Anterior Cruciate Ligament Injuries in Professional Hockey Players

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Background: Performance outcomes and return-to-play data have been reported after anterior cruciate ligament (ACL) injuries in professional football and basketball, but they have rarely been reported in professional hockey.

Hypothesis: The hypothesis was that performance after ACL reconstruction would be comparable to prior levels of play in a series of National Hockey League (NHL) players.

Study Design: Case series; Level of evidence, 4.

Methods: The NHL Injury Surveillance System (ISS) was utilized to identify all players with an ACL injury between 2006 and 2010. Medical staff members for all NHL teams were surveyed regarding these injuries. The medical staff completed a questionnaire for each injury, and statistics were analyzed using multiple analyses of variance to compare outcomes, performance, and the complication rate. A control group was identified and matched based on performance, career length before injury, age, height, and weight.

Results: There were 47 players identified by the NHL ISS. There were 3 goalies, 8 defensemen, and 36 wings or centers. The average age of these players was 27.69 years. The average length of time played after the injury was 2.8 years, which was less than that of the control group (4.4 years) (P = .004). The presence of a meniscal injury was associated with a decreased length of career compared with the control group (P = .012) and with patients with an isolated ACL injury (P = .002). For wings and centers, the number of games played decreased from 71.2 to 58.2 in the first full season after the injury (P = .05) and to 59.29 in the second season (P = .03). In the first season after the injury, for forwards and wings, assists and total points decreased from 20.3 and 35.2 to 13.8 (P = .005) and 25.9 (P = .018), respectively. In the second season after the injury, assists and goals decreased to 10.0 (P = .002) and 10.0 (P = .013), respectively. Compared with controls, the per-season averages of goals (P = .001), assists (P = .010), and total points (P = .004) decreased. Four players (8.5%) had subsequent failure of reconstruction, and there was a total reoperation rate of 20%. Five players (10.6%) did not return to play, and 4 (8.5%) were unable to return to play for a full season.

Conclusion: Most players are able to return to play in the NHL after an ACL injury. However, career length and performance may be significantly decreased compared with controls. This may represent a more severe initial injury, and more focused return-to-play pathways may identify barriers to return to play.

Keywords: knee; hockey; anterior cruciate ligament; sports; ligament
METHODS

Institutional review board approval was obtained prior to initiation of the study. The NHL Injury Surveillance System (ISS) was utilized to identify all players with an ACL injury between 2006 and 2010. Medical staff members for all NHL teams were surveyed and completed a questionnaire for each injury. Demographic information, mechanism of injury, timing of injury, missed practices and games, treatment, and outcomes were recorded from the survey. Performance statistics were obtained using an online database (http://www.hockey-reference.com). Years in the league and games played in the league were used as markers for the length of career. Statistics for performance were based on position. Forwards and wings were grouped together, and defensemen and goalies were each defined as separate groups. Performance measures included points, goals, assists, plus/minus rating, and ice time. Only players who returned to the NHL and had played at least 1 full season were included in the preinjury and postinjury in-game statistical analysis. Comparison was performed for athletes with a concomitant injury including a meniscal injury, chondral injury, or associated ligament injury. Players with injuries to the posterolateral corner and patients with a history of ACL injuries were excluded from the study.

A control group was identified and matched based on performance, years of experience, age, height, and weight. Controls did not have any history of ACL surgery, and athletes with a history of injuries were excluded. The average length of time played in the NHL before the injury was 5.65 seasons in the injured group and 5.72 seasons in the control group (P = .013) (Table 1). The average length of time played before the injury was 2.8 seasons versus 4.4 seasons (P = .004) in the control group. For forwards and wings, the average length of time played before the injury was 5.8 seasons, and the average time played after the injury was 2.8 seasons (P = .001). For defensemen, the average length of time played before the injury was 4.3 seasons, and the average length of time after the injury was 3.8 seasons (P = .692).

Thirty-two (68%) players had a concomitant meniscal injury, and 32 (68%) players had a concomitant medial collateral ligament (MCL) injury. Injuries were classified according to the American Medical Association grading of medial knee opening with valgus stress placed with the knee in 30° of flexion: <5 mm (grade 1), between 5 and 10 mm (grade 2), and >10 mm (grade 3); there were 12 grade 3, 14 grade 2, and 6 grade 1 MCL injuries. There was no statistically significant relationship between severity of the MCL injury and length of career or length of time missed. The presence of a meniscal injury was associated with a decreased length of career compared with the control group (P = .012) and with patients with an isolated ACL injury (P = .002). For wings and centers, the number of games played decreased in the first full season after the injury from 71.2 to 59.2 (P = .05) and in the second full season to 59.29 (P = .03) (Figure 1A).

For forwards and wings, in the first season after the injury, assists and total points decreased from 2.8 and 20.3 to 2.0 and 13.8 (P = .005) and 25.9 (P = .018), respectively (Figure 1). In the second season after the injury, assists and goals decreased to 10.0 (P = .002) and 10.0 (P = .013), respectively (Figure 1). Compared with controls, the total

RESULTS

There were 47 players identified by the NHL ISS: 3 goalies, 8 defensemen, and 36 wings or centers. The average age of these players was 27.69 years, and the average age of players in the control group was 28.01 years (Table 1). Forty-two of the injured players (89.4%) underwent reconstruction with a patellar tendon (n = 29) or hamstring autograft (n = 13), and 5 (10.6%) underwent allograft reconstruction (bone–patellar tendon–bone or tibialis posterior). There was no correlation between performance or the complication rate and the type of graft used. The mechanism for 46 injuries was contact with another player (n = 34) or sliding into the boards (n = 12), and 1 player was injured during a non–hockey-related activity.

The average length of time played in the NHL before the injury was 5.65 seasons in the injured group and 5.72 seasons in the control group (P = .013) (Table 1). The average length of time played after the injury was 2.8 seasons versus 4.4 seasons (P = .004) in the control group. For forwards and wings, the average length of time played after the injury was 5.8 seasons, and the average time played after the injury was 2.8 seasons (P = .001). For defensemen, the average length of time played before the injury was 4.3 seasons, and the average length of time after the injury was 3.8 seasons (P = .692).

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number of goals \( (P = .001) \), assists \( (P = .010) \), and total points \( (P = .004) \) decreased when adjusting for the shortened career length of the injured player. There was a 31\% reduction in goals scored per season, 60\% reduction in assists, and 42\% reduction in total points compared with controls (Figure 2), and players per game production also decreased compared with controls. Eleven (23\%) forwards or centers were able to maintain or increase the number of goals, assists, or points in the first full season back after the injury. Predictive factors for improved or maintained performance included players with greater than 30 goals or 20 assists in the season before the injury, and players with fewer than 5 goals in the season preceding the injury \( (P < .001) \). Risk factors for failure to return to play a full season included players who were older than age 30 years at the time of the injury (12 players), as 33\% of these players were unable to return to play a full season compared with only 20\% of players who were younger than 30 years who were unable to return for a full season.

For defensemen, there was no statistically significant performance change in games played, goals scored, assists, total points, or plus/minus rating in the first season after the injury (Figure 3). There was a statistically significant improvement in the plus/minus rating in the second season after the injury compared with preinjury levels, but not in the first season after the injury. This was because of greater variation in the plus/minus rating in year 1 compared with year 2 after the injury (Figure 3E). Over the remainder of their career, there was no statistically significant difference in goals, points, and assists in the control group compared with the injured group (Figure 4).
In this study cohort, there was an average of 9.4 injuries per team per season in the National Football League. Based on previous studies, an average of 1 to 2 ACL injuries were more commonly reported in professional hockey than in professional football or basketball. Therefore, ACL injuries are less common in professional football players. A combination of ACL reconstruction and meniscectomy was more detrimental to an athlete’s durability than either surgery alone. Aune et al. however, reported in a population of NFL players undergoing partial lateral meniscectomy that undergoing a concomitant procedure did not affect an athlete’s ability to return to play, nor did concurrent arthroscopic ACL reconstruction affect a player’s likelihood to return to play. Several subjective and objective outcome measures exist to describe performance after return to play. We assumed that standard outcome scores utilized do not account for leadership, durability, or other factors associated if there were specific clinical factors that predicted a shortened career or worse performance after the injury, and did not include all injuries that occurred over the time period. Erickson et al. also noted that left-handed shooters were more commonly identified in their cohort. This was not analyzed in the present study. In the present study, a concomitant meniscal injury was associated with a shorter career compared with those with isolated ACL injuries and controls. Additionally, forwards and wings were more likely to have a measurable performance decrease based on goals, points, and assists as well as games played, and this persisted into the second season after return to play. Carey et al. noted that approximately four-fifths of NFL running backs and wide receivers sustaining ACL injuries were able to return to an NFL game, typically 9 to 12 months after the injury. Shah et al. noted, in a subsequent study in 2010, that only 63% (31/49) of NFL athletes were able to return to NFL game play, at an average of 10.8 months after surgery. Busfield et al. reported on ACL injuries in 27 basketball players. Twenty-two percent did not return to a National Basketball Association game, and the average time to return to play was 325 days. The findings of the present study show similar outcomes in this population of hockey players, with 38 (81%) returning to play for 1 or more full seasons. The time to return to play was also similar between the 2 groups, with the majority of players able to return between 9 and 12 months.

Shah et al. reported factors correlated with improved return-to-play odds, including a larger number of games previously played and earlier round drafted in football players. Age at the time of surgery, position, and the type and number of procedures were not significantly different between those who did and did not return to play. There was no correlation noted in this study with round drafted or length of career before the injury; however, a concomitant meniscal injury did decrease performance in players and the likelihood of returning to play. These findings are similar to those reported by Brophy et al. in a population of NFL prospects. They noted that a history of meniscectomy, but not ACL reconstruction, shortened the expected career of a professional football player. A combination of ACL reconstruction and meniscectomy was more detrimental to an athlete’s durability than either surgery alone. Aune et al. however, reported in a population of NFL players undergoing partial lateral meniscectomy that undergoing a concomitant procedure did not affect an athlete’s ability to return to play, nor did concurrent arthroscopic ACL reconstruction affect a player’s likelihood to return to play. Several subjective and objective outcome measures exist after a knee injury. A study of collegiate athletes found no difference in mean Tegner, modified Lysholm, or Short Form–36 scores compared with matched cohorts after ACL reconstruction; however, there was a decreased rate of participation in elite-level athletics after college in the reconstructed patients. The current study did not use typical orthopaedic outcome measures and relied on sport-specific outcomes to describe performance after return to play. We assumed that standard outcome scores would not be sensitive to predict statistical performance outcomes in the elite athlete. The outcome measures utilized do not account for leadership, durability, or other factors associated...
intangibles that may be used to describe performance and value to a team. Similar outcome measures have been used in other studies to assess player performance in football and basketball populations.4-10

Carey et al8 noted that, on return to competition, running backs and wide receivers after an ACL injury were approximately two-thirds as productive as they were before the injury. Busfield et al7 reported that, after returning to play, performance decreased by more than 1 player efficiency rating point in 44% of basketball players, although the changes were not statistically significant relative to the comparison group. The current study reported that forwards and wings had significant performance deficits and a reduction in games played after ACL reconstruction and that return to prior performance levels was uncommon in this particular subset of professional hockey players. Defensemen, however, did not have a statistically

![Figure 3](https://example.com/figure3.png)

Figure 3. Number of (A) games played, (B) goals, (C) assists, (D) points, and (E) plus/minus rating in defensemen before and after an anterior cruciate ligament injury. Error bars indicate SDs; the number of players is in parentheses. There was a statistically significant improvement in the plus/minus rating in the second season after the injury compared with preinjury levels, but not in the first postinjury season.

![Figure 4](https://example.com/figure4.png)

Figure 4. Offensive production when compared with a set of controls before and after an injury in defensemen. The number of players is in parentheses. None of the differences were statistically significant.
significant decrease in performance or the number of games played. Injuries to goalies did not occur frequently enough to allow for statistical analysis. The relative performance compared with preinjury levels is comparable to that in studies examining outcomes of ACL injuries in professional basketball and football. There was a statistically significant decrease in performance for the majority of offensive players, and return to previous levels of performance was uncommon.

Studies in other sports have not always reported the mechanism of injury or described the difference in outcomes based on concomitant injuries. Busfield et al. noted that players sustaining a concomitant injury were 3.2 times less likely to return to play. There was a high prevalence of concomitant meniscal injuries in the current study population. A majority of the injuries sustained were contact injuries, and the speed at which hockey is played suggests that these injuries may have been more severe than those seen in other sports in which noncontact injuries are more common.

The strengths of the present study include its case-matched, control comparative design and the use of sport-specific performance parameters and that each injury that occurred during the study interval was included in the final analysis. However, this study has several limitations. The study was retrospective in nature and relied on the league’s ISS for the identification of injuries. It is possible that some ACL injuries were sustained and not identified by the surveillance system and that treatment was not standardized. However, all injuries that were identified were analyzed, and all teams cooperated with the injury survey. The methodology of using the ISS and team-reported surveys allowed for a more accurate clinical picture, and a more representative sample size of ACL injuries in this population, as opposed to using only media-reported injuries. This also allowed for a greater representation of career. There is a high association with concomitant meniscal injuries and MCL injuries, and the majority of injuries are contact injuries. This may represent a more severe initial injury than traditional noncontact ACL injuries seen in other sports, and future prospective studies may identify barriers to return to play.

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REFERENCES