



ON HEADING AND HEAD INJURIES IN FOOTBALL: THE F-MARC EXPERIENCE

DT Kirkendall, C Fuller, N Shewchenko*, A Junge, J Dvorak
FIFA Medical Assessment and Research Centre
Zurich, Switzerland

*Biokinetics & Associates Ltd
Ottawa Canada

Current issues



- The MEDIA
 - Is (insert your favorite sport) safe? Brain injuries? Headgear? Children's risk?
- The MEDICAL COMMUNITY
 - NP deficits? Long-term effects of concussion? Injury incidence? Risks? Impact tolerance?
- The SPORT
 - Restrict heading? Mandate headgear? Change rules? Other issues on equipment?

Background



- >250 million registered players worldwide
- Staggering viewing audience
- FIFA member nations > UN
- Football is the only sport to use the unprotected head to control and advance the ball
- Heading frequency varies widely amongst players from 0-10+ per match
- Clash of heads has a 'very high propensity' to cause injury for both players
 - Most often in the middle of the field . . .
 - When players approach from opposing directions
- Injuries to the head reported to be between 4 and 20%
 - Concussive injury the most common serious injury

From a historical perspective . . .



How did we get from this:



To this?



Incidence of Head Injury



- 3.9% (boys) and 4.3% (girls) of all injuries are to the head (ages 15-18)
- Head injuries make up 14% of all injuries in club soccer (age 12-18)
- Estimate one concussion every 4-6 seasons
- US college: 1 concussion per team per season
- 1 concussion per FIFA tournament
- Play 10 years:
 - *50% of all men and 22% of all women will have had 1 concussion*

Heading	0%
Head-ball	24%
Head-elbow	14%
Head-head	28%
Other	34%

From the English FA and FMARC



- “a head injury is a potentially serious injury which can lead, in a small number of cases, to significant complications. No head injury in trivial”
- In professionals and championship events:
 - Overall Injury rates range from 65 to 100+/1000 player hrs
 - FA audit: head/neck injuries = 1.4 to 4.1/1000 ph
 - Icelandic/Norwegian professionals: 1.7/1000 ph
 - German women’s professionals: 1.8/1000 ph
 - European amateurs: 0.4/1000 match hours
 - FIFA sponsored tournaments:
 - Males 12.8/1000 mh; females 11.5/1000 mh
 - Lost time injuries: 3.5 and 4.1/1000 mh respectively

Not all head injuries are concussions



	Men	Women	All
Contusion	57%	41	53
laceration	21	15	20
concussion	8	22	11
fracture	2	6	3
others	12	17	13
<i>TOTAL #</i>	<i>194</i>	<i>54</i>	<i>24</i>

8

From 20 FIFA sponsored tournaments, 1998-2004

Mechanism of injury: in the open field



QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

Mechanism of injury: in the penalty area



QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

John Terry

Other Actions Leading to Head Injury



- Backwards head flick with/without small jump
- Goalie collisions with foot or post
- Rarely caused by contact with ball
 - *more common with spectators.*

QuickTime™ and a YUV420 codec decompressor are needed to see this picture.

But a kicked ball can travel over 100kph!



But a kicked ball can travel over 100kph!



QuickTime™ and a
Cinepak decompressor
are needed to see this picture.

Of the 163 head/neck injuries seen on video, 6 risk factors detailed for each incident



- Location on field
 - Off/def PA, off/def outfield
- Ball possession
- Direction of approach to injured player
- Mode of approach
- Action
- Intent
- From MDs post match report
- Location
- Diagnosis
- Severity (estimated time lost)



		Where	Poss	where	Mode	Action	intent
sex	men	Def out	free	side	jump	elbow	fair
	women	Def out	free	front	jump	head	fair
Age	<20y	Att out	free	side	jump	Elbow	fair
	>20y	Def out	free	side	jump	head	fair
Dx	Conc	Att out	free	front	jump	head	fair
	cont	Att out	free	side	Jump	elbow	fair
	lac	Def out	free	side	jump	elbow	fair



**Obviously, head injuries are
risk of playing football**

The debate surrounds the
consequences of purposeful
heading or concussion

The History



- Footballer's Migraine (Matthews, 1972)
- Cumulative effects of concussion (Gromwell, 1975)
- Assoc football injuries to the brain
 - Norwegian studies, 1981 – 1991
 - Heading 1st blamed for cognitive deficits
- Disputed in later studies stating concussion was the factor in cognitive deficits
 - Haglund, Jordan, Matser, Putukian
- Cognitive deficits not a universal finding in footballers with concussion history
 - Guskiewicz, Bahr, Echemendia

F-MARC Head Impact Research Program



“... to improve the biomechanical understanding of heading and head impacts to quantify the response and identify avenues for reduction ...”



Areas of Head Response Research



- Heading techniques
- Ball characteristics
- Bodily contact
- Protective headgear



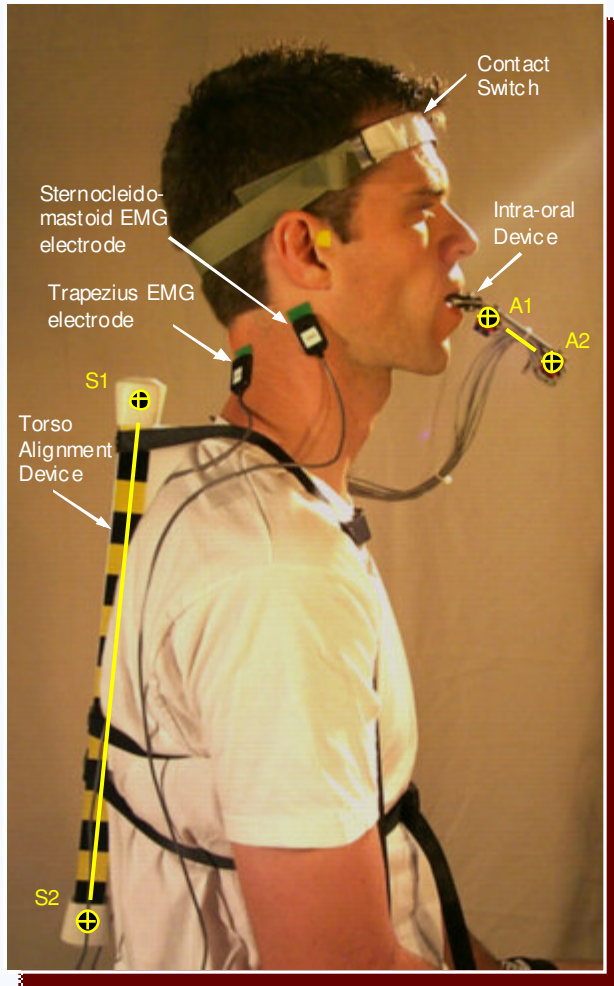
Areas of Head Response Research



- Heading techniques
- Ball characteristics
- Bodily contact
- Protective headgear



Modeling heading technique



Instrumentation

Kinematics



Methods – Numerical Model

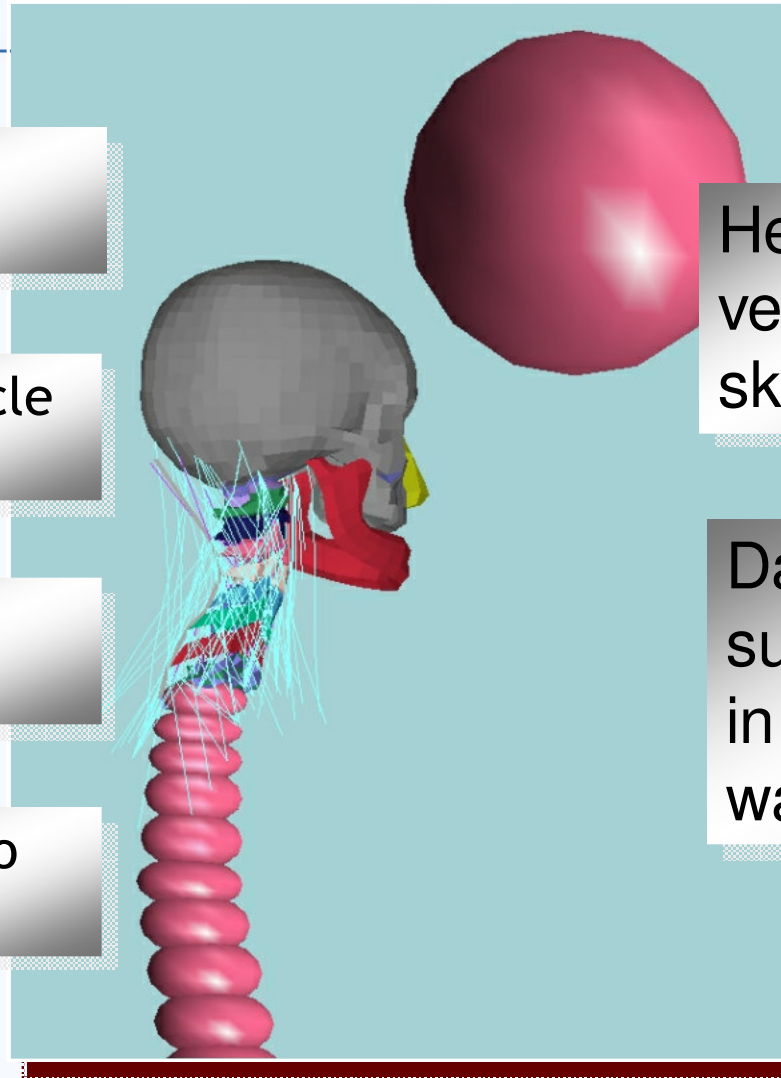


Head-Ball
Contact

Neck Muscle
Groupings

0C-C7
Vertebrae

Coupled to
Torso



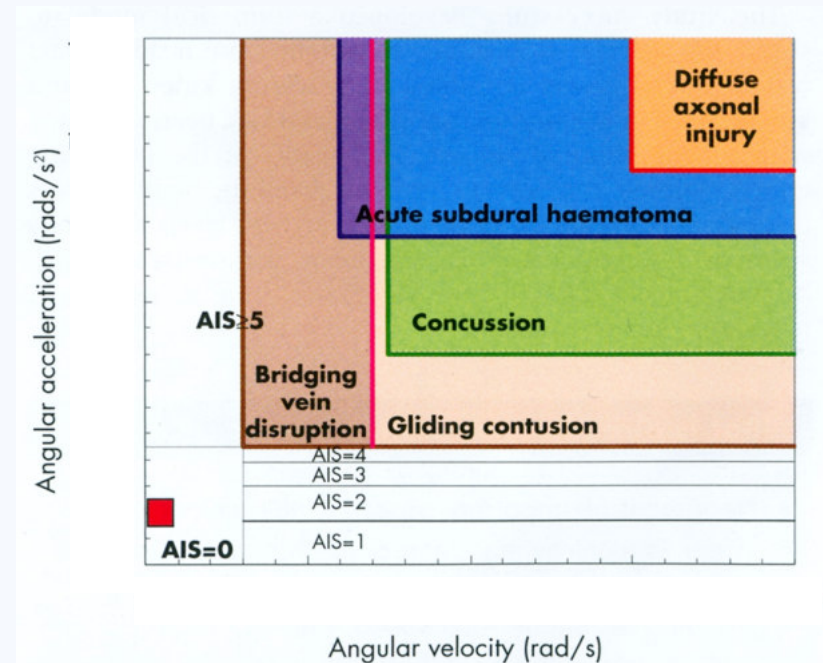
Heading is a
very complex
skill

Data doesn't
suggest a change
in the skill is
warranted

Estimated Impact of heading



- Minimum concussive force for a concussion estimated at 22 N/sec (a moving target?)
- Soccer ball impact = 12-13 N/sec
 - (at 65 kph)
- Therefore, impact of the ball during *purposeful heading* is below that to produce a concussion



Areas of Head Response Research



- Heading techniques
- **Ball characteristics**
- Bodily contact
- Protective headgear

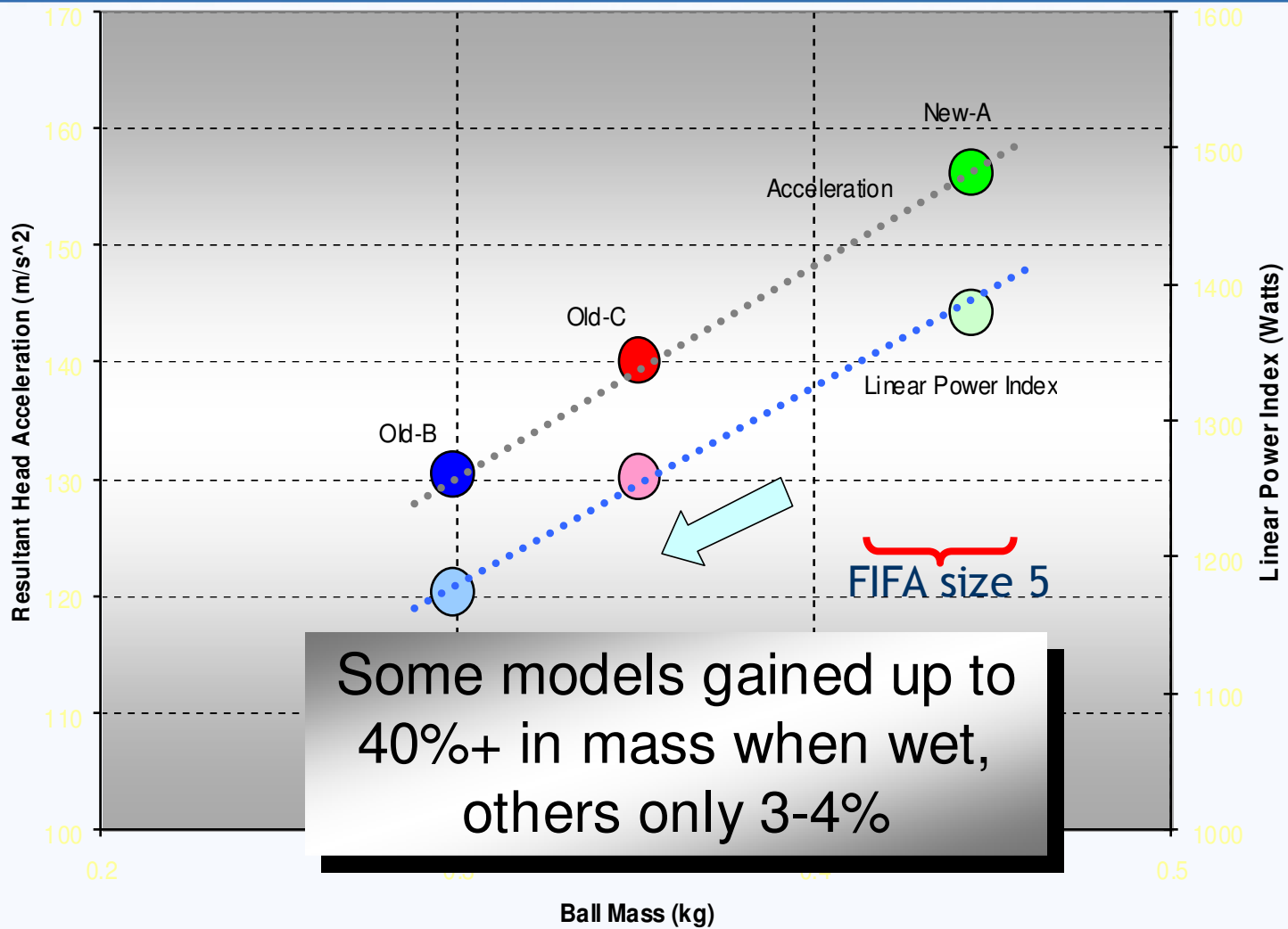


Ball Properties – Safety Concerns



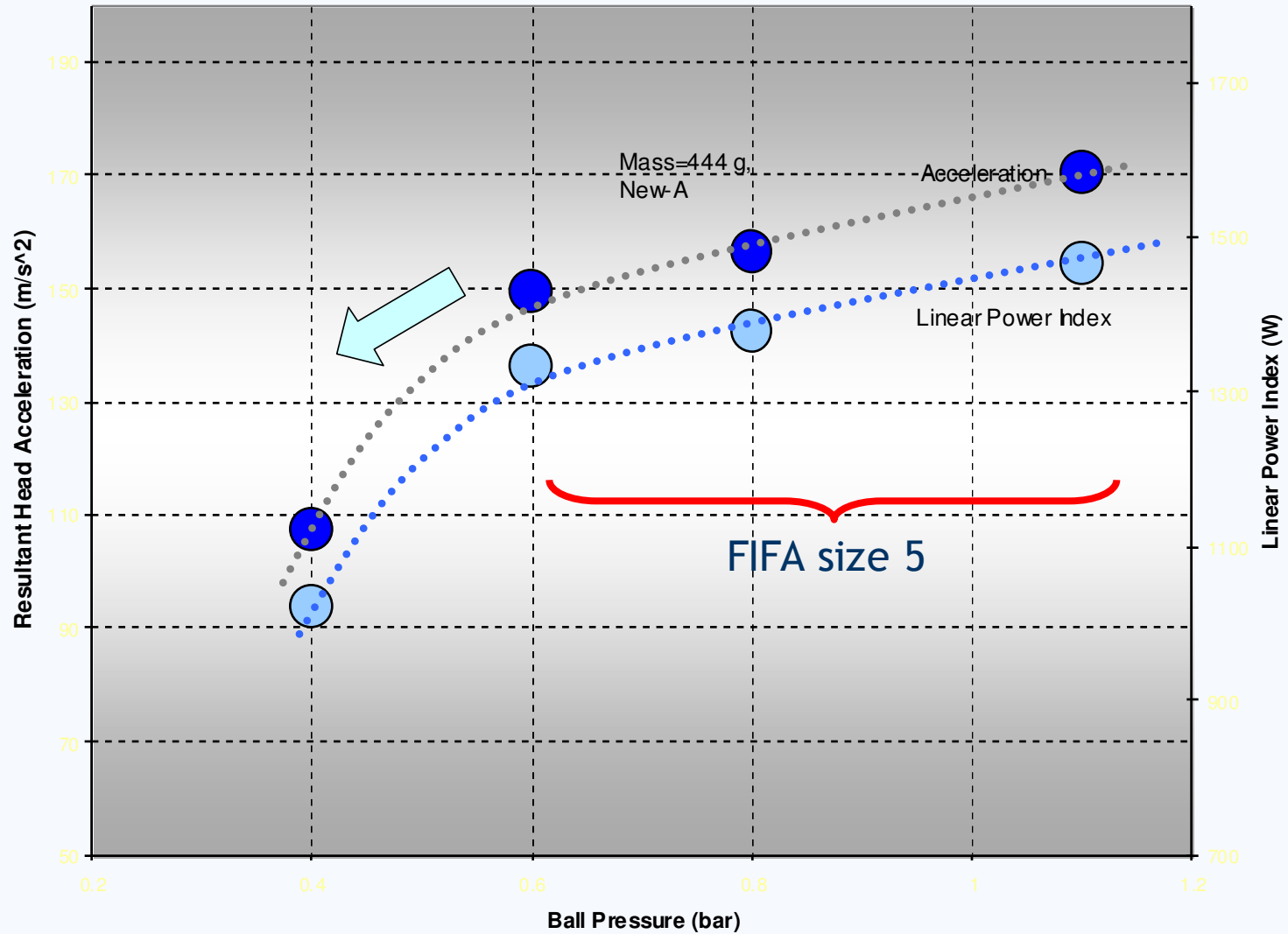
- Published reports implicating heading with chronic trauma
- Restrictions preventing children from heading
- Increased use of headgear
- Recommendations to use lighter balls
- Recommendations to use lower pressure balls
- Poor reporting by the media

Results - Ball Properties (Mass)



Some models gained up to 40%+ in mass when wet, others only 3-4%

Results - Ball Properties (Pressure)



Areas of Head Response Research



- Heading techniques
- Ball characteristics
- **Bodily contact**
- Protective headgear



Head Impact



- Impacts = low to life threatening
- Caused by head hitting:
 - upper extremity (mostly elbow)
 - head
 - lower extremity
 - goal post
 - ground
- Accidental & intentional



Methods – head-elbow impact

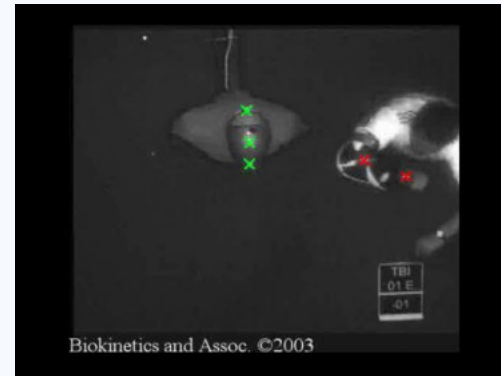


QuickTime™ and a YUV420 codec decompressor are needed to see this picture.



Identify Conditions

Assess Impact Severity



Kinematic Analysis

QuickTime™ and a YUV420 codec decompressor are needed to see this picture.

Biomechanics

Acute Head Impacts - Results



- Impact conditions established from video
- Head and neck impact response measured
- Upper extremity impacts have clinical significance
- Head-to-head impacts are of greater severity
- Accidental impacts = random, difficult to control
- Intentional impacts = red card sanction

FIFA.com - Media Services

THE OFFICIAL WEBSITE OF THE FÉDÉRATION INTERNATIONALE DE FOOTBALL ASSOCIATION



- Home
- News
- Men's & Youth
- Women's
- History of Football
- Developing the Game
- FIFA Fair Play
- Marketing & TV
- Media Services
- FIFA Organisation
- Regulations & Directories

Media Services Home

Media Releases

FIFA facts

Media Information

Fédération Internationale de Football Association

Hitzigweg 11, P.O. Box 85, 8030 Zurich, Switzerland.
Telephone: +41-43/222 7777, Fax: +41-43/222 7878

IFAB clamps down on time-wasting, reckless play and simulation

Zurich/Lucerne, 4 March 2006 - Less than 100 days before the kick-off of the 2006 FIFA World Cup™ in Germany, the International Football Association Board (IFAB) today sent out a clear message to the football world by approving a series of modifications to the Laws of the Game and endorsing instructions to referees and assistant referees to clamp down on time-wasting and reckless play as well as simulation and gamesmanship in general. The modifications will come into force on 1 July 2006. However, with the FIFA World Cup™ beginning on 9 June and lasting until 9 July, the IFAB decided that the modifications and instructions would also apply for FIFA's flagship competition.

Meeting at the Palace Hotel in Lucerne (Switzerland), football's lawmakers also gave the go-ahead for further tests with goal-line technology while clearly stating that technological assistance would be allowed only for determining whether or not a goal has been scored and provided that it gives an immediate indication. In accordance with its principles, the Board therefore gave the green light for the continuation of the experiment launched by adidas and cairos using chip-in-the-ball technology. The Board also approved an experiment presented by the Italian football association using a digital-camera system and UEFA's proposed trial of a referee communication system. Conversely, a request submitted by the French football association for tests with a video assistance system for referees was rejected because the proposed system and its scope went beyond the remit established by the Board and it would lead to delays in the decisions of the referee.

Looking ahead to the 2006 FIFA World Cup™, the Board supported FIFA's request that special instructions be issued to the match officials who will be in action in Germany. As a result, they will be asked to severely sanction all cases of elbowing, reckless tackling and serious foul play with red cards, while shirt-pulling and holding opponents will incur yellow cards. Furthermore, referees will also be told to caution any player who provokes a confrontation with an opponent by deliberately interfering with the ball after the referee has stopped play. These directives will be explained at the upcoming 2006 FIFA World Cup™ finalist teams' workshop in Düsseldorf (Germany) on 5-7 March.

[Click here to download snapshots of the IFAB's presentation](#)

FIFA President Joseph S. Blatter praised the visionary spirit of the founders of

Related Items

- FIFA Financial Report 2004
- Circular Letters
- List of 44 referees preselected for 2006 FIFA World Cup



Associations **FIFA®**

JOSEPH S. BLATTER

[click here to subscribe](#)

FIFAworldcup.com

Latest News:
Will the real Argentina please stand up?...

Areas of Head Response Research



- Heading techniques
- Ball characteristics
- Bodily contact
- **Protective headgear**



Protective Equipment - Head Impacts



- Why consider headgear?
 - Impacts with the ball (related to chronic injuries)
 - Impacts with objects (potential of acute injuries)

Protective Equipment - Head Impacts

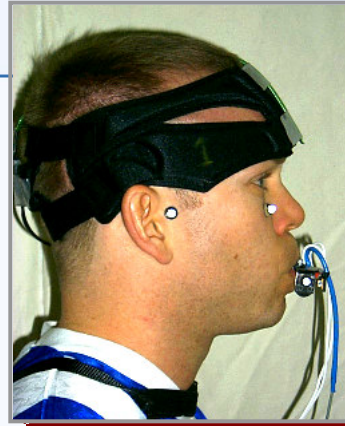


- What concerns are there with headgear?
 - potential hazard to players from hard/sharp edges
 - level of effectiveness and regulation of performance
 - Coverage, fit, and stability
 - false sense of safety given to players
 - ‘My headgear protects me from having another concussion’
 - increased aggressiveness
 - Some coaches put players in headgear for just this reason
 - negative perception regarding the game’s safety

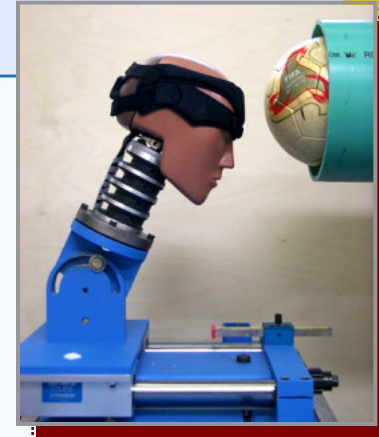
Protective Equipment - Methods



Heading
Contact



Low Impact
Severity



High Impact
Severity



Head-to-Head
Contact



Temple Impact
Response



Occipital
Response

Headgear and Heading



When 3 objects collide, the softest object absorbs the impact...

“During heading, the ball dominates the impact response”

QuickTime™ and a YUV420 codec decompressor are needed to see this picture.

Protective Equipment – Results



- Headgear has no significant benefit for ball impacts related to intentional heading (6-30 m/s)
 - Head acceleration responses when using headgear were within the variability of the unprotected condition
- “...headgear provides a measurable improvement in head response” (10%-30%) for the two impact sites tested
- “...further gains might be achieved if materials are optimized for impact with the head...”

Conclusions and Recommendations



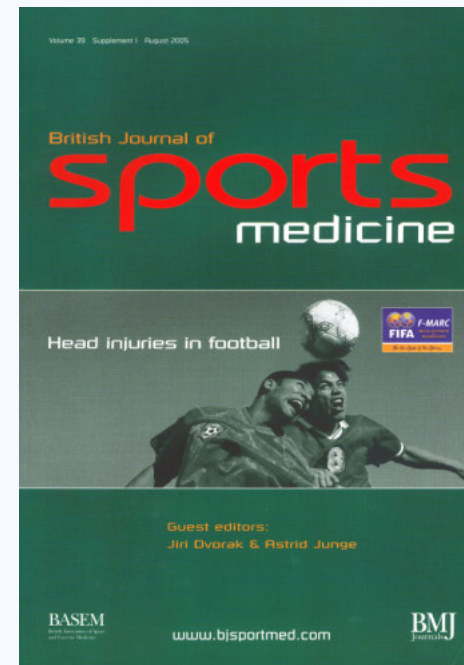
Impact Reduction Approaches

		Skills and Regulating	Ball Mass, Pressure	Headgear
Impact Contributors	Heading	?	✓	
	Head to head	?		?
	Head to Extremity	✓		?

Recent Advances - football



- Research published in BJSM (Vol. 39, S1, 2005)
- Prospective injury studies
 - type, exposure, incidence, mechanisms, biomechanics, cognition
- Statements on recognition and management
- Other supplements on injuries, Championship injuries, Doping, and women's football (9/07)



What can we tell coaches and parents?



- Purposeful heading is a safe skill
 - impacts are below concussive levels (minimal S-100B change)
 - cognitive deficits seem to be related more to concussions
 - but not all concussions
 - unknown if repetitive subconcussive impacts of purposeful heading has any long term affect on cognitive function
 - Early data on adults suggests no effect
 - Need longer follow-up
- concussions are the most common type of serious head injury
- head injuries are due to contact with a hard surface
- head injury by the ball can occur from accidental contact
- *concussions are mostly a game injury mostly around midfield when players approach from opposing directions*





ON HEADING AND HEAD INJURIES IN FOOTBALL: THE F-MARC EXPERIENCE

DT Kirkendall, C Fuller, N Shewchenko*, A Junge, J Dvorak
FIFA Medical Assessment and Research Centre
Zurich, Switzerland

*Biokinetics & Associates Ltd
Ottawa Canada