


Biomechanics

Biomechanics of Head Impact and Response in Football

Presented by:
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Presented at:
The Second International Symposium on Concussion in Sports, Nov. 5-6, Prague



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Current Issues

IN THE MEDIA

Is Soccer Safe?
Are Brain Injuries a Problem?
A Case for...
Is Heading...
Cumulative...
Are Children...

ON THE PITCH

No heading for children

...ss and...
...ed...
...ed...

MEDICAL COMMUNITY

Neuropsychological, neuropsychological deficit

Concussions, long term effects

Impact tolerance

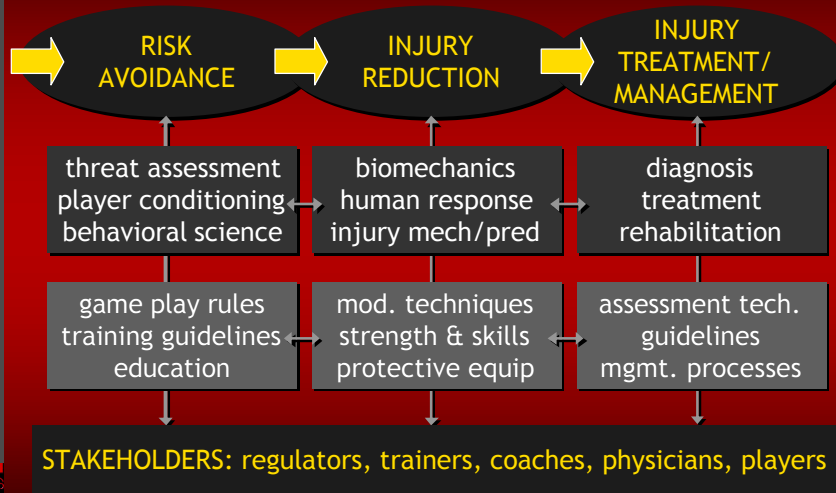
Incidence of injury

Research split about risks

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Injury Reduction Approaches



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F-MARC Head Impact Research

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

i-Head



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Areas of Head Response Research

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



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Methods – Human Trials and Model

Subject Instrumentation



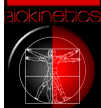
Subject Kinematics



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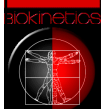
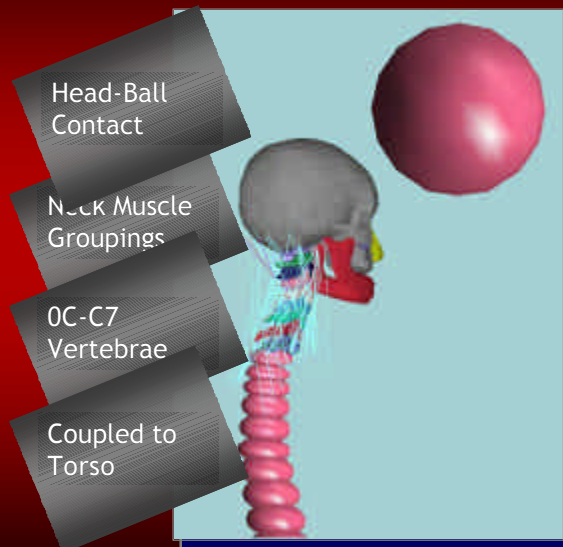
Numerical Model - Description

- 50th percentile male, mass and inertia
- active & passive neck musculature
- impact responses modelled
- model validated under inertial and impact loading



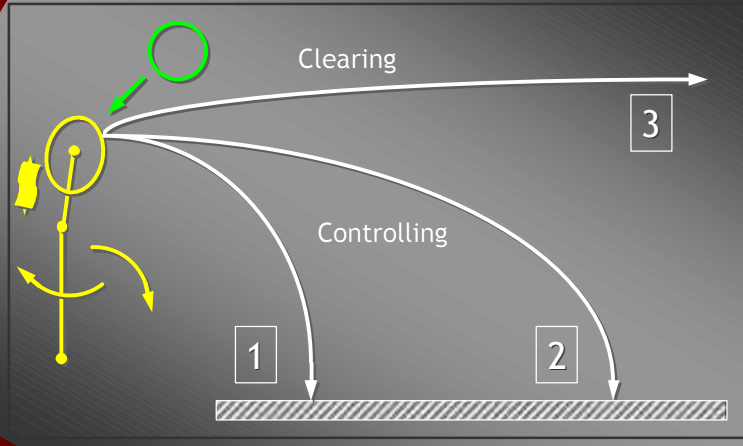
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Methods – Numerical Model



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Method



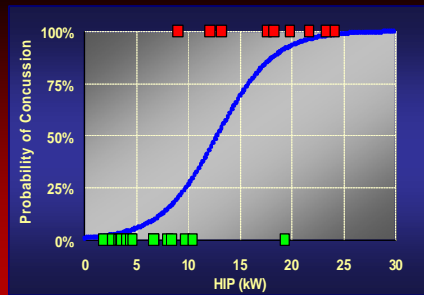
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Results

- Head responses:
 - linear accel
 - angular accel
 - impact power
- Numerical model showed changes with:
 - neck muscle tension
 - torso alignment
 - ball properties

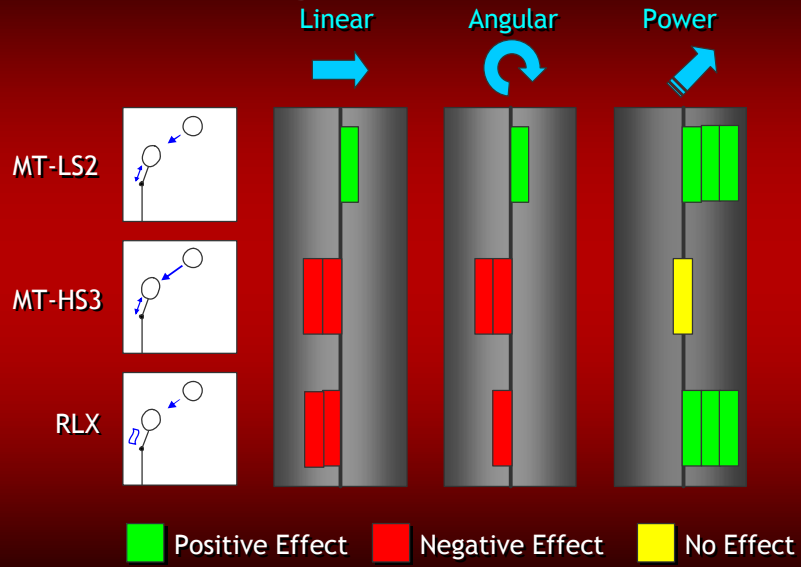


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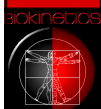
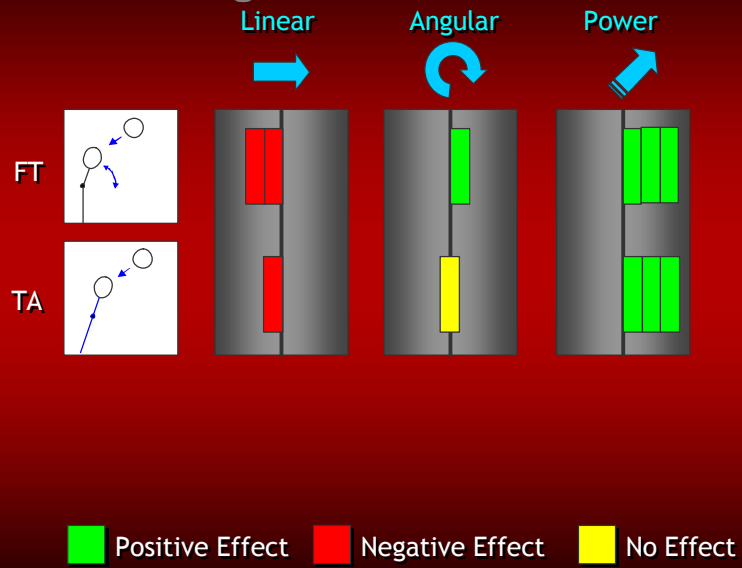
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Results – Heading / Neck Muscles



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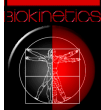
Results – Heading / Torso



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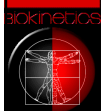
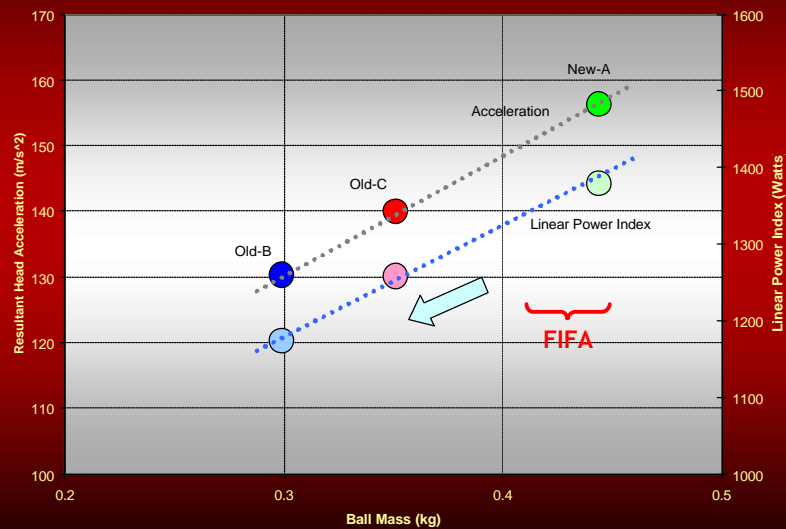
Ball Properties – Safety Concerns

- 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 publicity currently in media



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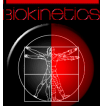
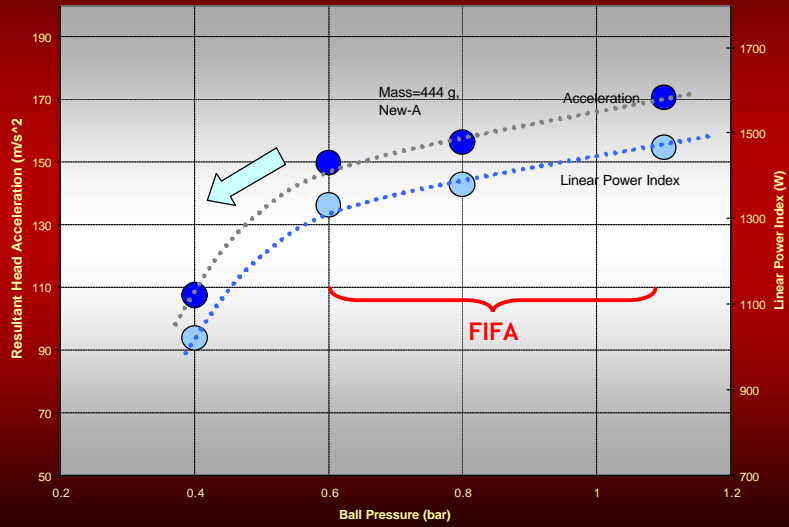
Results - Ball Properties (Mass)



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Results - Ball Properties (Pressure)

Effects of Ball Properties on Head Response



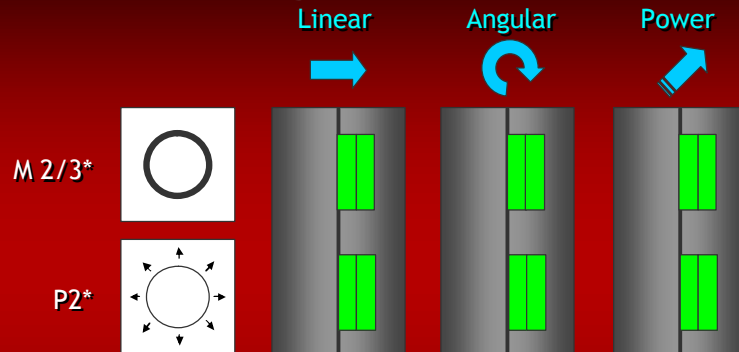
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Results - Ball Properties (Construction)



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Results – Heading / Ball



*All properties are either reduced mass or pressure

■ Positive Effect
 ■ Negative Effect
 ■ No Effect

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Head Impacts

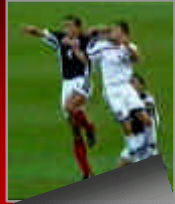
- Impacts result in low to life-threatening injuries.
- Impacts are frequent with:
 - *upper extremity*
 - *head to head*
 - *head to lower extremity*
 - *head to goal post*
- Impacts accid



Objective was to gain a better understanding for possible reduction and prevention

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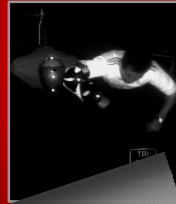
Head Impacts - Methods



Identify
Conditions



Assess Impact
Severity



Kinematic
Analysis



Biomechanical
Investigation

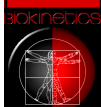


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Acute Head Impacts - Results



Elbow to Head

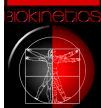


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Acute Head Impacts - Results



Wrist to Head

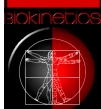


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Acute Head Impacts - Results



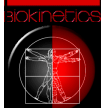
Head to Head



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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 = systematic,
can be controlled

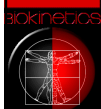


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Protective Equipment - Head Impacts



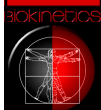
- ▶ What is headgear needed for ?
 - Impacts with the ball (related to chronic injuries)*
 - Impacts with objects (potential of acute injuries)*



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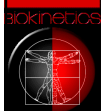
Protective Equipment - Head Impacts

- What concerns are there with headgear?
 - potential hazard to players from hard/sharp edges;
 - level of effectiveness and regulation of performance
 - coverage and stability;
 - false sense of safety given to players;
 - increased aggressiveness;
 - negative perception regarding the game's safety.



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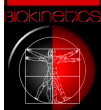
Protective Equipment - Methods



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Protective Equipment – Results

- Headgear has no significant benefit for ball impacts related to intentional heading or accidental impact (6-30 m/s)
- Headgear provides some benefit (10%-30%) for head-to-head contact up to a certain impact level (<3 m/s)



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Conclusions and Recommendations

		Impact Reduction Approaches		
		Regulating	Ball Mass, Pressure	Headgear
Impact Contributors	Heading	?	✓	X
	Head to Head	?		?
	Head to Extremity	✓		?



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