Jersey Design and Pattern Making for Disable Players of Ice Sledge Hockey

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Abstract

As the quality of life has improved with development of science and technology, desire for better quality of life of disable people has also increased. Currently, prejudiced views of disabled people in South Korea are changing, but sports for all disabled people is not revitalized and social support is also inadequate. In developed countries, administration and systems for sports among people with disabilities are provided at the consumer level, and many companies willingly provide support to disabled athletes. However, in South Korea, low awareness of sports for disabled people is accompanied by minimal support companies. In order for South Korea to advance, support for the disable sports players is needed, especially sports-wear that fits their body conditions and differences game playing from ordinary sports players. This study specifically focused on the ice sledge hockey players, taking into account the complaints on their jersey and their special conditions through motion analysis while sleds. For the easy use of the hockey, armhole depth and sleeve breadth was reduced and sleeve hem was designed for flexibility of sleeve such that it does not slide down. Also, because only the front of the Jersey is tucked in the pants, the side vent was designed to be deep such that the back hem is prevented from being pulled. Sportswear pattern making for the players with disabilities required to account for distinct body characteristics, as compared to the ordinary players. Thus, studies that develops sports-wear design for those with disabilities contributes to the qualitative development of sports for people with disabilities.

Keywords: Ice sledge hockey, Jersey, sports, pattern, disable player

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I. Introduction

As the quality of life has improved by the development of science technology, desire for better quality of life of the disable people has also increased. According to the statistics of the disabled from the Employment Development Institute (EDI, 2014), people with disabilities who enjoys sports are recorded to be 8.3% in 2010, 9.6% in 2011, 10.6% in 2012, and 12.3% in 2013, indicating the increase in its numbers, and their desire to achieve treatment through training and to manage communal life through sports activity is increasing. Although the awareness and attention about people with disabilities are changing, only few of disabled people take an interest and participate in the programs and support projects on physical training that improving sports programs for the disabled is, in fact, only nominal. (http://www.kspo.or.kr/)

As Seoul Olympic Games and the 8th Paralympics was held in South Korea at the same time, disability sports moved into new era, but social supports for the disabled athletics are still insufficient. This is because there is a negative awareness among companies of enterprises that marketability of sports is low compared to the ordinary sports and administration is being done without considering the distinct characteristics of disabled and of athletics. Today, administration and systems for disabled sports in advanced countries are focused on the betterment of the beneficiary. And the administration is transforming and running in the direction opinions and suggestions of the disable people are involved in disabled sports. Many companies spare no cost for disabled athletes.(Kim 2009) Therefore, in order for South Korea to move forward and to become like one of the advanced countries, the supports for the sportmen with disabilities are needed, as well as suitable uniforms for their body and the method of a game.

Because ice sledge hockey players are the disabled people who have spinal cord disorder, polio, or cutting disability which are the disorders that relate with the difference in length of both legs and calves muscles(Bae,2009), they don’t need a pants and according to the players fondness, they can curl up the whole edges of the garments or the front part of them to the inside. Therefore, there need to be a jersey for the disabled that is different from the normal ice hockey players.(Decauw & Gavron 1995 /2005)

Thus, this study deals with the players in Gang Won-Do Provincial Office and is trying to make a jersey that improves the fitting and the movement of the body by finding out the problems of the jersey that are now using.

1. Current status of domestic ice hockey player

According to Korean Society for Rehabilitation of persons with Disabilities (2013), there are total 39teams of disabled sports work team in South Korea that mostly belong to public institution and the ice sledge hockey team in Gangwon-Do Provincial office is the only work team that participate as a national athletes in 2018 winter Pyeong Chang Paralympic. The national ice sledge hockey team is supposed to be composed of 17 people but there are only 11 players in a team and the rest of them are selected in normal club team.

Ice sledge hockey is an unpopular sport in Korea and to practice for the game, Ice rink is must-have item. Therefore, it is almost impossible to invest in a study for everyday clothes such as jersey or basic inner-wear and
there is almost no support from the business. Even though now, for warming up, they exercise five days a week for 40 minutes, exercise game training for 2 hours and weight training for 1 hour and 30 minutes, they have hard time getting the opponents team on doing an essential training.

2. Current status of domestic and foreign Ice Hockey uniform

Jersey for ice hockey is named generally as Jersey and today in South Korea, it costs about 3~7 hundred won. Jersey is generally made of a polyester mesh tissue and has a characteristic that immediately emit the moisture without keeping it inside a fiber. According to team, team’s logo or designate number on the front, a player’s last name or full name is positioned on the upper back and given number is positioned on the bottom. Designate number is placed on the side of the upper sleeve and the letter that distinguishes captain is placed on the upper part of the left chest.

At past, Hockey jersey was just a normal T-shirt that had wide armhole depth but today, the wrist part is narrowed as in the shape of a narrowed jar and the shoulders come down, curved a little to the front to make players more maneuverable. The patterns for domestic Ice hockey uniforms have T-shirt shaped patterns and are designed with digital printers. Jerseys overboard made for players cost 20~30 won (Korean currency unit) and are designed and made by global sports brands. Jerseys used different thickness in materials according to movement and water absorbance. Besides, numbers, letters and team names were embroidered in a soft, clear pattern. It also has sleeves with patterns that fall to the front and are made of elastic material, giving it enough room for care-free activity through reducing the armhole depth and waist hem. Especially, by cutting down the sleeve range and using straight-up ribbed top sleeves, the protective gloves are fixed to the wrist. Since ice sledge hockey is a game with players seated on sledges, the arm and the tail edge touches the ground multiple times compared to ice hockey, therefore, relatively roomy jerseys can be uncomfortable.

It is general to put on hockey jerseys on top of inner wear and protective gear. Therefore, jerseys cannot be applied to Korean sportswear standard size. Moreover, the big gap between the size of the players in Korea make it more difficult to apply standard size. Jerseys made by oversea brands use measure size as their standard while in Korea, the standard is according to body size.

As shown in Table 1, Size Korea provides only to XL and calculating the size by chest size deviation, Gangwon-do Provincial Office players are classified up to 3XL. As a result, more than half of the players do not fit into Korea’s standard size and Global brand Jersey is also unsuitable because when the chest size fits the top length and arm length is too long for local players, so repair is inevitable.

Therefore, jersey development for local ice sledge

| Table 1. Jersey Size Comparison |
|---------------------------|
| Korea standard size       | M | L | XL | 2XL | 3XL |
| Global Brand Jersey size  | S | M | L  | XL  | 2XL |
hockey players that is suitable for their distinct body conditions and sport movements will be contributing to the qualitative development of the sports for people with disabilities. (Choi & Lee 2007)

II. Research method and Process

1. Carried out a survey targeting disabled Ice sledge hockey players.

The survey was carried out in August 2015 at Chuncheon and Gangneung practice range. Investigated complains about current Jersey and measured 10 athletes physical size and size of the uniform they were actually wearing.

Players of Gangwon-do Provincial Office were in their late 30s in average which is relatively high and their training career varied. The reason for the wide deviation of age and career is because they mostly start sledge hockey by acquired disabilities than by congenital disorder.

2. Analysis of movement

Ice sledge hockey’s game time is divided into 3 games which are 15 minutes each and during the game players play 1 minute 30 seconds each by turns. Therefore, 20 minutes of the whole 45-minute game was recorded by a digital camera in this study to measure athletes arm bending angle and the number of times the arm touches the ground according to the area of the arm.

3. Jersey Development

Design for Jersey considered the existing uniform, investigated size, and interview of preferred style. Prior experiment was done by giving deviation to sleeve form, extra, side vent length, and different front and back length based on the complaints on Jersey and opinions of the athletes and the pattern was designed according to the result of the prior experiment.

Table 2. Global Brand Jersey Measure Size (Unit: cm)

| Jersey size | S    | M    | L    | XL   | 2XL  |
|-------------|------|------|------|------|------|
| bust girth  | 104~106 | 110~117 | 120~127 | 130~137 | 140~147 |
| Total length| 71~79  | 73.5~81 | 76~83.5 | 78.5~85 | 81~87.5 |
| Cervical to wrist | 79~81  | 80~82  | 87~89  | 88.5~90.5 | 91.5~93.5 |
| upper arm girth | 47~62  | 48.5~62 | 51~66  | 52.5~66 | 56~72  |
| Wrist girth  | 28  | 28  | 30.5  | 30.5  | 33  |
| Side vent length | 9  | 9  | 9  | 9  | 9  |

Table 3. Players’ Age

| age | 20’s | 30’S | 40’S | Total |
|-----|------|------|------|-------|
| person | 4 | 2 | 4 | 10 |

Table 4. Players’ Career (unit:year)

| Career | 1~5 | 6~10 | 11~15 | Total |
|--------|-----|------|-------|-------|
| person | 2  | 3 | 5 | 10 |

min. 1 year 8 months, max. 14 years
Result of the prior experiment showed that athletes preferred chest extra +32cm, Jersey form which is not T-form but raglan sleeve, 15cm of side vent length, back length longer than front length for more than 3cm, narrow sleeve hem width, and flexible material.

### 3. Result and Consideration

#### 1. Ice sledge hockey Players’ survey

1) players’ body size

Players’ body size is measured only the top part. The result is showed on Table 5, and ‘Total length’ is from neck base girth to the height of chair. The deviation of the players’ body size was large, and players had different size of jerseys even if they had similar body size, which was because each player chose his jersey size based on one that they feel comfortable.

#### 2) Complaints on Jersey

The complaints of Jersey were that large armhole disturbs players’ activities, sleeves are unfixed to the wrists, and the Jersey was generally too heavy. Also, players did not like the design including unclear color and the lack of elasticity. Ice sledge hockey players sit on the sled during the game, the total length of the jersey should not be too long because of relatively low distance between the ground and the jersey. Also, because the frequent accidents with short hockey sticks, the jerseys should be thin but strongly durable, and the armhole should not be too large.

Table 6 shows the uniforms and protective items that players individually wear. Generally, players ear pants or socks depending on their disability, but do not tend to wear mouth pad. It’s because their faces rarely get wounded, and the purpose of the pad is usually to stimulate instant strength instead of protection. They do not prefer mouth pads because they feel uncomfortable.

### Table 5. Players’ Body Size (unit: cm)

| body | position | striker | | defender | | Goalie |
|------|-----------|---------| |----------| |--------|
| Total length | 72 | 60 | 68 | 68 | 71 | 66 | 78 | 70 | 71 | 75.5 |
| Back length | 45 | 43 | 45.5 | 48 | 46 | 42.5 | 50 | 47 | 49 | 47 |
| Bust girth | 117 | 93.5 | 95 | 107 | 111 | 90 | 110 | 108.5 | 110 | 119 |
| waist girth | 98 | 73.5 | 81 | 95 | 93 | 68 | 94 | 89 | 89.5 | 105 |
| Shoulder width | 51 | 46.5 | 45 | 46 | 47 | 41.5 | 53 | 86.5 | 49.5 | 46 |
| Neck base girth | 45 | 43 | 47 | 49.5 | 48 | 40 | 50 | 47 | 47.5 | 50 |
| arm length | 63 | 59.5 | 59.5 | 62.5 | 61.5 | 55.5 | 60.5 | 62.5 | 63 | 63 |
| Elbow length | 37.5 | 35.5 | 32.5 | 36 | 35 | 32 | 35 | 35 | 36.5 | 36 |
| Upper arm girth | 40 | 33.3 | 35 | 41 | 38 | 31.5 | 41 | 38 | 41 | 41 |
| Forearm girth | 32 | 29 | 28 | 31 | 31 | 27 | 33 | 32 | 30 | 32 |
| Jersey size | 2XL | M | L | XL | XL | M | XL | L | XL | 2XL |
Table 6. Protective Items for Players

| Item                        | Number of persons | Note                        |
|-----------------------------|-------------------|-----------------------------|
| Jersey                      | 10                |                             |
| Pant                        | 6                 |                             |
| Socks                       | 7                 |                             |
| Helmet & Face mask          | 10                |                             |
| Mouth guard                 | 2                 | Defender/Offense            |
| Shoulder pad                | 10                |                             |
| Glove                       | 10                | included Goalie glove       |
| Neck guard                  | 10                |                             |
| Elbow pad                   | 8                 |                             |
| Shin pad                    | 9                 |                             |
| Shoes                       | 3                 |                             |
| Hairband                    | 1                 |                             |
| Goalie pad                  | 1                 | Goalie                      |

Table 7. Movement Angle of Arms during Ice Sledge Hockey Game (Mean)

| side  | N | wrist | elbow | shoulder |
|-------|---|-------|-------|----------|
| Left  | 9 | 17.5  | 94    | 61.5     |
| Right | 9 | 16    | 93.5  | 66       |

As they wear jerseys after the protective items, they want their items to have less friction with the jerseys and to remove unnecessary extra space that might impede their plays.

Other problems except their uniform are communication problems, healthcare, and lack of support with athletic instruments when going abroad. In the U.S. DELTA airline provides favor when delivering sledge.

2. Analysis of movements

Ice sledge hockey plays for 3 games and 15 minutes per game, except the time for warm up, and there is 10 minutes break between the games. Sledge hockey is one of the most intense sports requiring strong physical strength. There are 6 players including Goalie. Field players play on the sledge, so they often twist their back right and left to change the direction of the sledge or to strike the puck with stick. Also, the forearm is maintaining horizontal with the ground to strengthen the power.

Table 7 shows the result of movement analysis during the training. They measured ROM activities based on X-axis for body and Z-axis for the ground. Elbows were seldom unfolded over 160° unless they were tired. In addition, the wrists usually moved right and left instead of back and forth.

Table 8 shows the result of movement measurement in three angles, front, left, and right. It was measured by counting the part of the players’ body where it touches the ground. Both sides such as wrists, elbows, or shoulders often touched the ground, which would cause the overload the side of the back.
Table 8. Contact Number of Body and Floor during Hockey Game (Mean±SD)

| side  | N | wrist   | elbow   | shoulder |
|-------|---|---------|---------|----------|
| Left  | 9 | 37.5±7.05 | 17.33±8.34 | 3.06±3.54 |
| Right | 9 | 46.27±9.06 | 16.01±8.05 | 55.09±3.35 |

Figure 1. Korean Jersey Shape

3. The design and the measure of Jersey

The current uniform for Ice sledge hockey has no difference with other ordinary players and is T-shaped like in Fig. 1. It has slightly modified V-shaped neckline, wide sleeves with narrow sleeve hem width which look like a jar. There is no side vent, and the number and the name is digitally printed. The current Jersey actual measurement is shown in Table 9. The goalies’ uniform is relatively bigger than other field players because they have to wear big and thick protective items on their upper body and hands. Usually, players wear jersey after functional inner-wear or protective items to prevent injury.

When comparing with foreign brands, the size of domestic products is big because of different stretch of jerseys. However, the sleep hem width was relatively wider, which is consistent with the opinions that players are having difficulties with unfixed gloves on their wrists. Also, they are having problems when wearing or taking of the jerseys because of the back neck width. The fabrics of the clothes need amendment instead of the change in size because it is not a problem of appearance.

According to the prior assessment, the most appropriate extra size is body size + 32cm, on the basis of bust girth. The current jersey has too deep armhole depth gets stuck to hockey pick or makes the arm gestures uncomfortable, so raglan sleeve type and lower armhole depth is preferred.(J-Armstrong 2010) Also, with deep side vent, the new Jersey is designed for the front, bottom part of upper clothes to go inside the pants, considering the aspects of players.
Table 9. Jersey Measure Size in Korea

|                | M   | L   | XL  | goalie |
|----------------|-----|-----|-----|--------|
| Bust girth     | 60  | 64  | 68  | 75     |
| Upper arm girth| 30  | 31  | 32  | 42     |
| Total Front length | 71  | 75  | 79  | 80     |
| Total Back length | 76  | 80  | 84  | 85     |
| Cervical to wrist | 81  | 83  | 85  | 81     |
| sleeve hem width | 18  | 19  | 19  | 32     |
| Side length    | 33  | 35  | 37  | 33     |
| Back Neck width | 19  | 19.5| 20  | 21     |
| Front neck depth | 16.5| 17  | 17.5| 16     |
| Armhole depth  | 33  | 34  | 35  | 48     |
| Shoulder layer length | 69  | 74  | 79  | 85     |
| shoulder layer width | 10  | 10  | 10  | 10     |

Figure 2. Jersey Pattern Making and Flat Design

Also, to prevent to impede to move the sled, end of both sides were rolled up and produced patterns.

Fig. 2 demonstrates the complete Jersey, produced in pattern method, in the basis of 94cm (L size) of bust girth with 4cm deviation.

The total length and back length was based on Korea standard body type, and sleep hem width has difference of ±0.5cm with standard size. To have three dimensional sleeves, the angle of back neck-point wrist is modified. For more comfortable gestures, the extra part of forearm
is reduced. It’s because players rarely raise their hands up to their shoulders but usually maintain slightly folded posture and prevent sleeves dangling when playing the games. Back neck width and front neck depth is widened, and neck band width got larger to make it more comfortable for players to wear and take off the clothes by using stretch fabric with no difference in actual size of neckline.

Currently, because of digital printing, the vividness of colors decrease, and color spreads. To solve this problem and have the players’ names and number distinct and distinguishable, needlework is used, but removed thick and solid feeling of the patch to prevent players to feel uncomfortable when playing games and to prevent needlework to hinder when slipping on the ice.

Fig. 3 is the complete design with fold line of shoulder line. The fabric with smooth texture and high density and mass was used. The front part of chest where the team name is marked and the central part where identification number is marked are made of middle density and mass fabric. The lines on the sleeves embody the three dimensional figure and show the change of color more clearly. By matching the panel color, the uniform is saddle-stitched along the margin to sew up. The numbers on the back and both sides of the sleeves should be easily recognized by referees, and there will be full name or last name, depending on season.

Different fabric was used to consider aspects of body part. Most part of Jersey is made of quick dry fabric, but back and front part where there is frequent friction or rip by sticks are made of thick and tough fabric. Where sweat breaks out often, including under the arms, more thin and light fabric is used. Table 10 shows knitting was used to have fastness of water, friction, or sweat. There was 1.5% of change in size after the wash, but it was not considered because the jersey is not designed to tightly fit on body.

IV. Conclusion

This study is for making a jersey for those who are in special physical condition. We tried to make Jersey that could improve the fitting

![Figure 3. Jersey Design](image)
Table 10. Using Materials’ Analysis

| test item                  | material  | Material 1 | Material 2 | Material 3 | note                                |
|----------------------------|-----------|------------|------------|------------|-------------------------------------|
| fiber mixture rate         | polyester | 100        | 96.3       | 100        | KS K 0210:2015                      |
|                            | poly uretan | 3.7        |            |            |                                     |
| color fastness to washing | change in color | 4–5      | 4–5        | 4–5        | KS K ISO 105-C06:2014 A 2S          |
|                            | contamination | 4–5       | 4          | 4–5        |                                     |
| size change rate to washing | wale    | -1.5       | -1.5       | -1.5       | KS K ISO 5077:2014                   |
|                            | corse    | -1.5       | -1.5       | -1.5       |                                     |
| rubbing fastness           | dry      | 4–5        | 4          | 4          | KS K 0650:2011                      |
|                            | dama     | 4–5        | 4          | 4–5        |                                     |
| color fastness to perspiration | acidity | change in color | 4–5      | 4–5        | 4–5                                |
|                            | contamination | 4–5       | 4–5        | 4–5        |                                     |
|                            | change in color | 4–5      | 4–5        | 4–5        |                                     |
|                            | contamination | 4–5       | 4–5        | 4–5        |                                     |
| density                    | wale      | 75.2       | 85.34      | 84.8       | KS K0512:2012                       |
|                            | corse     | 103.2      | 136.2      | 100.4      |                                     |
| mass                       |          | 154.7      | 305.6      | 150.1      | KS K 0514:2011                      |
| pilling                    |          | 4–5        | 4–5        | 4–5        | KS K ISO 12945–1:2014               |
| bursting strength          |          | 1194       | 1216       | 808        | KS K ISO 13938–1:2011               |
| pattern part               |          | Front/Back | Shoulder   | side/sleeve |                                     |

and the movement of body by investing on the presently wearing jersey and finding out the problems through a sledge hockey player working at the present. The ice sledge hockey jersey pattern was completed with a consideration of things that dissatisfied the players and suitableness of the sport; the satisfaction was shown in an order of the fabric’s quality, pattern(action-fitness), and a design. The players’ satisfaction on design would be relatively low because all the opinions of players, directors, team managers have to be gathered up. Because each player has one’s own favorite color among various colors, it will be desirable that the color changes according to the color trend of each season and by considering the opinion of the association. This design offered a three dimensional pattern by considering the arm motion range and using different materials at each part of body. The complete Jersey was produced in the basis of 94cm (L size) of bust girth with 4cm deviation. The total length and back length was based on Korea standard body type, and sleep hem width has difference of ±0.5cm with standard size. The most appropriate extra size is body size + 32cm, on the basis of bust girth. To have three dimensional sleeves, the angle of back neck–point wrist is modified. For more comfortable gestures, the extra part of forearm.
is reduced. Ice sledge hockey is the most popular game in winter season Paralympic and is provided with governmental support compared to other disabled sports, but is still inadequate in comparison with sledge hockey teams of other countries. Although national attention on disabled sports game and support of companies is still poor, research about sports apparel for disabled people is necessary. Disabled people have clear physical limitations, so functional clothes can help them to overcome their limitations. Also, continuous research can encourage disabled athletes morale and that can carry out better results at Pyeong-Chang Olympics which will lead to expansion of national, entrepreneurial interest.

Reference

Bae, H.(2009). Sports for the disable: History and the classification. *Hanyang medical Review*, 29(1), 94–106.

Choi, J., Lee, E.(2007). Coordination pattern of upper limb of sweep shot movement in ice hockey. *Korean journal of sport biomechanics*, 17(4), 169–179.

Current status of supports for disable sports. (2015). Retrieve November 10, 2015 from http://www.kspo.or.kr/

Deoauw, K. P. & Gavron, S. J. (2005). *Disability Sports*. (Choi, S., Han, D., Kang, M., Kim, G., Park, B., Lee, J.) Seoul: Rainbow book(Original work published 1995)

Joshep-Armstrong, H. (2010). *Patternmaking for Fashion design*(5th ed.) N.Y.: Prentice Hall.

Kim, M.(2009) A developmental process of disable sports in germany. *the korean journal of history for Physical education, sport and dance*. 14(2), 125–136.

O’Mahony, M & Braddock, S. E. (2002). *Sportstech*. London: Thames & Hudson Inc.