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Ice Hockey Injuries: Weber Type C Fibular Fracture in a Collegiate Hockey Player: A Case Report

Stefanie K. Arndt
St. Cloud State University

This starred paper submitted by Stefanie K. Arndt in partial fulfillment of the requirements for the Degree of Master of Science at St. Cloud State University is hereby approved by the final evaluation committee.

Chairperson

Dean
School of Graduate Studies

ICE HOCKEY INJURIES: WEBER TYPE C FIBULAR FRACTURE IN A COLLEGIATE HOCKEY PLAYER: A CASE REPORT

by

Stefanie K. Arndt

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INTRODUCTION

Women's hockey is one of the fastest growing sectors of hockey and has gained considerable popularity in the last decade (1). Women's ice hockey was added as a medal sport in the Olympics in 1998 to increase the number of female athletes. Collegiately, there are 82 NCAA-sanctioned teams, with 34 teams at the Division I level, which is an increase of 40 teams over the last 10 years. According to USA Hockey, female registration in hockey has increased from 10,416 in 1992-93 to 59,506 in 2008-09. This extremely fast-paced sport demands high levels of skill and all-around fitness. Unlike the men's game, intentional body checking is not allowed, which leads many to assume that the women's game does not produce contact-related injuries.

Purpose

The purpose of this case study was to illustrate a possible career-ending injury to an elite Division I women's hockey player and the progression of events leading to her return to full athletic activity in her sport. This report provided insight into the treatment and care of an injury not commonly seen in an athletic setting. This case study presented the acute care, surgical repair, treatments and rehabilitation techniques used for the full physical return of the athlete to elite

competition the following season. Due to the less common nature of this injury in athletics, it has not been well reported. The intent of this case report was to serve as a guide to athletic trainers and other sports medicine professionals. In the case that an individual is presented with a similar type injury, this case report could aid in the recognition, treatment and rehabilitation for return to activity.

Methods

The method used in this project was a reported case study. The participant in the case study was a female 20-year-old, right-handed, 5'2" junior defensemen Division I hockey player. These data were collected using the on-site account of the athletic trainer, the medical reports from the University of Minnesota Medical Center-Fairview, Fairview Southdale Hospital, Centennial Lakes Clinic, and the Centennial Lakes Surgery Center. The information provided in the case study is a chronological progression of the follow-up visits with various medical personnel. The author gathered the medical reports by means of a signed medical information release by the patient. The interview was conducted with the athlete a year and a half post-injury directly with the author.

REVIEW OF LITERATURE

The review of literature will address studies performed on ice hockey-related injuries and breakdown the sample groups, injury types, body part and rates of overall injuries. Information regarding ankle injuries, the syndesmotic ankle injury, and the Weber Type C ankle fracture will be provided to clarify the information in the case report.

Studies Conducted on Hockey Injuries

Jorgensen and Schmidt-Olsen (2) investigated the injury pattern and the frequency of ice hockey injuries of elite hockey players. They gathered their information by means of a questionnaire that was given to 14 randomly chosen Danish elite hockey teams before the last match in each of two consecutive seasons. Of the 266 players that received the questionnaire, 210 players completed the questionnaire (79%). The uniform briefing of all players defined injuries that were acquired in connection with hockey training or matches, which hindered activity, and/or required special treatment to enable the injured to play or made play impossible. The injury pattern showed that approximately half of the injuries were located to the head (28%) and lower extremities (27%), and concussions (14.3%).

Tegner and Lorentzon (3) brought all the physicians together before each season from 1981-1989 of the highest Swedish hockey elite leagues. They attended an informational meeting concerning the background and purpose of the investigation. The physicians were instructed to record all injuries on a special card and return them to the authors. An injury was defined as any injury occurring during ice practices or games and causing the player to stop playing or to miss the next practice session or game. There were 12 teams in the highest Swedish hockey division that played a total of 664 games. There were a total of 285 injuries that occurred at 267 occasions. The severities of injury were classified as 174 injuries that were minor, 66 injuries that were moderate, and 25 injuries that were severe. The remaining 20 injuries were unclassifiable.

Hostetler et al. (4) used data regarding ice hockey-related injuries treated in United States Emergency Departments between January 1, 2001 and December 31, 2002. The data were extracted from the National Electronic Injury Surveillance System (NEISS). The data reviewed included age, gender, race, injury diagnosis, and body region injured. Ice hockey-related injury cases were identified using the consumer product code for ice hockey and narrative description of the incident in the NEISS. There was an estimated 32,750 individuals with ice hockey-related injuries according to the NEISS with an actual sample size of 750 individuals.

Pettersson and Lorentzon (5) investigated the incidence of injuries of different severity, types of injury, and mechanisms of injury during ice hockey practice and games of one Swedish elite hockey team. The team was closely observed during four seasons (1986-1990). An injury was defined as any injury occurring during on-ice practice or games and that required medical attention and treatment. A total of 376 injuries were reported and 148 of those injuries resulted in absence from practices or games.

McKnight et al. (6) invited 15 schools from the Eastern Collegiate Athletic Conference (ECAC) and the Hockey East Conference to participate in the study. The purpose of the study was to investigate the type, nature, and frequency of injuries sustained in intercollegiate ice hockey. A participant was defined as an athlete who maintained candidacy for varsity competition by subscribing to the team's eligibility rules and requirements. The start of the season was defined as the first regularly scheduled practice under the direct supervision of a coach as allowed by the NCAA. The end of the season was defined as the conclusion of the competitive season, including playoffs. A certified athletic trainer from each school was responsible for collecting and reporting injury and exposure data, which followed the National Athletic Injury/Illness Reporting System (NAIRS). A total of 280 injuries were reported during this study.

Hart and Walker (7) examined the incidence and nature of injuries in female recreational hockey players from women's ice hockey leagues in

Edmonton, Canada for the 1997-1998 season. Participants were recruited from all teams in the two women's ice hockey leagues, which represented approximately 90% of the area's total women's recreational ice hockey players. The study included 314 players from 33 teams and was subdivided into women in adult teams (mean age 27 years old) and midget teams (mean age 14.7 years old). Injuries were defined as any acute injury sustained while playing women's ice hockey during any game or practice that resulted in the women missing the remainder of the game or practice, a subsequent game or practice, and/or required women to consult a health professional. Diagnoses were self-reported or obtained from health professionals. A total of 125 injuries were reported during the season with 93 injuries credited to the adult teams and 32 injuries credited to the midget teams.

Schick and Meeuwisse (8) designed a 1-year cohort study that utilized the Canadian Intercollegiate Sport Injury Registry (CISIR). The CISIR was developed to longitudinally track injury rates in university sports. The system was used to collect data over the entire 1998-1999 varsity ice hockey season of six male and six corresponding female teams from the Canada West University Athletic Association (CWUAA). Each player completed preseason medical history forms. The injury definition used in this study was any event causing a subsequent time loss from participation in ice hockey. A total of 261 players, 114 women and 147

men were enrolled into the study. A total of 41 female players sustained 66 injuries and 84 male players sustained 161 injuries during the varsity season.

Agel et al. (9) collected data over a 4-year period from the 2000-2001 season through the 2003-2004 season. The objective of this study was to review 4 years of NCAA injury surveillance data for women's ice hockey and to identify potential areas for injury prevention initiatives. An average of 15.6% of schools sponsoring varsity women's ice hockey programs participated in the annual NCAA Injury Surveillance Systems (ISS) data collection. On average, 11 schools contributed data each year; only one Division II school reported data and only in 1 year. Preseason practice injury rates were almost twice as high as in-season practice rates. The rate of injury in games was more than five times higher than the injury rate in practices.

Hockey Injuries

The studies used to gather information on ice hockey injuries ranged from 1986-2004. Those studies ranging from 1986-1998 are considered "early" studies where a facemask was not required in most cases, resulting in more facial injuries. The two studies that were conducted between 1998-2004 are more recent, which provided different injury occurrence. The differences of injury occurrence between the "early" to "later" studies stem from the increased awareness of symptoms and reporting of concussions.

The early studies (3, 4, 5, 6, 7) conducted on ice hockey injuries identified the highest occurrence rate of injuries as contusions, lacerations, and sprains or strains (see Table 1). These injuries were primarily caused by a direct trauma mechanism, which included impact with another player, the ice, boards, puck, stick, or the goal. The high rate of contusion and laceration injuries could be attributed to rules that allowed players to compete without wearing the facemask. All collegiate players are now required to wear the full facemask.

A more recent study (9) conducted on female collegiate players indicated concussions as the primary type of injury. Agel (9) noted that the rate of concussions increased over a 4-year period. The primary mechanism of injury was caused by direct player to player contact. Secondary mechanisms of injury were attributed to direct impact with the ice, the puck, or the boards. Changes in the primary types of injuries suffered during competitive ice hockey could be attributed to the higher awareness of traumatic brain injuries and symptoms, the variance in skill level, and the increase of reporting. Schick (8) found that the overall injury rate between male and female collegiate players did not differ significantly, but a larger proportion of injuries for females were caused by contact. The lower extremity experienced a great amount of injuries overall (2, 5, 6, 7, 8, 9).

Table 1

Overview of Research Studies on Ice Hockey Injuries

Study/ Authors	Sample Group	Year	Total Injuries (#)	Injury Type	Body Part	Games vs Practices
Jorgensen & Schmidt-Olsen	Danish Elite Hockey Teams	N/A	189	(178 injuries – 11 not classified) Unknown (73) Concussion (49) Sprain (38)	Head (27) Knee (25) Teeth/Hand/Fingers (14)	**Games** (70%) **Practices** (30%)
Tegner & Lorentzon	Swedish Elite Hockey Teams	1988-1989	285	Strain/Sprain (24.2%) Laceration (23.9%) Contusion (18.2%)	Head/Face (39.4%) Knee (13.2%) Hip/Thigh (12.1%)	**Games** (74%) **Practices** (26%)
Hostetler, Xiang & Smith	Ice Hockey-Related Injuries Treated in US Emergency Dept's	Jan 01-Dec 02	750	Contusion/Abrasion (26.9%) Fracture (17.5%) Sprain/Strain (17.3%)	Upper Extremity (43.8%) Head (16.3%) Lower Extremity (16.1%)	N/A
Pettersson & Lorentzon	Swedish Elite Team	1986-1990	376	Contusions (139) Lacerations (82) Sprains/Strains (68)	Head/Face/Neck (115) Knee (47) Thigh (28)	**Games** (68.9%) **Practices** (31.1%)

Table 1 (continued)

McKnight, Ferrara & Cerwinska	Eastern Collegiate Athletic Conference (ECAC) & Hockey East	1989-1990	280		Contusion (91) Sprain (82) Strain (41)		Shoulder (51) Knee (44) Upper Extremity (33)		**Games** (65%) **Practices** (35%)
Hart & Walker	Women's Ice Hockey Leagues Edmonton, Canada	1997-1998	125		**Adult** Sprain/Strain (57%)	**Midget** Contusion (50%)	Lower Back (14%) Knee (12%) Shoulder (10%)		**Games** (66%) **Practices** (34%)
Schick & Meeuwisse	Canada West University Athletic Association (CWUAA)	1998-1999	**Males** 161	**Females** 66	**Males** Concussion (17) Adductor Strain (13) AC Sprain (13)	**Females** Concussion (10) Adductor Strain (9) Ankle Sprain (7)	**Males** Thigh (27) Knee/Shoulder (24) Head (23)	**Females** Head/Thigh (11) Knee (10) Ankle (8)	N/A
Agel, Dick, Nelson, Marshall & Dompier	NCAA Varsity Women's Ice Hockey Teams	2000-2004	**Games** 264	**Practices** 167	**Games** Concussion (21.6%) Internal Derrangement of Knee (12.9%) Acromioclavicular Injury (6.8%)	**Practices** Concussion (13.2%) Muscle-Tendon Strain of the Hip/Pelvis (12%) Foot Contusion (7.2%)	**Games** Lower Extremity (31.8%) Upper Extremity (30.3%) Head/Neck (25.4%)	**Practices** Lower Extremity (31.1%) Trunk/Back (26.4%) Upper Extremity (22.2%)	**Games** (12.6/1000 athlete exposures) **Practices** (2.5/1000 athlete exposures)

Earlier and more recent studies (2, 3, 5, 6, 8) both indicated a higher rate of injuries seen in games than in practices by at least 50%. Schick (8) was able to determine that women were most often injured during the second period of a game. Older research that analyzed injury rates by position described a greater susceptibility of injuries to defensemen (5, 6) whereas, the research conducted on NCAA female players indicated an even distribution of injuries to forwards and defensemen (9). Only Agel (9) reported on the location at the time of injury, which was evenly distributed between the neutral zone, between the blue line and face-off circle, the front of the goal, and the corner.

Ankle Injuries

The ankle is commonly injured in the athletic population and can be classified as either traumatic or chronic in nature. Ankle sprains are abnormal stresses placed on ligamentous structures. The anatomical boney arrangement of the ankle helps stabilize the ankle. The fibula extends inferiorly approximating the lateral talus completely. The ligaments on the lateral side include the anterior talofibular, the posterior talofibular, and the calcaneofibular ligaments. These lateral ligaments are not as large or strong as the deltoid ligament on the medial side of the ankle joint. Pfieffer (10) estimated that 80-85% of ankle sprains experienced in sport affect the lateral ligaments. Lateral ankle sprains are caused by plantar flexion and inversion of the ankle joint.

The ankle can also be subject to a syndesmotic sprain, which is less common than the lateral ankle sprain. Syndesmotic injuries involve disruption of the ligamentous structures between the distal fibula and tibia, just proximal to the ankle joint. Previous studies (11, 12, 13) indicated between 1-18% of all ankle sprains involve injury to the syndesmosis. The distal syndesmotic articulation between the tibia and fibula is comprised of three major ligaments: the anterior inferior tibiofibular ligament, the posterior inferior tibiofibular ligament, and the interosseous ligament (14).

A syndesmotic ankle sprain is typically caused by one of the following mechanisms: external rotation of the foot, eversion of the talus within the ankle mortise, or excessive dorsiflexion. Lin et al. (14) reported that the most common mechanism of injury of the syndesmosis involves external rotation and excessive dorsiflexion of the foot relative to the leg. Studies (15, 16, 17, 18) have shown that syndesmotic injuries result in more time lost from participation in athletics and longer treatment times compared to other ankle sprain injuries.

Most syndesmotic sprains of the ankle can be treated conservatively if no fracture is present. More severe injuries may require surgical intervention to help restore stability to the ankle mortise. Wuest (19) proposed that syndesmotic screw fixation should be used if persistent lateral displacement of the fibula or significant widening of the mortise is observed with malleolar fractures. Miller et

al. (20) suggested that surgical repair assures the reduction of the injury and stability of the ankle mortise.

Studies (21, 22, 23) have shown that isolated syndesmotic ligamentous injury is rare and are usually accompanied by a lesion of the deltoid ligament and fibular fracture. The Danis-Weber classification system is widely used to clarify and describe ankle fractures at different levels of the fibula (24). A Weber type A fracture is a fracture of the lateral malleolus distal to the syndesmosis. A Weber type B fracture is a fracture of the fibula at the level of the syndesmosis. A Weber type C fracture is a fracture of the fibula proximal to the syndesmosis and involves a deltoid-medial malleolus complex injury creating instability of the fibula (25, 26).

There are three types of indirect fracture of the fibula proximal to the distal tibiofibular syndesmosis. They are produced by different mechanisms and characterized by a specific fracture, which is usually located at the junction of the distal and middle parts of the fibula. Pankovich (27) described the three main types of mechanism of injury that result in a Weber type C fracture. In the explanation of these mechanisms, the first word refers to the position of the foot at the time of injury and the second, to the direction of the injuring force on the talus. The mechanisms of injury include: supination-external rotation fracture, pronation-abduction fracture, and pronation-external rotation force.

Supination-external rotation fractures occur because the deltoid ligament is relaxed in supination causing the fracture of the fibula to occur before the deltoid ligament ruptures or the medial malleolus fractures. There are four stages in the development of the complete injury (27):

1. Stage one: rupture of the anterior tibiofibular ligament or avulsion fracture of one of its bone insertions.
2. Stage two: fracture of the fibula above the syndesmosis.
3. Stage three: rupture of the posterior tibiofibular ligament or fracture of the posterior tubercle of the tibia.
4. Stage four: fracture of the medial malleolus or rupture of the deltoid ligament.

Pronation-abduction fractures are caused when the deltoid ligament is under tension while the foot is pronated and either ruptures or the medial malleolus is avulsed when an abduction force is applied to the talus. A complete diastasis of the syndesmosis occurs and results in the fracture of the fibula. There are three stages recognized in the development of a complete lesion of this type (27):

1. Stage one: rupture of the deltoid ligament or fracture of the medial malleolus.

2. Stage two: rupture of all ligaments of the syndesmosis or avulsion fracture of one of their bone insertions.
3. Stage three: fracture of the fibula proximal to the syndesmosis.

Pronation-external rotation fractures occur because when the deltoid ligament is under tension in pronation, either it ruptures or the medial malleolus is avulsed when the strong external-rotation force acts on the talus. As the external rotation continues, the anterior tibiofibular and interosseous ligaments ruptures followed by the fibula fracture. There are four stages in the development of a complete injury (27):

1. Stage one: fracture of the medial malleolus or rupture of the deltoid ligament.
2. Stage two: rupture of the anterior tibiofibular ligament or avulsion fracture of one of its bone insertions.
3. Stage three: fracture of the fibula above the syndesmosis.
4. Stage four: rupture of the posterior tibiofibular ligament or fracture of the posterior tubercle or process of the tibia.

Open reduction internal fixation (ORIF) may be required if the ankle joint is unstable. Yamaguchi et al. (28) suggested that the decision to use syndesmotic screw fixation may be dictated by the presence of deltoid ligament disruption and the location of fibular fracture above the tibiotalar joint line. Internal fixation techniques tend to enhance outcomes for all patients with ankle fractures (29).

Egol et al. (30) found that the use of a functional brace and early movement after surgery for fractures of the ankle improves functional outcome. The aim of ORIF is to obtain stable fixation and allow early movement (31, 32).

Relative to these injuries, the case report follows a Weber Type C fracture that occurred during competition. The mechanism of injury was caused by a pronation-external rotation force. The Weber Type C fracture is less commonly seen in the athletic setting. The goal was for a quick turn-around for return to elite competition the following season.

CASE REPORT

In February 2009, a 20-year-old, right-handed, 5'2" junior, female collegiate defensive hockey player was injured while going for a puck in the defensive zone along the boards. The mechanism of injury was hyper dorsiflexion with external rotation of the left leg. She was skating full speed into the corner when her opponent hooked her under the arm. This action led to her running into the boards at a high rate of speed and force with her foot in front of her body. The impact caused the rivets in her tuik to blow out of the skate. Upon initial evaluation, the athletic trainer did not notice any gross deformity. The athlete complained of severe pain in the lower left leg and ankle and reported that, "it felt like the leg was twisted inside the skate." The left hip and knee were both in 90 degrees of flexion. Pain was experienced with movement of the left leg as the EMT tried to straighten the knee or accidently moved while holding the skate blade. There were no signs of cardiorespiratory distress nor showed any signs of head or neck trauma. Due to the severity of pain, the medical staff was unable to remove the skate or shin pad on the ice and she was transported to the nearest emergency room for further evaluation. The athletic trainers and EMT staff spine boarded her, placing a medical kit under the left knee and lower leg to keep the

hip and knee at 90 degrees of flexion. Her upper body was strapped in while her lower legs were manually stabilized by one of the athletic trainers.

Radiographic examination revealed a fracture of the medial malleolus as well as a fracture of the fibula (see Figure 1). The fibular fracture was approximately 9cm proximal to the distal tip with two butterfly fragments. There was 100% displacement of the distal segment of the fibula and the talus was 20% subluxated laterally. No proximal fractures were seen and the knee joint appeared well aligned. The syndesmosis was widely disrupted and the injury pattern represented pronation and external rotation, indicative of a Weber type C fracture.

Figure 1

Pre-Surgical X-ray

The initial plan was to perform a reduction to alleviate the possibility of compartment syndrome and reduce the pressure on the medial skin (see Figures

2 and 3); as well as, improve pain. This procedure was done under conscious sedation as performed by the emergency department to facilitate pain control and muscle relaxation. At the request of the patient, her care was transferred to a physician at another hospital that evening to discuss surgical options for the next morning.

Figure 2

Medial Malleolus Deformity

Figure 3

Pressure on Medial Skin

The next day following the injury, the orthopedic surgeon performed an ORIF of the distal fibula and repair of the syndesmosis along with ORIF of the medial malleolus and repair of the posterior tibial tendon sheath (saee Figure 4).

Figure 4

Post-Surgical X-ray

During surgery, the physician found segmental comminution of the fracture site of the fibula. An 8 hole 1/3 semitubular plate and screws were placed over the fibula to allow for rigid fixation of the fibula extending into the fibular shaft. While examining the medial side of the ankle, the medial malleolar fragment was exposed and loose flaps of articular cartilage along the anterior medial aspect of the talus were also found. The loose flaps were debrided using a rongeur. No evidence of loose bodies were found in the joint. There was significant stripping of the posterior tibial tendon sheath and was repaired using a 0 Vicryl suture. The fracture was reduced anatomically and held in place with provisional K-wire fixation. A screw was drilled into the medial malleolus to allow for rigid fixation. A 4.5 syndesmotic screw was also placed to restore the mortise and the normal relationship of the distal tibia and fibula. The incisions

were irrigated and the periosteal layer was closed using 0 Vicryl, the subcutaneous layer closed with 2-0 Vicryl and the skin closed with 3-0 nylon. A sterile dressing was applied with a bulk Robert Jones splint.

At 10 days post surgery, the patient had the Robert Jones splint removed and the sutures were taken from both the medial and lateral incisions and covered with steri-strips (see Figures 5 and 6). The steri-strips were removed 17 days post surgery (see Figures 7 and 8). The patient was to remain non-weight-bearing for 4 weeks and was placed in a pneumo-boot (see Figure 9). The pneumo-boot was chosen because its ability to inflate and deflate with air to maintain constant blood flow and good circulation.

Figure 5
Medial Incision with Steri-Strips

Figure 6
Lateral Incision with Steri-Strips

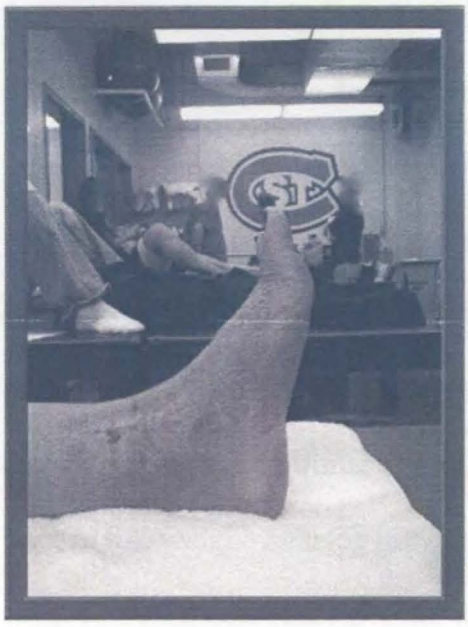

Figure 7

Healing Medial Incision

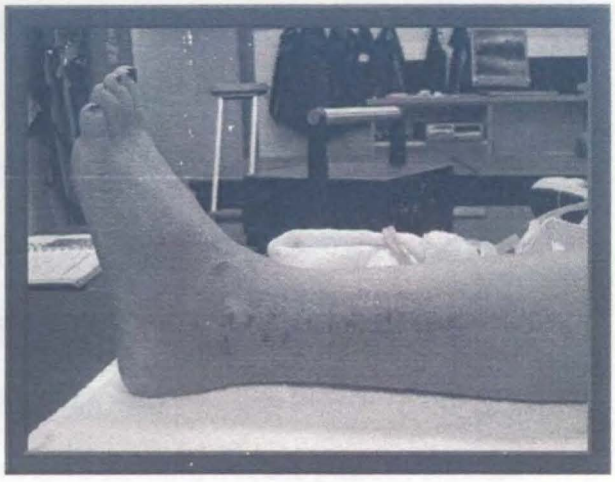

Figure 8

Healing Lateral Incision

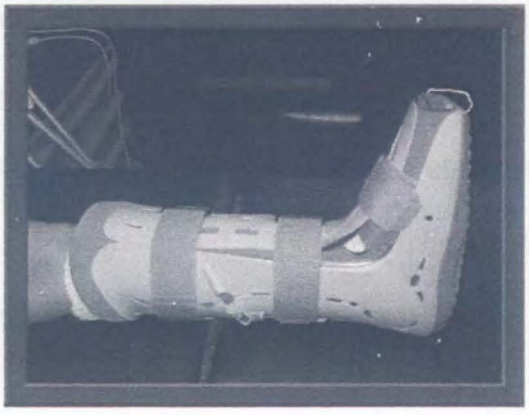

Figure 9

Pneumo-Boot

For the first 2 weeks, the boot was removed and gentle range of motion exercises were performed three to four times per day consisting of plantar

flexion, dorsiflexion and toe flexion. The addition of sitting in a chair while trying to flatten the foot to the floor was added in the third week.

At 7 weeks post surgery, aquatic exercises while holding onto the edge of the pool at chest level with toe touching began. The following week, the patient progressed to using one crutch in the pool away from the edge. Nine weeks post surgery, the patient began full-weight-bearing exercises in the pool, started exercise using the stationary bike, and began weaning the use of the pneumo-boot to full-weight-bearing in tennis shoes. By 12 weeks post surgery, the surgeon noted decreased plantar and dorsiflexion, but the patient was full-weight-bearing with a normal gait. At this time, proprioceptive retraining and rehabilitation exercises with plyometrics began. Exercises were comprised of body squats, body squats with jumping, double leg toe raises, double leg mini tramp jumping and split squats. The syndesmotic screw was removed 16 weeks post surgery and crutches were used to assist with weight bearing for 1 week. As soon as a normal gait pattern returned, jogging and the previous mentioned exercises were reinstated with the addition of jumping from a high surface to the mini trampoline and jumping from a medium height surface to the floor.

At 20 weeks post surgery, on-ice workouts were initiated in combination with the exercises and strengthening. The patient returned to school for the fall semester 26 weeks post surgery with a marked decrease in plantar flexion, dorsiflexion, as well as, strength of the ankle. More aggressive treatment and

rehabilitation exercises were applied to the program. Treatments included warm whirlpool with active range of motion followed by massage of the arch/foot and triceps surae before activity. Exercises included maximum passive range of motion, resisted multi-directional range of motion, multi-directional theraband, and side-lying weighted eversion, double leg calf raises, and over-exaggeration of plantar and dorsiflexion while walking. After any type of activity, ice was used to decrease inflammation and soreness. The combination of treatment and rehabilitation increased range of motion, overall ankle strength, and improved recovery rate following activity.

Official team practice commenced at 30 weeks post surgery, where participation occurred every other day. For on-ice practice, elastic adhesive tape (Sher-Light, Kendall) was used to assist with stability, but also allow room for edema that occurred during activity. The patient demonstrated no functional deficits during competition. Over the next 2 weeks, participation in only three of four practices per week and one of two competitions per weekend was permitted.

At 34 weeks, full participation in practice and competition was allowed. Continued work on ankle stability and strength throughout the season were used to maintain participation status. Exercises included single and double leg calf raises, body weight squats, lunges, split squats, proprioception on uneven surfaces, and stick handling while balancing on a bosu ball. Upper body weight

training exercises and core strengthening exercises were also performed three to four times per week. A pneumatic compression unit (Game Ready, CoolSystems, Inc.) was used aggressively post practice and games to control and reduce acute inflammation acquired during activity.

There was limited contact between the patient and the athletic trainer between May and August due to the summer break. This factor may have attributed to the deficits in active range of motion and ankle strength. A recommendation would be for the athletic trainer to engage in more consistent contact with the patient and the physician in creating an all-incumbent rehabilitation program that addresses active and passive range of motion and exercises to increase ankle strength in anticipation for the return to activity.

Participation in daily activities and being an active individual in the future have a great outlook. This injury is more often reported from motor vehicle accidents. There have not been many studies or case reports in the athletic setting reporting on this particular injury and recovery. The injury could have been career ending, but the perseverance, excellent administration of health care by the athletic trainers, EMT's, and physicians assisted with the full athletic return to elite Division I athletics.

INTERVIEW

The interview was conducted 16 months post injury and sent to the patient via email from the athletic trainer. The responses provided are direct quotes from the patient. These responses are subjective and individual to the athlete, but may provide insight in assisting a patient psychologically through a similar-type recovery/rehabilitation process.

1. What was going through your head at the time of the injury?

   When I first went into the boards I didn't know exactly what was wrong but I just kept thinking that I needed to get up and off the ice. Everything went silent and I couldn't hear until I realized that I broke my leg. And then I went into a panic. I started breathing hard and I could feel the pain shooting up my leg and into my back. Initially my head hit the boards too so that was what hurt at first.

2. What was going through your mind when you were being taken care of on the ice?

   I was really scared when I was being taken off the ice. A lot of people were trying to work together to get me off and all I was concerned about was making sure nobody touched or moved my ankle. I gave my

teammates a thumbs-up because I knew that they were shaken up too and I wanted them to know that I was going to be okay.

3. What were you thinking about when you were being taken off the ice and to the Ambulance?

   I honestly cannot remember what was going through my head. My mind was blank...I just kept thinking please do not go over any bumps and what just happened.

4. What changed in your life following the surgery? How did this make you feel?

   Well I moved home for a month and missed 3 weeks of college, which was tough because I was in my junior year. I had a lot of homework to make up! I only sat/layed in two places for the entire month at my parent's house; the couch and a twin size bed. I always had my foot above my heart and needed help with everything I did. I am the type of person who likes to do things on my own so it took me awhile to get used to asking for help. I literally needed help with everything: getting to and from the bathroom in the middle of the night, getting ice, having someone make me food. I felt helpless. There were many days where I would just sit and cry because of the pain and because I was sooooo bored!

5. What were your feelings the first couple weeks when you were 100% non-weight-bearing?

   The first couple of weeks I was in a wheelchair which was really hard to get used to at first but once I got the hang of it, it was very helpful. It was very difficult getting around. Whenever I needed to go somewhere or need something I always needed someone's help getting me loaded up in the car and then dropped off. I tried to have a positive attitude but at times it became very frustrating and I thought I was never going to get through it.

6. What did it feel like when you started to walk again?

   I felt really weak and was very nervous. I thought I was going to hurt it again if I put weight on it, so I was always very careful, probably too careful.

7. How ecstatic were you the first time you put a skate on after the injury?

   The first time I put a skate on I couldn't believe that my foot actually could fit! My leg/ ankle was always so swollen so when it finally fit in the boot I was sooooo excited. During my recovery process I sometimes thought, "how am I ever going to skate again." The first time I skated I went to open skating with my dad and he held my hands and helped me try and skate. It felt like I was a little kid again. I had to

completely retrain my muscles on that leg. It was really hard to push off and get my ankle to bend the right way. I had to start at square one. I took skating lessons in the mornings the month of August. I would wake up at 630 and skate with a skating coach to help me learn how to do my edges again, push off, and stop. Stopping was the hardest part of skating to learn again.

8. What were some of your greatest struggles/battles going through the recovery process?

My biggest struggle in the recovery process was being patient. I thought that it would be better in a month. I didn't realize how bad it really was. They told me I broke it in seven places, but to me I thought it was going to be a speedy recovery. So when I hit the third month I was getting annoyed and wanted to be as active as I was before. It was really hard for me to not be able to work out like I used too and just be my normal self. I hated always having to get help and get my leg worked on everyday. I felt like I was that kid that was always hurt. Even though I needed the help everyday and the staff was great I just hated always having to get help. I think that I might have gone back too early because I still have problems with my leg today. It is the same pain I have had since I started up again. I do not know if it still

needs to be given time to heal, but the swelling seems to never go away!

9. Was there anything in particular that kept you pushing to get better and play the next season?

   I knew that I wanted to play no matter what. I was going to do everything and anything I needed to do to be able to play. I worked my butt off. I went to rehab everyday, ran did pool workouts, took skating lessons, shot pucks, worked out in my wheelchair. I knew that I wanted to play with my senior class and I was going to do everything it took. Luckily my hard work paid off. It was hard hearing no when I couldn't play some games early in the season even though I knew it was good for me.

10. Were there times you wanted to quit or give up? If so, what persuaded you or changed your mind?

    Yes, of course there were times that I wanted to quit and give up. There were times where I thought I was never going to bounce back. I did a lot of personal healing. I tried to write down mini goals for each week with my leg, which helped me focus and do it with baby steps. I would write goals each week and stick to them. It helped a lot having strong support of my family, friends, coaches, and trainers. I knew that I needed to do the rehab and recovery and some days were harder

than others but having my parents there making sure I was doing everything, helped a lot.

11. Did you face any emotional or physical challenges during the season?
Yes, during the season I felt like I faced a lot of emotional and physical challenges. My leg would hurt during practice, games, and workouts and I would get emotionally frustrated with my body and myself. I think I did a good job at staying positive and covering up the frustration, but at times it would just come pouring out.
12. Do you feel like this injury has changed your outlook on life at all?
Yes, I learned a lot from having my leg broken. I learned a lot about myself and about people who support me. I couldn't believe all the support I received. I am so blessed to have such wonderful people in my life. This injury has made me realize that the things I take for granted everyday can be taken away in matter of seconds. I love the game of hockey so much and it shattered my leg in seven places and I still love it the same or even more. You really appreciate your abilities. I couldn't believe how much I appreciated being able to walk when it was my time. I learned how hard it is to get around in a wheelchair. I am so thankful to be able to walk again and play the game I love.

13. What are your plans for your future and has this injury affected those decisions in any way?

    I have always wanted to run a half marathon and I just do not know if that will ever happen because of my injury. I also want to continue to play hockey but I feel like it is almost more work trying to keep my leg strong enough to do that. I am surprised I made it through this entire year!

14. What advice would you give to other athletes that may endure a similar-type injury?

    Just to never give up. Everything happens for a reason, even if it feels like your world has come crashing down, but to stick with it because what doesn't kill you only makes you stronger! I can say I truly believe that statement now!

SUMMARY

As girls/women's ice hockey continues to grow in the nation and across the world, the components of the game continue to excel as well. The game has evolved over time and the studies conducted on ice hockey injuries have shown that there are equal rates of injuries seen when comparing men and women to the time of on ice exposure. The incidence of injuries has turned toward a greater number of concussions, which is most likely due to the heightened awareness of symptoms and reporting. The assumption that women suffer fewer injuries due to the no-checking rule is fading quickly. Women play a strong, physical, and fast-paced game where non-contact and contact injuries do occur. An ankle injury is less commonly seen in ice hockey due to the equipment used and the protection the equipment provides from a typical lateral sprain. In the case of one elite athlete, the force of impact on her foot/ankle into the boards caused what could have been a career ending injury. A Weber Type C ankle fracture is less commonly seen in the athletic setting, so the occurrence of this particular injury revealed insight to the care, treatment and rehabilitation. At the time of the injury, EMS was activated by the athletic trainers on-site. The progression of care transferred to the EMT's, the emergency room physician, and the patient's choice of orthopedic surgeon. Post surgery, the patient transitioned from non-weight-

bearing. to partial-weight-bearing, to full-weight-bearing with the addition of functional activities. The patient was back on the ice and participating with no restrictions at 8 ½ months post surgery. The battle back from surgery and rehabilitation triumphs this athletes deepest fears with the return to elite collegiate athletics after that shocking evening.

RECOMMENDATION FOR POST-SURGICAL REHABILITATION PROGRAM

Weber Type C Fracture

0-4 Weeks

- Post-op: Dressing changes, instruction in signs & symptoms of infection, instruction in cryotherapy, issue home exercise program for AROM of ankle
  - Considerations: wound healing, edema control
- Goal: Work on active motion at least 3-4 times/day and maintain NWB with elevation as much as possible
  - NWB wearing pneumo-boot with assistance from wheelchair or crutches
  - AROM: plantar flexion, dorsi flexion, toe flexion, toe extension
  - Seated with foot flat on floor moving into dorsiflexion and plantar flexion

4-6 Weeks

- Goals: AROM 25-50%, begin strengthening with low resistance at moderate repetitions, proprioception with assistance for short-moderate period of time

- Wearing pneumo-boot with crutches PWB
- AROM: plantar flexion, dorsi flexion, toe flexion, toe extension, inversion, eversion, circles
- PROM: plantar flexion, dorsi flexion, toe flexion, toe extension, inversion, eversion
- RROM: plantar flexion, dorsi flexion, inversion, eversion
- Proprioception (floor)

6-10 Weeks

- Goals: AROM 50-75%, strength 25-50%, strengthening with low resistance at high repetitions, proprioception unassisted for moderate-long period of time
  - Gradually wean the use of pneumo-boot and crutches
  - Wear supportive tennis shoes
  - Aquatic exercises: holding on to the edge at chest level, one crutch at waist level, no crutches working on gait
  - Double leg calf raises on slant board
  - RROM: plantar flexion, dorsi flexion, inversion, eversion
  - Proprioception (unstable surface—foam)
  - Stationary bike

10-15 Weeks

- Goals: FWB with normal gait, AROM 100%, strength 50-75%, strengthening at moderate resistance at high repetitions, proprioception for long periods of time
    - RROM: plantar flexion, dorsi flexion, inversion, eversion
    - Double leg calf raises on leg press
    - Squats
    - Split squats
    - Lunges
    - Straight leg dips
    - Proprioception (unstable surface—disk)
    - Mini-trampoline double leg jumping
    - Leg press (single and double leg)
    - Hamstring curl
    - Multi-hip machine (AB)
    - Eversion while side-lying with ankle weight
    - Elliptical

15-20 Weeks

- Goals: Strength 75-100%, increase strengthening exercises to moderate-high weight and moderate-high repetitions

- Continue strengthening exercises from weeks 10-15
- Single leg calf raises on leg press
- Walking lunges
- Proprioception (unstable surface—bosu)
- Mini-trampoline jumping to base surface
- Leg press (double and single leg)
- Jogging
- Plyometrics: double leg—forward and latera
    - Start equal work:rest (15 seconds jumping: 15 seconds rest) with gradual increase in time
    - Increase work amount and decrease rest time in progressionl

20+ Weeks

- Goals: Strength 100%, strengthening exercises high weight and low-moderate repetitions
    - Continue strengthening exercises from weeks 15-20
    - Functional Exercises
        - Proprioception on bosu while stick handling
        - Slide board
        - Theraband with stick resisting forward motion/shot

- Theraband resisting hip/knee flexion @ 45°
- 45° lateral hops

20+ Weeks (continued)

- Skating
  - Straight ahead
  - Backwards
  - Transitioning
  - Cross-overs
  - Acceleration

Return to Play Criteria:

- Strength 100%
- AROM 100%
- Normal gait
- Ability to perform functional exercises

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