A Systematic Review: Does Neck Strength Play a Role in the Prevention of Sports Related Concussion

Katie Turner, Kate Giefer, Steven G. Lesh
Southwest Baptist University, Bolivar, Missouri

Background
Sports related concussions are a growing epidemic impacting youth, collegiate and professional sports alike. Participation in high-risk sports like football, ice hockey and soccer account for nearly half of all observed concussions. A rotational cervical component is thought to be a predominant mechanism of the concussion mechanism as opposed to direct impact. It has been theorized that factors related to neck strengthening may mitigate the acceleration of impact forces transmitted through the head and therefore may play a positive role in limiting the onset of sports related concussions.

Study design was a systematic review of recent literature to identify relevant evidence related to the clinical question. The search was completed by utilizing EBSCOhost search engine A.P.S.G.M database strategy utilizing key words identified 568 articles. After applying screening criteria 6 articles were included for data extraction and analysis. Two reviewers assessed quality of evidence using the quality checklist developed by Downs and Black. A neutral third reviewer was utilized to resolve disagreements leading to a consensus quality rating of good, fair, or poor.

Methods

Year & Lead Participants Total N Intervention Outcome Measures Results/Finding
2013 Dieman NCAA Div. 1 and 2 collegiate soccer players 16 6 men 10 women Heading a ball in a controlled environment - Head acceleration measured by 14-accelerometer on MDS Motion Capture - Neck strength measured via string type cervical dynamometer Players were served the ball at a mean velocity of 4.20 m/s. Players returned the ball to the server using a head acceleration of 6.71 g. Mean neck strength difference was positively correlated with angular head acceleration (r = .475, p < .05)
2013 Stamer Male and female contact sport athletes 46 Maximum isometric strength was measured A leading apparatus applied impulsive forces to athletes' heads in flexion, extension, lateral flexion, and axial rotation during baseline and anticipatory cervical muscle activity - Maximum isometric strength during anticipatory activity of cervical muscles Greater isometric neck strength and anticipatory activation were independently associated with decreased head peak linear and angular velocity
2014 Gulleher Female varsity high school soccer players from 3 school team Subjects completed HANCT nonneurocognitive test, then had neck strength assessed Directional order was randomized among subsets, each study subject completed 2 times. Next, the subjects were equipped with the accelerometer and time switches. Head impact protocol was conducted into mild regular heading and1 random heading in practice. Eagon, acceptable headers were collected in total (3 each direction). After the 2nd axial IMPACT test was completed again 
- IMPACT neurocognitive test head strength - heading drills with accelerometer IMPACT test results found no significant differences between pre- and post-heading neurocognitive performance. Moderate, consistent negative correlations were noted between all direction neck strength and rated-case general resultant head acceleration in the heading drills. The key findings from this study indicate that increased neck strength was related to decreases in the magnitude of impacts during heading. The hypothesis that neck strength would be related to head impact was confirmed.
2005 Mansell NCAA Div 1 collegiate soccer players 35 17 men 18 women The resistance training program underwent an 8-week cervical resistance training program that consisted of 3 sets of 10 repetitions of neck flexor and extensor exercise at 55% to 70% of their 10-Rep Max 2 times a week.
- Head neck segment kinematics and stiffness - Cervical muscle activity of the upper trapezius and sternomastoid muscles during force application to the head - Neck flexor and extensor isometric strength When kinematic, electromyographic, or stiffness training effects were seen. The posttest resistance training group increased neck neck segment stiffness in neck flexor and neck extensor muscle activity compared to pretest. Isometric cervical neck strength was 22.5% greater posttest. Women's neck grip increased 5.4% over time regardless of training group. Women exhibited 7% lower neck segment height and 26% lower neck head height than men. Increases in isometric strength and grip, the neck isometric static cervical resistance training did not enhance head neck segment dynamic stabilization during force application in the laboratory.
2014 Schmidt High school and college American football players 34 14 high school 15 collegiate A pre-season cervical testing protocol was completed, which included measures of cervical isometric strength, muscle size, and response to cervical perturbation. Head impact biomechanics were captured for each player, with emphasis on head impact, cervical motion system. The odds of sustaining moderate and severe head impacts were computed against the reference odds of sustaining mild head impact as a function of cervical characteristic categorizations. A linear model was used to categorize players as either high or low performers of cervical segment responses of anterior and posterior cervical impact and 1 cervical motion system. The odds of sustaining moderate and severe head impacts were computed against the reference odds of sustaining mild head impact. Lower isometric cervical segment strength was positively associated with a higher risk of sustaining a cervical perturbation. Stronger players had approximately 1.75 times increased odds of sustaining moderate head impacts rather than mild impacts compared with weaker players. Lower isometric cervical segment strength had 2 times the odds of sustaining severe head impacts rather than mild. However, players with greater cervical stiffness had reduced odds of sustaining both moderate and severe head impacts compared to those with lesser stiffness. Findings revealed greater cervical stiffness and less angular displacement were positively associated with the odds of sustaining higher magnitude head impacts. However, findings did not show differences between players with stronger and larger neck muscles mitigate head impact severity.

Results

Quality of articles were determined to be good and 4 fair 201 subjects were included across the scope of the current systematic review. Inclusion criteria for participation in the treatment groups were assessed using accelerometers and dynamosimeters on various perturbations of heading a ball or actual game/practice footage. No single studies directly linked the cervical strength with the observed external forces to the actual presence of a diagnosed concussion. The analyzed reports produced mixed results. The present systematic review did not show that increased neck strength of the neck directly mitigated observed angular forces. The remaining 3 studies related significant results linking increased cervical strength to reduced forces transmitted through the head and neck. It was suggested that other factors such as non-dynamic structures related to stiffness may play a greater role in force attenuation.

Conclusions

There is not clear evidence to either support or reject the notion that cervical strengthening may reduce concussion producing forces on an athlete. It is demonstrated and supported that neck strengthening is a modifiable factor with potential to reduce head impact loads, yet not directly relate to the intended outcome. More evidence is clearly needed to clearly link measured functional neck strength to actual sustained external forces during game/practice situations resulting in head injury.

Clinical Relevance

As athletes place increasing demands on the cervical musculature to function in functional tasks of daily living and in the work place, it is critical for the clinician to be aware of the cervical musculature and the role it plays on the prevention of concussions. Neck strengthening is a modifiable factor with potential to reduce head impact loads, yet not directly relate to the intended outcome. More evidence is clearly needed to clearly link measured functional neck strength to actual sustained external forces during game/practice situations resulting in head injury.

References


Contact Information

Steven G. Lesh, PhD, PT, SCS, ATC
Southwest Baptist University 1600 University Ave. Bolivar, MO 65613 sleesh@sbuniv.edu

The poster team would like to acknowledge the work of Kara Mierzwecki in the data collection phase of this project.