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Original Contribution

THE INFLUENCE OF HOCKEY SKATE SHARPENING CHARACTERISTICS ON THE PERFORMANCE AND RISK OF INJURY IN HOCKEY PLAYERS

I. Krumov*

Department of Technical and Ice Sports, National Sports Academy “Vasil Levski”, Sofia, Bulgaria

ABSTRACT
PURPOSE: The purpose of this report is to investigate the relationship between ice hockey blade sharpening and the performance and risk of injury of ice hockey players. METHODS: Laboratory tests, field observations, and statistical data analysis were used. The effects of ice hockey blade sharpening on player mechanics and safety were investigated by analysing key variables: radius of hollow (ROH), radius of contour (ROC), pitch, and blade alignment. RESULTS: The results indicate that different sharpening characteristics have a significant impact on grip, speed, manoeuvrability, and the likelihood of injury. CONCLUSIONS: Identifying optimal blade configurations for individual players and adapting to different ice conditions can help reduce fatigue and mitigate injuries.

Keywords: radius of hollow, radius of contour, pitch

INTRODUCTION

Ice hockey requires a high level of physical fitness, quick reactions and excellent skating technique. The special speed and explosive power of the competitors are directly and strongly correlated with the indicators of technical and tactical skills (1). To date, the scientific literature published on ice hockey focuses mainly on physiology (2-7), biomechanics of movement on the ice (8-11), and the characteristics of the players' performance (12-15) and the prevalence and potential for injury (16-18). In order to optimize the sports preparation of athletes, it is necessary to improve the technique of the game and develop the motor qualities of the athletes to be built in unity and interrelation (19).

Very little research has been devoted to the most important component from the athletes' perspective, namely contact with the ice. The characteristics of hockey skates and their sharpening can be classified as one of the most important elements of every hockey player's game.

Effective movement on the ice depends largely on how the skate blades are sharpened. Different sharpening parameters can significantly change the contact between the blade and the ice, which in turn affects the player's grip, acceleration, manoeuvrability and stability. In addition, improperly selected or inconsistent sharpening characteristics can increase the risk of injury - both due to loss of control and increased stress on the joints and muscles.

The purpose of this study is to analyse the influence of four key variables in sharpening hockey skate blades: Radius of Hollow (ROH), Radius of Contour (ROC), Pitch, and Blade Alignment. By combining theoretical analysis, instrumental measurements, and practical observations, a deeper understanding of the relationship between sharpening and performance is sought, as well as ways to reduce the risk of injuries during play.

***Correspondence to: *Correspondence to:** *Ioan Krumov, National Sports Academy “Vasil Levski”, Department of Technical and Ice Sports
Sofia, 21 “Akad. Stefan Mladenov” str., Email: ioan.krumov1@gmail.com, Phone: +359893888985*

METHODS

Hockey skate blade characteristics

Broadbent (20, 21) outlines the dimensions and characteristics of a skate blade. The blade of a hockey skate consists of three main dimensions: height, length, and width. When the blade of the skate is sharpened, these dimensions can be modified to define two radii, the radius of contour (ROC) and the radius of hollow (ROH). Specific aspects of the two radii are a prerequisite for controlling the performance of the skate blade and defines the blade-ice interaction.

The radius of contour (ROC), more commonly referred to as the rocker or blade profile, describes the longitudinal shape of the blade and determines how much of the blade is in contact with the ice **(Figure 1).** In theory, the shorter 2.44 m ROC allows greater agility, while the longer 3.66 m ROC has greater blade contact with the ice, allowing the hockey player to potentially achieve greater speed. The practice of shaping the blade with multiple contours shows that this idea is outdated. Multiple contours provide the hockey player with the opportunity to access the advantages of skating on both longer and shorter contours by simply shifting the weight to a specific area of the blade. However, it is imperative regardless of number of contours, the blade should be free of protrusions and irregularities in the rocker. This is usually caused by uneven pressure on the grinding wheel when sharpening and hockey players feel like they are skating on an uneven ice surface.

Figure 1. Skate blade radius of contour (ROC)

The radius of hollow (ROH) is the groove across the width of the blade defining the two edges, the outer edge and the inner edge **(Figure 2).** This groove can be deep or shallow depending on the desired effect. The deeper the ROH, the higher the edges, creating a greater bite angle between the edge and the ice. With sharper bite angle, the hockey player will be more stable on the ice and feel more confident during starts, stops and turns. However, this angle also causes more digging into the ice and thus takes more energy to acceleration and as a result, speed is often sacrificed.

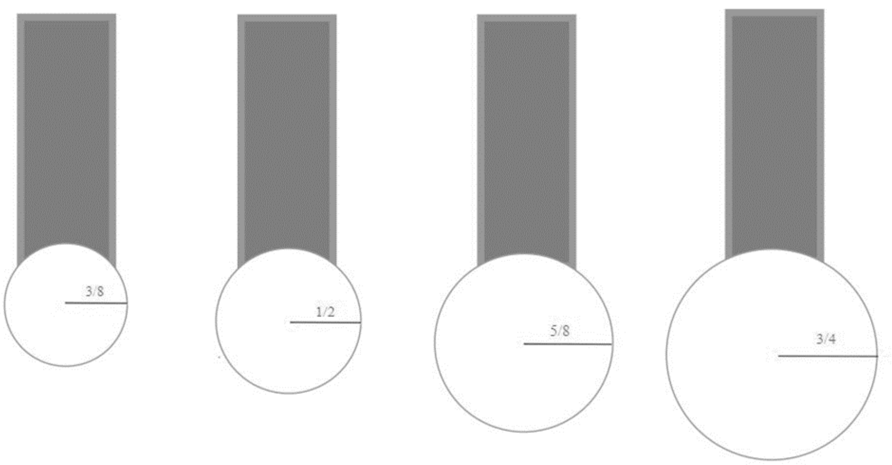

Figure 2. Skate blade radius of hollow (ROH) (frontal view). Units for the 3/8, 1/2, 5/8 and 3/4 are inches.

skating step is determined by the height of the blade and the position of the tip. It has the ability to change the position of the blade on the ice or the angle of inclination of the skate and directly affects the balance of the hockey player. If the height of the blade is greater in front than in back, a backward tilt will be created. Proper lying allows the hockey player to be more efficient in movements and make easier transitions between skating forward and backward.

The ROH is created by the radius of the grinding wheel. A short radius creates a deeper groove or cavity. Conversely, a longer radius will result in a shallower or flatter edge.

PARTICIPANTS

The study was conducted with the participation of 24 hockey players – 12 professional and 12 amateurs – aged between 18 and 32 years old on the territory of the Winter Palace of Sport in November 2023. The participants were selected to represent different levels of playing experience and physical fitness. Each of them underwent a series of tests on an ice rink with regulated conditions, using skates with different sharpening settings.

Four different radius of recess (ROH) were used: 3/8", 1/2", 5/8" and 3/4", two different radius of contour (ROC): 2.74 m and 3.35 m, as well as two pitch settings (neutral and forward offset) and two edge flatness options (perfectly flat and with a deviation of 0.25 mm).

In the first study, 12 participants performed two on-ice tests to investigate the relationship between ROC and aerobic performance. The first test was a ROC selected based on the players' preferences, and the second was customized based on body weight. Laboratory assessments of VO_2max were performed. The two tests were separated by at least 48 hours of rest. Results were analysed using repeated-measures ANOVA.

In the second study, each participant performed an anaerobic ice performance test (Reed Repeat Skate - RRS) on three separate days with different ROH values: 3/8", 1/2", and 3/4". The performance time for each session was recorded, and anaerobic power (W), anaerobic capacity (W), and fatigue index (s, %) were then calculated.

The third study focused on the effect of pitch on balance, controllability, and movement dynamics in various game situations. Each participant was tested in two pitch configurations: neutral and forward-shifted, using identical ROH and ROC to eliminate lateral influences. The tests included simulated game scenarios - standing starts, high-speed turns, and obstacle crossing, accompanied by measurements using inertial sensors and high-speed cameras.

All data were analysed using the SPSS software (version 29) and MS Office.

RESULTS

Descriptive data on all participants (n=24) are shown in **Table 1**. A positive correlation was seen between the height and weight of the subjects ($r = 0.67$, $p < 0.05$).

Table 1. *Anthropometric measures of participants*

	Mean	SD
Age(y)	27	1.5
Weight (kg)	78.6	7.68
Height (cm)	179.8	7.50

Data are mean ± SD (n = 24)

The results of the first study **(Table 2)** showed that customized ROC settings for body weight resulted in statistically significant improvements in aerobic efficiency. Mean VO_2max was 6.2% higher with customized ROC compared to player preference ($p < 0.05$), as well as improvements in motion economy during skating.

Table 2. *Relationship between ROC and aerobic performance*

ROC	Average VO_2max (ml/kg/min)	SD
Player preference	52.3	2.8
Personalized by weight	55.5	2.6

In the second study **(Table 3)**, a clear relationship was observed between the ROH value and anaerobic performance indicators. The lowest ROH value (3/8") resulted in the highest anaerobic power ($p < 0.01$), while at the highest ROH (3/4"), participants demonstrated lower fatigue but also lower maximum speed.

Table 3. *Anaerobic performance test on ice*

ROH (cm)	Anaerobic power (W)	Anaerobic capacity (W)	Fatigue Index (%)
0.63	720	7800	28.2
1.27	680	7550	24.5
1.90	645	7300	20.3

The differences between the three ROHs were statistically significant in all variables measured by ANOVA.

The results of the third study showed that a forward-shifted stride improved initial acceleration (by an average of 4.6%) and made it easier to start from a standing position, while also placing slightly more stress on the front of the ankle and knee. Some participants reported a decreased sense of stability during sudden changes in direction, especially at higher speeds. However, in players with a more aggressive style, the forward-shifted configuration was associated with better control and predictability of movement. The neutral stride was preferred by participants who placed more emphasis on stability and long, smooth movements.

The final part of the study examined blade alignment and its role in the risk of falls and unilateral lower limb loading. To this end, designs with perfectly aligned edges were compared with designs with an intentional deviation of 0.25 mm towards the inner or outer edge.

Measurements showed that even a minimal deviation in alignment led to a statistically significant increase in load asymmetry (an average increase of 11.3% in lateral weight transfer) and an increased frequency of micro-losses of balance, especially during turns. Survey data also showed a significant decrease in the feeling of control and predictability of the skate behaviour. Most participants reported increased muscle tension in the dominant leg with incorrectly aligned blades. These results emphasize the importance of high precision in sharpening and checking symmetry to minimize the risk of overload and injury.

Analysis of the collected data revealed significant differences in participant performance depending on the sharpening configurations. The main observations are as follows:

Radius of hollow (ROH)

The smallest radius (3/8") provided the best grip on the ice, which led to faster accelerations and more efficient turns, especially for professional players. However, the same radius caused faster fatigue and increased the risk of overload in amateurs, due to increased sliding resistance. Larger radii (5/8" and 3/4") showed lower grip, but allowed for longer and smoother glides, suitable for longer transitions and lower energy expenditure.

Radius of contour (ROC)

The smaller 9-foot ROC blades provided better manoeuvrability in tight spaces, while the 11-foot ROC allowed for greater stability at high speed. This difference was especially evident in the tight turn and change of direction tests, where the 9-foot ROC showed advantages in tight turning radii.

Pitch adjustment

The forward-stride skates improved acceleration and control when starting, but caused some participants to experience instability in the rear end when stopping. The neutral stride provided a more balanced feel, which was preferred by most amateurs.

Blade Alignment

Even a minimal deviation of 0.25 mm in edge alignment had a negative impact on control and caused significantly more errors in turns and accelerations. This confirms the importance of precise sharpening and maintenance of skates. Professional players demonstrated better adaptation to non-ideal alignment, while amateurs showed a significant decrease in efficiency.

Subjective assessment and physiological response

Survey data showed a preference for a 1/2" ROH for most participants as the "optimal compromise" between control and energy efficiency. At the same time, heart rate was highest when using a 3/8" ROH, especially in amateurs, which coincides with the higher muscle effort with a more aggressive grip.

DISCUSSION

The effects on performance show that customizing ROC to the player's physiological characteristics can increase aerobic efficiency,

while choosing a smaller ROH leads to improvements in power and acceleration, key for sprints and quick manoeuvres in a game.
Regarding the risk of injury, a smaller ROH increases traction, but increases stress on the joints and the likelihood of sprains or falls during sharp turns. A larger ROH provides a smoother glide and lower stress on the lower extremities, making them more suitable for players with old injuries or for rehabilitation training.

The choice of optimal sharpening should be tailored not only to the playing position, but also to the physical condition, playing technique and injury history of each hockey player. A personalized approach, based on the analysis of biomechanical and physiological parameters, can reduce the risk of injuries and improve sports results.

CONCLUSION

The best overall performance in terms of speed, manoeuvrability and subjective comfort was achieved with the ROH 1/2" configuration, ROC 2.74 m, neutral pitch and perfectly aligned edges. Variants with more aggressive or more passive sharpening showed advantages in specific situations, but compromised other aspects of performance.

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