Prevention / Protection: Where are we headed?

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Outline

Question: Do specialized equipment help reduce the risk of concussion in sports?

1. Helmet Selection
2. Mouth Guards
3. Soccer Head Bands
4. Neck Collar
5. Future Directions

Helmets

- Star Evaluation System – Virginia Tech
  - Football, Bicycle, Hockey, Soccer
  - Baseball, Softball, Sensory

- Proper Fit is Key
  - Chin straps
  - Sizing
  - Individualized fit

Ref: Rowson, S. & Duma , S.M. (2011). Development of the STAR Evaluation System for Football Helmets: Integrating Player Head Impact Exposure and Rick of Concussion. Journal of Biomedical Engineering, 39(8), 2130-2140. doi: 10.1007/s10439-01100322-5

https://www.helmet.beam.vt.edu/varsity-football-helmet-ratings.html

Bicycle Helmets – 10 tested

Results:

- Helmet performance differs significantly between models
- Peak Linear Acceleraton (PLA) varied as well depending upon the impact
- Temporal injury resulted in higher PLA due to linear stiffness in the helmet and was an identified area of weakness
- Nonroad helmets performed less well

Conclusions:

- Need for nonstandardized examination
- More research on temporal region stability

Ref: Bland, M.L., Zuby, D.S., Mueller, B.C., Rowson, S. (2017). Differences in the protective capabilities of bicycle helmets in real-world and standard-specific impact scenarios. Traffic Injury Prevention, 19. doi: 10.1080/15389588.2017.1388915

Football Helmets: Sports Injury Monitoring System

Results:

- NCAA study over 4 year time period - 2,107 athletes
- Concussion rate remains unchanged between newer and advanced helmet models
- No helmet is able to completely eliminate or to prevent concussions from occurring

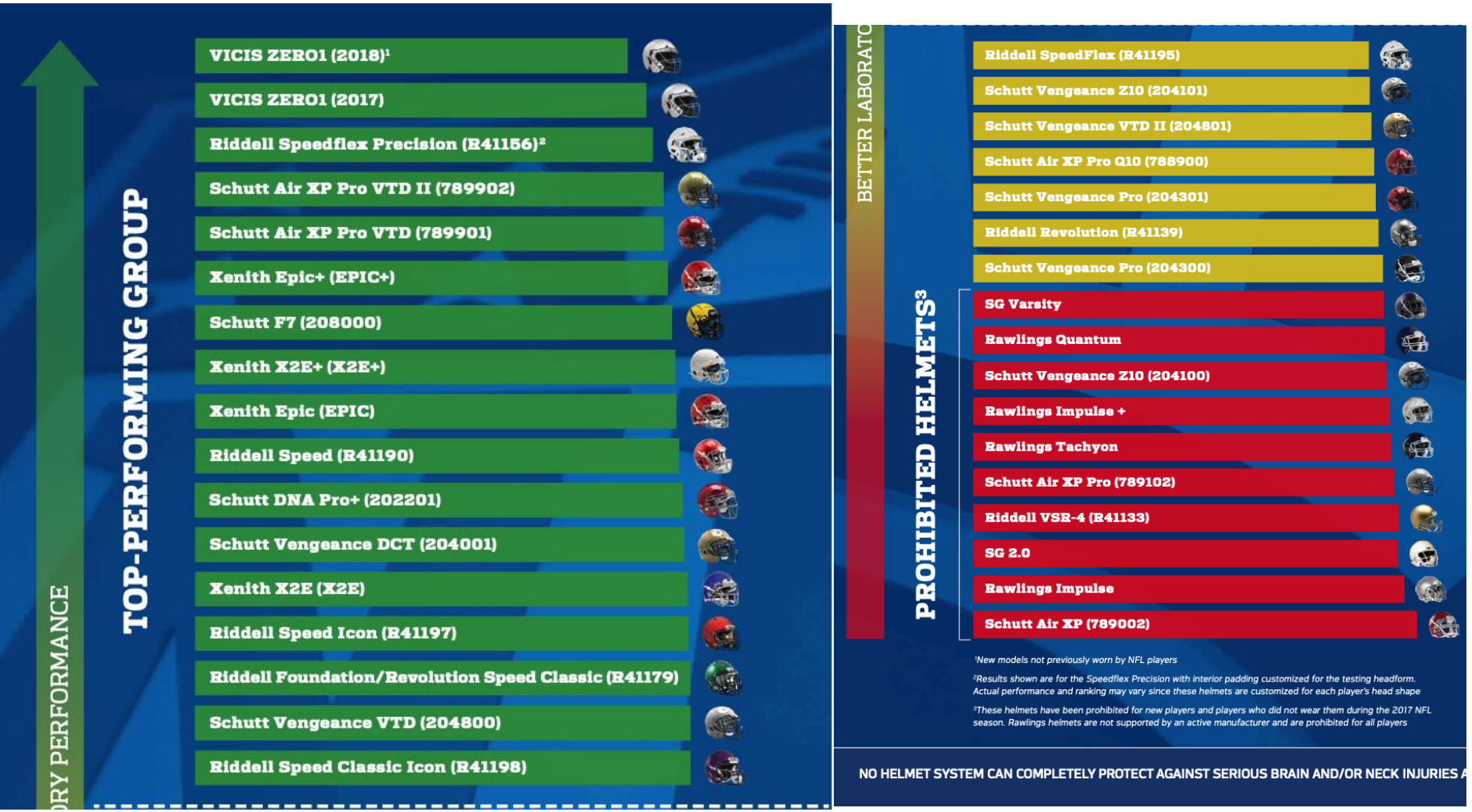
Future Directions

Reducing Rotational Forces

Studying Biomechanical forces on the brain

Ref: Moran, R. & Covassin, T. (2015). An Examination of Concussion Injury Rates in Various Models of Football Helmets in NCAA Football Athletes. *Journal of Sports Science,* 3, 29-34. doi: 10.17265/2332-7839/2015.01.004

2018 Helmet Laboratory Testing Performance Results



https://www.playsmartplaysafe.com/resource/helmet-laboratory-testing-performance-results/

The Influence of Heavier Football Helmet Faceguards on Head Impact Location and Severity

- Football players with heavier faceguards sustained a higher proportion impacts to the top of the head (24.7% vs 17.5%) and had slightly increased odds of sustaining top (OR, 1.72; 95% CI, 1.01-2.94) head impacts rather than front of the head impacts.

- slightly more prone to sustaining a higher proportion of top of the head impacts, suggesting that greater faceguard mass may make players more likely to lower their head before collision.

- The Heads Up Tackling and Blocking programs, developed by USA Football, are aimed at teaching football players to keep their head up so that they can “see what they hit.”

- Schmidt et al 2018

What about other sports

- 2 taekwondo head- gear approved by the WTF and 2 boxing headgear approved by the International Boxing Association were selected for impact testing.

- None of the head- gear tested passed the ASTM criterion to reduce head acceleration below the criterion cut-off of 150 g.

O'Sullivan & Fife 2016

2016 Olympics stopped using

Take Away Message for Helmets

- Padding in helmets generally reduce acceleration upon impact:
  - Thicker not always better
  - Zygoma and Mandible?

- Expensive helmets are not always better

  (cost ≠ performance)

Future Directions:

- Using sensory and understanding impact and TBI
- Using Force to understand impact on cognitive outcome
- Materials better energy absorption
- Rotational acceleration

Ref: https://wrvo.org/post/making-helmets-safr-star-rating-system-sets-standard

Mouthguards

1960's-1970's – mouthguard used to reduce dental and orofacial injury.

Limited evidence that mouthguards provide protection against concussion.

Future directions:

dissipate force through better-designed mouthguard appliance.

Ref: Danehvar, D.H., Baugh, C.M., Nowinski, C.J., McKee, A.C., Stern, R.A., Cantu, R.C. (2011). Helmets and Mouth Guards: The Role of Personal Equipment in Preventing Sports Related Concussions. *Clinical Sports Medicine, 30, 145-163.*
doi: 10.1016/j.csm.2010.09.006

Mom, I have my headgear on !!

- 8 studies with basketball, rugby and hockey
- 6 studies make claim but no significance
- **FOOTBALL**: Single prospective study Singh et al 2009 – customized mandibular orthotic
- Claim: *correction of TMJ MAY provide indirect protection of temporal lobes*

- **RUGBY**: The incidence of mTBI in players who rarely used a mouthpiece was also almost twice the incidence of those who reported always using a mouthpiece higher in players reporting higher impulsivity scores and in players with less than 3 h/wk of training.

Navarro 2011

Effectiveness of Protective Equipment in Preventing Concussions.

Sport	*Equipment Type*	*Effective?*	*Highest Level of Evidence*
Football	CMO	No	4
Rugby	Mouthguard	No	2
Rugby	Headgear	Inconclusive	2
Soccer	Headgear	No	3
Field hockey	Faceshield	Inconclusive	4
Ice hockey	Faceshield	No	2

REF: NAVARRO, 2011. Protective Equipment and the Prevention of Concussion V What Is the Evidence? Current Sports Medicine Reports.

Soccer Heading

- Female soccer players (n=210). Concussed vs. Normal
- Results demonstrated:
  - Heading frequency is surprising low in competition
  - No significant differences between two groups on all cognitive testing
  - No evidence of either subconcussive or concussive insults

Conclusion: "There appears to be no negative consequences on neuropsychological testing or concussion related symptoms."

Ref: Forbes, C.R., Glutting, J.J., Kaminski, T.W. (2016). Examining Neurocognitive Function in Previously Concussed Interscholastic Female Soccer Players. *Applied Neuropsychology,* 5, 14-24. doi: 10.1080/21622965.2014.933108

Soccer Headbands

- Neurocognitive performance and symptoms following heading with protective soccer headgear
- Symptomatic change might be better after heading
- Reaction time is worse when wearing the headband

Conclusion:

- "Protective Soccer Headgear likely does not mitigate the subtle neurocognitive effects of acute soccer heading"

Ref: Elbin, R.J., Beatty, A., Covassin, T., Schatz, P., Hydeman, A., Kontos, A.P. (2015). A Preliminary Examination of Neurocognitive Performance and Symptoms following a Bout of Soccer Heading in Athletes Wearing Protective Soccer Headbands. *Research in Sports Medicine, 23, 203-214. doi: 10.1080/15438627.2015.1005293*

Woody Woodpecker …

Impact on the head …

- Woodpecker head moves at 1200-1400 G/peck
  - 20 times higher than what would cause a concussion.
- Human concussion 90-100G, roller coaster at 6G.
- Woodpecker able to take the impact within body (99.7% force).
- Tongue wraps around neck and pinches jugular vein.
- Meyer et al – 30% decrease in concussions at higher altitudes and 32% AT NFL players at higher altitudes.
- Increased blood volume.

Q-collar

- Clamps down on jugular vein to increase amount of blood volume in brain

But we are not woodpeckers or cartoon characters

- Alterations in trabecular bone changes
- Hyoid bone and tongue structure dissipate shock
- Woodpeckers don’t really use jugular occlusion
- Woodpeckers mechanism of head injury different from concussion
- Are woodpeckers really unaffected? Tau Protein Farah et al
- The have bird brains→ no sulci or Gyri

Q-Collar

- Yuan et al 2018 longitudinal WM changes over the course of two consecutive high-school football seasons and explored the long-term effects of a jugular vein compression collar on these WM alterations.
- Significant reductions in mean, axial, and/or radial diffusivity were identified in Season 1 in multiple WM regions.
- An 8- to 9-month long off-season, these changes observed in the non-collar group partially and significantly reversed but also remained significantly different from the baseline.
- Myer et al 2018 Reduced WM diffusivity alteration was noted in participants wearing a neck collar after a season of competitive football.
- Myer et al 2018- high school female soccer participants (14–18 years) at up to three time points over 9 months. Head impacts were monitored using accelerometers during all practices and games.
- WM changes in the non-collar group partially resolved at 3 months off-season follow-up.
- Clinical Symptoms and Neuropsychology Profiles not tested.

Neck Strength

- After adjusting for gender and sport, overall neck strength remained a significant predictor of concussion (p = 0.004). For every one pound increase in neck strength, odds of concussion decreased by 5 % Collins et al 2014

- Mihalik 2011- Hockey increased static cervical neck strength in isolation was not enough to reduce the severity of head impacts sustained by youth hockey players

- Schmidt et al. (2014) The study found that football players with stronger and weaker cervical musculature had equal odds of sustaining moderate to severe head impacts. However, players with greater neck stiffness during anticipated forces and less head displacement after contact displayed reduced odds of sustaining higher magnitude head impacts.

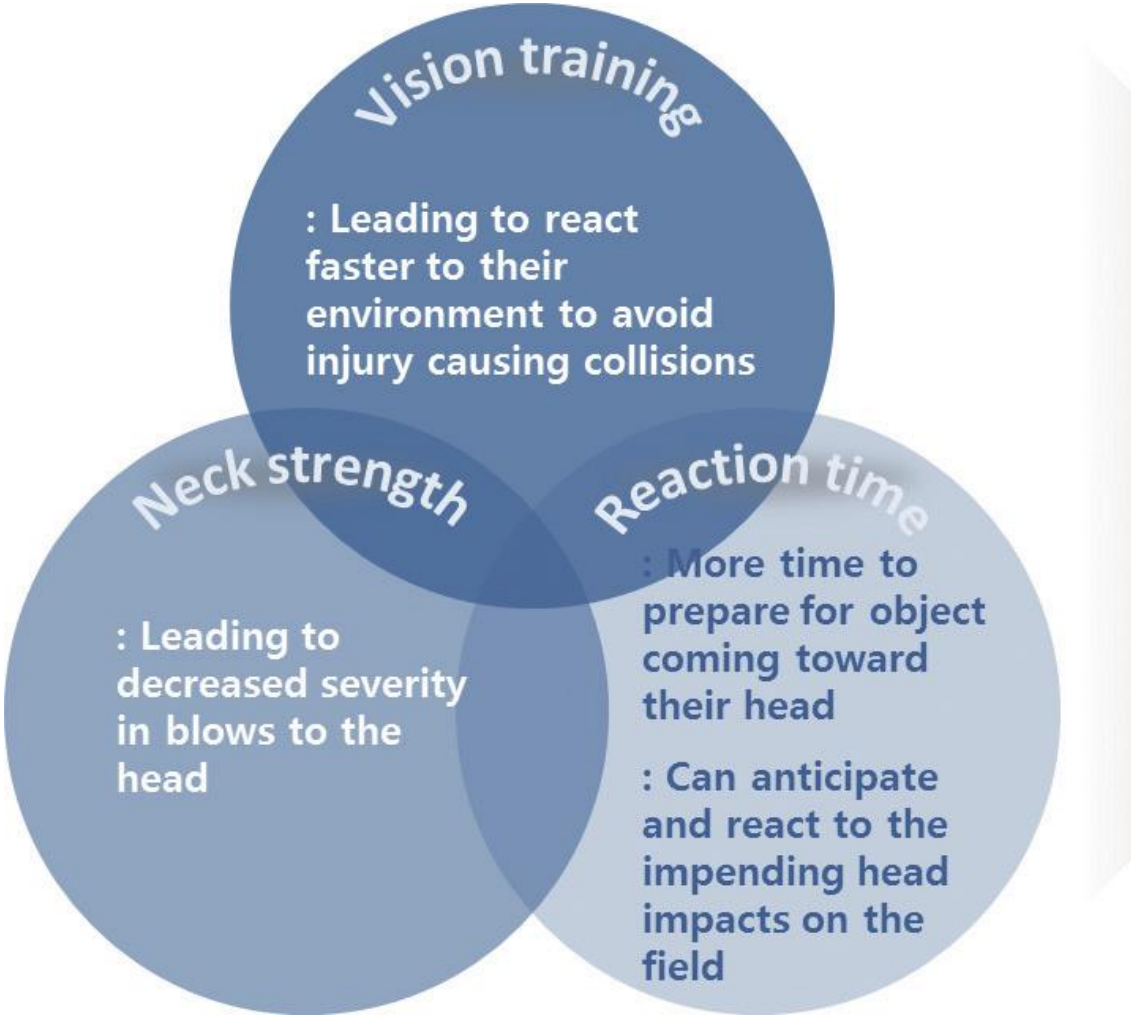
Vision Training – Directions for the Future

- Harpham et al. 2014 found division I football players with higher visual and sensory skills lead to less head impact during hits.
- Clark 2017- Female players closed eyes while heading ball.
- Schmidt et al 2015 high school football players with greater visual performances will have reduced odds of sustaining a moderate to severe head impact.

Reaction Time

- Eckner 2011 clinical reaction time test is predictive of a functional sport related head protective response.

- Harpham et al. 2014 division I collegiate football players, found the faster reaction times less severe head impacts they sustained.


Vision training
: Leading to react faster to their environment to avoid injury causing collisions
Neck strength
: Leading to decreased severity in blows to the head
Reaction time
: More time to prepare for object coming toward their head
: Can anticipate and react to the impending head impacts on the field

Questions?

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