

Assessment of the effectiveness of practice games between the Korean women's national hockey team and men's junior hockey team using movement pattern analysis

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Abstract

Background/Objectives: This study aimed to verify the effectiveness of practice games of the Korean women's national field hockey team by comparing position-specific movement patterns in international competitions and practice games.

Methods/Statistical Analysis: Sixteen Korean national female hockey players were volunteered in this study. This study analyzed 10 international-level games hosted by the International Hockey Federation and 10 practice games

with the Korean men's national junior team. GPS analysis was used to quantify the players' movements. The dependent variables used for movement pattern analysis were total movement distance, movement distance within each speed category, and sprint distance. A two-way repeated measures ANOVA was performed to examine the differences in the dependent variables related to game type and position.

Findings: There were no significant differences in the total movement distance and distance by quarter between competitions and practice games. Overall, however, sprint distance was greater in competitions than in practice games; particularly, midfielders' sprint distance in the third quarter in competitions was significantly greater than that in practice games ($p < .017$). Regarding position-specific differences within each speed category, there were no significant differences in different positions in the low speed category (< 12 km/h), but defenders showed lower movement distance than forwards and midfielders in the medium to high speed category (1224 km/h) ($p < .017$). Furthermore, defenders also showed lower sprint distance in the third quarter than that of the midfielders ($p < .017$). These movement patterns were more prominent in international competitions than in practice games.

Improvements/Applications: When we compared international competitions and practice games to verify the effectiveness of practice games, there was no significant difference in total movement distance. However, movement distance within each speed category and position-specific movement distance were lower during practice games than in competitions.

Key Words : Field Hockey, GPS, Movement Pattern, Distance, Velocity, Acceleration.

1 Introduction

The Global Positioning System (GPS) is a satellite navigation system that was originally developed for military purposes, but advances in scientific technology have enabled its application in sports. Particularly, GPS is utilized in team sports as a means to overcome

the disadvantages of video-based analysis. It is widely used for establishing strategies and tactics, as it enables real-time analysis of the players' movement patterns during games and practices, including variables such as position and speed ¹. Such data may be used to assess individual athlete performance, evaluate the physical fitness demands for each position, develop training programs, and optimize team performance. Currently, measurement sensors, such as the GPS, are utilized in competitions; its real-time data are immediately used to adjust game strategies and tactics in hockey, owing to the lack of regulations on the matter ².

Because field hockey demands athletes to continue high-intensity activity with quick recovery, many past studies have focused on enhancing the physical fitness of the athletes ^{3,4}. However, such studies cannot provide information pertaining to game features and position-specific movement patterns to establish strategies and tactics. Moreover, most national teams concentrate on testing various strategies and tactics and performing practice games to maintain the edge rather than improving their physical fitness when preparing for major competitions. Accordingly, the women's national field hockey team prepares for international competitions through practice games against men's junior teams instead of women's business teams because the athletes of the former teams are more agile and stronger.

In a study that analyzed movement patterns in relatively recent competitions and practice games, low-intensity movements occurred more frequently in practice games than in competitions ⁵. A study that analyzed movement patterns in relation to position and time of activity revealed that forwards engage in high-speed movement more frequently while defenders engage in low-speed movement more frequently ^{6,7}. It has also been reported that defenders recover twice as fast as forwards and midfielders because defenders perform low-intensity exercise ⁸. In one study, good performance tended to be associated with increased movement distance and speed in general ⁹, while, in another study, movement distance was low in all positions with a big score gap ¹⁰.

As illustrated above, field hockey features flexible movement patterns according to the type of game, position, and status of the game, suggesting that hockey players should engage in practice games with similar movement patterns as those of actual games to

efficiently prepare for competitions. Therefore, this study aimed to compare position-specific movement patterns of the Korean women's national field hockey team in international competitions and in practice games with the junior men's field hockey team, in an attempt to verify the effectiveness of practice games, thereby providing implications for future training sessions in preparation for the 2016 Rio Olympics.

2 Materials and Methods

2.1 Participants

Sixteen Korean women's national field hockey players (5 forwards, 5 midfielders, and 6 defenders) who had no musculoskeletal illness at the time of the games were enrolled in this study. Two goalkeepers were excluded from the study. The mean age of the players was 27.5 ± 2.6 years, with a mean height of 165.9 ± 3.2 cm, mean weight of 59.3 ± 5.2 kg, and mean career length of 14.2 ± 2.2 years. To ensure the rights and safety of all participants, we obtained approval by the Institutional Review Board of the Korea Institute of Sports Science, and only those who volunteered for the study and provided informed consent were enrolled.

2.2 Measurement apparatus and procedure

Data on the participants' movement distance during the games was collected using a GPS measuring system (SPI-HPU; GPSports, Canberra, Australia) at a sampling frequency of 15Hz. The collected raw data was synced to a real-time monitor (SPI-Realtime; GPSports, Canberra, Australia) for monitoring during the game. This study analyzed 5 games in the World League Finals in Argentina in December 2015, 5 games in the Hawke's Cup in New Zealand in April 2016, and 10 practice games with the men's national junior field hockey team (1719 years of age) at the Korea National Training Center from March to May 2016. The number of players was limited to 18, excluding the goalkeepers in all competitions and practice games, and all games comprised four 15-minute quarters as per the official rules of the International Hockey Federation (FIH). All Korean female hockey players who played in the

games wore a special vest with a GPS sensor inside their uniforms and a GPS receiver on their backs [Figure 1]. In field hockey, there is no limitation to the number of players who can be substituted during a game; the players' playing time and the start and end of each quarter were recorded in seconds using the satellite time obtained from the SPI-HPU, and the games were recorded with the Hero 4 (GoPro, California, USA) to distinguish between substituted players. The dependent variables to analyze movement patterns were set to total distance, distance within each speed category, and sprint distance. Speed was divided into the following six categories: walking (0-6 km/h), fast walking (6-12km/h), jogging (12-14km/h), running (14-18km/h), fast running (18-24km/h), and sprinting (> 24 km/h); sprint distance was computed when speed change was greater than 2.5 m/sec^2 ^{11,12}.



Figure 1: Field hockey player with GPS sensor in uniform.

2.3 Statistical Analyses

Two-way repeated measures ANOVA was used to examine the differences in dependent variables in relation to game type (competition or practice) and position (forward, midfielder, or defender) and

significance level $p < .05$ was used to indicate statistical significance. A paired t-test was performed as a post-hoc test; the significance was set to $p < .05$ to verify the differences between game types and to $p < .017$ to verify the differences among positions. All statistical analyses were performed with SPSS ver. 18.0 (SPSS, Inc., Chicago, IL, USA).

3 Results and Discussion

The total movement distance in international competitions was 4983.2m for forwards, 5637.0m for midfielders, and 5658.4m for defenders. The total movement distance in practice games was 5080.9m for forwards, 5900.1m for midfielders, and 5110.8m for defenders. There were no statistically significant differences in total distance and distance by quarter in relation to game type (international competition and practice game) and position (forward, midfielder, and defender) [Table 1]. Thus, the practice games with the men's national junior hockey team are appropriate as preparation for international competitions regarding total movement distance. A study comparing total movement distance during an international competition in a national-level league using similar methods as that used in our study also revealed that the total movement distance was significantly greater in teams that played in international competitions, which supports the results of our study¹³. However, the total movement distance by the Korean national team is short of that of the Australian national team by 6,600 m for both international competitions and practice games; this result necessitates improvement in this aspect of performance⁵.

Table 1: Results of repeated measures ANOVA for analyzing total and quarterly movement distance in relation to type of game and position

Variables		Position			Interaction <i>p</i> -value
		Forward	Mid-field	Defense	
Total	Competition	4983.2±618.1	5637.0±621.4	5658.4±596.7	.517
	Exercise	5080.9±733.6	5900.1±554.5	5110.8±886.3	
Q1	Competition	1272.8±161.2	1474.2±191.0	1307.9±134.0	.939
	Exercise	1259.2±230.4	1483.5±127.1	1262.0±336.5	
Q2	Competition	1231.2±172.1	1401.0±181.7	1424.5±95.9	.543
	Exercise	1259.2±230.4	1483.5±127.1	1262.0±336.5	
Q3	Competition	1258.5±146.3	1408.2±128.5	1374.8±154.4	.936
	Exercise	1175.9±252.5	1400.5±121.3	1321.0±162.6	

Q4	Competition	1272.8±159.4	1420.6±199.3	1500.5±251.8	.169
	Exercise	1373.0±158.4	1541.9±164.2	1219.8±381.4	
Values are presented as mean ± SD in meters. ANOVA indicates two-way repeated measures ANOVA between match and position.					

There were no statistically significant differences in walking and fast walking distance regarding game type and position. However, jogging and running distance, which fall under medium- to high-intensity exercise, and fast running, which falls under high-intensity exercise, were the greatest in midfielders, followed by forwards, and finally by defenders in both international competitions and practice games. The total jogging distance of midfielders in practice games was 749.3m, which was significantly greater than that of forwards was 575.2m and defenders was 505.0m ($p < .017$). In addition, running distances of defenders were 665.5m in international competition and 644.7 in practice games, which were lower than those of forwards and midfielders ($p < .017$). Fast running distance of defenders in international games was 275.2m, which was lower than that of forwards was 420.2m and midfielders was 426.6m ($p < .017$). Fast running and sprinting, which are high-intensity activities, are reported to be the greatest in forwards, followed by midfielders, and finally by defenders^{10,14}. In our study, sprinting distance was in line with that of previous studies; however, fast running distance differed, as this study found the midfielders to show the greatest fast running distance, followed by forwards, and finally by defenders [Table 2].

Table 2: Results of repeated measures ANOVA for analyzing movement distance within each speed category in relation to type of game and position

Variables		Position			Interaction p-value
		Forward	Mid-field	Defense	
Walking	Competition	1384.3±223.8	1411.3±191.1	1967.8±448.3	.410
	Exercise	1461.0±225.6	1530.8±149.3	1709.2±294.1	
Fast walking	Competition	1790.6±239.4	2120.6±265.0	2212.7±153.1	.328
	Exercise	1909.3±360.3	2254.2±332.0	1934.1±413.8	
Jogging	Competition	566.4±95.3	707.1±124.1	528.1±56.4#	.886
	Exercise	575.2±87.2	749.3±87.3*	505.0±105.4#	
Running	Competition	801.1±103.3	953.4±136.4	665.5±58.3*#	.999
	Exercise	773.4±91.3	973.3±161.2	644.7±138.6#	
Fast running	Competition	420.0±71.4	426.6±26.6	275.2±50.5*#	.326
	Exercise	348.9±53.0	380.4±103.6	307.6±61.1	
Sprinting	Competition	20.7±10.1	18.1±8.8	9.5±5.5	.494
	Exercise	13.2±7.8	12.1±10.0	10.1±9.6	
Values are presented as mean ± SD in meters. ANOVA indicates two-way repeated measures ANOVA between match and position. * $p<.017$ compared with forward, # $p<.017$ compared with mid-field.					

There was no significant difference in sprint distance by position and game type in the first, second, and fourth quarters. However, in the third quarter, the sprint distance of midfielders was 117.2m in international games and 100.1m in practice games, indicating a statistically significant difference ($p < .017$). Further, defenders' sprint distance was 78.8m, which was lower than that of the midfielders ($p < .017$). It has been reported that muscular endurance and anaerobic power are required by field hockey forwards and midfielders because they need to create space through immediate acceleration to score points [5]. Particularly, a previous report suggested that forwards must show the greatest proportion of sprint distance against total distance [8]; however, in our study, midfielders showed the greatest sprint distance overall. This is speculated to be the result of the fierce battle for control of the ball in the midfield in the Korean women's national hockey team compared to that in other teams. Although only midfielders showed significant differences in sprint distance, forwards and defenders showed high movement distances in international games overall [Table 3]. Therefore, position-specific training programs or practice games with other countries would be more effective than practice games with the men's junior team for the Korean women's national hockey team when preparing for international competitions.

Table 3: Results of repeated measures ANOVA for analyzing sprint distance in relation to type of game and position

Variables		Position			Interaction p-value
		Forward	Mid-field	Defense	
Sprint Q1	Competition	99.0±28.8	118.8±30.5	75.8±33.5	.570
	Exercise	68.4±7.2	88.1±35.7	72.7 ±22.5	
Sprint Q2	Competition	94.8±19.7	127.9±44.1	97.8±15.6	.559
	Exercise	72.5±17.8	100.1±27.5	65.0±16.7	
Sprint Q3	Competition	102.4±25.6	117.2±26.8†	78.8±23.1#	.110
	Exercise	70.9±22.5	84.2±33.5	68.0±24.8	
Sprint Q4	Competition	91.3±20.7	113.8±28.9	98.9±30.6	.526
	Exercise	80.8±9.0	93.1±31.5	80.1±25.3	

Values are presented as mean ± SD in meters. ANOVA indicates two-way repeated measures ANOVA between match and position. # $p < .017$ compared with mid-field, † $p < .017$ compared with exercise.

4 Conclusion

This study aimed at utilizing the GPS measuring system to assess the effectiveness of practice games with the men's national junior hockey team in training the Korean women's national hockey team. After analyzing data for total movement distance, distance within each speed category, and sprint distance of 16 female athletes in 10 international-level games and 10 practice games, the following conclusions were drawn. First, there were no significant differences in total movement distance regarding game type (international competition and practice game) and position (forward, midfielder, and defender); however, the Korean women's national team showed lower total movement distance than its competitors. Second, there were no significant differences in low-intensity movement patterns among game types and positions. However, medium-intensity movement was the greatest in midfielders, followed by forwards, and finally by defenders. Third, the sprint distance of midfielders was significantly higher in the third quarter of international competitions than in that of practice games. Although statistically insignificant, forwards and defenders also showed higher sprint distance in international competitions, suggesting that practice games against other national teams or position-specific training programs would be more effective than practice games with the men's national junior team in preparing the women's national hockey team for international competitions.

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