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A prospective study of concussion education in 2 junior ice hockey teams: implications for sports concussion education

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Object. The aim of this study was to evaluate the effectiveness of an educational intervention on concussion knowledge within a sample of junior fourth-tier ice hockey players.

Methods. A prospective cohort study, called the Hockey Concussion Education Project, was conducted during 1 junior ice hockey regular season (2009–2010) with 67 male fourth-tier ice hockey players (mean age 18.2 ± 1.2 years, range 16–21 years) from 2 teams. All participating players were randomized into 3 concussion education intervention groups (DVD group, interactive computer module [ICM] group, or control group) before the beginning of the season. Each individual received a preintervention knowledge test prior to the intervention. The DVD and ICM groups received a posttest after the completion of their intervention. All participants were offered the same knowledge test at 15 games (50 days) and 30 games (91 days) later.

Results. In the concussion education intervention component no significant group differences were observed at baseline between individuals in the control group and between individuals within the interventional group. At the 15-game follow-up, however, the difference between groups approached significance ($F [1, 30] = 3.91$, $p = 0.057$). This group difference remained consistent at the 30-game follow-up.

Conclusions. This study demonstrates a positive trend concerning concussion education intervention and knowledge acquisition with either the ICMs or the educational DVD. Both forms of intervention produced a positive and sustainable improvement that approached statistical significance when compared with the control group. The control group demonstrated a negative longitudinal trend concerning concussion knowledge.
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Key Words • concussion • ice hockey • education • Hockey Concussion Education Project • Canada

Failure to recognize and report concussions noted in previous publications in the literature may be the result of a lack of a standardized knowledge base among athletes, coaches, trainers, and parents regarding the signs and symptoms of concussion.[1,3,6,12,13,16,17,24,25,,27] Such underreporting is likely associated with undertreatment, which may also have very significant immediate and long-term social and health implications.[7,8,14,15,18,19,20,22,23] The primary goal of this study is to evaluate the effectiveness of different types of educational interventions on improving concussion knowledge and retention of that knowledge within a sample of junior fourth-tier ice hockey players. This study did not investigate behavioral changes resulting from the educational intervention.

Abbreviations used in this paper: HCEP = Hockey Concussion Education Project; ICM = interactive computer module.

Methods

Patient Population

This study was part of a larger surveillance and reporting study (see other papers in this issue). The experimental sample described herein was collected during the 2009–2010 junior ice hockey regular season, and included 67 male fourth-tier junior ice hockey players (mean age 18.2 ± 1.2 years, range 16–21 years) from 2 teams.

Concussion Knowledge and Education Component

At the beginning of the season all participating players were randomly assigned to 1 of 3 concussion education intervention groups: the Thinkfirst[1] concussion DVD (Concussion Clinic for Hockey Coaches; 16 players); the ICM group (20 players); or a control group that did not receive any educational intervention (22 players). Although a total of 67 players participated in the study, only 58 players participated in the baseline testing session. Due to individual and team noncompliance with study protocol, no other baseline tests were performed. The ThinkFirst Foundation of Canada is a national nonprofit organization dedicated to the prevention of brain and spinal cord injuries. Each individual received a preintervention knowledge test prior to the intervention to establish a baseline level of for all participants.

This 26-question multiple choice and true/false test was based on the ThinkFirst DVD content and the recent Zurich consensus guidelines concerning concussion injury knowledge and treatment protocol.[18] The concussion information tested was given to the intervention groups in the DVD and ICM formats. An identical concussion knowledge test was administered after 15 games, and again after 30 games. At each time period, the concussion knowledge test was administered under the supervision of study personnel.

The DVD and ICM groups received their interventional education only once at the start of the study. The 2 intervention groups (DVD and ICM) completed their educational interventions in the same computer lab, supervised by several study officials. A postintervention knowledge test was completed immediately after the completion of the intervention. All participants were offered the same knowledge test at 15 games (50 days) and 30 games (91 days) later. All interventions were completed under supervision by study personnel. For a complete and detailed description of the methods used in the HCEP please see Echlin and collegues' article, "A prospective study of physician-observed concussions during junior ice hockey: implications for incidence rates," in this issue of *Neurosurgical Focus*.

Statistical Analysis

The rates of missing data were unacceptably high in the posttest time period and the 30-game follow-up session. The control group did not participate in the postintervention test and the exclusion of 1 team at Game 21 left few participants in the sample for follow-up comparisons. Accordingly, all statistical analysis presented herein will be based on the pretest data and the 15-game follow-up data.

The effects of educational intervention were tested within 3 separate ANOVA designs, each of which was evaluated against a probability level of 0.05. In the first analysis, the effects of intervention type were tested within a 3 × 2 split-plot ANOVA, with group (control vs ICM vs DVD) as the between-subject variable, and time (pretest vs 15-game follow-up) as the within-subject variable. In the second analysis, the 2 educational interventions were collapsed into a single group, and the overall effects of education were tested within a 2 × 2 split-plot ANOVA, with group (control vs intervention) serving as the between-subject variable, and time (pretest vs 15-game follow-up) serving as the within-subject variable.

Results

No significant difference was found among groups at baseline, nor were there significant differences on test scores of concussion knowledge among groups who received either type of educational intervention or those who received no intervention, at the pretest time period or at the 15-game follow-up. There was no significant interaction between group and time ($F [2, 29] = 1.95$), and no significant main effect for either group ($F [2, 29] = 0.80$) or time ($F [1, 29] = 1.23$). When the educational intervention is evaluated without considering the type of intervention, the interaction between group and time approaches significance at an alpha level of 0.05 ($F [1, 30] = 3.91$, $p = 0.057$). This result suggests that there may be a meaningful effect of concussion education on concussion knowledge (Fig. 1).

The test consisted of 26 questions as stated in the *Methods* section. The scores were based on the number correct out of 26. Means and standard deviations for the concussion education results are summarized for each group in Table 1.

The effect of contamination of the data caused by exchange of information between the groups was not found to be significant. Given that random assignment to treatment groups was performed within teams, it is possible that team members shared information among themselves, thereby diffusing the effectiveness of the independent variable. This diffusion of the treatment effect would reduce the potency of the independent variable in this study, which suggests that these results are likely to be a conservative estimate of the effects of education on concussion knowledge.

Discussion

The Zurich consensus statement on concussions recognized that education of the athlete, referee, administrators, parents, coaches, and health care providers is a mainstay of progress in this field.[18] There has been some moderate success using computer-/video-based educational interventions.[4,5,10,11] These interventions have demonstrated an improvement in testable knowledge levels. Very few studies have attempted to actively educate the athlete concerning concussions and then prospectively

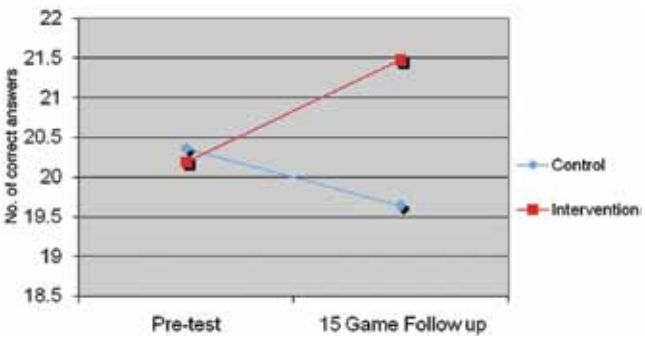

Fig. 1. Line graph showing interaction between group (intervention vs control) and time (pretest vs 15-game follow-up).

TABLE 1: Pretest and 15-game follow-up test scores according to experimental group*

Group	Pretest Score	15-Game FU Score
control	20.36 (1.80)	19.64 (4.01)
ICM	19.71 (3.99)	21.14 (2.77)
DVD	21.14 (2.04)	22.14 (1.77)
combined†	20.19 (3.47)	21.48 (2.48)

* All values given as means (SDs). Tests consisted of 26 questions. Abbreviation: FU = follow-up.
† Combination of the ICM and DVD groups (individuals were in either the ICM or the DVD group).

examine the retention of that knowledge or measure the effects of that knowledge on behavior.[5] Only 1 study has attempted to assess the effect of the educational program on behavior: ThinkFirst's "Smart Hockey" program was shown to reduce specific body checking penalties.[5] Educational research has demonstrated that interactive educational tools that force an individual to be involved in the process often have an improved success rate compared with passive noninteractive systems.[2]

A recent study of concussion knowledge of ice hockey athletes, coaches, trainers, and parents demonstrated a significant lack of knowledge concerning concussive injuries.[6] The documented lack of concussion knowledge has been demonstrated by Delaney et al.[9] who found that only 20% of those professional athletes who were experiencing a concussion actually realized that they had suffered this injury. There have been several studies that investigated the concussion knowledge of athletes and coaches. The majority of these studies have been retrospective cross-sectional survey designs.[1,3,5,6,12,13,16,24,25] Williamson and Goodman[26] found that studies based solely on administrative records or reports may not account for all concussions. These investigators believed that their findings indicated the importance of prospective study of the sport-induced injury.[26]

Provvidenza and Johnston[21] found that although there are a variety of concussion education resources currently available such as interactive educational modules and passive noninteractive video-based resources, there is no evidence to indicate which modality is the most appropriate as resources are rarely compared with each other within the same study. These researchers identified the need to evaluate and determine the most effective resources that will promote optimal learning of concussions within each group (physicians, physiotherapists, coaches, trainers, therapists, and athletes).[21]

In a prospective cohort study the HCEP evaluated the concussion knowledge level and retention of concussion knowledge using consistent definitions. The intervention groups demonstrated a trend toward significance (α = 0.057) concerning the retention of concussion knowledge when their knowledge scores were compared with the control group at the 15-game point in the season.

The education and compliance of the athlete, coaching staff, medical/training staff, club executive, and parents concerning the importance of the protocol as well as the cooperation of the team coaching and training staff is essential to fulfill the proper implementation of concussion knowledge education. The trend of knowledge retention among the athletes who underwent the intervention (vs controls) was a small but important finding, and is worthy of repeating in a larger study with better compliance control to determine validity and reliability. The base question that the primary investigator sought to discover was the level of knowledge that the participants began the study with and then the level of retention that occurred over time. In this study only the players were tested concerning their baseline knowledge of concussion. It is important in future studies to test and retest all of the aforementioned individuals associated with the sport to provide a broad-based acceptance of concussion identification, care, and prevention.

The cause and effect relationship of the knowledge and resultant behavior was beyond the scope of this study. If a larger study demonstrates that most players have a reasonable understanding of concussion (including definition, treatment, and long-term effects) then the other more complex questions to consider would be why this behavior continues to occur at such a high incidence level. Consideration of this relationship is difficult and multifactorial and has many significant social components that need to be evaluated and documented, and should form the basis of future studies.

Concussion prevention and incidence reduction involves all individuals (athlete, coaching staff, medical/training staff, club executives, and parents) involved in the particular sport that is under study. The cultural background must be investigated, as it is often influenced by the overwhelming result-oriented pressures at all levels, and the acceptance of previous patterns of behavior concerning this "invisible injury." The resistance to change cultural patterns prevents individuals with a knowledge of concussion from utilizing that knowledge for the benefit of themselves and others. This resistance was demonstrated in the noncompliance with the baseline knowledge and neuropsychological testing components of the protocol by the participating individuals and the teams, other than the initial preseason baseline sessions.

A limitation of this study included the size of the population that received the educational intervention, to provide true significance of the intervention. A second limitation was the lack of a matched control group that was independent of the ice hockey teams involved in this study. Future studies involving larger randomized cohort groups should be conducted to validate the findings of this study. Future studies may also attempt to correlate the use of a concussion education intervention to determine if there is an effect upon the measured direct and documented incidence of concussion.

Conclusions

This study demonstrates a positive trend toward significance concerning concussion education intervention and knowledge acquisition using either the ICMs or the educational DVD. Both forms of intervention produced

a positive and sustained improvement over time that approached statistical significance when compared with the control group. The control group demonstrated a negative longitudinal trend concerning concussion knowledge.

Disclosure

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