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The ice hockey goaltender is almost in his or her own category when considering hockey athletes. As compared to their teammates, the goaltender possesses different physiological and neuropsychological needs, requiring a specialized set of skills and physical and mental characteristics that need to be trained accordingly (8). Rather than accelerating up ice to fight for the puck or breakaway to score a goal, for example, the goaltender's job is to perform saves and clear the puck away from the net. Bell et al. found that National Hockey League (NHL) goaltenders move most vertically, laterally, and into a full-butterfly position within the goal area (Figure 1). They also skate out of the goal area to move the puck (1).

As compared to forwards and defenders, goaltenders generally play the entire period as opposed to shifts with forwards and defenders, but this is at a lower intensity, reaching lower post-game blood lactate and displaying lower  $VO_{2max}$  values (4,8). Research in junior level goaltenders, for examples, indicates approximately 75% of the game to be at low intensity, 21% medium intensity, and 4% at high intensity (4).

The ice hockey goaltender requires exceptional skill and tactical decision making, including excellent hand-eye coordination with skilled glove work to perform saves and stick handling skills to prevent scoring and promote the play of his or her team (4,6). Goaltenders require fast reaction times, quickness, agility, mobility, explosiveness (e.g., to repeatedly drop in and out of the butterfly position), and stamina (4,6). The goaltender should have adequate stamina to enhance recovery between the short high-intensity periods, maintain alertness, and be ready throughout the game (8). To be successful, he or she needs to remain focused during every shot and situation, through intensive high-pressure situations, as this can be the potential difference in the game results (4). Their position also leads to greatly increased risk of specific muscle imbalances and injuries, particularly hip and groin injuries.



FIGURE 1. GOALTENDER BUTTERFLY POSITION

The purpose of this article is to investigate a few important considerations: common injuries faced by the ice hockey goaltender, specific physical characteristics and conditioning, and the mental game.

### COMMON INJURIES FACED BY THE ICE HOCKEY GOALTENDER – HIP AND GROIN INJURIES

Hip and groin injuries are prevalent amongst hockey players (14). Some studies demonstrate the goaltender to be at higher risk (14). Seven out of 10 ice hockey goaltenders will experience hip and groin problems at some part during the season, often attributed to the movements they frequently perform (13). During a butterfly save, for example, the goaltender drops to their knees and flairs their lower legs. During this movement, injury risk is increased at the hip joint due to a combination of vertical impact from the knees through the femur, along with maximal internal hip rotation (9,12). The skating movement pattern of the goaltender, with large internal rotation, also attributes to high hip loads and risk of injury (13).

Besides groin injuries, femoroacetabular impingement (FAI) is another increasingly common injury amongst ice hockey goaltenders (7,8). FAI occurs when the bones rub against each other in the hip joint, and is associated with pain and several injuries including labral tears and early onset hip osteoarthritis (7). FAI is an increased risk, particularly in athletes requiring end-range hip movements of flexion, adduction, and internal rotation. Because hockey goaltenders are exposed to unique hip positions dynamically, especially the butterfly technique, they are at greater risk (7,9).

An imbalance of hip adductor to hip abduction strength may be an important underlying factor in the prevalence of groin and hip injuries. Tyler et al. found that ice hockey athletes who suffered groin injuries during a season had a hip adduction strength of 78% of abduction strength, whereas players who did not suffer groin injuries had adduction strength of 95% hip abduction strength (12). According to the Tyler et al. study, these muscle imbalances are common in ice hockey and also apply to the goaltender (12). For the strength and conditioning coach, it is advised to seek an adductor to abductor strength ratio of 1:1.25 or greater (12).

Ensuring an adequate combination of mobility, stability, core strength, and balancing adductor and abductor strength, could be useful tools for the strength and conditioning coach. Maintaining a combination of mobility, endurance, strength, and power at the hip complex is suggested by MacIntyre et al. for injury resilience and return to sport following injury (7). To help avoid FAI, MacIntyre et al. recommends watching for progressive decreases in hip internal rotation in young goaltenders (7). To help reduce tension and enhance mobility, rolling out work using a foam roller, lacrosse ball, trigger point release, and hip stretches are recommended by Miers (10).

## SPECIAL PHYSICAL CHARACTERISTICS AND CONDITIONING OF THE ICE HOCKEY GOALTENDER

The ice hockey goaltender is a highly specialized position with specific physical characteristics. Ice hockey goaltenders require tremendous flexibility, mobility, quickness, agility, explosiveness and power, hand-eye coordination, fast reaction time, and fast decision making (8). To be able to make saves, react properly to sudden changes in play, and reduce risk of injury, ice hockey goaltenders need to move quickly in all three planes of motion at the hip joint (8). They tend to possess less upper body strength and endurance versus their teammates, which is not necessary to perform their role well (8). Goaltenders do not spend their time rallying for the puck and engaging in physical contact that would require the same upper body strength as their teammates. With this in mind, it would not make sense to emphasize upper body strength within the strength and conditioning program. For the strength and conditioning coach, focusing on mobility, core, lower body strength and stability, quickness, and power would be beneficial for the ice hockey goaltender.

### GOALTENDER CORE AND LOWER BODY STRENGTH

Good core muscular strength and endurance is of great importance to withstand abrupt directional changes for making saves, passing, and clearing the puck (8). Strong core strength and endurance also enhances muscular power, strength, balance, and speed of the lower limbs, as well as reduce risk of injury (8). Ice hockey goaltenders also have a high recruitment of hip flexor, adductor, and rotator muscles, and strong lower limbs to repeatedly drop down into the butterfly position (8). For core strength and endurance, dead bug variations, glute bridges with mini band, exercise ball plank stir the pot, and standing Pallof press are a few suggested exercises (7). If adduction is comparatively weak, strength and conditioning coaches could incorporate glute bridge exercises with adduction using an exercise ball or similar exercises. Suggested hip strengthening exercises include multi-angle lunges, three-way step-ups, and single-leg squats (7). For added stability, once movement patterns and baseline strength are sufficient, a strength and conditioning coach could implement tools, such as a stability ball for the Pallof press and slide board for lunges (7).

### GOALTENDER QUICKNESS AND POWER

Research reveals a need for NHL goaltenders to be explosive and agile, repeating fast lateral, vertical, and up and down actions (4). Within the strength and conditioning program, movements emphasizing quickness, lateral movements, as well as dropping or ground up actions can help the goaltender develop his or her quickness. Medicine ball skaters, goaltender rolls, knees to feet, and burpee ball toss are a few example movements, with the burpee ball toss including hand-eye coordination.

### ENDURANCE

During a game, ice hockey goaltenders have fast, repetitive, and explosive actions between periods of rest or low intensity (4,8). Unlike other hockey players who perform shifts, goaltenders typically play all three periods, with the occasional overtime (8). Although they may not have or require the same  $VO_{2max}$

values of their teammates and have lower post game blood lactate concentrations, they do require excellent aerobic capacity (8). A high aerobic capacity will allow the goaltender to recover between intense short durations of play and action, thus being able to better maintain alertness, promote recovery from the high-intensive periods of action, and be physically in a ready position (4,8). A high aerobic capacity also matches the predominant energy system used during hockey games, with aerobic metabolism as the greatest contributor (8). Studies show approximately 75% of game time being of low-intensity, with an average heart rate of 64% of maximum heart rate (8).

### THE MENTAL GAME

The ice hockey goaltender needs to be able to maintain focus throughout the game despite a heightened level of stress and fatigue, including after making a great save or alternatively, after letting in a goal. Given the high level of pressure and stress, ice hockey goaltending may be one of the most demanding positions (3,4). Mental stress also manifests in the body and vice versa. Anxiety causes muscle tension, reducing mobility and flexibility as well as hampering coordination (3).

According to Gelinis, relaxation techniques can help when a goaltender is overwhelmed with a high level of anxiety. One method to combat this is alternatively tightening and relaxing muscles of the body through a method of breathing control (2). Besides ensuring adequate conditioning, specific activation warm-up movement patterns combining mobility, stability, and breathing patterns, could be useful for the goaltender as part of the pre-practice and pre-game routine for both physical and mental readiness. A strength and conditioning coach could help to combat high levels of anxiety by prescribing some dynamic stretches paired with breath control, for example.

Opposite of hyper arousal is that some goaltenders need to be more psyched up or energized (3). According to Gelinis, some symptoms of low arousal include a heavy feeling in the limbs, wandering attention, slow locomotion, lack of enthusiasm, and feeling fatigued (3). In these incidences, a pre-competitive light workout several hours before competition can enhance activation and combat fatigue (3). Designing a light pre-competition workout, with athlete feedback during lower priority games, would be a good approach in helping the athlete overcome low arousal levels.

### CONCLUSION

Ice hockey goaltenders possess unique and specialized characteristics, requiring a blend of mobility, stability, strength (especially core and lower body), quickness and reaction time, aerobic conditioning and stamina, and mental attributes to be successful. Table 1 provides a sample two-day off-season training program that aims to address many of these training needs. Getting to know the athlete and programming a specific series of exercises addressing these characteristics helps the ice hockey goaltender not only perform to their best ability, but to enjoy the sport they love with greater injury resilience.

## ICE HOCKEY SPECIAL CONSIDERATIONS—THE GOALTENDER

**TABLE 1. SAMPLE TWO-DAY OFF-SEASON TRAINING PROGRAM**

<b>Day 1</b>	
<b>EXERCISE</b>	<b>SETS X REPETITIONS</b>
<b>Mobility</b>	
Foam roller work and lacrosse ball mobilization for trigger point release to reduce tension and enhance mobility (10)	
Hip stretches (10)	
Example: world's greatest stretch, half-kneeling lunge hip-ankle mobilizer, 90/90 hip stretch	2 x 10
Half-kneeling reach backs or other t-spine mobilization stretches as needed	2 x 10
Dynamic inchworms	2 x 5
<b>Main Set 1</b>	
Rolling pattern (progress to goaltender roll into standing position, further progress with reactionary component)	3 x 6
Deadbug (contralateral movement plus exercise ball) (7)	3 x 15 or until fatigue
Bridge variations (figure 4, mini band with abduction, or exercise ball with adduction); if adduction is comparatively weak, glute bridge exercises with adduction using a exercise ball is recommended (7)	3 x 15 or until fatigue
Plank bear crawls various directions (forward, side to side, reverse)	3 x 20 – 30 steps or until fatigue
<b>Main Set 2</b>	
Step-up variations, including crossover step-up (7)	3 x 10
Standing Pallof press (progressing to on Bosu ball or disc) (7)	3 x 10
Standing cable row (optional with Bosu ball or disc)	3 x 10
<b>Main Set 3</b>	
Exercise ball plank to stir-the-pot (7)	2 x 15 s
Kettlebell swing with single-arm switch	3 x 10
Single-leg box squat (7)	3 x 10
<b>Main Set 4</b>	
Spiderman plyo push-up (progress only if athlete demonstrates ability)	3 x 8 – 12
Knees to feet (progressing to reactionary component)	3 x 4 – 6
Active rest with low aerobic activity 2 – 3 min	

## Day 2

EXERCISE	SETS X REPETITIONS
<b>Mobility</b>	
Foam roller work and lacrosse ball mobilization for trigger point release to reduce tension and enhance mobility (10)	
Hip stretches (10)	
Example: world's greatest stretch, half-kneeling lunge hip-ankle mobilizer, 90/90 hip stretch	2 x 10
Half-kneeling reach backs or other t-spine mobilization stretches if needed	2 x 10
Dynamic inchworms	2 x 5
<b>Main Set 1</b>	
Deadbug (contralateral movement plus exercise ball) (7)	3 x 15 or until fatigue
Bridge variations (figure 4, mini band with abduction, or exercise ball with adduction); if adduction is comparatively weak, glute bridge exercises with adduction using a exercise ball is recommended (7)	3 x 15 or until fatigue
Slide board mountain climbers	3 x 10 or until fatigue
Multi-angle lunge (clock lunge) progressing to slide board (7)	
<b>Main Set 2</b>	
Multi-plane monster walks (7)	3 x 15 or until fatigue
Power curls	3 x 5
<b>Main Set 3</b>	
Landmine split squat to overhead press	3 x 8
Standing cable press (progressing to performing on Bosu ball or disc)	3 x 10 - 12
Single-arm dumbbell tripod dumbbell row	3 x 8 - 10
<b>Main Set 4</b>	
Medicine ball side facing underhand toss with stance switch	3 x 10
Burpee ball toss (goaltender performs a burpee and immediately catches the ball tossed by the strength and conditioning coach) *placed at end for purpose of enhancing resistance to fatigue	3 x 6

*\*Note: the exercises, repetitions and sets depend upon the athlete weaknesses and strengths, training status, injury history, program goals, and training phase. It is also recommended that the ice hockey goaltender include aerobic conditioning. Examples include incorporating jump rope, as well as running before or after sessions or between main sets.*

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### ABOUT THE AUTHOR

Tammy Kovaluk has over a decade experience as a strength and conditioning coach. She has worked with both teams and individuals in most sports with a special interest in dynamic correspondence and metabolic conditioning for hockey and American football. Kovaluk was the strength, speed, and assistant wide receiver coach for Belmont High School football. She works with a variety of hockey athletes from youth to the National Hockey League (NHL) prospects, and is the current strength and conditioning consultant for Beyond the Edge International Search and Rescue. She has also worked as a clinical corrective exercise specialist alongside Dr. Rob Hasegawa, Team Canada's chiropractor. Kovaluk holds a Master of Science degree in Kinesiology and Sport Conditioning through AT Still University, where she was awarded a certificate for academic excellence. She is also a Certified Strength and Conditioning Specialist® (CSCS®) through the National Strength and Conditioning Association (NSCA), Certified Speed and Agility Specialist (CSAS) through the International Youth Conditioning Association (IYCA), and is certified as a Level 2 Function Movement Screen™ (FMS™).



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