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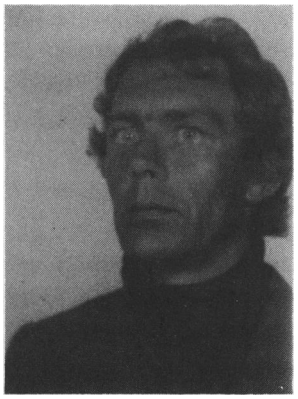

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ASSOCIATION FOOTBALL INJURIES TO THE BRAIN
A PRELIMINARY REPORT

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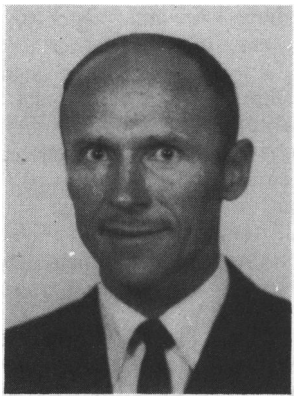

O. Storli

ABSTRACT

In 1975 the authors sent a questionnaire to all players in the Norwegian First Division League Clubs to record the incidence of head injuries due to heading. The conclusion of the questionnaire is that there seems to be a low percentage of serious head injuries. None of the players had been operated on for epi- or subdural hematoma or other brain damage and only a few have had concussion due to heading. In sixty per cent of the players a full neurological examination and EEG recording was undertaken. The result of these studies will be published in a subsequent article.

INTRODUCTION

Football is one of the most popular sports in Europe and according to Diehl and Wilke (1957), there are between five and six million organised football players in Europe. In Norway there are about one hundred thousand senior players.

Although accidents in sport involve other parts of the body more frequently than the brain, injuries to the brain assume special importance because they are sometimes followed by incapacitating neurological damage, such as intellectual defects varying from slight impairment of memory and concentration, to profound dementia or sometimes to death (Petterson, 1971).

The impact necessary to cause concussion is very close to that which produces gross anatomical damage (Ward, 1966). It is also known that severe injuries of the brain can occur with lower levels of impact than are usually required to produce concussion (Reid et al, 1975). Head trauma in football may result from a hard blow or repeated blows from the ball, from hard contact between players, by striking the ground, from the opponents head, elbow or boot. In the literature there are reports of several serious head injuries or even death caused by head injuries in football games (Blonstein, 1966; Eckhardt and Kobbe, 1971; Matthews, 1972; Merrem, 1954). Head injuries occur in other contact sports, but tend to follow patterns we did not find in association football.

The intention of the present study was to examine to what extent a blow or repeated blows to the head due to heading, produced discomfort or permanent head trouble. The tolerance of the living human brain to impact is unknown. Extensive research on brain concussion has been in progress in various laboratories for several years. Experimental models, animals, and human cadavers have been used to achieve impact data (Danny-Brown and Russell, 1941: Edberg et al, 1963; Gurdjian et al, 1962; Holbourn, 1943; Lindgren, 1966; Ommaya et al, 1964; Ward, 1966), but the extrapolation to the living human brain has been difficult.

As early as in 1945, Denny-Brown recorded EEG changes after blows to the head of anaesthetised cats. The EEG demonstrated a great loss in the amplitude of the waves, followed by a progressive but slow recovery. Low voltage spikes for seven seconds and low amplitude for two minutes were noted.

When a football-player is heading a ball, his physiologic response adds a new dimension to the measurement of brain tolerance. His head no longer reacts as a freely movable body because the neck muscles resist movement of the head. This results in a prolonged response. Holbourn (1943) has shown that an impact of short duration produces an injury that results from change in the velocity of the head, whereas impact of relatively long duration produces injury that results from acceleration of the head. Holbourn speaks about straight-line, or linear acceleration forces, due to the

change in linear velocity, and rotational acceleration forces, due to change in rotational velocity. Usually rotational acceleration is the main cause of brain injury (Denny-Brown and Russel, 1941; Yarnell and Ommaya, 1969). By bracing the neck muscles the football-player, when heading a ball, decreases the rotation which is, to some extent, insurance against brain damage. Many authors (Denny-Brown and Russell, 1941; Ommaya et al, 1964) have found that concussion was very difficult to produce in animals when the head was fixed, but easy when it was freely mobile.

When heading a ball, the player creates other forces, produced by muscle tension, to oppose the force of the ball. The opposing forces can be considered as an increase in the mass involved in the impact (Reid et al, 1975). The weight of the head plus the torso must therefore figure in the calculation of the mass. By applying Newton's Law of Motion (F = M x A), the same force (F) applied to a greater mass (M) results in less acceleration (A). In this way the player reduces the acceleration both by decreasing the rotational acceleration and by increasing the mass. This is when a player heads a ball correctly. The correct place to head a ball is with the frontal bone, but often the contact is made with other places, and then there is momentum of rotational acceleration. A famous English player once said: "If you catch the ball wrongly, it makes your eyes water and your head ache".

MATERIALS AND METHODS

In 1975 the authors observed the total number of headings in 10 First Division games in Norway, 6 English games on TV and 4 international games between Norway and other countries. We found the average number of heading for all players, to be 117, 124 and 94 respectively. The Norwegian First Division and the International matches were observed by both authors who actually were present in the stands. The games of the English League were televised in full, and observed on the TV screen by both authors. All 22 players in each game were included. All players were noted to head the ball, though with varying degrees of skill.

A questionnaire was sent to 192 players in our twelve First Division League Clubs. We received answers from 155 players (81.3 per cent). A total of 27 players were excluded, including 13 goal-keepers and 14 other players who had had concussion and head trauma outside sport, or in other sports than football. Of the remaining 128 players, 77 players (60.2 per cent) in 6 of the 12 clubs were interviewed and underwent a full neurological and EEG examination.

RESULTS

The 128 players included in the present study were from 18 to 34 years old, average 25 years. They had played a total of 12,816 games (First and Second Division and international games), in average 100.1 games per player. Sixty-one of them had played international games.

Twenty-three (18 per cent) of the players answered that they were typical headers, specified as such in newspaper reports, and considered so by team mates and knowledgeable observers. Sixty-four (50 per cent) players, including 16 typical headers, had had acute symptoms due to heading (Table I). Ten of the 64 players needed hospitalisation, one player twice, also 3 players with concussion. Of the 53 who did not need hospitalisation, there were 4 with concussion. Twenty-one players (16.4 per cent), including 6 typical headers, complained of protracted symptoms and 6 players (4.7 per cent), including 3 typical headers, had permanent symptoms due to heading (Table II). Two players treated in hospital, and one player with concussion

TABLE I

Acute signs and symptoms

	Nos. of players	Consciousness	Additional signs or symptoms		Hospitalisation
Hospitalised	3	Unconscious	Fracture of nose	1	1-2 days
	8	Conscious	Fracture of nose	3	
			Fracture of zygomatic	3	
			Disorientation, headache, vomiting, nausea, dizziness	2	1-15 days
Not hospitalised	4	Unconscious			0 days
	49	Consciouss	Fracture of nose	1	
			Fracture of maxillae	1	
			Disorientation, headache, nausea, etc.	47	0 days

TABLE II

Complaints after heading

Symptoms	Protracted complaints (21 players including 6 headers)	Permanent complaints (6 players including 3 headers)
Headache	12	2
Neck pain	6	0
Dizziness	5	1
Irritability	1	1
Insomnia	1	1
Hearing disturbance	1	0
Weakened memory	0	2
Abnormal alcohol reaction	0	1

without hospitalisation (Table I), had permanent symptoms: one weakened memory and dizziness, one abnormal alcohol reaction and one irritability.

Thirty-one players (24.2 per cent) have been in hospital once or several times and operated on for other injuries: fractures, string injuries, rupture of meniscus, etc. Five of these players are among the 6 with permanent symptoms due to heading.

Thirty-one players (24.2 per cent) are participating in other sports, most of them in bandy, ice-hockey and skiing. None of these have permanent symptoms.

COMMENTS

If a player plays about 300 top division games during his football career, he receives about 2,000 head blows, some many more. The introduction of a plastic-coated football with constant weight, unlike the all-leather ball, which gathers water and mud, has probably reduced head injuries (Adams, 1976). A leather ball increases in weight by about 20 per cent on a wet pitch (Matthews, 1972). On the other hand the players now perform under more intense pressure and in twice as many games. The effect of a blow may or may not be reversible. Even rapid and complete recovery of cerebral function after a head injury does not necessarily exclude the possibility that a small number of neurons may perish or that others may have been permanently disconnected, a number so small as to be negligible at the time but which may become clinically significant after further damage. In a recent demonstration for the authors, 4 active footballers all ended up with a headache after about ten minutes in spite of correct heading. In 1975 Cronwall and Wrightson studied twenty adults, 16 to 26 years old, after a second concussion. They showed that the capacity to process information was reduced significantly, and that the reduction lasted longer when the patient has been concussed before. The effects of concussion seem to be cumulative. This may also have important implications for footballers who have received hundreds of blows to the head.

Participating in many sports carries some risk of injury to the head, and this is more pronounced in body contact. In football, it is often difficult or impossible to differentiate head injuries due entirely to heading a ball from other head injuries due to opponents' heads or arms. It will never be possible to eliminate completely head injuries in football, but it is important to reduce the risk as much as possible. Today we know too little about the effect of heading and there is a need for further clinical studies. What about the effect of heading on a child's skull, the bone of which does not become full-grown until the age of eighteen or more?

CONCLUSION

There seems to be a low percentage of serious head injuries in Norwegian Top Division football. None of the players in this investigation have been operated on for epi- or subdural haematoma or other brain damage, although a subdural haematoma was evacuated by A.T. in a football player of a lower division. Petechial haemorhage is a much more likely pathological condition. Only 6 players complained of permanent symptoms,

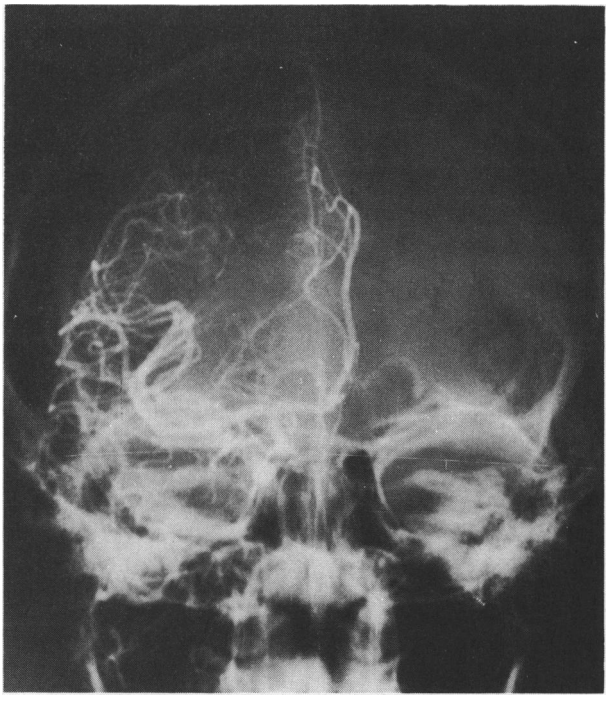

Fig. 1. Angiogram of football player's sub-dural haematoma (not one of the First Division players surveyed in this article).

but it is interesting to see that 5 of these are among the players who have been in hospital and operated on for other injuries. One player with concussion who was not hospitalised (Table I) complained of permanent symptoms. This player was a very hard player with a lot of head injuries due to football. It seems that hard players are more exposed to head injuries than other players. We know that heading can be dangerous, therefore greater attention should be paid to teach boys and girls how to play football in a safer way and to head correctly.

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