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technical note

Early Results of a Helmetless-Tackling Intervention to Decrease Head Impacts in Football Players

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Objective: To test a helmetless-tackling behavioral intervention for reducing head impacts in National Collegiate Athletic Association Division I football players.

Design: Randomized controlled clinical trial.

Setting: Football field.

Patients or Other Participants: Fifty collegiate football players (intervention = 25, control = 25).

Intervention(s): The intervention group participated in a 5-minute tackling drill without their helmets and shoulder pads twice per week in the preseason and once per week through the season. During this time, the control group performed noncontact football skills.

Main Outcome Measure(s): Frequency of head impacts was recorded by an impact sensor for each athlete-exposure (AE). Data were tested with a 2 × 3 (group and time) repeated-measures analysis of variance. Significant interactions and main effects ($P < .05$) were followed with *t* tests.

Results: Head impacts/AE decreased for the intervention group compared with the control group by the end of the season (9.99 ± 6.10 versus 13.84 ± 7.27, respectively). The intervention group had 30% fewer impacts/AE than the control group by season's end (9.99 ± 6.10 versus 14.32 ± 8.45, respectively).

Conclusion: A helmetless-tackling training intervention reduced head impacts in collegiate football players within 1 season.

Key Words: injury prevention, athletic injuries, head and neck injuries

Key Points

- Given proper training, education, and instruction, collegiate football players can safely perform supervised tackling and blocking drills in practice without helmets.
- Helmetless tackling eliminates the false sense of security a football player may feel when wearing a helmet.
- Younger football players and those with less experience may require modifications to the intervention to realize a positive effect. More research is needed on players at these levels before widespread implementation.

Head impacts in football players are directly associated with brain and spine injury, have been proposed to be associated with chronic injuries such as chronic traumatic encephalopathy, and have become a national concern. High school and college football participants can experience more than 1000 head impacts in a single season.[1,2] Youth football players may sustain more than 100 impacts in a season, with linear acceleration greater than 80*g* reported.[3] To mitigate the risk of head-impact injury, researchers, league officials, and administrators have sought to improve helmet technology, reduce the number of allowable contact practices, and alter game rules. Although each of these factors has merit, none directly address the common fundamental cause: impacts to the head. In fact, current efforts directed at improving helmet technology may promote a false sense of security[4] and perpetuate the use of the head as a point of contact during play.[1,5]

To directly address these concerns, we initiated a study to investigate the effectiveness of a helmetless-tackling behavioral intervention to reduce head-impact exposure in a National Collegiate Athletic Association Division I football program. We share important findings on our primary variable of interest after the first year of data collection.

METHODS

Fifty National Collegiate Athletic Association Division I Football Bowl Subdivision collegiate football players with at least 2 years of eligibility were enrolled in a 2-year prospective randomized controlled investigation for the 2014 and 2015 seasons. Before consenting to the study, participants were briefed on the design, purpose, risks, and benefits of the study as approved by the university's institutional review board. Participants were stratified by position (offense or defense) and randomized to an intervention (n = 25) or control (n = 25) group. Before the first preseason practice, participants were assigned an xPatch head-impact sensor (X2 Biosystems, Inc, Seattle,

Table. Helmetless-Tackling Training Program Interventions and Potential Athlete-Exposures, No.

	Preseason	Competitive Season[a] Midpoint	End
Date range	August 6–27, 2014	August 30–October 25, 2014	October 26–December 20, 2014
Weeks, No.	3	8	8
Interventions	6	7	7
Total potential athlete-exposures	19	36	32
Practices	19	29	25
Games	0	7	7

[a] The first half of the competitive season included 2 open weeks (no game, practice only). The second half included 3 postseason playoff games.

WA) and equipped with a new Riddell Revolution Speed helmet (BRG Sports, Scotts Valley, CA).

Before each football session, an xPatch was affixed to the participant's skin directly over the right mastoid process by adhesive strip per the manufacturer's instructions. When necessary, hair was removed from the placement site using an electric razor. Participation in a game or practice was recorded and counted as 1 athlete-exposure (AE). Football activities took place as they normally would except on days the intervention occurred (description follows). The xPatch sensors were returned after each session for data download and recharging.

The intervention group participated in a drill of approximately 5 minutes without their helmets and shoulder pads as part of the Helmetless Tackling Training (HuTT) program. Drills occurred twice per week during the preseason (3 weeks) and once per week throughout the competitive season (16 weeks). Each drill involved multiple supervised repetitions of executing proper tackling at 50% to 75% effort into an upright pad or a teammate holding a padded shield. The control group was separated from the treatment group and completed placebo, noncontact football skills of the same frequency and duration during this time. Both groups were supervised by members of the football coaching staff following standardized instructions. The principal investigator (E.E.S.) was present for each intervention to verify standardization and record attendance.

Frequency, location, peak linear acceleration, rotational acceleration, and duration of all head impacts of the $\geq 10g$ threshold of linear acceleration were recorded by the xPatch for each football session (game or practice) and stored on the device until uploaded.

Data Reduction

Before the statistical analysis was performed, we reduced the raw impact data in the following manner. The X2 impact-measurement software first removed any spurious linear-acceleration data that did not meet the proprietary algorithm criteria for a head impact. A second proprietary filtering method (waveform parameters) was used during data export to remove spurious linear-acceleration data with additional layers of analyses, including the area under the curve, number of points above threshold, and filtered versus unfiltered peaks. The remaining data were reduced after visual examination using Excel (version 2013; Microsoft Corporation, Redmond, WA). Impact time stamps (hour:minute:second) were screened for identical and sequential patterns for each participant (using Excel conditional formatting and duplicate values) with multiple (≥ 2) linear accelerations having the same hour:minute:second time stamp in quick succession milliseconds after the preceding impact(s) had been removed. Impact time stamps were also cross-referenced with AE records for practices and games. In addition, AEs coded as being *present for a game* were further cross-referenced with the football staff's attendance documents. Impact data recorded erroneously on days when an xPatch was activated although the athlete was unable to practice or did not enter a game were removed.

The reduced and filtered data were then organized categorically into 3 temporal sessions. The first time point represents the end of preseason, when HuTT interventions were carried out twice per week. The remaining time points (middle and end of the season) accounted for an equal distribution of HuTT interventions (once per week) over the course of the competitive season. Descriptive information for each session relative to potential exposures (practices and games) and number of interventions are found in the Table.

Statistical Analysis

The frequency of head impacts recorded from the xPatch was normalized to each AE in the preseason and middle and end of the season. We first inspected the data visually using Q-Q plots and box plots. Skewness and kurtosis were assessed, and the Shapiro-Wilk test of normality was conducted. The data were slightly skewed to the left and kurtotic at the midpoint and end of the season and were not normally distributed according to the Shapiro-Wilk test ($P < .01$). The sample variances and covariances were equal according to the Levene test of equality of variances and Box test of equality of covariance matrices (all P values $>$ .05). The frequencies of helmet impacts per AE in raw and log-transformed data were compared between the groups with a 2×3 repeated-measures analysis of variance. Significant interactions and main effects ($P < .05$) were followed with dependent and independent t tests. In this preliminary study, we did not perform Bonferroni corrections to control the familywise error rate. Similar results were obtained from the raw and log-transformed data, and the results from the raw analyses are reported.

KEY FINDINGS

The helmetless-tackling training intervention resulted in a 28% reduction in head-impact frequency per AE by the

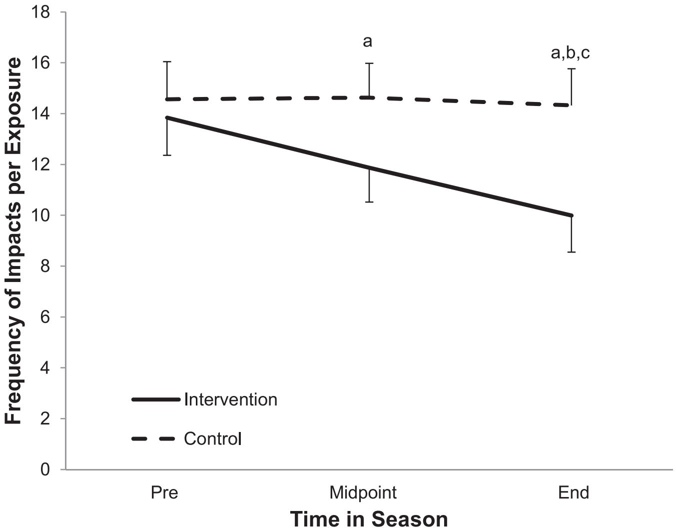

Figure. Average frequencies of impacts per athlete-exposure at preseason, midpoint, and end of season. Data are mean ± standard error. [a] Different from preseason ($P < .01$). [b] Different from midpoint ($P < .01$). [c] Different from control at end of season ($P = .045$).

end of the season, whereas the control group's head impacts remained the same (9.99 ± 6.10 and 13.84 ± 7.27, respectively; $P = .009$). At the end of the season, the intervention group experienced an average of 30% fewer impacts per AE than the control group (9.99 ± 6.10 and 14.32 ± 8.45, respectively; $P = .045$; Figure).

COMMENTARY

The purpose of this ongoing study is to determine if a novel helmetless-tackling intervention can improve tackling behavior by reducing head-impact exposure in football players. Our most important finding is the early indication that a helmetless-tackling training program reduced head impacts by 28% in collegiate football players after only 1 season.

Regardless of group assignment, our participants experienced 14 head impacts per AE, on average, at the start of the regular season. Although this value is slightly higher than data reported for 3 collegiate teams,[2] it is similar to research on high school players.[6] Differences in impact characteristics among teams have been documented[7] and may account for some of the variance seen here. However, the impact frequency of our control group remained the same throughout the season, whereas the treatment group began to demonstrate a reduction by midseason that continued as the season progressed.

The notion of removing the football helmet for discrete and regular periods during practice to reduce head-impact frequency is counterintuitive to the sport. However, these findings elucidate the risk-compensation phenomenon.[4] That is, a football helmet is designed to protect players from traumatic head injury, but it also *enables* them to initiate and sustain head impacts because of the protection it affords. Risk compensation helps to explain the evolved behavior of "spearing" and the associated rise in catastrophic head and neck injuries that paralleled the application of the hard outer shell to the football helmet in the 1950s and 1960s.[8] Hence, improving protective equipment, in and of itself, will likely not resolve the risk of concussion and spine injury in football. Rather, the solution may be found in behavior modifications that directly minimize head impacts during play.

The extent to which this intervention may yield similar outcomes in younger players with less experience and incomplete physical maturation is unknown. The intervention may need to be modified for age and experience. Furthermore, we do not know if the benefits derived from the intervention will persist or if, as with other fundamental sport skills, they should be rehearsed on a regular basis, regardless of performance level, to avoid decay. These factors require additional research.

CONCLUSIONS

Should future investigators replicate our findings, the eventual widespread adoption of helmetless-tackling training can improve public health and decrease the associated economic burden by reducing football-related head and neck injuries and the risk of long-term neurologic deficits. This is of vital importance for younger, more vulnerable populations.

FINANCIAL DISCLOSURE

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