

Sport-Specific Injuries and Medical Problems of Figure Skaters

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ABSTRACT

Figure skating is becoming increasingly popular as both a recreational and competitive sport. As the number of figure skating participants increases, so will the number of active patients who present to their primary care physician with sport-related injuries and medical problems. Figure skating is a unique sport that continues to evolve and progress with participants partaking in more difficult moves and more rigorous training programs. Common problems in figure skating include acute musculo-skeletal injuries and chronic overuse injuries, which primarily occur in the foot, ankle, knee, leg, hip, and lower back. Figure skaters are also more likely to endure specific medical problems such as exercise-induced bronchospasm and eating disorders. Primary care physicians are able to contribute to their figure skating patient's health by recognition and appropriate treatment of acute injuries and prevention of chronic injuries and other medical problems.

INTRODUCTION

Although most people only think of figure skating at the Winter Olympics, for others in the United States, figure skating is a way of life. In 2007, the United States Figure Skating Association (USFSA) reported 196,000 members and 645 clubs nationwide.¹ Physicians who take care of these athletes must be familiar with common and unique injuries, as well as medical problems in figure skaters.

THE SPORT

Figure skating is a unique combination of athleticism, strength, endurance, gracefulness, and artistry on ice.

There are 4 major disciplines: singles skating, pairs skating, ice dance, and synchronized skating. Singles skating focuses on an individual skater performing jumps and spins interspersed among connecting steps that rely on footwork and efficient use of blade edges. Pairs skating consists of a man and woman skater performing jumps and spins separately and in tandem, along with overhead lifts and throw jumps. Ice dance is similar but with more focus on intricate footwork and performance on deep edges, with specific rules about lifts and the amount of time the skaters can skate separately. Synchronized skating is performed by a team of 8-24 skaters on the ice together, moving simultaneously as a group.

Figure skating is an evolving sport in which elite performances continue to push the technical and artistic envelope. It began in the early 1800s, when the sport consisted of complicated figures traced on the ice. Jumps and spins were introduced in the 1860s, and figure skaters have been developing more complex moves ever since. Men now routinely perform at least 1 quadruple jump (4 revolutions in the air) in their long programs and several women have performed triple axels (3 and a half revolutions in the air) in competition.

THE SKATE

Figure skates are composed of a leather boot and a blade. The boots have become increasingly stiff over the past 20 years to accommodate the stress placed on them by skaters performing triple and quadruple jumps.² It has been hypothesized that the increased stiffness of the boot has contributed to weaker ankles in competitive skaters and an increased number of skating injuries.² Competitive skaters often have their boots custom-fit to their feet; however, boots still tend to fit poorly. The shape makes placing traditional orthotics into the boot difficult and it may be necessary for special orthotics to be molded into the boot when needed. Figure skaters are the only jumping athletes to wear a high-heeled shoe, which puts the skater's ankle in constant slight

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plantarflexion (Figure 1).^{2,3} Boots can cost \$200-\$700 per pair depending on the level of the skater and are usually replaced every 6-12 months, depending on how fast the skater breaks them down. Figure skating blades differ from hockey or speed skating blades in that they contain a large front toe pick, which is used in jump landings and some jump take-offs.

THE SKATER

The majority of figure skaters are female, began skating when they were 5-8 years old, and reach the peak of their competitive careers by their teens or early 20s.^{2,4} By the time they reach adolescence, competitive figure skaters spend 2-4 hours per day in on-ice training plus 1-3 hours per day in off-ice training for up to 11 months of the year.^{2,3} Off-ice training includes strength and flexibility training, dance, aerobic and anaerobic conditioning, and choreography. Strength training is particularly important to figure skaters since it has been shown that the height of skaters' single and double axels correlate with the strength of their knee and shoulder muscles.⁵ Power is also required of skaters, since skaters do not jump any higher when performing triple or quadruple jumps, but rather explode into and out of the jump faster and rotate faster.⁴

Training can often become all-encompassing to elite skaters and their families. It is not uncommon for young skaters to move to new cities or opt for homeschooling as they make training their first priority. The intensity and stress of the vigorous training can take a toll on figure skaters and lead to emotional and psychological problems such as burnout and eating disorders. These problems can be compounded by the aesthetic demands of the sport, especially during puberty when there are marked changes in behavior, physiology, and body morphology. The development of positive coping strategies is imperative for figure skaters competing at an elite level, and may require the expertise of a sports psychologist.⁶

THE PROBLEMS

Common problems in figure skating include acute musculo-skeletal injuries, chronic overuse injuries, and medical problems (Table 1). Contributing factors are the boot, training regimen, environment factors, and conventions of the sport that reward high risk moves and slender body type. Studies have shown that about 50% of injuries are traumatic and 50% are due to an overuse mechanism.⁴ Overuse injuries are more common in singles skaters, whereas acute injuries are more common in pairs skaters and ice dancers (Table 2).³ This



Figure 1. Standard competitive figure skate.

difference is likely due to the lifts and throws that pairs skaters and ice dancers perform, which increase speed, momentum, and force in falls and severity of injury. The frequency and spectrum of overuse syndromes in singles skaters appears to be increasing as athletes continue to increase the intensity of their training.³

Foot Injuries

Lace bite is an irritation of the tibialis anterior and toe extensor tendons due to irritation from the tongue of the boot. Treatment includes proper tongue positioning, extra padding, alternative boot lacing, or placing a molded orthoplast between the leather of the boot and the boot's padding.² Malleolar bursitis is caused by friction over the malleolus and occurs more commonly on the medial side. Treatment consists of having the boot "punched out" over the problem spot using a ball and ring contraption found commonly in specialty skating stores, or placing a foam donut over the area. If the bursitis is severe, fluid can be aspirated and the bursa injected with corticosteroids.⁷

Pump bumps, also known as Haglund's deformities, arise on the lateral heel and are caused by a boot heel that is too wide, which allows the skater's heel to slip up and down inside the boot. The most successful treatment consists of placing moleskin on either side of the skater's Achilles tendon and covering it with prewrap to fill the extra space in the boot. However, this is often cumbersome and time-consuming.² A simpler yet less effective treatment is to simply apply a foam donut pad to the area. Consultation with an orthotist or shoe specialist may be helpful when treating chronic foot conditions.

Achilles tendonitis may be caused by compression of

Table 1. Common Figure Skating Injuries by Body Region

Injury	Notes
Foot	
Achilles tendonitis	Caused by compression or overtraining
Lace bite	Irritation of tibialis anterior and toe extensor tendons from tongue of boot
Pump bumps	Lateral heel prominence caused by boot heel that is too wide
Other foot abnormalities: Corns, hammer toes, inflammation of accessory tarsal navicular, prominence at base of fifth metatarsal	May benefit from referral to podiatry, orthotist or shoe specialist
Stress fractures	Common in first/second metatarsal and navicular bones
Ankle	
Ankle sprains	May be prevented with ankle stabilization and proprioceptive exercises
Shoe-rim pseudotumors	Soft tissue tumor arising from compression of subcutaneous fat between skate, fibula and peroneal muscles
Knee/Leg	
Patellar compression injuries	Actual patellar fracture rare
Patellar tendonitis	More common in elite skaters than in amateur skaters
Patellofemoral syndrome	May benefit from referral to physical therapy
Stress fractures	Common in tibia and fibula
Hip	
Iliac crest apophysitis	More common in skeletally immature athletes
Muscle strains: adductor complex, hip flexor, oblique abdominal muscles	May benefit from referral to physical therapy
Low Back*	
Facet pain	NA
Lumbar strains	NA
Posterior iliac crest injuries	NA
Spondylolisthesis	NA
Spondylolysis	NA
Upper Extremity	
Rotator cuff injuries	More common in pairs skaters
Wrist ganglion	More common in pairs skaters
Wrist sprain/fracture	May result from falling in singles or pairs skaters

*All chronic low back pain should be evaluated radiologically

the tendon from the boot as it comes across the posterior portion of the leg. In these cases, the area may be punched out or padding may be placed across the top of the boot in the area of the irritation. Achilles tendonitis can also be a sign of overtraining in the skater, as the Achilles is required for explosive jumping power.⁴ Referral to physical therapy for further treatment may be beneficial.

Stress fractures were the most frequent overuse injury recorded in a 2003 study of elite junior women skaters.³ They are common in the first and second metatarsals, and occur more frequently in the skater's take-off leg for toe-pick jumps.^{4,8} They are also commonly seen in the tibia, fibula, and navicular bones. Stress fractures are usually due to repetitive forces placed on bones and not low bone density, since bone density is usually increased in figure skaters compared to age-matched controls.⁹ However, screening for osteoporosis may still be indicated in select female skaters, especially those with amenorrhea or disordered eating patterns. Other common foot abnormalities include inflammation of an accessory tarsal navicular, a prominence at the base of the fifth metatarsal, corns, and hammer toes.

Ankle Injuries

The ankle is a common area of injury for figure skaters. In a 2003 study of over 200 nationally competitive figure skaters, 27.7% of injuries reported on a medical history report involved the ankle, making it the most commonly injured body part.¹⁰ Because of the support of their stiff boots, competitive skaters have relatively weak peroneal muscles, which places them at increased risk for ankle sprains.² Thus, in skaters, ankle sprains usually occur during off-ice training sessions. To prevent these injuries, skaters should incorporate ankle stabilization and proprioceptive training into their off-ice training. Shoe-rim pseudotumors are soft-tissue tumors that arise from subcutaneous fat compression and impingement between the top of the skate, lateral fibula, and peroneal muscles. These tumors can develop into necrotic tissue and form a mass.¹¹

Knee/Leg Injuries

Patellofemoral syndrome is common in figure skating as in most jumping sports. Skaters are at increased risk when their vastus lateralis is relatively over-developed compared to the vastus medialis and the quadriceps and hamstring muscle groups have poor flexibility. Patellar compression injuries arise from repetitive falling, although actual patellar fractures are rare.⁴ These injuries are seen with increased frequency when performing more difficult jumps and with increased jump

Table 2. Percentage of Acute and Overuse Injuries in Male and Female Elite Junior Figure Skaters

Injury Type	Female Singles	Female Pairs	Female Ice Dance	Male Singles	Male Pairs	Male Ice Dance
Acute	14.6%	60.0%	77.8%	18.6%	60.4%	58.8%
Overuse	72.7%	31.7%	22.2%	68.5%	26.4%	41.2%
Low back pain	12.7%	8.3%	0%	12.9%	13.2%	0%

Adapted from Dubravcic-Simunjak, et al. The Incidence of Injuries in Elite Junior Figure Skaters. *Am J Sports Med.* 2003;31(4):511-517. The authors surveyed over 500 elite junior figure skaters competing at the World Junior Figure Skating Championships and the Croatia Cup regarding the nature of their past injuries. Results above indicate the nature of the total past injuries sustained.

frequency. Patellar tendonitis is less common in figure skating than in other jumping sports, although it is seen more commonly in elite rather than amateur skaters.⁴ Osgood-Schlatter syndrome may affect skaters around the time of puberty. Physical therapy should be considered for all skaters with chronic knee pain.

Ligamentous and meniscal injuries are uncommon in skaters. Two hypotheses for this finding are (1) skaters land gliding backwards, requiring co-contraction of the quads and hamstrings, which protects the ligaments and meniscus,⁴ and (2) there is a relative lack of fixation of the blade on the ice.²

Hip Injuries

Muscle strains of the hip flexor, adductor complex, and oblique abdominal muscles are seen commonly in skaters performing triple and quadruple jumps.⁴ Iliac crest apophysitis can present as pain in the abdominal, lumbar, and gluteal muscles with tenderness in the iliac crest region.⁴ It is more likely to affect skeletally immature athletes. It is also commonly seen in skaters performing triple and quadruple edge jumps and can be a nagging injury that may require several months to heal. Physical therapy may be of great benefit.

Low Back Pain

Low back pain may be caused by lumbar strains, facet pain, posterior iliac crest injuries, spondylolysis, or spondylolisthesis. These injuries may be related to the stiffness of the skater's boot. The increased rigidity limits ankle and knee motion, causing the skater to increase flexion at the hip and extend the back to maintain balance.⁴ Sacroiliac joint dysfunction is also a common problem due to repeated unilateral loads and shearing forces from jump landings and missed jumps.¹⁰ Evaluation of low back pain should include radiologic imaging to rule out congenital etiologies, spondylolysis, spondylolisthesis, and stress fractures. Treatment should include physical therapy and exercises to strengthen the skater's core muscles to protect the spine.

Upper Extremity Injuries

Upper extremity injuries are less common in skaters, especially in singles skaters. Wrist sprains and fractures

may occur as a result of falling. Rotator cuff injuries can occur in male pair skaters due to repetitive lifting. Another common wrist pathology in pairs skaters is the development of wrist ganglions.²

Medical Problems

Exercise-induced bronchospasm (EIB) is reported in many skaters. It can be aggravated by exposure to the cold, dry air found in ice rinks, as well as the chemicals used to maintain the ice surface or Zamboni fumes, which can contain air pollutants such as carbon monoxide and nitrogen dioxide.¹² EIB should be suspected in skaters with a chronic cough, wheezing, shortness of breath with exertion, increased mucus production, or a family history of asthma.

Disordered eating is prevalent in figure skating, most likely because the skater's appearance plays a major role in the judges' performance evaluation. Results from studies examining figure skaters' dietary intake have varied widely, suggesting that some skaters have disordered eating patterns but they are not pervasive through the sport.¹³ Several studies evaluating the body composition of competitive figure skaters show that the majority of female skaters are below the 50th percentile for height, weight and body mass index (BMI) based on age;¹⁴⁻¹⁶ however, other published studies contradict these findings with reports that studied groups of skaters do not fall below the mean for body weight and BMI.¹³ Figure skaters do not appear to have lower body fat than that reported for athletes in similar competitive sports such as gymnastics and ballet dancing.¹⁴ Warning signs of disordered eating include a preoccupation with food and food labels; a significant change in appetite; excessive weight loss; an obsession with appearance, mirrors, or the scale; and social withdrawal. Restrictive eating patterns may contribute to delayed menarche in skaters,^{3,17} which is perceived as an advantage by many skaters and coaches, since the onset of puberty is often accompanied by the accumulation of additional body fat and mass that must be lifted into the air with each jump, as well as wider hips that contribute to decreased rotational speed.² Later maturation has been noted to be a significant feature of elite figure skaters, which has

also been seen in other aesthetic sports such as artistic gymnastics and diving.¹⁷ Although osteoporosis has not frequently been found in women skaters, physicians caring for competitive figure skaters must be suspicious for the female athlete triad (a syndrome consisting of disordered eating, amenorrhea, and osteoporosis).²

PREVENTION

It is estimated that 50%-78% of figure skating injuries are preventable.^{2,4} Many injuries can be prevented by ensuring the skater is wearing a properly fit boot that is not overly stiff. Newer lighter, more flexible boot styles may help decrease injury rates. A hinged-style boot has been proposed to increase flexibility at the ankle while maintaining proper support.² Manufacturers are also working to increase quality control, as it has been estimated that up to 20% of skating boots are defective.¹ Physicians can remind skaters about this problem so they can act as informed consumers.

Physicians can review the skater's training schedule to ensure it is appropriate for the skater's skill and age, and contains a sufficient amount of rest or cross-training. This may require consultation with a sports medicine physician or athletic trainer who is familiar with figure skating. Other preventative measures include advising the skater to maintain proper flexibility and participate in an off-ice strength and proprioceptive training program. Nutrition counseling may be beneficial for skaters who appear to be struggling with weight and body image issues. Pulmonary function tests and inhaled bronchodilators should be considered in any skater who complains of chronic cough to evaluate for exercise-induced bronchospasm. Coping strategies and emotional health issues should be addressed with all competitive figure skaters. Overall, a team approach, including the skater, coach, parents, and physician, with the addition of an athletic trainer, physical therapist, nutritionist, sports psychologist, and orthotist or shoe specialist as needed, will help to ensure the healthiest figure skaters.

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