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Return to play after an initial or recurrent concussion in a prospective study of physician-observed junior ice hockey concussions: implications for return to play after a concussion

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Object. The authors investigated return-to-play duration for initial and recurrent concussion in the same season in 2 teams of junior (16–21-year-old) ice hockey players during a regular season.

Methods. The authors conducted a prospective cohort study during 1 junior regular season (2009–2010) of 67 male fourth-tier ice hockey players (mean age 18.2 ± 1.2 years [SD], range 16–21 years) from 2 teams.

Prior to the start of the season, every player underwent baseline assessments that were determined using the Sideline Concussion Assessment Tool 2 (SCAT2) and the Immediate Post-Concussion Assessment and Cognitive Test (ImPACT). The study protocol also required players who entered the study during the season to complete a baseline SCAT2 and ImPACT. If the protocol was not followed, the postinjury test results of a player without true baseline test results were compared with previously established age- and sex-matched group normative levels.

Each game was directly observed by a physician and at least 1 neutral nonphysician observer. Players suspected of suffering a concussion were evaluated by the physician during the game. If a concussion was diagnosed, the player underwent clinical evaluation at the physician's office within 24 hours.

The return-to-play decision was based on clinical evaluation guided by the Zurich return-to-play protocol (contained in the consensus statement of international expert opinion at the 3rd International Conference on Concussion in Sport held in Zurich, November 2008). This clinical evaluation and return-to-play protocol was augmented by the 2 tests (SCAT2 and ImPACT) also recommended by the Zurich consensus statement, for which baseline values had been obtained.

Results. Seventeen players sustained a physician-observed or self-reported, physician-diagnosed concussion during a physician-observed ice hockey game. The mean clinical return-to-play duration (in 15 cases) was 12.8 ± 7.02 days (median 10 days, range 7–29 days); the mean number of physician office visits by players who suffered a concussion (15 cases) was 2.1 ± 1.29 (median 1.5 visits). Five of the 17 players who sustained a concussion also suffered a recurrent or second concussion. One of the 5 individuals who suffered a repeat concussion sustained his initial concussion in a regular season game that was not observed by a physician, and as a result this single case was not included in the total of 21 concussions. This initial concussion of the player was identified during baseline testing 2 days after the injury and was subsequently medically diagnosed and treated. The mean interval between the first and second concussions in these 5 players was 78.6 ± 39.8 days (median 82 days), and the mean time between the return-to-play date of the first and second concussions was 61.8 ± 39.7 days (median 60 days).

Conclusions. The mean rates of return to play for single and recurrent concussions were higher than rates cited in recent studies involving sport concussions. The time interval between the first and second concussions was also greater than previously cited. This difference may be the result of the methodology of direct independent physician observation, diagnosis, and adherence to the Zurich return-to-play protocol. *(DOI: 10.3171/2010.9.FOCUS10210)*

Key Words • concussion • return to play • traumatic brain injury • sports injury • ice hockey

The direct independent medical assessment and protocol-guided return to play after an athlete has sustained a medically diagnosed concussion is believed to be essential in the acute concussion care.[19,23] This approach may decrease the frequency of short- and long-term sequelae (such as postconcussion syndrome; mild cognitive impairment; chronic traumatic encepha-

Abbreviations used in this paper: HCEP = Hockey Concussion Education Project; ImPACT = Immediate Post-Concussion Assessment and Cognitive Test; MBESS = Modified Balance Error Scoring System; SAC = Standardized Assessment of Concussion; SCAT2 = Sideline Concussion Assessment Tool 2.

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lopathy) related to this injury.[4,5,8,9,19,20,22,25,26] It may also improve the return-to-play data on which individual decisions are determined. Previously published return-to-play concussion-focused studies have been difficult to compare, as they have been based on different surveillance and return-to-play protocols.[1,10,12,14–16,18,24,28]

The primary goal of the present study was to prospectively measure the duration of medical restriction from play (return-to-play period) after each physician-observed and -diagnosed concussion or recurrent concussion, by direct clinical evaluation augmented with the SCAT2 and ImPACT neuropsychological tools. We studied players from 2 teams of junior ice hockey players during a single regular (36-game) season using the Zurich return-to-play protocol.[19]

Methods

This study was part of a larger surveillance and reporting study also published in this issue.[6] The experimental sample described herein was collected during the 2009–2010 junior ice hockey regular season, and it included 67 male fourth-tier ice hockey players (mean age 18.2 ± 1.2 years, range 16–21 years) from 2 teams.

Prior to the start of the season, every player underwent baseline assessments that were determined using the Sideline Concussion Assessment Tool 2 (SCAT2) and the Immediate Post-Concussion Assessment and Cognitive Test (ImPACT). The study protocol also required players who entered the study during the season to complete a baseline SCAT2 and ImPACT. If the protocol was not followed, the postinjury test results of a player without true baseline test results were compared with previously established age- and sex-matched group normative levels.

Each game was directly observed by a physician and at least 1 neutral nonphysician observer. Players suspected of suffering a concussion were evaluated by the physician during the game. If a concussion was diagnosed, the player underwent clinical evaluation at the physician's office within 24 hours.

The return-to-play decision was based on clinical evaluation guided by the Zurich return-to-play protocol (contained in the consensus statement of international expert opinion at the 3rd International Conference on Concussion in Sport held in Zurich, November 2008). This clinical evaluation and return-to-play protocol was augmented by the 2 tests (SCAT2 and ImPACT) also recommended by the Zurich consensus statement, for which baseline values had been obtained. Mean results are presented ± the SD.

For a complete and detailed description of the methods used in the HCEP please see Echlin and colleagues' article, "A prospective study of physician-observed concussions during junior ice hockey: implications for incidence rates," in this issue of *Neurosurgical Focus*.[6]

Results

In 15 players who suffered a concussion, the mean interval before clinical return to play was 12.8 ± 7.02 days (median 10 days, range 7–29 days); the mean number of physician office visits by 15 players who suffered a concussion was 2.1 ± 1.29 (median 1.5 visits).

These calculations exclude 1 player (an outlier who was out for the season and did not return to play [more than 75 days]), 5 players who refused follow-up, and 4 HCEP players with a physician-diagnosed concussion in whom the event had occurred outside the parameters of the study (2 players in the first round of the playoffs and 2 players in games that were not being observed).

The mean return-to-play duration of players with a reported medical history of concussion were as follows: 11.5 ± 7.60 days in 8 players with 0 previous concussions; 10.7 ± 2.94 days in 6 players with 1–2 previous concussions; more than 28 days in players with more than 3 previous concussions (1 case) (excluding the 1 outlier player and the 5 players who refused to follow-up with the physician).

Eighteen (53%) of the 34 potential concussions identified by the physician and nonphysician observers were positively diagnosed by the physician at rinkside. Three of the diagnosed concussions were not directly identified in an observed game, and were self-reported to the physician either at rinkside or within the next 48 hours. The remaining 16 (47%) of the concussions that were initially identified by the observers were returned to play after a negative clinical and SCAT2 evaluation by the physician.

Five (29%) of 17 players who suffered a concussion also sustained a recurrent concussion during that interval. One of the 5 individuals who suffered a repeat concussion sustained his initial concussion in a regular season game that was not observed by a physician, and as a result this single case was not included in the total of 21 concussions. This initial concussion of the player was identified during baseline testing 2 days after the injury and was subsequently medically diagnosed and treated. The mean interval between the first and second concussions in these 5 players was 78.6 ± 39.8 days (median 82 days), and the mean span between the return-to-play date of the first and second concussions was 61.8 ± 39.7 days (median 60 days).

The concussion diagnosis and return-to-play decision of the athlete were augmented by the use of the ImPACT and the SCAT2. The linear neurocognitive recovery trend over time (number of office visits) of the SCAT2 symptoms, the SAC score, and the Modified BESS score are presented in Figs. 1–3.

Discussion

This is the first study to use independent on-site physicians to diagnose and then determine a player's return-to-play status according to the Zurich protocol.[19] Among the published concussion studies, the lack of a single standardized methodology involving documentation of return to play makes direct comparison of results difficult and allows only trends to be discussed.

In the present study, the mean clinical return-to-play duration of the participants who suffered a new or recurrent concussion during the observed season was 12.8 days. Seven (33%) of the 21 athletes diagnosed with a concussion required more than 12.8 days before returning to play. This calculation includes 2 players who were unable to return to play for the rest of the season due to ongoing symptoms. Previous studies have demonstrated that athletes tend to recover from perceived symptoms

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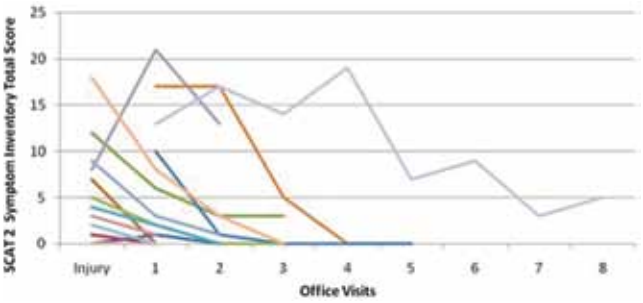

Fig. 1. Graph demonstrating change of the SCAT2 symptom inventory total during the recovery period.

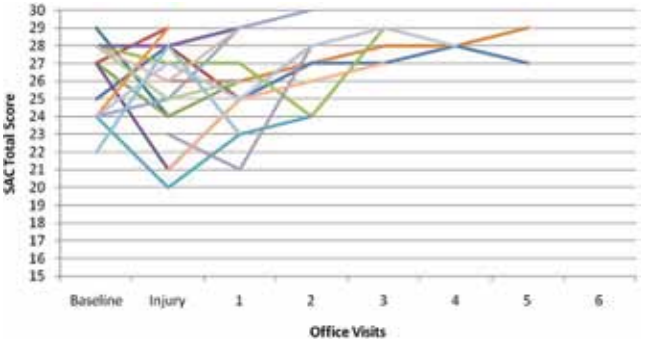

Fig. 2. Graph showing SCAT2 SAC total scores for concussed athletes during the recovery period.

and their neurocognitive performance normalizes within 3–10 days, with a smaller percentage of individuals that require more time to recover.[1,12,14–16,18]

Previous studies have also demonstrated that players who sustained a concussion in a season were 3 times more likely to sustain a second concussion in the same season compared with uninjured players.[11,29] Five (29%) of 17 players who sustained a concussion in this study also sustained a second concussion in the same season. Three of these 5 players who suffered a repeat concussion had a medical history of sustaining at least 1 concussion prior to the beginning of the season.

The mean clinical return-to-play duration for individuals who reported never previously suffering a concussion before the start of the observed season (8 players) was 11.5 days; this value was greater than the mean clinical return-to-play duration (10.7 ± 2.94 days) for individuals (6 players) who reported having between 1 and 2 previous concussions.

The literature documents lengthened recovery times in individuals who reported suffering 3 or more prior concussions.[3,7,10,13] There were 2 HCEP players who reported 3 or more previous concussions and who sustained a concussion during the study. In both players a significantly longer duration for recovery from symptoms and objective neurocognitive measurements was demonstrated. One player, who reported 5 previous concussions, had a significantly longer return-to-play duration (28 days), and the second player who reported 4 previous concussions was unable to return to play and had to retire permanently due to ongoing symptoms. Individual concussion history data may be underreported due to individual bias and to the interpretation of the definition of concussion.

Recurrent concussions may be related to the fact that players are often prematurely returned to play.[24,28] This was not found in the results of the HCEP, as the mean interval between the first and second concussions in the same season (in 5 players) was 78.6 ± 39.8 days (median 82 days). These results differ from the 10-day period in which the second or recurrent concussion most frequently occurred in previous studies.[10,17] The difference in these findings may be attributable to the direct surveillance and strict adherence to the Zurich return-to-play protocol used in the HCEP, and the small sample size used in this study.

The present study used neurocognitive tools such as SCAT2 and ImPACT to augment clinical decision making. These tools should not be considered independent decision-making instruments. Rather, they can supplement clinical information but not override physician judgment. In 8 (38%) of 21 cases of concussions diagnosed and sequentially followed, the athletes scored either in the normal range or within their baseline ImPACT score but were clearly still symptomatic. In 2 (10%) of 21 concussions evaluated, the player would be symptom free and would exhibit cognitive deficits on SCAT2 or ImPACT. These findings of inconsistent results in the objective neuropsychological tools may be attributed to operator error, the learning effect of the participant athlete, or the lack of sensitivity of the test itself.[24,27]

This study concurs with previous studies in the literature that conclude that there is currently no single direct measure of recovery after concussion and that clinical decisions should be made based on multifactorial input including concussion history, symptoms, balance, and cognitive function.[2,14,21]

A limitation of this study was the lack of compliance of HCEP participants with objective baseline testing and retesting at the requested intervals. Although general trends in the objective testing data demonstrated the utility of the objective testing tools, the lack of participant compliance made it difficult to document a complete data set of the objective measurements for comparison purposes. A second limitation of this study was the absence of a matched control group of individuals not involved with the participating teams.

Future studies should focus on improved compliance of participant baseline and postinjury testing. The complete SCAT2 data should be collected and compared across the population to assist in validating and improving this screening tool compared with the components that were

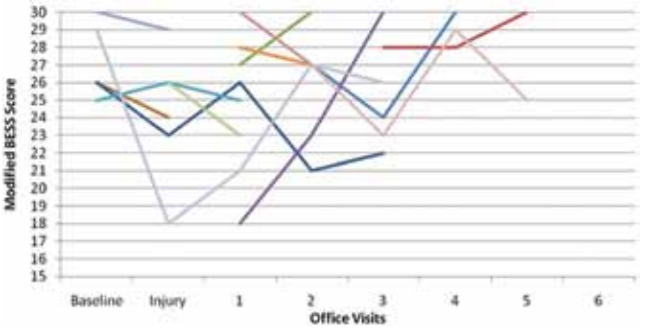

Fig. 3. Graph demonstrating changes of SCAT2 Modified BESS total scores for concussed athletes during the recovery period.

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used in this study. Future studies should also be performed in larger populations, in other contact sports, across sex, across different levels of play, and across different countries to assess the generalizability of these findings.

Conclusions

The mean rate of return to play after a single and recurrent concussion was higher than the rate in recent studies involving sports-related concussions. The interval between the first and second concussions was also greater than previously cited. This difference may be a result of the present methodology, including independent direct physician observation and adherence to the Zurich return-to-play protocol.

Disclosure

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