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Ice Hockey Injuries in a Japanese Elite Team: A 3-Year Prospective Study

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Context: As the Asian Ice Hockey League gradually expands and becomes more competitive, ice hockey-related injuries may increase. However, no reports have been published on ice hockey injuries in Japan, including the method of injury and the daily supervision of the players during the regular season.

Objective: To prospectively study the incidence, types, and mechanisms of ice hockey injuries in an elite Japanese ice hockey team.

Design: Prospective observational cohort study design.

Setting: An elite ice hockey team, Tokyo, Japan.

Patients or Other Participants: Ninety-four players during the 2002–2005 seasons.

Main Outcome Measure(s): Data were collected for 3 consecutive seasons using an injury reporting form.

Results: The overall game injury rate was 74.3 per 1000 player-game hours and 11.7 per 1000 player-game hours for injuries resulting in any time loss. The overall practice injury rates were 11.2 per 1000 player-practice hours and 1.1 per 1000 player-practice hours for injuries resulting in any time loss. Forwards had the highest rate of injury, followed by defensemen and then goalkeepers. Contusions were the most common injury, followed by strains, lacerations, and sprains.

Conclusions: Most injuries among Japanese ice hockey players occurred during games. Game or play intensity may influence the injury rate during games.

Key Words: injury rates, epidemiology, injury surveillance

Key Points

- Most injuries occurred during games, which were associated with greater play intensity than practices.
- Forwards demonstrated the highest rate of injury, followed by defensemen and then goalkeepers.
- The most common injuries were contusions, strains, lacerations, and sprains.

Ice hockey is one of the most popular sports in northern Europe and North America[1–3] and is inherently dangerous because of the fast and random nature of the game, physical contact among players, and collisions with sticks, pucks, boards, and goalposts.[1,4–6] Although previous authors[1,3–6] have reported ice hockey injuries in European and North American countries, no such data have yet been reported regarding ice hockey injuries in Japan using a method of injury recording and daily supervision of the players during practices and games.

The Japanese Ice Hockey League is the second-oldest elite sports league in Japan. It was established in 1966 to prepare for the 1972 Winter Olympic Games in Sapporo. The first Japanese Ice Hockey League was started with 5 teams and expanded to 6 teams in 1974. In 2003, the Japanese Ice Hockey League was replaced by the Asian Ice Hockey League, which expanded to 8 teams in 2004, including 4 Japanese teams, 1 Korean team, 2 Chinese teams, and 1 Russian team. As the Asian Ice Hockey League gradually expands and becomes more competitive, ice hockey–related injuries may increase.

According to the *Japanese Ice Hockey Yearbook 2002–2003*,[7] Japan had 1229 teams with 25 421 players participating on 644 adult club teams, 150 university teams, 82 high school teams (16- to 18-year-old players), 65 junior high school teams (13- to 15-year-old players), 140 junior club teams (13- to 18-year-old players), 59 elementary school teams, and 89 women's teams. Although Japanese ice hockey teams exist at all skill levels from youth hockey to elite, the true injury risk is not well known.

Our purpose was to determine the incidence, types, and mechanisms of injuries sustained in practices and games for a Japanese elite ice hockey team during 3 consecutive seasons.

METHODS

Participants

During the 2002–2005 seasons, all injuries that occurred on the Kokudo Ice Hockey Team (Tokyo, Japan) during on-ice practices or games were recorded. Most Japanese elite players are amateurs who maintain outside full-time employment in addition to playing ice hockey. *In season* describes the time from the opening game until the final game of the regular season, excluding preseason exhibition games and postseason playoff games.

Twenty-five players (age = 26.7 ± 4.4 years, body mass index [BMI] = 24.9 ± 1.4, playing experience = 7.5 ± 4.2 years) joined the team during the 2002–2003 season. In the 2003–2004 season, 37 players (age = 26.1 ± 3.9 years, BMI = 25.1 ± 1.7, playing experience = 6.1 ± 3.7 years) joined the team due to the merger of 2 company teams. Thirty-two players (age = 26.2 ± 4.0 years, BMI = 25.1 ±

Table 1. Practice and Game On-Ice Hours for a Japanese Elite Team of the Asian Ice Hockey League, 2002–2005

Measure	2002–2003	2003–2004	2004–2005	Total
No. of players	25	37	32	94
No. of on-ice practices	104	88	90	282
Average length of each practice session, h	1.75	1.08	1.17	N/A
Total player-practice hours	4550	3516	3370	11 436
No. of players participating in each game	20	20	22	62
No. of games	36	43	45	124
Total player-game hours	720	860	990	2570

Abbreviation: N/A, not applicable.

1.5, playing experience = 6.1 ± 4.0 years) joined the team during the 2004–2005 season.

Injury Definition

An *injury* was defined as any event that occurred during on-ice practices or games that required medical attention and treatment.[1,5,6] All injuries were recorded on an evaluation sheet in the SOAP (subjective, objective, assessment, and plan) format by the team's certified athletic trainer. The final clinical diagnosis was made by the team doctor. Preseason screening at the Japan Institute of Sports Sciences was conducted for all players to identify preexisting injuries and to establish a musculoskeletal baseline examination. Injuries that were present during the screening but not related to ice hockey were excluded so that each injury could be considered an independent event.

Injuries were classified into 4 severity categories[5]: nuisance (which did not result in any time loss from practice or games), minor (time loss of 1–7 days), moderate (time loss of 8–30 days), and major (time loss of >30 days). After injuries, return-to-participation determinations were made by the team doctor. If an injury occurred near the end of the season, the number of absent days was estimated by the team doctor as if the practices and games had continued.

The team's certified athletic trainer was present at all practices and games, and the team doctor was in attendance at all home games. Attendance records for all practices and games were kept by the head coach.

Statistical Analyses

Exposure information was calculated based on hours of participation in each practice and game by each player. Two injury rates were calculated: the number of injuries (regardless of time loss) divided by the number of hours per 1000 player-hours, and the number of injuries causing time loss (>1 day lost from participation) divided by the number of hours per 1000 player-hours. Injury rates with 95% confidence intervals (CIs) were calculated separately for practices and games. Incidence rate ratios and their 95% CIs were estimated to compare rates between games and practices for the overall sample and by position, injury type, anatomical location, and injury mechanism. Additionally, incidence rate ratios and their 95% CIs were estimated to compare rates between games and practices separately by position, with goalkeepers as the referent group. Frequencies and χ^2 tests were used to determine the differences in proportions of injury type, body part, mechanism of injury, and player position affected during practice and games. *P* values below .05 were regarded as significant. All analyses were performed using SPSS software for Windows (Japanese version 14.0; SPSS Japan Inc, Tokyo, Japan).

RESULTS

Injuries During the 3 Seasons

Total player-practice hours and the total player-game hours during the 3 seasons are shown in Table 1. A total of 319 injuries occurred during the 3 seasons. Of these, 191 (59.9%) occurred during games and 128 (40.1%) occurred during practice. The overall game injury rate was 74.3 per 1000 player-game hours and 11.7 per 1000 player-game hours for injuries resulting in any time loss (Table 2). The overall practice injury rates were 11.2 per 1000 player-practice hours and 1.1 per 1000 player-practice hours for injuries resulting in any time loss. Players were 6.6 times more likely to be injured during games than during practices ($P < .05$) and 10.6 times more likely to sustain injuries resulting in time loss during games than during practices ($P < .05$).

Player Position

Of the 319 injuries, 210 injuries (65.8%) occurred in forwards, 94 (29.5%) in defensemen, and 15 (4.7%) in goalkeepers. Of the 43 injuries resulting in any time loss, 21 injuries (48.8%) occurred in forwards, 16 (37.2%) in defensemen, and 6 (14.0%) in goalkeepers. The game injury rate by position was 49.4 per 1000 player-game hours for forwards, 22.6 per 1000 player-game hours for defensemen, and 2.3 per 1000 player-game hours for goalkeepers (Table 3). The game injury rate resulting in any time loss by position was 5.9 per 1000 player-game hours for forwards, 3.9 per 1000 player-game hours for defensemen, and 2.0 per 1000 player-game hours for goalkeepers.

Types of Injuries

The most common types of injuries during games were contusions (35.4 per 1000 player-game hours), strains (15.6 per 1000 player-game hours), lacerations (9.3 per 1000 player-game hours), and sprains (7.0 per 1000 player-game hours) (Table 4). More contusions occurred in games (35.4 per 1000 player-game hours) than in practices (2.6 per 1000 player-practice hours) ($P < .05$).

Contusions of the foot (n = 14, 5.4 per 1000 player-game hours), hand and finger (n = 13, 5.1 per 1000 player-game hours), knee (n = 9, 3.5 per 1000 player-game hours), and lower leg (n = 8, 3.1 per 1000 player-game hours) occurred most often during games. The injury rate for strains based on exposure was higher in games (15.6 per 1000 player-

Table 2. Injury Rates for a Japanese Elite Team of the Asian Ice Hockey League, 2002–2005

Measure	2002–2003		2003–2004		2004–2005		All 3 Seasons	
	Practices	Games	Practices	Games	Practices	Games	Practices	Games
No. of injuries	46	70	53	72	29	49	128	191
Injuries per 1000 player-hours (95% CI)	10.1 (8.2, 12.0)	97.2 (86.7, 107.7)	15.1 (13.1, 17.0)	83.7 (73.1, 94.2)	8.6 (6.7, 10.5)	49.5 (39.0, 60.0)	11.2 (9.3, 13.1)	74.3 (63.8, 84.8)
Game/practice rate ratio (95% CI)	Referent	9.6 (6.6, 13.9)	Referent	5.5 (3.9, 7.8)	Referent	5.8 (3.7, 9.2)	Referent	6.6 (5.3, 8.3)
No. of injuries related to time loss from practices or games[a]	4	11	5	11	4	8	13	30
Injuries related to time loss from practices or games per 1000 player-hours (95% CI)	0.9 (0.3, 1.5)	15.3 (11.1, 19.5)	1.4 (0.8, 2.0)	12.8 (8.6, 17.0)	1.2 (0.6, 1.8)	8.1 (3.9, 12.3)	1.1 (0.5, 1.7)	11.7 (7.5, 15.9)
Game/practice rate ratio related to time loss (95% CI)	Referent	17.0 (5.4, 53.4)	Referent	9.1 (3.2, 26.2)	Referent	6.8 (2.0, 22.6)	Referent	10.6 (5.5, 20.3)

Abbreviation: CI, confidence interval.

[a] Time loss = >1 day lost from practices or games.

Table 3. Injury Rates by Player Position for a Japanese Elite Team of the Asian Ice Hockey League, 2002–2005

Player position	Setting	n	Injuries Per 1000 Player-Hours (95% CI)	Position Rate Ratio (95% CI)	Game/Practice Rate Ratio (95% CI)	n[a]	Injuries Related to Time Loss From Practices or Games Per 1000 Player-Hours (95% CI)	Position Rate Ratio (95% CI)	Game/Practice Rate Ratio (95% CI)
Forwards	Practices	83	7.3 (5.7, 8.9)	9.1 (4.6, 18.1)	Referent	6	0.5 (0.1, 0.9)	5 (0.6, 41.5)	Referent
	Games	127	49.4 (40.8, 58.0)	21.5 (9.5, 48.8)	6.8 (5.2, 9.0)	15	5.9 (2.9, 8.9)	3 (1.1, 8.3)	11.8 (4.6, 30.4)
Defensemen	Practices	36	3.1 (2.1, 4.1)	3.9 (1.9, 8.1)	Referent	6	0.5 (0.1, 0.9)	5 (0.6, 41.5)	Referent
	Games	58	22.6 (16.8, 28.4)	9.8 (4.2, 22.7)	7.3 (4.8, 11.1)	10	3.9 (1.5, 6.3)	2 (0.7, 5.9)	7.8 (2.8, 21.5)
Goalkeepers	Practices	9	0.8 (0.3, 1.3)	Referent	Referent	1	0.1 (0.0, 0.3)	Referent	Referent
	Games	6	2.3 (0.4, 4.2)	Referent	2.9 (1.0, 8.1)	5	2 (0.4, 4.2)	Referent	20 (2.3, 171.2)

Abbreviation: CI, confidence interval.

[a] n = The number of injuries related to time loss from practices or games.

Table 4. Injury Rates by Injury Type for a Japanese Elite Team of the Asian Ice Hockey League, 2002–2005

Injury Type	Practices		Games		Game/Practice Rate Ratio (95% CI)	Total, n
	n	Injury Rate (95% CI)	n	Injury Rate (95% CI)		
Contusions	30	2.6 (1.7, 3.5)	91	35.4 (28.1, 42.7)	13.6 (9.0, 20.5)	121
Strains	43	3.8 (2.7, 4.9)	40	15.6 (10.8, 20.4)	4.1 (2.7, 6.3)	83
Lacerations	9	0.8 (0.3, 1.3)	24	9.3 (5.6, 13.0)	11.6 (5.4, 25.0)	33
Sprains	12	1.0 (0.4, 1.6)	18	7.0 (3.8, 10.2)	7.0 (3.4, 14.5)	30
Fractures	0	0	5	1.9 (0.2, 3.6)	0	5
Concussions	1	0.1(0.0, 0.3)	4	1.6 (0.1, 3.1)	16.0 (1.8, 143.2)	5
Tooth lesions	3	0.3 (0.0, 0.6)	1	0.4 (0.0, 1.4)	1.3 (0.1, 12.5)	4
Meniscus tears	1	0.1 (0.0, 0.3)	1	0.4 (0.0, 1.4)	4.0 (0.3, 64.0)	2
Dislocations/subluxations	0	0	1	0.4 (0.0, 1.4)	0	1
Others	29	2.5 (1.6, 3.4)	6	2.3 (0.4, 4.2)	0.9 (0.4, 2.2)	35

game hours versus 3.8 per 1000 player-practice hours) ($P < .05$). Strains of the medial thigh (n = 20, 7.8 per 1000 player-game hours), neck (n = 7, 2.7 per 1000 player-game hours), and shoulder (n = 5, 1.9 per 1000 player-game hours) occurred most often during games.

More lacerations occurred in games (9.3 per 1000 player-game hours) than in practices (0.8 per 1000 player-practice hours) ($P < .05$). Lacerations during games most often involved the head and face (n = 21, 8.2 per 1000 player-game hours), elbow (n = 2, 0.8 per 1000 player-game hours), and forearm (n = 1, 0.4 per 1000 player-game hours). Sprains of the ankle (n = 4, 1.6 per 1000 player-game hours), wrist (n = 4, 1.6 per 1000 player-game hours), and knee (n = 3, 1.2 per 1000 player-game hours) occurred most frequently during games.

Localization and Severity of Injuries

The most common sites of injury during games were the head, including the face (11.7 per 1000 player-game hours), the medial thigh (8.2 per 1000 player-game hours), and the hand and finger (7.0 per 1000 player-game hours) (Table 5). The injury rate to the head, including the face, was higher in games (11.7 per 1000 player-game hours) than in practices (1.1 per 1000 player-practice hours) ($P < .05$). The most commonly injured anatomical area was the lower limb (31.9 per 1000 player-game hours).

Of the 191 game injuries, most were classified as nuisance (n = 161, 62.6 per 1000 player-game hours), 19 were minor (7.4 per 1000 player-game hours), 8 were moderate (3.1 per 1000 player-game hours), and 3 were major (1.2 per 1000 player-game hours). Of the 130 practice injuries, most were classified as nuisance (n = 115, 10.1 per 1000 player-practice hours), 10 were minor (0.9 per 1000 player-practice hours), 3 were moderate (0.3 per 1000 player-practice hours), and no major injuries occurred.

During the 3-year study, surgery was performed on 3 athletes during the hockey season, including repair of a maxillary fracture, arthroscopy for a knee meniscus suture, and plate stabilization of a fifth metacarpal fracture. The most serious injuries were a grade II posterior cruciate ligament tear and a meniscus tear, which resulted in a loss of 8 weeks of playing time.

Table 5. Injury Rates by Anatomical Area for a Japanese Elite Team of the Asian Ice Hockey League, 2002–2005

Anatomical Area	Practices		Games		Game/Practice Rate Ratio (95% CI)	Total, n
	n	Injury Rate (95% CI)	n	Injury Rate (95% CI)		
Head and neck	14	1.2 (0.6, 1.8)	40	15.6 (10.8, 20.4)	13.0 (7.1, 23.9)	54
Head (face)	13	1.1 (0.5, 1.7)	30	11.7 (7.5, 15.9)	10.6 (5.5, 20.3)	43
Neck	1	0.1 (0.0, 0.3)	10	3.9 (1.5, 6.3)	39.0 (5.0, 304.7)	11
Upper limb	29	2.5 (1.6, 3.4)	59	23.0 (17.1, 28.9)	9.2 (5.9, 14.3)	88
Shoulder	9	0.8 (0.3, 1.3)	9	3.5 (1.2, 5.8)	4.4 (1.7, 11.1)	18
Upper arm	3	0.3 (0.0, 0.6)	2	0.8 (0.0, 1.9)	2.7 (0.5, 16.2)	5
Elbow	3	0.3 (0.0, 0.6)	10	3.9 (1.5, 6.3)	13.0 (3.6, 47.2)	13
Forearm	1	0.1 (0.0, 0.3)	14	5.4 (2.5, 8.3)	54.0 (7.1, 410.7)	15
Wrist	5	0.4 (0.0, 0.8)	6	2.3 (0.4, 4.2)	5.8 (1.8, 19.0)	11
Hand/finger	8	0.7 (0.2, 1.2)	18	7.0 (3.8, 10.2)	10.0 (4.3, 23.0)	26
Trunk and back	30	2.6 (1.7, 3.5)	10	3.9 (1.5, 6.3)	1.5 (0.7, 3.1)	40
Thoracic	0	0	2	0.8 (0.0, 1.9)	0	2
Upper back	4	0.3 (0.0, 0.6)	2	0.8 (0.0, 1.9)	2.7 (0.5, 14.7)	6
Abdomen	1	0.1 (0.0, 0.3)	1	0.4 (0.0, 1.2)	4.0 (0.3, 64.0)	2
Lower back	25	2.2 (1.3, 3.1)	5	1.9 (0.2, 3.7)	0.9 (0.3, 2.4)	30
Lower limb	55	4.8 (3.5, 6.1)	82	31.9 (25.0, 38.8)	6.6 (4.7, 9.3)	137
Hip	2	0.2 (0.0, 0.4)	5	1.9 (0.2, 3.7)	9.5 (1.8, 49.0)	7
Medial thigh	11	1.0 (0.4, 1.6)	21	8.2 (4.7, 11.7)	8.2 (4.0, 17.0)	32
Thigh	13	1.1 (0.5, 1.7)	9	3.5 (1.2, 5.8)	3.2 (1.4, 7.5)	22
Knee	15	1.3 (0.6, 2.0)	15	5.8 (2.8, 8.8)	4.5 (2.2, 9.2)	30
Lower leg	3	0.3 (0.0, 0.6)	8	3.1 (0.9, 5.3)	10.3 (2.7, 38.8)	11
Ankle	9	0.8 (0.3, 1.3)	9	3.5 (1.2, 5.8)	4.4 (1.7, 11.1)	18
Foot	2	0.2 (0.0, 0.4)	15	5.8 (2.8, 8.8)	29.0 (6.6, 126.8)	17

Table 6. Injury Rates by Injury Mechanism for a Japanese Elite Team of the Asian Ice Hockey League, 2002–2005

Mechanism	Practices		Games		Game/Practice Rate Ratio (95% CI)	Total, n
	n	Injury Rate (95% CI)	n	Injury Rate (95% CI)		
Stick contact	15	1.3 (0.6, 2.0)	63	24.5 (18.4, 30.6)	18.8 (10.7, 33.0)	78
Puck contact	21	1.8 (1.0, 2.6)	40	15.6 (10.8, 20.4)	8.7 (5.1, 14.8)	61
Overuse	52	4.5 (3.3, 5.7)	2	0.8 (0.0, 1.9)	0.2 (0.04, 0.8)	54
Player contact (including checking)	9	0.8 (0.3, 1.3)	34	13.2 (8.8, 17.6)	16.5 (7.9, 34.4)	43
Falling	12	1.0 (0.4, 1.6)	10	3.9 (1.5, 6.3)	3.9 (1.7, 9.0)	22
Collision with boards	2	0.2 (0.0, 0.4)	8	3.1 (0.9, 5.3)	15.5 (3.3, 73.0)	10
Skate contact	1	0.1 (0.0, 0.3)	0		0	1
Others or unknown	18	1.6 (0.9, 2.3)	32	12.5 (8.2, 16.8)	7.8 (4.4, 13.9)	50

Mechanisms of Injury

Stick contact was the most prevalent mechanism of injury during games (24.5 per 1000 player-game hours, $P < .05$) (Table 6). Puck contact was next (15.6 per 1000 player-game hours, $P < .05$), followed by player contact, including checking (13.2 per 1000 player-game hours, $P < .05$). Other or unknown mechanisms mainly included explosive skating, quick stopping and turning, body twisting, and overstretching (12.5 per 1000 player-game hours). Overuse was the most prevalent mechanism of injury during practice (4.5 per 1000 player-practice hours).

Most of the 21 facial lacerations sustained during games were caused by stick contact (n = 20, 7.8 per 1000 player-game hours) or puck contact (n = 1, 0.4 per 1000 player-game hours). During the 3 seasons, an average of 38.4% of the players (n = 36) wore visors during practices, and 78.3% (n = 74) wore visors during games. The players wearing visors had 14 facial lacerations (5.4 per 1000 player-game hours) during games, whereas those without visors had 7 injuries (2.7 per 1000 player-game hours). Interestingly, the occurrence of facial lacerations below the visor during games was greater in the players wearing visors (n = 10, 3.9 per 1000 player-game hours) than in those without visors (n = 2, 0.8 per 1000 player-game hours).

DISCUSSION

Our prospective 3-year analysis of ice hockey injuries is the first reported for a Japanese elite team. We had a strict injury definition, daily recording of injuries during practices and games, a single team doctor who diagnosed and treated each injury, and an injury rate that was calculated using player exposure time for practices and games in the regular season.

The game injury rate resulting in any time loss (11.7 per 1000 player-game hours) was much lower than the rates reported by Lorentzon et al[1] (78.4 per 1000 player-game hours), Pettersson et al[5] (74.1 per 1000 player-game hours), and Molsa et al[2] (66.0 per 1000 player-game hours). The difference is likely due to the method used to calculate injury rates. Previous authors[1,2,4–6,8,9] assumed that 6 players were on the ice during games at any one time. Thus, their calculations may have inflated the game injury rate. In our study, game exposures were based on all players who participated in each game, including a back-up goalkeeper, because they would be at risk for a game-related injury. Flik et al[10] used the same calculation method we did, and their game injury rate resulting in any time loss (13.8 per 1000 player-game hours) was similar to ours.

The practice injury rate resulting in any time loss (1.1 per 1000 player-practice hours) was similar to rates reported by Lorentzon et al[1] (1.4 per 1000 player-practice hours) and Molsa et al[2] (1.4 per 1000 player-practice hours). The practice injury rate was calculated as if the whole team was on the ice during the whole practice session, as reported by previous authors.[1,2,5,8,9]

In our study, most injuries (59.9%) occurred during games, and the injury rate resulting in any time loss was 10.6 times higher during games than during practices. Our findings are similar to those of others[1,2,5] who reported higher injury rates resulting in any time loss during games than practices. Investigators[8,9] studying the Canadian Junior A hockey league showed that the injury rate during games was 20 to 25 times higher than during practices. Practices required the same protective equipment as games, but body checking, aggressive play, and other potentially injurious acts, such as slashing with a stick, were less common during practices than during games. Therefore, intensity of play during games may be higher, with more frequent and forceful body contact, aggressive play, and more stick uses.

Injury rates for Swedish ice hockey players resulting in any time loss during games[1,5] were similar to those reported in a study[2] of Finnish ice hockey players. Swedish and Finnish ice hockey may be comparable in terms of game intensity, number of games per season, rules, and training methods.[5]

Differences in injury rate calculation methods and intensity of play may influence the injury rate during games. Hockey injuries, categorized as the rate of injury per player per year, were shown to increase from youth hockey to the professional level.[3] Although we believe that the level of competition may influence the game injury rate, we cannot confirm this speculation because we lack injury data for Japanese youth and collegiate ice hockey.

In our study, forwards were more likely to sustain injuries than defensemen, and goalkeepers had the lowest injury rate, with 4.7% of all injuries. This result is consistent with reports by Molsa et al,[2] Stuart and Smith,[8] Pinto et al,[9] and other authors[1,5,10,11] who noted that goalkeepers were at the least risk for injury.

Some authors[1,5] have suggested that defensemen may be at higher risk than forwards because more aggressive checking, shot blocking, and physical contact are required for effective position play. In contrast, our results suggest that forwards may be at higher risk than defensemen because of the "dump and chase" offensive strategy, wherein one player hits the puck into the attack area and other players chase it.

As indicated by Flik et al,[10] the American ice hockey style is traditionally more physical than the European style and

places forwards at higher risk for contact injuries because of the common "dump and chase" offensive strategy. Because Japanese ice hockey has been played in the American style, offensive strategy probably influences injury rates for each position. However, further investigation is needed in this area before any firm conclusions can be drawn.

Contusions were the most common type of injury, followed by strains, lacerations, and sprains. Contusions involving the foot, hand or finger, knee, and lower leg may be associated with body contact or puck or stick contact, a finding consistent with previous studies.[1,5]

Strains involving the adductors, neck, rotator cuff, and lower back muscles may reflect the posture and motion of skating on ice. Strains were most frequently localized to the medial thigh (adductors), which is consistent with other studies.[1,5,8] The groin is a very common site for muscle strains because the main thrust of the skating stride involves a forceful contraction of the adductors.[3,12] Ice hockey players whose adductor strength is less than 80% of their abductor strength are more likely to sustain an adductor muscle strain.[13] An intervention program for strengthening the adductor muscles appears to be an effective method for preventing adductor strains in professional ice hockey players.[14] Thus, Japanese elite ice hockey teams should consider adding adductor strengthening programs to their regular season training to help decrease the incidence of adductor strains.

Lacerations were more common in games than in practices, consistent with a previous study.[8] Of all lacerations, facial lacerations occurred most frequently during games, similar to findings of previous studies.[1,4,8]

Sprains were most often localized to the ankle during games, including syndesmotic ankle sprains, which are "high ankle sprains" affecting the anterior-inferior tibiofibular ligament. According to Wright et al,[11] syndesmosis sprains represented 74% of all ankle sprains in 2 National Hockey League franchises. Syndesmosis sprains require a significant recovery time, as demonstrated by a mean of 45 days of time loss. Flik et al[10] stated that the relatively high rate of syndesmosis injuries was unique to ice hockey and led to the longest average time lost from participation.

In our study, most of the syndesmosis sprains were minor, except for 1 moderate syndesmosis sprain (which required 16 days to recover). The most serious sprain was a grade II posterior cruciate ligament tear caused by a forward player falling, which resulted in 8 weeks of lost playing time. In this case, a custom knee brace was used during practices and games to prevent further injury, and the player participated in a program to strengthen the quadriceps and stretch the hamstrings and calf muscles.

The anatomical location with the highest injury rate was the head, including the face. The most common injuries were lacerations. In Japanese ice hockey, full face masks or visors are mandatory only for players born in or after 1974. It is likely that the reason we observed such a high rate of laceration injury to the head was because some players did not wear face protection. One of the major injuries during the 3-year study was a maxillary fracture caused by high sticking during a game to a veteran player without a visor. This injury might have been prevented if the player had worn a visor or mask.

The medial thigh was the second most-injured site, which is inconsistent with previous reports.[1,5,6,8,9] However, when considered as an anatomic region, the lower limb was the second most commonly injured area, followed by the upper limb, the head and neck, and the trunk and back, which is consistent with previous findings.[5]

In our study, stick contact, puck contact, and player contact (including checking) were the most frequent injury mechanisms during games, accounting for 57.1% of all injuries, a finding consistent with previous studies.[5,6] We noted that 95.2% of facial lacerations were caused by stick contact, such as high sticking. Previous authors[1,5] have shown that about 60% of facial lacerations were caused by the opponent's stick. Another group[8] indicated that facial lacerations were often caused by players wielding high sticks in the third period of the game. In another study,[1] the incidence of facial laceration was much higher among players not wearing visors. However, we observed that the incidence of facial lacerations was higher in players wearing visors, even when a higher percentage of players wore visors during games. Therefore, strict rule enforcement and attitudinal changes among hockey officials and coaches may be required to reduce the risk of facial lacerations.

LIMITATIONS

Several limitations of our study should be noted. Many injuries occurred during training camps, preseason games, and playoff games, but we did not report the profile of injuries in the preseason and postseason periods. In addition, injuries occurring during each game period were not reported because data for the 3 consecutive seasons were lacking. Injuries sustained during off-ice practice, such as resistance training and interval running training, were excluded because they were rare.

CONCLUSIONS

The majority of injuries analyzed in our study occurred during games with more frequent and forceful body or puck contact and more stick violations. Forwards had the highest rate of injury, followed by defensemen and then goalkeepers. Contusions were the most common injury, followed by strains, lacerations, and sprains. Game or play intensity, stricter rule enforcement, and attitudinal changes among hockey officials and coaches are factors that may reduce the injury rate during games.

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