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Shoulder instability, performance, and return to play in National Hockey League players



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Background: The shoulder is a commonly injured area in hockey, yet information is lacking on the prevalence and effect of shoulder instability. Our study investigates the incidence of shoulder dislocation events in the National Hockey League (NHL) and the effects on return-to-play (RTP) and player performance. We hypothesize that NHL players would have high RTP rates without significant changes in performance after injury.

Methods: NHL players who suffered in-season shoulder instability events between 2003-2004 and 2017-2018 seasons were identified. Demographic characteristics, incidence of injury, recurrences, RTP, and statistical performance data were collected. Postinjury performance was compared with experience-matched, era-matched, position-matched, and age-matched controls. A mixed generalized linear regression model was used to compare postinjury performance as a function of operative and nonoperative treatment.

Results: A total of 57 players experienced 67 shoulder instability events with 98.5% of players returning to play after an average of 26.3 ± 20.8 regular season games missed. Surgery was performed in 47.8% of players with no recurrent injuries postoperatively. Nonoperatively managed players experienced a decrease in points per game ($P = .034$) compared with surgically treated patients. Recurrence occurred in 14.3% of conservatively managed players, with 33.3% experiencing a season-ending injury. Players with recurrent injuries missed significantly more career games compared with those treated initially with surgery ($P = .00324$).

Conclusion: Professional hockey players experience high rates of RTP with acceptable performance outcomes after shoulder instability events; however, recurrent injuries led to significantly more career games missed when treated nonoperatively at the time of injury.

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Ice hockey players are at risk for various injuries due to the aggressive nature of gameplay.²⁷ Direct or indirect collisions with other players, collisions with the surrounding boards or equipment-related mechanisms all predispose hockey players to potential injuries.^{5,21} Within hockey, the upper limb makes up nearly 32% of all injuries with shoulder injuries comprising 8.6% to 21.9% of injuries.^{8,12} With the glenohumeral joint's large arc of motion and the high-speed collision nature of hockey, the shoulder is therefore prone to injury in ice hockey players.

Shoulder dislocations present a unique challenge to the competitive athlete as expedient management and treatment can be integral to career longevity and sustained athletic performance.¹⁶ Currently, literature exists to support both operative treatment with labral and instability repairs, and nonoperative treatment characterized by immobilization and physical therapy.^{1,22,31,32} Contact athletes, such as football players and wrestlers, are at a higher risk for recurrent instability after an initial dislocation event; however, no consensus exists for the management of shoulder dislocations in hockey players.²⁵ Although prior studies have examined the impact of shoulder instability in other sports,^{2,6,16,24,31} there is a paucity of data examining its impact on hockey players with even less data available on outcomes in professional hockey players. Therefore, our study sought to investigate the incidence of shoulder dislocation events in the National Hockey

Institutional review board approval was not required for this retrospective study.

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League (NHL) and the subsequent effects on return-to-play (RTP) and player performance. We hypothesized that NHL players sustaining a shoulder instability event would return to play at a high rate without significant changes in player performance after injury. We believe that this information will provide valuable insight into the ideal management after shoulder dislocation in NHL players and to better educate players on potential changes in performance after injury.

Materials and methods

A retrospective cohort study was conducted evaluating NHL players who suffered at least 1 in-season shoulder instability event between the 2003–2004 and 2017–2018 seasons. Using previously described methods,^{10,11,13,17,19,20,23,24} publicly available Internet-based reports were reviewed to identify players meeting inclusion criteria. Sources used for injury reports included team injury reports, professional hockey statistical websites (“NHL.com,” “hockeyreference.com”), press releases, team web sites, and nationally recognized news sources. Player information and injury reports were cross-referenced across multiple sites to confirm diagnostic accuracy and subsequent treatment administered. A shoulder instability event was defined as a dislocation of the glenohumeral joint requiring reduction. Players with an instability event were included if they played in at least 1 NHL game before sustaining the aforementioned injury. Injuries occurring in

preseason, postseason, offseason, during international play or before a lockout season were excluded from analysis. If injuries occurred within the final 3 games of the season, they were not considered “season-ending injuries.” These injuries were excluded from the analysis of season-ending injuries in order to prevent bias given the proximity of the injury to the end of the regular season (Fig. 1). Demographic data such as age, height, weight, body mass index, years played in the NHL, position, career games played, and career seasons played were collected for each player. Injury data such as date of injury, season of RTP, date of player’s return to an NHL game, number of games missed, and presence of injury recurrence were also collected. RTP was defined as a player’s ability to play in at least 1 NHL regular season game after injury. Performance data including number of total seasons played, games played, goals per game, assists per game, points per game, average time on ice (ATOI), shooting percent, offensive point shares (OPS), defensive point shares (DPS), and overall point shares were also collected, similar to the methods used by Longstaffe et al.¹⁷ Players who underwent surgical treatment were identified and information on surgical timing (ie, within the same season, following season of injury, or another season) was recorded.

Matched controls without prior documented shoulder injuries were determined for each player suffering an instability event. Players were matched according to position, height, weight, age, career length (ie, seasons played preinjury season), and year of injury.

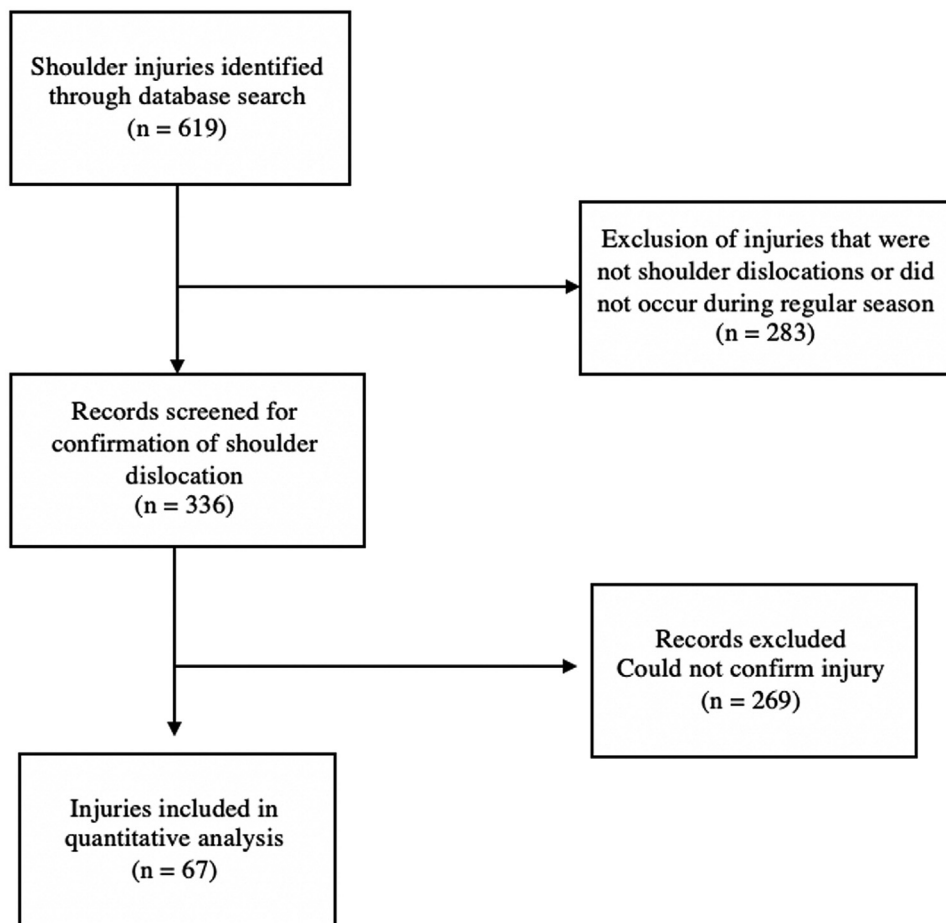


Figure 1 CONSORT diagram showing exclusion criteria of analyzed subjects.

Primary outcome measures included treatment (operative vs. nonoperative), ability to RTP, time to RTP (number of games missed, season of return), and presence of recurrence. The following pre-injury and postinjury performance variables were analyzed: seasons played, games played, goals per game, assists per game, points per game, ATOI, shooting percentage, OPS, DPS, and overall point shares.

A paired Student *t*-test was used to analyze preinjury differences between matched controls. A mixed generalized linear model was used to assess the difference in performance statistics between cases and matched controls after injury. Additional analyses were performed comparing performance and RTP between surgically and nonsurgically treated players. All analyses were performed using SPSS (Version 19.0; IBM, Armonk, NY, USA) and Microsoft Excel (Version 16. Redmond, WA, USA). Statistical significance was set a priori at *P* < .05.

Results

Between the 2003–2004 and 2007–2018 seasons, 56 NHL players experienced 67 confirmed in-season shoulder instability events with 9 recurrent instability events occurring in 5 players. The average age of all studied players was 25.3 ± 3.8 years with a body mass index of 26.8 ± 1.4. The average number of career seasons played was 10.7 ± 4.3 with an average of 571.7 ± 256.1 career games played. Demographic characteristics of players and their matched controls are listed in Table I.

An average of 4.19 shoulder dislocations occurred per season in the NHL with an overall incidence rate of 0.020 dislocations per 1000 game exposures (confidence interval, 0.017–0.027). In terms of player position, no statistically significant differences occurred between forwards and defensemen (*P* = .871) (Table II). Overall, 38.8% (26 of 67) of players suffered season ending injuries, but 98.5% (66 of 67) of all players were able to return to play after missing an average of 26.3 ± 20.8 regular season games. Ultimately, 50% (13 of 26) of players who suffered a season-ending injury underwent surgery. Compared with matched controls, players suffering a shoulder instability event experienced an increase in both ATOI and shooting percentage on returning to gameplay (*P* = .002, *P* < .001, respectively), yet there were no statistically significant differences in seasons played; goals, assists, and points per game; and offensive, defensive, and overall point shares. Complete analysis of player performance data compared with matched controls is shown Table III.

Operative treatment was performed on 47.8% (32 of 67) of all players (Fig. 2). Of the players who underwent surgery, 40.6% (13 of 32) were out for the remainder of the season. In regard to surgical timing, players either underwent surgery before RTP, or trialed nonoperative management before eventually undergoing surgery. The former group comprised 16 players: 75.0% (12 of 16) underwent surgery and were out for the remainder of the season and 25.0% (4 of 16) underwent surgery and returned to play within the same season.

Table I
Baseline demographic characteristics of cases and controls

Characteristic	Cases	Controls	<i>P</i> value
Age	25.3 (3.8)	27.2 (4.5)	.1573
Height (m)	1.9 (0.04)	1.9 (0.05)	1.0000
Weight (kg)	93.2 (6.7)	91.0 (7.7)	.3412
BMI (m/kg ²)	26.8 (1.4)	26.6 (1.5)	.6654
Games played	571.7 (256.1)	662.6 (370.9)	.3728
Seasons played	10.7 (4.3)	11.3 (4.3)	.6615

BMI, body mass index.

Table II
Incidence of shoulder instability event by player position

Position	Incidence per 1000 game exposures	95% CI
Forwards (F)	2.380	1.757–3.156
Defensemen (D)	2.282	1.467–3.399
Overall	2.116	1.653–2.671

CI, confidence interval.

Of the 28 players and 32 injuries that were treated non-operatively, 14.3% suffered recurrent shoulder dislocations, with 10.7% of players and 9.4% (N = 3) of injuries recurring within the season of the original injury. All recurrences within the same season were season-ending, with 33.3% of season-ending recurrences requiring surgery. Players with recurrences missed significantly more total career games compared with patients treated initially with surgery (80.3 ± 50.7 vs. 35.2 ± 18.2, *P* = .00324). Within the studied cohort, no recurrences were seen after operative intervention (Fig. 3).

Operative patients missed an average of 23.3 ± 18.4 games, whereas players treated initially with nonoperative management missed an average of 25.6 ± 22.6 games (*P* = .3832) before returning to play in an NHL game. Compared with players undergoing surgery, nonoperatively managed players experienced a significant decrease in points per game after injury (*P* = .034). There were no significant differences in number of seasons played, goals per game, assists per game, and offensive, defensive, and overall point shares between treatment groups. Postinjury analysis of performance data between operative and nonoperative groups is listed in Table IV.

Discussion

Ice hockey is a collision sport, during which athletes deliberately hit or collide with other players with great force.^{4,28} This can transmit significant stress on the shoulder, and therefore these athletes at higher risk of shoulder trauma.²⁷ Shoulder instability has previously been studied in hockey players of all levels, but despite evidence on the frequency of general upper extremity injuries in hockey players,^{3,6,8,15,22,30–32} there is minimal literature discussing RTP and the impact of shoulder dislocations on performance. In our study, we found an incidence of 0.020 shoulder dislocations per 1000 game exposures in the NHL between the 2003–2004 and 2007–2018 seasons. Compared with matched controls, players who suffered a shoulder dislocation experienced an increase in ATOI and shooting percentage on returning to gameplay (*P* = .002, *P* < .001, respectively). In regard to treatment options, we found that amongst players treated nonoperatively, 14.3% suffered recurrent shoulder dislocations, with all same-season recurrences becoming season-ending injuries and 33.3% ultimately requiring surgery. Furthermore, players with recurrent injury missed significantly more total career games compared with patients treated initially with surgery (80.3 ± 50.7 vs. 35.2 ± 18.2, *P* = .00324). Finally, when evaluating postinjury performance statistics as a function of treatment, nonoperative management led to significantly lower points per game after injury (*P* = .034).

Our investigation found a lower incidence of shoulder dislocations (4.19 shoulder dislocations per season or 0.020 per 1000 game exposures) than the 0.53 shoulder instability events per 1000 athlete exposures reported on the collegiate level.²⁶ One potential explanation for this finding may be owed to the level of expertise shown by players at a higher level, leading to less injuries. Previous studies examining the incidence of shoulder sprains and dislocations found shoulder pathology to comprise 11% of all injuries in Canadian youth hockey and 2% of all injuries amongst French hockey players.^{9,22} Dwyer et al¹⁸ note an 8.6%–21.9% rate of shoulder

Table III
Comparison of performance data between cases and controls

Variable	Cases		Control		P value
	Pre	Post	Pre	Post	
Seasons	4.4 (3.5)	5.3 (2.7)	5.6 (4.8)	4.8 (3.8)	.3224
Goals/game	0.14 (0.13)	0.12 (0.10)	0.14 (0.09)	0.10 (0.10)	.307
Assists/game	0.26 (0.17)	0.21 (0.15)	0.23 (0.16)	0.20 (0.15)	.161
Points/game	0.40 (0.27)	0.33 (0.25)	0.37 (0.23)	0.69 (0.21)	.226
Average TOI	16:02 (6:57)	17:06 (5:12)	16:46 (6:52)	16:55 (5:38)	.002
Shooting %	7.3 (5.1)	7.4 (4.4)	8.4 (4.1)	6.1 (4.2)	<.001
Offensive point shares	1.9 (2.2)	1.3 (2.3)	2.6 (6.6)	0.96 (1.53)	.761
Defensive point shares	1.4 (1.1)	1.7 (1.5)	2.0 (1.9)	1.6 (1.3)	.227
Point shares	3.3 (3.0)	3.0 (3.2)	3.0 (2.9)	2.5 (2.2)	.512

TOI, time on ice.
Bold indicates $P < .05$.

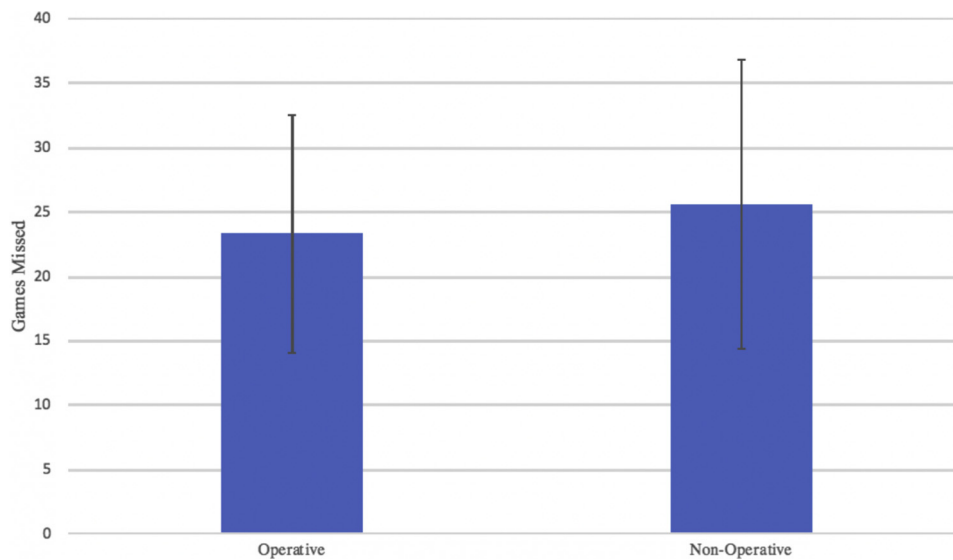


Figure 2 Average number of games missed based on treatment type.

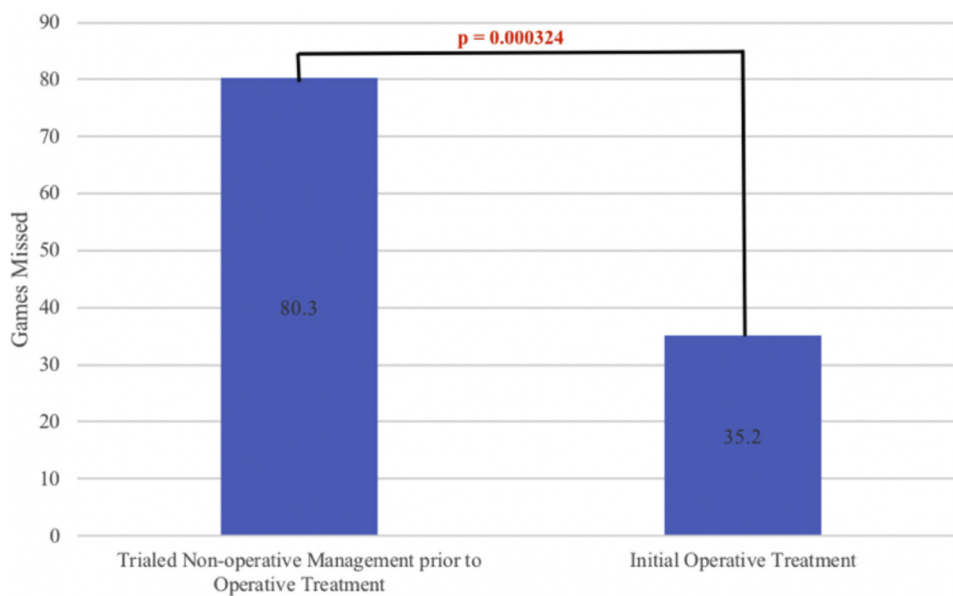


Figure 3 Average number of total career games missed in recurrent injuries.

Table IV
Comparison of performance data between operative and nonoperative cases

Variable	Underwent surgery		Did not undergo surgery		P value
	Pre	Post	Pre	Post	
Seasons	5.4 (3.0)	4.3 (3.2)	4.3 (3.8)	4.9 (3.1)	.882
Goals/game	0.16 (0.15)	0.14 (0.13)	0.20 (0.16)	0.15 (0.19)	.333
Assists/game	0.27 (0.21)	0.22 (0.18)	0.27 (0.19)	0.24 (0.18)	.088
Points/game	0.44 (0.32)	0.35 (0.29)	0.46 (0.30)	0.31 (0.29)	.034
Average TOI	15:54 (5:47)	16:54 (6:37)	15:47 (5:20)	14:25 (4:43)	.514
Shooting %	7.3 (5.0)	7.8 (4.8)	10.0 (6.5)	6.5 (5.6)	.612
Offensive point shares	2.3 (2.9)	1.6 (2.4)	1.9 (2.6)	1.4 (2.3)	.067
Defensive point shares	1.7 (1.4)	1.6 (1.2)	1.5 (1.3)	1.3 (1.3)	.441
Point shares	4.0 (3.7)	3.3 (3.1)	3.5 (3.1)	2.7 (3.0)	.100

TOI, time on ice.

Bold indicates $P < .05$.

injury in professional (NHL and Ontario Hockey League) hockey players; however, an incidence rate was not defined in their investigation.

Our RTP findings (98.5%) are similar to NHL players who suffered anterior cruciate ligament injuries (95% RTP),¹⁷ National Football League players who suffered shoulder instability events (92.8%),²⁴ and high school and collegiate athletes who suffered shoulder dislocations among various sports, including ice hockey (100%).¹⁴ Lubbe et al¹⁸ found that 92.6% of NHL players return to play after any orthopedic procedure with no statistically significant difference in RTP time after shoulder injuries compared with other procedures. In addition, players who underwent these procedures did not experience decreases in performance scores in their post-operative season.¹⁸

No recurrences occurred after surgical intervention, and no significant differences in games missed occurred as a function of initial treatment; however, a significantly greater number of games were missed after recurrent injury ($P = .00324$). The initial evaluation and treatment decision after player injury are paramount in professional sports as time lost from injury can introduce a significant burden on an athlete's career. Donaldson et al⁷ showed that shoulder injuries had the highest mean cost per injury in the NHL leading to one of the largest financial burdens for players unable to play due to injury. Our findings suggest that there may be some benefit to operative intervention in terms of reducing total career games missed due to injury. However, our findings must be viewed in the context of other intangible factors related to athletic play such as seasonal timing of injury and individual player aspirations.

In terms of player performance, those who suffered a shoulder dislocation saw no difference in seasons played, goals per game, assists per game, points per game, OPS, DPS, or PS following when compared with matched controls. Similar conclusions were demonstrated in other contact sports as a study of National Football League players found no difference in pro-bowl involvement, games, seasons, or games played per season from their matched controls.²⁴ Our analysis did, however, find a significant increase in ATOI and shooting percentage of those players who suffered an injury compared with matched controls, as well as higher points per game averages after injury in those treated operatively. Our findings may be secondary to coaching decisions geared to give more playing time, and thus more opportunities to score, to these less fatigued players on their return to the active roster yet further investigation is needed to better rationalize these differences. However, despite these statistical differences, the absolute differences in ATOI (26 seconds), shooting percentage (1.3%), and points per game (0.04) after injury are relatively small. As such, these findings may not be clinically significant within routine gameplay.

Compared with current literature, we present one of the first investigations on postinjury performance in professional hockey. Such information is useful as it can serve to better inform treatment decisions and educate players on the expected outcomes after a shoulder instability event. As there is no consensus on the appropriate treatment method, there is a need for additional research to determine appropriate algorithms. Currently, there is no consensus on treatment, treatment timing, and rehabilitation for shoulder instability injuries in hockey. Given the physical and financial impact of this type of injury on professional players, we feel that there is a need to work toward development of a treatment protocol for shoulder instability in hockey.

This study is not without limitations. Most notably, the current documentation of shoulder injuries in injury reports lacks significant detail. As such, we are unable to comment on specific details related to a player's injury or the exact indications for nonoperative or operative management by the treating surgeon. Further, data collection was inherently limited as shoulder injuries are often listed as "unspecified," "unconfirmed," or more generally as "upper extremity injury" within hockey. As a result, our reported incidence of shoulder instability events may be a gross underestimate. Several potential dislocations were likely excluded from injury reports which inherently reduced the power of our study and subsequently increased the risk of type II error within our analysis. To combat this inherent limitation, multiple public websites and new sources were cross-referenced to confirm the integrity of the data obtained. In addition, this small sample size prevented us from consistently being able to perform statistical analyses to determine the full differences between groups. Furthermore, the NHL experienced lockout periods during the 2004–2005 and 2012–2013 seasons, thus reducing the amount of overall data that could be included in our study and further underpowering our findings. However, this event did not affect our RTP findings as players whose postinjury season was during a lockout were excluded as outlier values in games missed after injury. Lastly, intangible gameplay-related factors such as coaching decisions or individual player disputes that might have affected RTP could not be controlled.

Despite these limitations, our study possesses a number of strengths as it is, to the authors' knowledge, the largest investigation on RTP and changes in performance in professional hockey after shoulder instability. Although there are studies assessing shoulder instability in other contact sports^{16,24,32} as well as other injuries in professional hockey,^{15,17,29} there is a deficit of studies on shoulder instability in professional hockey. To date, this study provides the most comprehensive data available as it evaluates over a 15-year period. Lastly, we presented a rigorous analysis comparing postinjury athletes with a set of era- and experience-matched controls. Selecting controls based on position, number of games played, respective years played, professional era, and

demographic characteristics allowed the authors to present a robust analysis of performance data with limited confounders.

Conclusion

Professional hockey players experience high rates of RTP with acceptable performance outcomes after shoulder instability events; however, recurrent injuries led to significantly more career games missed when treated nonoperatively at the time of injury.

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References

- Arciero RA, Wheeler JH, Ryan JB, McBride JT. Arthroscopic Bankart repair versus nonoperative treatment for acute, initial anterior shoulder dislocations. *Am J Sports Med* 1994;22:589–94.
- Brophy RH, Lyman S, Chehab EL, Barnes RP, Rodeo SA, Warren RF. Predictive value of prior injury on career in professional American football is affected by player position. *Am J Sports Med* 2009;37:768–75. <https://doi.org/10.1177/0363546508329542>.
- Buss DD, Lynch GP, Meyer CP, Huber SM, Freehill MQ. Nonoperative management for in-season athletes with anterior shoulder instability. *Am J Sports Med* 2004;32:1430–3. <https://doi.org/10.1177/0363546503262069>.
- Committee on Sports Medicine and Fitness. Medical conditions affecting sports participation. *Pediatrics* 2001;107:1205–9.
- Crowley SG, Trofa DP, Vosseller JT, Gorroochurn P, Redler LH, Schiu B, et al. Epidemiology of foot and ankle injuries in National Collegiate Athletic Association Men's and Women's Ice Hockey. *Orthop J Sport Med* 2019;7. <https://doi.org/10.1177/2325967119865908>. 2325967119865908.
- Dickens JF, Owens BD, Cameron KL, Kilcoyne K, Allred CD, Svoboda SJ, et al. Return to play and recurrent instability after in-season anterior shoulder instability. *Am J Sports Med* 2014;42:2842–50. <https://doi.org/10.1177/0363546514553181>.
- Donaldson L, Li B, Cusimano MD. Economic burden of time lost due to injury in NHL hockey players. *Inj Prev* 2014;20:347–9. <https://doi.org/10.1136/injuryprev-2013-041016>.
- Dwyer T, Petrerá M, Bleakney R, Theodoropoulos JS. Shoulder instability in ice hockey players: incidence, mechanism, and MRI findings. *Clin Sports Med* 2013;32:803–13. <https://doi.org/10.1016/j.csm.2013.07.013>.
- Emery CA, Meeuwisse WH. Injury rates, risk factors, and mechanisms of injury in minor hockey. *Am J Sports Med* 2006;34:1960–9. <https://doi.org/10.1177/0363546506290061>.
- Erickson BJ, Gupta AK, Harris JD, Bush-Joseph C, Bach BR, Abrams GD, et al. Rate of return to pitching and performance after Tommy John surgery in Major League Baseball pitchers. *Am J Sports Med* 2014;42:536–43. <https://doi.org/10.1177/0363546513510890>.
- Erickson BJ, Harris JD, Heninger JR, Frank R, Bush-Joseph CA, Verma NN, et al. Performance and return-to-sport after ACL reconstruction in NFL quarterbacks. *Orthopedics* 2014;37:e728–34. <https://doi.org/10.3928/01477447-20140728-59>.
- Flik K, Lyman S, Marx RG. American collegiate men's ice hockey: an analysis of injuries. *Am J Sports Med* 2005;33:183–7. <https://doi.org/10.1177/0363546504267349>.
- Keller RA, Steffes MJ, Zhuo D, Bey MJ, Moutzouros V. The effects of medial ulnar collateral ligament reconstruction on Major League pitching performance. *J Shoulder Elbow Surg* 2014;23:1591–8. <https://doi.org/10.1016/j.jse.2014.06.033>.
- Kraeutler MJ, Currie DW, Kerr ZY, Roos KG, McCarty EC, Comstock RD. Epidemiology of shoulder dislocations in high school and collegiate athletics in the United States: 2004/2005 through 2013/2014. *Sports Health* 2018;10:85–91. <https://doi.org/10.1177/1941738117709764>.
- Laprade RF, Surowiec RK, Sochanska AN, Hentkowsky BS, Martin BM, Engebretsen L, et al. Epidemiology, identification, treatment and return to play of musculoskeletal-based ice hockey injuries. *Br J Sports Med* 2014;48:4–10. <https://doi.org/10.1136/bjsports-2013-093020>.
- Leclere LE, Asnis PD, Griffith MH, Granito D, Berkson EM, Gill TJ. Shoulder instability in professional football players. *Sports Health* 2013;5:455–7. <https://doi.org/10.1177/1941738112472156>.
- Longstaffe R, Leiter J, MacDonald P. Anterior cruciate ligament injuries in the National Hockey League: epidemiology and performance impact. *Clin J Sport Med* 2020;30:224–30. <https://doi.org/10.1097/JSM.0000000000000584>.
- Lubbe RJ, Freshman RD, Singh G, Katchko KM, Schneider AD, Sharma S, et al. Performance outcomes and return-to-sport rate of National Hockey League athletes vary after common orthopedic surgical procedures. *Clin J Sport Med* 2020. <https://doi.org/10.1097/JSM.0000000000000696> [Epub ahead of print].
- Makhni EC, Lee RW, Morrow ZS, Gualtieri AP, Gorroochurn P, Ahmad CS. Performance, return to competition, and reinjury after Tommy John surgery in Major League Baseball pitchers. *Am J Sports Med* 2014;42:1323–32. <https://doi.org/10.1177/0363546514528864>.
- Marshall NE, Keller RA, Lynch JR, Bey MJ, Moutzouros V. Pitching performance and longevity after revision ulnar collateral ligament reconstruction in Major League Baseball pitchers. *Am J Sports Med* 2015;43:1051–6. <https://doi.org/10.1177/0363546515579636>.
- Melvin PR, Souza S, Mead RN, Smith C, Mulcahey MK. Epidemiology of upper extremity injuries in NCAA men's and women's ice hockey. *Am J Sports Med* 2018;46:2521–9. <https://doi.org/10.1177/0363546518781338>.
- Mölsä J, Kujala U, Myllynen P, Torstila I, Airaksinen O. Injuries to the upper extremity in ice hockey: analysis of a series of 760 injuries. *Am J Sports Med* 2003;31:751–7. <https://doi.org/10.1177/03635465030310051901>.
- Okoroha KR, Kadri O, Keller RA, Marshall N, Cizmic Z, Moutzouros V. Return to play after revision anterior cruciate ligament reconstruction in National Football League players. *Orthop J Sport Med* 2017;5. <https://doi.org/10.1177/2325967117698788>. 2325967117698788.
- Okoroha KR, Taylor KA, Marshall NE, Keller RA, Fidai M, Mahan MC, et al. Return to play after shoulder instability in National Football League athletes. *J Shoulder Elbow Surg* 2018;27:17–22. <https://doi.org/10.1016/j.jse.2017.07.027>.
- Olds MK, Ellis R, Parmar P, Kersten P. Who will redislocate his/her shoulder? Predicting recurrent instability following a first traumatic anterior shoulder dislocation. *BMJ Open Sport Exerc Med* 2019;5:e000447. <https://doi.org/10.1136/bmjsem-2018-000447>.
- Owens BD, Agel J, Mountcastle SB, Cameron KL, Nelson BJ. Incidence of glenohumeral instability in collegiate athletics. *Am J Sports Med* 2009;37:1750–4. <https://doi.org/10.1177/0363546509334591>.
- Popkin CA, Nelson BJ, Park CN, Brooks SE, Lynch TS, Levine WN, et al. Head, neck, and shoulder injuries in ice hockey: current concepts. *Am J Orthop (Belle Mead NJ)* 2017;46:123–34.
- Popkin CA, Schulz BM, Park CN, Bottiglieri TS, Lynch TS. Evaluation, management and prevention of lower extremity youth ice hockey injuries. *Open Access J Sport Med* 2016;7:167–76. <https://doi.org/10.2147/OAJSM.S118595>.
- Rangavajjula A, Hyatt A, Raneses E, McCrossin J, Cohen S, DeLuca P. Return to play after treatment of shoulder labral tears in professional hockey players. *Phys Sportsmed* 2016;44:119–25. <https://doi.org/10.1080/00913847.2016.1168688>.
- Tuominen M, Stuart MJ, Aubry M, Kannus P, Parkkari J. Injuries in world junior ice hockey championships between 2006 and 2015. *Br J Sports Med* 2017;51:36–43. <https://doi.org/10.1136/bjsports-2016-095992>.
- Watson S, Allen B, Grant JA. A clinical review of return-to-play considerations after anterior shoulder dislocation. *Sports Health* 2016;8:336–41. <https://doi.org/10.1177/1941738116651956>.
- Zaremski JL, Galloza J, Sepulveda F, Vasilopoulos T, Micheo W, Herman DC. Recurrence and return to play after shoulder instability events in young and adolescent athletes: a systematic review and meta-analysis. *Br J Sports Med* 2017;51:177–84. <https://doi.org/10.1136/bjsports-2016-096895>.