' representatives, on-line search engines, and professional associates of the researchers. Data collection would have been impossible without the help of the National Federation of State High School Associations, the National Collegiate Athletic Association, and the American Football Coaches Association. The research was funded by a grant provided by the National Collegiate Athletic Association.

Upon receiving information concerning a possible catastrophic football injury, contact by telephone, personal letter, and questionnaire is made with the injured player's coach, physician and athletic director. The questionnaire provides background data on the athlete (age, height, weight, experience, previous injury, etc.), accident information, immediate and post-accident treatment, and equipment data.

In 1987, a joint endeavor was initiated with the Sports Medicine section of the American Association of Neurological Surgeons. The purpose of this collaboration was to enhance the collection of medical data. Dr. Robert C. Cantu, Chairman, Department of Surgery and Chief, Neurosurgery Service, Emerson Hospital, in Concord, MA, and the Medical Director of the National Center for Catastrophic Sports Injury Research has been responsible for collecting the medical data.

BACKGROUND

An early investigation into serious head and neck football injuries was conducted by Schneider.(1) He reported 30 permanent cervical spinal cord injuries in high school and college football during the period from 1959 - 1963. A later study by Torg indicated a total of 99 permanent cervical spinal cord injuries in high school and college football from 1971 - 1975. (3) Torg has discontinued his research, but his data show a decline in permanent cervical cord injuries in high school and college from 34 cases in 1976 to 5 cases in 1984. A study published in 1976 reported the incidence of neck injuries based on roentgenographic evidence was as high as 32% in a sample of 104 high school students and 75 college freshmen in Iowa. (2)

In order to help alleviate this problem the National Collegiate Athletic Association and the National Federation of State High School Associations implemented rule changes in 1976 to prohibit using the head as the initial contact point when blocking and tackling. Furthermore, the American Football Coaches Association Ethics Committee went on record opposing this type of blocking and tackling. The National Federation of State High School Associations 2006 Football Rule Book states that butt blocking, face tackling and spearing are illegal. Butt blocking is defined as a technique involving a blow driven directly into an opponent with the face mask, frontal area or top of the helmet as the primary point of contact either in close line play or in the open field. Face tackling is defined as driving the face mask, frontal area or top of the helmet directly into the runner. Spearing, as

opposed to butt blocking and face tackling, is defined as the use of the helmet in an attempt to punish an opponent. All three of these illegal techniques can cause catastrophic head and neck injuries to the athlete. Coaches should not teach these techniques and referees should do a better job of calling these penalties in a game. The rules have also eliminated the word intentional from the spearing rule.

In the 2010 high school football rule book the concussion rule (3-5-10b) was revised as follows; Any player who exhibits signs, symptoms, or behavior consistent with a concussion (such as loss of consciousness, headache, dizziness, confusion or balance problems) shall be immediately removed from the game and shall not return to play until cleared by an appropriate health-care professional. This time-out, if not charged, is an official's time-out. In Appendix B, page 100, they also have suggested guidelines for management of concussion injuries.

Emphasis on complete physical examinations and improved physical conditioning programs has also been recommended to mitigate the injury issue.

SUMMARY

1. During the 2010 football season there were a total of seven cervical cord injuries with incomplete neurological recovery. Five of the injuries occurred at the high school level and two at the college level. The 2010 number is seven fewer than the 14 in 2008 and two fewer than the nine in 2009. (Table I)
2. The incidence of catastrophic injuries is very low on a 100,000-player exposure basis. For the approximately 1,800,000 participants in 2010 the rate of injuries with incomplete neurological recovery was 0.39 per 100,000 participants.
3. The rate of injuries with incomplete neurological recovery in high school and junior high school football was 0.33 per 100,000 players and the rate at the college level was 2.66. (Table II)
4. A majority of catastrophic spinal cord injuries usually occur in games. During the 2010 season five injuries took place in games and two in practice.
5. Tackling and blocking have been associated with the majority of catastrophic football injuries. In 2010, one injury was caused

by tackling, three tackling on a kick-off, two being tackled, and one in a tackling drill. As shown in Table IV tackling has been associated with 67.8% of the catastrophic injuries since 1977.

6. As indicated in Table III a majority of the catastrophic injuries occur while playing defensive football. In 2010 five players were on defense and two on offense. Since 1977, 221 players with permanent cervical cord injuries were on the defensive side of the ball and 52 were on the offensive side with 41 being unknown. Defensive backs were involved with 110 (35.0%) of the permanent cervical cord injuries followed by members of the kick-off team (9.6%) and linebackers with 9.2%. (Table V).

7. During the 2010 football season there were also four brain injuries which resulted in incomplete recovery. All four were at the high school level. That is a reduction of five compared to the 2009 data. (Table VI).

8. In 2010 there were also 13 injuries that involved either a head or neck injury, but the athlete had full neurological recovery. High school athletes were associated with three cervical vertebrae fractures, three brain injuries, one lumbar vertebra fracture, and in addition there was one sickle cell injury, one heart related injury, and one commotio cordis injury with recovery. College football was associated with two cervical vertebrae injuries. Youth football was associated with one spinal cord transient injury. It should be emphasized that the researchers are not confident concerning the number of injuries with full recovery, but data collection in 2007, 2008, and 2009 produced the highest number of catastrophic recovery injuries since the study was initiated in 1977. (Table VII).

DISCUSSION

For the past 34 years there have been a total of 314 football players with incomplete neurological recovery from cervical cord injuries. Two hundred and fifty-eight of these injuries have been to high school players, thirty-six to college players, six to sandlot players and fourteen to professionals. This data indicate a reduction in the number of cervical cord injuries with incomplete neurological recovery when compared to data published in the early 1970's. The 2005 data showed a major reduction to five from the 13 injuries in 2004, but the 2008 data show a major increase to 14. If future reports continue to show these high numbers steps will have to be taken for reducing these injuries. Any injury that causes permanent disability is a major concern and

future reports must be monitored closely. The numbers for 2010 show seven cervical cord injuries.

The thirteen cervical cord injuries with incomplete recovery in 2004 was a dramatic increase from the years of single digits - 1991-1998. An update in 1999 increased that number to 10. The 2005 data showed a return to single digits, but 2006 and 2008 put the **numbers back to double digits. Four of the last eight** years show double digits. Since 1984 there have also been 145 brain injuries with incomplete recovery. These numbers also are a concern, and if the cervical cord injuries and the cerebral injuries with incomplete recovery are combined, the number of incomplete recovery injuries is 459. That is an average of approximately 13.5 injuries with incomplete recovery for the past 34 years. Coaches, players, athletic trainers, physicians and administrators must continue the emphasis on eliminating permanent spinal cord and brain disability injuries to football players at all levels of play.

The latest participation figures show 1,500,000 players participating in junior and senior high school football and 75,000 in college football. Table II illustrates the incidence of spinal cord injuries for both high school and college participants. The incidence rate per 100,000 participants in 2010 is less than one per 100,000 at the high school level (0.33) and 2.66 at the college level. In looking at the incidence rates for the past 34 years, the high school incidence is 0.53 per 100,000 participants and the college incidence is 1.41 per 100,000 participants. The 27 year incidence rate for brain injuries with disability is 0.33 for the high schools and 0.54 for the colleges.

As indicated in past reports a majority of the permanent cervical cord injuries are taking place in games. In 2010 five of the seven injuries took place in games and two in practice.

Table III indicates that when comparing cervical cord injuries to offensive and defensive players, it is safer playing offensive football. During the 34 year period from 1977-2010, 221 (70.4%) of the 314 players with cervical cord injuries were playing defense. A majority of the defensive players were tackling when injured. In 2010, four of the seven injured players were tackling (three on kick-offs). Coaches have indicated that their players have been taught to tackle with the head up, but for some reason many of the players are lowering their heads before making contact. Sixty-two or 19.6% of the injured players were tackling with the head in a down position (chin to chest and contact with the top or crown of the helmet). These are the only players we are

sure had their heads down, but it is possible that there were others tackling with the head down. In addition to tackling with the head down, ball carriers are being injured with their heads in a down position while being tackled. It is important for coaches to emphasize head up tackling, but it is also important to emphasize head up blocking and head up ball carrying when being tackled. Many coaches teach their ball carriers to lower the head before being tackled and to run over the tackler, but this activity can be dangerous and can cause cervical spine and brain injuries with incomplete recovery. Nine-point-two percent of the cervical cord catastrophic injuries happened when being tackled.

Past reports (Table V) have revealed that defensive backs were injured at a higher rate than other positions. In 2010 three players were on kick-off coverage, one was a running back, one was a defensive back, one was in a drill, and one was unknown.

In 2010 there were four brain injuries with incomplete neurological recovery. All four of the injuries were at the high school level. In addition to the injuries with incomplete recovery, there were 13 injuries with complete recovery. As shown in Table VII, high school football accounted for 10, college football two, and youth football one. As stated earlier the researchers do not have full confidence in the full recovery data, but the data in 2007, 2008, and 2009 are the highest number of catastrophic injuries with recovery since the study was initiated in 1977. It has always been our belief that there are a higher number of recovery injuries that we are not receiving information on, but the data from the last three years show that we are making progress. There has been a dramatic decline in the recovery injuries for the 2010 season.

RECOMMENDATIONS

As stated in earlier reports, there has been a reduction of permanent cervical cord injuries when compared to data from the early 1970's. The 1991 and 1994 data show a dramatic reduction to one permanent cervical cord injury in high school football (two total each year for all levels). That was a great accomplishment and every effort should be made to continue that trend. The problem is the double digit numbers in four of the last eight years with 11 in 2003, 13 in 2004, 10 in 2006, and 14 in 2008. These numbers are not acceptable and an all out effort must be made to reduce them. For the past ten years, 2001-2010, there has been an average of 9.4 cervical cord injuries with incomplete

neurological recovery, and 6.5 cerebral injuries with incomplete recovery in football. The prior ten years averaged 6.9 cervical cord injuries with incomplete recovery and 5.2 cerebral injuries with incomplete recovery. The 12 cerebral injuries in 2008 was the highest number since we started to collect that data in 1984.

The initial reduction of permanent disability injuries was the result of efforts put forth by the total athletic community concerned with safety to football participants. **Major areas of emphasis that once again should receive attention are the 1976 rule change that eliminated the head as the initial point of contact during blocking and tackling, improved medical care both at the game site and in medical facilities, improved coaching techniques in teaching the fundamentals of tackling and blocking, and the increased concern and awareness of football coaches. The original 1976 rule defined spearing as "the intentional use of the helmet (including the face mask) in an attempt to punish an opponent". In the new 2005 definition of spearing the word "intentional" was removed from the rule in order to make it easier for the referees to call. There continues to be a number of disability injuries caused by helmet-to-helmet contact. During the 2010 football season there continued to be a number of helmet-to-helmet contacts that were related to disability injuries.**

A concerted effort must be made to continue the reduction of cervical spine and cerebral injuries and to aim for the elimination of these injuries. Following are several suggestions for reducing these catastrophic injuries:

1. Brain and spinal injuries in football have been dramatically reduced since the rules were changed in 1976 to prohibit butt blocking and face tackling, and other techniques in which the helmet and facemask purposely received the brunt of the initial impact. There are still a number of football players that become paralyzed due to cervical cord injury. Because head contact largely caused these injuries it is important to remember the lesson to keep the head and face out of blocking and tackling. Coaches should drill the players in the proper execution of the fundamentals of football - particularly blocking and tackling. **SHOULDER BLOCK AND TACKLE WITH THE HEAD UP - KEEP THE HEAD OUT OF FOOTBALL.**

2. **Preseason physical exams for all participants. Identify during the physical exam those athletes with a history of previous brain or spinal injuries - including concussions. If the**

physician has any questions about the athlete's readiness to participate, the athlete should not be allowed to play.

3. Athletes must be given proper conditioning exercises that will strengthen their necks in order to be able to hold their heads firmly erect while making contact during a tackle or block. Strengthening of the neck muscles may also protect the neck from injury.

4. Coaches and officials should discourage the players from using their heads as battering rams when blocking, tackling, and ball carrying. The rules prohibiting spearing should be enforced in practice and games. The players should be taught to respect the helmet as a protective device and that the helmet should not be used as a weapon. **Ball carriers should also be taught not to lower their heads when making contact with the tackler.**

5. **Football officials can play a major role in reducing catastrophic football injuries.** The use of the helmet-face mask in making initial contact while blocking and tackling is illegal and should be called for a penalty. **Officials should concentrate on helmet-face mask contact (helmet-to-helmet contact) and call the penalty. If more of these penalties are called there is no doubt that both players and coaches will get the message and discontinue this type of play.** A reduction in helmet-face mask contact will result in a reduction of catastrophic football injuries.

6. All coaches, physicians and athletic trainers should take special care to see that the players' equipment is properly fitted, particularly the helmet.

7. It is important, whenever possible, for a physician to be on the field of play during game and practice. When this is not possible, arrangements must be made in advance to obtain a physician's immediate services when emergencies arise. Each institution should have a team certified athletic trainer who is a regular member of the institution's staff and who is qualified in the emergency care of both treating and preventing injuries.

8. Coaches must be prepared for a possible catastrophic head or neck injury. The entire staff must know what to do. Being prepared and knowing what to do may be the difference that prevents permanent disability. Have a written emergency plan and give copies to all personnel. Areas that should be covered are, 1) an evacuation plan, 2) available transportation, 3) portable and open communication, and 4) game/practice schedule awareness in local hospital emergency department.

which an athlete should be withheld from competition pending clearance by a physician.

Football catastrophic injuries may never be totally eliminated, but continued research has resulted in rule changes, equipment standards, improved medical care both on and off the playing field, and changes in teaching the fundamental techniques of the game. These changes were the result of a united effort by coaches, administrators, researchers, equipment manufacturers, physicians, athletic trainers and players. The new concussion recommendations by the NFHS and the NCAA should play a major role in reducing brain injuries that often result in death or disability. They will also play a role in the reduction of second impact syndrome.

Research based on reliable data is essential if progress is to be made. Research provides data that indicate the problems and reveal the adequacy of preventive measures. It is important to point out that the information in this report is only as good as the data collected. The report only includes data on cases that are reported to us by the NFHS, the NCAA, coaches, athletic directors, and national newspaper and television news. . It is our feeling that we receive information on a majority of the cases, but that it is not possible to state we have information on 100% of the cases.

REFERENCES

1. Schneider, R.C.: Head and Neck Injuries in Football. Baltimore, William and Wilkins Co., 1973.
2. Albright, J.P., Moses, J.M., Feldick, H.G., et al.: Nonfatal Cervical Spine Injuries in Interscholastic Football. JAMA 236: 1243 - 1245, 1976.
3. Torg, J.S., Trues, R., Quedenfeld, T.C., et al.: The National Football Head and Neck Injury Registry. JAMA 241: 1477 - 1479, 1979.
4. Mueller, F.O., Colgate, B.: Annual Survey of Football Injury Research 1931 - 2010. National Collegiate Athletic Association, National Federation of State High School Associations and the American Football Coaches Association, 2011.

CATASTROPHIC INJURY CASE STUDIES

HIGH SCHOOL

A high school sophomore was injured in a game on September 3, 2010 when he was tackled, but continued to play after the injury. A few days after the game he experienced symptoms which required hospitalization. He had a lacerated pancreas and underwent pancreatic surgery. He was in intensive care for a week. The long term effects of the injury are unknown at this time. This injury was included in the report due to the seriousness of the injury.

A 16 year-old high school football player was injured in a game on October 8, 2010. He was making a tackle on a kick-off in the first quarter and had a fractured C-5 vertebra and crushed C-4. At the time of this writing the player has paralysis and is confined to a wheelchair.

A 14 year-old high school football player fractured a cervical vertebra during a game on September 17, 2010. He was making a tackle from behind and hit the ground face mask first when his neck buckled under the pressure. He had surgery and recovery was incomplete.

A 15 year-old sophomore high school football player was injured during practice on August 14, 2010. He was involved in a tackling drill and had head contact with his opponent. He fractured his 5th cervical vertebra, had surgery, and recovery was incomplete. He came home after three months in the hospital after the surgery and rehabilitation.

A high school football player was injured on August 23, 2010, while participating in a tackling drill as the tackler. He remembers a first hit to the head and then the next hit sent a shock to his head. He suffered a subdural hematoma, had emergency surgery, and recovery was incomplete.

A 17 year-old high school football player suffered a subdural hematoma during a game on September 24, 2010. He was a running back and had helmet-to-helmet contact with the tackler. He had a five hour surgery and recovery was incomplete.

A 16 year-old high school football player suffered a serious brain injury during a JV game on October 28, 2010. He was a defensive back and collapsed on the field while vomiting and suffering a headache. He was in a coma for two weeks. The activity at the time of the injury was unknown and recovery is incomplete.

A 13 year-old middle school football player was injured in practice after being tackled and driven into the ground. He suffered axial loading to the spinal column and flexion injury with the result being fractures of cervical vertebra 4-5. The athlete is quadriplegic.

A 17 year-old high school football player was injured in a game on September 30, 2010. He was a quarterback who was tripped by a defensive player and as he was going down he suffered a helmet-to-helmet hit by a second player. He had a fractured cervical vertebra, had six hours of surgery, and recovery is incomplete.

A 17 year-old high school football player was injured during practice on September 15, 2010, after a hard hit and suffered a severe brain bleed. He complained of a headache to the athletic trainer before collapsing. He had surgery and recovery was incomplete, but the physician stated he may be able to play lacrosse in the spring.

This injury was included due to the seriousness of the injury. On September 24, 2010, the athlete suffered a compound fracture of the lower leg during a game. Due to complications during surgery the leg was amputated above the knee.

A high school junior was injured in football practice on August 8, 2010 when tackling. He fractured two cervical vertebrae, had surgery and recovery was complete.

A 16 year-old high school football player was injured in a contact drill in practice on August 24, 2010. The injury was diagnosed as a brain contusion. The athlete had a full recovery.

A high school sophomore football player was injured in a JV game on October 14, 2010. He was hit in the facemask and in the back of the head. He had a brain bleed, had surgery, and had a full recovery.

A high school sophomore football player was injured in a game on October 8, 2010. He was a defensive tackle and suffered a fractured cervical vertebra. No other information was available. He has made a full recovery.

A 17 year old high school football player's heart stopped on the sideline during a game on September 10, 2010. A cardiac nurse was at the game and administered CPR. He later had surgery and a

full recovery is expected. The left coronary artery was not supplying enough blood during exertion.

A high school senior football player suffered a fractured cervical vertebra in August 2010. He has recovered, but no other information was available.

A senior high school football player suffered three fractured lumbar vertebrae during a game on September 24, 2010. He was tackling with his head in a down position and the ball carrier's body struck his head. He had a full recovery, but missed the remainder of the season.

A 17 year-old high school football player was injured during a practice session on September 7, 2010, when he was hit in the chest by another player. He was a defensive lineman. He had cardiac arrest and with the use of an AED regained consciousness. He has recovered from the injury.

A high school football player lost consciousness on the sideline during a game on November 12, 2010. He had surgery to relieve pressure on the brain. As a running back he was twice thrown to the ground by a tackler who grabbed his face mask. He has recovered from the injury.

A 17 year-old high school football player collapsed during a voluntary practice on July 27, 2010. He had an undetected heart problem and had surgery to place a defibrillator in his chest. CPR and an AED saved his life. The injury was diagnosed as cardiomyopathy, and the athlete also had sickle cell trait. He will not play football again.

1997 UPDATE

A 16 year-old high school football player was injured in a game on August 30, 1997, and spent 16 days in the hospital after suffering a brain injury. He had a collision with two other players, continued to play, collapsed on the bench, and was later induced into a coma for 11 days. Recovery was incomplete.

1999 UPDATE

A high school football player was injured in a game on October 23, 1999, after a collision with an opposing player during a kick-off play. He had a brain bleed and was unconscious for eight days. Recovery was incomplete.

2001 UPDATE

A high school football player was injured in a game on September 28, 2001. He passed out on the sideline after being tackled and was in critical condition with a brain injury. He suffered from a headache from a hit two weeks earlier, but did not tell anyone. He recovered from his injury.

2002 UPDATE

A high school football player made a goal-line tackle in a game on October 12, 2002, and held his head stating that he had a bad pain. He had a brain bleed which stabilized after two days. He previously had several concussions in both football and ice hockey but never told anyone - one was severe. He has recovered.

A high school football player suffered a concussion two years ago playing ice hockey and had another one in a football game on September 20, 2002. He continued to play with possibly more than one concussion. He vomited at home that night and woke up the next morning with a severe headache. He suffered from post concussion syndrome and recovery was incomplete.

2004 UPDATE

A high school football player suffered a severe concussion on September 11, 2004, while blocking in a game. He hit his head to the turf when his head snapped back and hit the synthetic turf. He had a concussion a year earlier from a head-to-head hit. He will not play anymore football and recovery is incomplete.

2005 UPDATE

A 17 year-old high school senior was injured on October 7, 2005, suffering a concussion while tackling a receiver in a game. He collapsed on the sideline and had a brain bleed, surgery, and incomplete recovery. He had several previous concussions.

2007 UPDATE

A high school football player suffered from a possible second impact syndrome injury in September 2007. He had a subdural hematoma that healed without surgery and which was thought to have happened in practice and was aggravated in a fall during a game. Recovery was incomplete.

2008 UPDATE

A high school football player was injured in a game on October 24, 2008, while covering a kick and collided with a teammate. He fractured cervical vertebra #6 as well as a ruptured disk. He had surgery and recovery was complete.

A high school football player was injured in practice sessions on August 14, 2008. In the morning practice the athlete had a head injury which involved headache, dizziness, and vomiting. Coaches told him not to sleep between morning and afternoon practices. Coaches cleared him to practice in the afternoon practice. In the afternoon practice he suffered a subdural hematoma, had surgery and recovery was incomplete. The injury prompted a lawsuit.

2009 UPDATE

A 15 year-old high school football player was injured in a game on September 10, 2009 after being tackled. As he approached the tackler he lowered his head and there was a helmet-to-helmet hit. He had surgery for a fractured cervical vertebra # 6. Recovery was complete.

A senior high school football player was injured in a game after a helmet-to-helmet hit in 2009. He suffered a series of concussions during his high school football career - freshman year, junior year, senior year missed a week before returning to play, next game thrown to ground for another concussion. CAT scan showed no brain damage. He struggled through the basketball season with headaches and academic problems. The athlete is now in college with complete recovery.

SANDLOT

A 12 year old youth football player was injured in a game in October 2010. During a head-to-head collision he was temporarily paralyzed due to a spinal concussion. He was in the hospital for two days and recovery was complete.

COLLEGE

A Division I college football player was paralyzed in a game on October 16, 2010, after making a tackle on a kick-off. He made the initial contact with the top of his helmet hitting the shoulder of the ball carrier. He was 6' 3" and weighed 230 pounds at the time of the injury. At the time of this writing the athlete

was quadriplegic.

A Division III college football player was injured during a game on October 16, 2010, and suffered a fractured cervical vertebra. He was tackling on a kick-off, fell forward and hit the thigh of the ball carrier with his head. He had a three hour surgery and at the time of this writing recovery was incomplete.

A Division I college football player was injured in a game on September 11, 2010, when he fractured a cervical vertebra when he hit the crown of his helmet on the turf after diving over a pile. He was covering a punt at the time and ran off of the field after the injury. Recovery was complete.

A Division I college football player was injured in spring practice in April 2010. He fractured cervical vertebra #1 and did not know it was fractured until August of 2010. He was placed in a halo cast. He will not play anymore football since one hit could paralyze him.

PROFESSIONAL

2008 UPDATE

A semi-professional football player was injured in a game on April 25, 2008. He received hits to the head in two games two weeks apart. He had signs of a concussion - headaches, nausea, dizziness, blurred vision, and insomnia. He was cleared to play a week after the second hit. He has permanent brain damage and the case involved a lawsuit.

2009 UPDATE

A NFL professional football player suffered a fractured cervical vertebra in a game during the 2009 season. He was a tight end and had an awkward landing near the sideline after being tackled. He did not have surgery and was wearing a neck collar. Recovery was complete, but it was still questionable if he would continue to play.

TABLE I
CERVICAL CORD INJURIES 1977 - 2010*

YEAR	SANDLOT	PRO AND SEMI-PRO	HIGH SCHOOL	COLLEGE	TOTAL
1977	0	0	10	2	12
1978	0	1	13	0	14
1979	0	0	9	3	12
1980	0	0	11	2	13
1981	1	0	6	2	9
1982	1	1	7	2	11
1983	0	0	11	1	12
1984	1	0	6	0	7
1985	0	0	6	3	9
1986	0	0	4	0	4
1987	0	0	9	0	9
1988	0	0	10	1	11
1989	0	1	12	2	15
1990	0	0	11	2	13
1991	0	1	1	0	2
1992	0	1	6	0	7
1993	0	1	8	0	9
1994	0	0	1	1	2
1995	0	0	8	1	9
1996	0	0	6	3	9
1997	0	1	7	1	9
1998	0	0	4	0	4
1999	1	0	8	1	10
2000	0	0	6	2	8
2001	0	0	9	0	9
2002	0	0	6	1	7
2003	0	1	9	1	11
2004	1	1	11	0	13
2005	0	0	5	0	5
2006	0	0	8	2	10
2007	1	1	7	0	9
2008	0	3	11	0	14
2009	0	1	7	1	9
2010	0	0	5	2	7
TOTAL	6	14	258	36	314

*Figures are updated annually due to new cases investigated after publication.

TABLE II
INCIDENCE PER 100,000 PARTICIPANTS 1977-2010*

YEAR	HIGH SCHOOL	COLLEGE
1977	0.77	2.67
1978	1.00	0.00
1979	0.69	4.00
1980	0.85	2.67
1981	0.46	2.67
1982	0.54	2.67
1983	0.85	1.33
1984	0.46	0.00
1985	0.46	4.00
1986	0.31	0.00
1987	0.69	0.00
1988	0.77	1.33
1989	0.80	2.66
1990	0.73	2.66
1991	0.07	0.00
1992	0.40	0.00
1993	0.53	0.00
1994	0.07	1.33
1995	0.53	1.33
1996	0.40	4.00
1997	0.47	1.33

TABLE II CONTINUED

1998	0.27	0.00
1999	0.53	1.33
2000	0.40	2.66
2001	0.60	0.00
2002	0.33	1.33
2003	0.60	1.33
2004	0.73	0.00
2005	0.33	0.00
2006	0.53	2.66
2007	0.40	0.00
2008	0.67	0.00
2009	0.46	1.33
2010	0.33	2.66

*From 1977-1988 Based on 1,300,000 High School - Junior High School Players and 75,000 College Players. In 1989 High School and Junior High School Figure Increased to 1,500,000.

TABLE III**OFFENSIVE VS. DEFENSIVE FOOTBALL 1977 - 2010***

YEAR	OFFENSE	DEFENSE	UNKNOWN	TOTAL
1977	0	7	5	12
1978	2	11	1	14
1979	1	6	5	12
1980	3	8	2	13
1981	3	5	1	9
1982	3	8	0	11
1983	2	10	0	12
1984	1	5	1	7
1985	1	8	0	9
1986	0	3	1	4
1987	1	6	2	9
1988	2	9	0	11
1989	0	14	1	15
1990	2	11	0	13
1991	1	1	0	2
1992	2	3	2	7
1993	0	7	2	9
1994	0	2	0	2
1995	0	6	3	9
1996	1	6	2	9
1997	4	5	0	9

TABLE III CONTINUED

1998	1	3	0	4
1999	3	7	0	10
2000	3	5	0	8
2001	0	5	4	9
2002	0	5	2	7
2003	1	9	1	11
2004	1	11	1	13
2005	3	2	0	5
2006	3	5	2	10
2007	3	5	1	9
2008	3	10	1	14
2009	0	8	1	9
2010	2	5	0	7
TOTAL	52	221	41	314

*Figures updated with availability of new information.

TABLE IV
CATASTROPHIC INJURIES 1977 - 2010

ACTIVITY	NUMBER	PERCENT
Tackling	128	40.8
Tackling Head Down	62	19.7
Tackling on Punt	4	1.3
Tackling on Kick-Off	19	6.1
Tackled	29	9.2
Tackled on Kick-Off	3	1.0
Collision	10	3.2
Blocking on Kick	4	1.3
Blocking on Kick-Off	4	1.3
Blocking	6	1.9
Contact After Interception	2	0.6
Blocked	4	1.3
Hitting Tacklematic Machine	1	0.3
Drill Hit Indoor Wall	1	0.3
DRILL	2	0.6
Unknown	35	11.2
TOTAL	314	100.0

TABLE V
CATASTROPHIC INJURIES 1977 - 2010
POSITION PLAYED

POSITION	NUMBER	PERCENT
Defensive Back	110	35.0
Kick-Off Team	30	9.6
Defensive Line	11	3.5
Linebacker	29	9.2
Kick-Off Return	12	3.8
Defensive End	7	2.2
Offensive Back	17	5.4
Quarterback	9	2.9
Flanker	2	0.6
Wide Receiver	6	1.9
Punt Coverage	3	1.0
Punt Return	1	0.3
Drill	6	1.9
Offensive Lineman	6	1.9
Unknown	65	20.7
TOTAL	314	100.0

TABLE VI
CEREBRAL INJURIES 1984 - 2010*

INCOMPLETE RECOVERY

YEAR	SANDLOT	PRO AND SEMI-PRO	HIGH SCHOOL	COLLEGE	TOTAL
1984	0	0	5	2	7
1985	0	0	4	1	5
1986	0	0	2	0	2
1987	0	0	2	0	2
1988	0	0	4	0	4
1989	0	0	6	0	6
1990	0	0	2	0	2
1991	0	0	3	1	4
1992	0	0	4	0	4
1993	0	0	5	0	5
1994	0	0	4	1	5
1995	0	0	4	0	4
1996	0	0	5	0	5
1997	0	0	8	1	9
1998	0	0	4	0	4
1999	0	0	5	0	5

TABLE VI CONTINUED

2000	0	0	6	1	7
2001	0	0	2	0	2
2002	0	0	2	1	3
2003	0	0	8	1	9
2004	0	0	3	1	4
2005	1	0	6	1	8
2006	0	0	9	0	9
2007	0	0	5	0	5
2008	1	1	10	0	12
2009	0	0	9	0	9
2010	0	0	4	0	4
TOTAL	2	1	131	11	145

*Figures are updated annually due to new cases investigated after publication.

TABLE VII
CATASTROPHIC INJURIES 2010*
COMPLETE RECOVERY

INJURY	SANDLOT	PRO	HIGH SCHOOL	COLLEGE	TOTAL
Brain (subdural)	0	0	3	0	3
CV FX	0	0	3	2	5
Transient	1	0	0	0	1
Lumbar Fx	0	0	1	0	1
Sickle Cell	0	0	1	0	1
Heart - AED	0	0	1	0	1
Commotio Cordis	0	0	1	0	1
TOTAL	1	0	10	2	13

*Researchers realize that this data may not be complete due to the difficulty of receiving non-disability injury information.