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ORIGINAL

Kinematic Comparative Analysis of Long Turns between Experienced and Inexperienced Ski Instructors

Hyun Dai Jo

Gonjiam Middle School, Gyeonggi-do, South Korea

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Corresponding Author
Hyun Dai Jo
Gonjiam Middle School, 82, Gonjiam-ro, Gonjiam-eup, Gwangju-si, Gyeonggi-do, 12804, South Korea
Tel : +82-10-4195-3323
Fax : +82-31-763-1773
Email : scottiejoe@korea.kr

Objective: The purpose of this study is to provide a better understanding of long turn mechanism by describing long turns after kinematic analysis and provide skiers and winter sports instructors with data through which they are able to analyze right postures for turns in skiing in a systematic, rational and scientific manner.

Method: For this, a mean difference of kinematic variables (the center of gravity (CG) displacement of distance, trajectory, velocity, angle) was verified against a total of 12 skiers (skilled and unskilled, 6 persons each), regarding motions from the up-start to down-end points for long turns.

Results: First, concerning the horizontal displacement of CG during a turn in skiing, skilled skiers were positioned on the right side at the upstart and edge-change points at a long turn. There was no difference in anteroposterior and vertical displacements. Second, in terms of CG-trajectory differences, skilled skiers revealed a significant difference during a long turn. Third, regarding skiing velocity, skilled skiers were fast at the edge-change and maximum inclination points in long turns. Fourth, there was no difference in a hip joint in terms of a lower limb joint angle. In a knee joint, a large angle was found at the up-start point among skilled skiers when they made a long turn.

Conclusion: In overall, when skilled and unskilled skiers were compared, to make a good turn, it is required to turn according to the radius of turn by reducing weight, concerning the CG displacement. Regarding the CG-trajectory differences, the edge angle should be adjusted via proper inclination angulation. In addition, a skier should be more leaned toward the inside of a turn when they make a long turn. In terms of skiing velocity, it is needed to reduce friction on snow through the edging and pivoting of the radius or turn according to curvature and controlling ski pressure. Regarding a lower limb joint angle, it is important to make an up move by increasing ankle and knee angles instead of keeping the upper body straight during an up motion.

Keywords: Ski turn, Kinematic ski, Ski trajectory, Ski instructor

INTRODUCTION

Alpine skiing is a speed event. In general, it is extremely hard for ordinary people to overcome a steep slope and huge external forces such as centrifugal force, which take place when they make a turn at high speed. Alpine skiing is the sport of sliding down snow-covered hills on skis fast, making turns (Lee, 2009).

Turnbull, Kilding & Keogh (2009) divided alpine skiing into four disciplines: downhill, super giant slalom, giant slalom and slalom. In downhill alpine skiing, racers can exceed speeds of 120 km/h. Super giant slalom is a combination of giant slalom and downhill. The course is shorter than downhill but it has more turns. A typical super-G race takes 1~2 minutes to complete. In slalom and giant slalom characterized as disciplines that require technical skills, skiers only reach 30~60 km/h, slower than the speed sport. Giant slalom is the event characterized as being the discipline requiring the most technical skill. It is positioned between downhill and slalom. Compared to slalom, giant slalom gates are set farther apart, requiring smooth flexibility and techniques. In technical events, in particular, after the first round, gates are reset. Then, the second round starts. The sum of the times from both rounds is decisive. In super-G, on the contrary, the time from one run is counted (Chung, Kim & Kim, 2011).

Joo et al. (2008) insisted that unlike alpine skiing events where the time and velocity matter, in interski in which skiing techniques and teaching methods are developed and guided against demonstrators produced through skilling championships or other events or general skiers, not-that-fast and easy-to-control skidding techniques are learned in beginner and intermediate levels. In an advanced level, fast carving techniques are taught. Carving is a difficult skill in which a skier has to endure centrifugal force by putting his/her body weight on a line like carving on snow with skis. In alpine skiing events, however, skiers make turns along with skidding turns when they pass through a gate (Heinrich, Mössner, Kaps & Nachbauer, 2011). In regular skiers as well, skidding and carving turns could be made together depending on circumstance even though carving is enabled (Kim, 2014). Regarding turns made to shorten the time in alpine events, body movement is greater than the demonstrator's move in terms of variation. Furthermore, in case rotation, pivoting, inclination, edging and angulation are combined properly at the proper speed for the slope instead of classifying carving and skidding, skiers are able to make proper turns even without carving. Therefore, it could be more reasonable to analyze demonstrators, not alpine skiing athletes, with a kinematic viewpoint. In addition, the carving-like skidding turns made via good timing and coordination can be good approach to the analysis of general turns in skiing.

After all, this study comparatively analyzed the turns of ski instructors who demonstrate interski rather than showing alpine skiing athletes' skills. This study concluded that it would better for general club members and ski lovers to analyze ski instructors' turns and provide quantitative data, not professional athletes' turns which have large move variation for the purpose of time reduction.

METHODS

1. Participants

In this study, a total of 12 ski instructors from 'K' Resort in Gangwon-do were chosen. Specifically, 6 skilled skiers with more 3 or more years of ski instructor experiences and 6 unskilled skiers who have never taught skiing before were selected. These subjects' characteristics are stated below (Table 1).

2. Experimental variables

In independent variables, the moves of 6 skilled skiers and 6 unskilled skiers were divided by event while dependent vari-

Table 1. Subjects' general characteristics

	Subjects	Age	Height (cm)	Weight (kg)	Career year (Level)
Skilled	S1	33	178	72	10 (Level Ⅱ)
	S2	32	174	71	8 (Level Ⅱ)
	S3	30	172	70	8 (Level Ⅱ)
	S4	28	173	74	6 (Level Ⅱ)
	S5	26	169	69	4 (Level Ⅱ)
	S6	25	173	72	5 (Level Ⅱ)
Unskilled	S7	22	173	72	1
	S8	22	175	69	1
	S9	21	179	78	1
	S10	21	177	77	1
	S11	21	168	79	1
	S12	21	173	73	1

Table 2. Experimental equipment

Equipment	Model	Quantity	Manufacturer
Laptop	Satellite	2	TOSHIBA
Camera	Motion Master100	4	VISOL INC.
Control pole	Range pole (4 m)	4	·
A/D Converter	Universal Sync Box (DT-9800)	1	VISOL INC.
LED	Light emitting diodes	2	VISOL INC.
Motion analysis program	Kwon 3D XP	1	VISOL INC.

ables are the following kinematic variables. Then, they were set to CG displacement, trajectory, velocity and angle of a body joint by event.

3. Experimental equipment

The equipment used in this study is classified into imaging equipment and image data analysis system (Table 2).

4. Procedures

In this study, experiments were performed on the K Resort's J Scope. To set spatial coordinates, a single control object was set up within a range which completely includes subjects' turns. In such turn moves, the left-right direction, forward direction and vertical direction were set to 'X', 'Y' and 'Z' axes respectively. In addition, four motion cameras were set up to film the whole range of motion including the control object.

For dynamic trial filming, the subjects made a turn 6 times with a 10-minute interval between attempts. To get accurate data, each turn was made 6 times, and the researchers classified and analyzed the data measured according to the purpose of the research.

A single turn comprised of a right turn in which both skilled and unskilled skiers' body weight was put on their left foot, and the radius of turn was 9.15 m. The gradient was approximately 25% in average. The distance from the start to the start of the first turn was 21.55 m. Both left and right turns were attempted. Then, the data from the start to the end of the left turn (second turn) were processed.

5. Angle definition

1) A lower limb angle was defined to the angle of YZ plane.
2) Hip angle: the angle of the thigh and shank.
3) Knee angle: the angle of the thigh and shank.
4) Ankle angle: the angle of the shank and foot.

6. Data analysis

For data analysis, human joints, CG and control poles were coordinated. Then, the exact positions on the coordinates were examined, using the direct linear transformation method (DLT) (Abdel-Aziz & Karara, 1971). After smoothing, they were analyzed through a motion analysis program.

7. Measuring events and phases

To analyze turns in skiing, events and phases were defined as follows:

1) Events

(1) Event 1 (up1): Up-start point
(2) Event 2 (up2): Edge-change point
(3) Event 3 (down1): Maximum inclination point
(4) Event 4 (down2): Down-end point (Figure 1)

8. Data processing

With the data obtained in this study, mean and standard deviation on kinematic variables within the measurement range were estimated against both skilled and unskilled skiers, using SPSS. To investigate differences in such variables between skilled

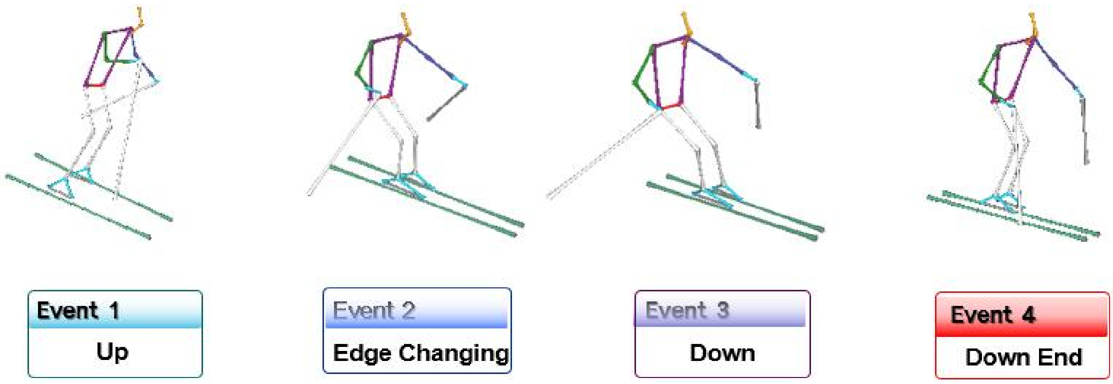

Figure 1. Events

Table 3. Displacement of CG (m)

Subjects \ Event		E1	E2	E3	E4
Skilled (n=6)	X	6.43±0.49	3.30±0.95	0.56±0.37	0.36±0.53
	Y	0.94±0.62	4.70±1.30	9.96±0.91	12.00±0.08
	Z	2.86±0.16	2.08±0.28	1.03±0.22	0.51±0.04
Unskilled (n=6)	X	5.46±0.72	1.96±0.45	0.11±0.22	0.20±0.38
	Y	1.04±0.79	5.25±0.65	9.62±0.27	11.85±0.24
	Z	2.89±0.20	2.06±0.11	1.20±0.05	0.58±0.07
t-value	X	2.71*	3.11*	2.54*	0.60
	Y	-0.24	-0.92	0.87	1.41
	Z	-0.30	0.15	-1.67	-1.88

*$p<.05$, E1: The up-start, E2: The edge change, E3: The maximum inclination, E4: The down-end

and unskilled skiers, *t*-test was performed.

RESULTS

1. Displacement of CG

Changes in CG displacement regarding turns in skiing are stated in Table 3. In horizontal displacement during a long turn, there was a left move when a skier moved from the left turn to the right turn, causing a decrease in numbers. At the up-start point (E1), skilled and unskilled skiers revealed 6.43±0.49 m and 5.46±0.72 m respectively. At the edge-change point (E2), skilled and unskilled skiers showed 3.30±0.95 m and 1.95±0.45 m each with statistical significance. At the maximum inclination point (E3), skilled and unskilled skiers were 0.56±0.37 m and 0.11±0.22 m respectively without statistical significance. In terms of anteroposterior displacement, at the up-start point (E1), skilled and unskilled skiers showed 0.94±0.62 m and 1.04 ±0.79 m each. At the edge-change point (E2), skilled and unskilled skiers revealed 4.07±1.30 m and 5.25±0.65 m respectively. The coordinate axis of the vertical displacement of the center of the body used the coordinates that were perpendicular to gravity, but there was no difference in the vertical displacement.

2. Trajectory comparison between CG and ski

The formula for the trajectory for the coordinates of X and Y in Ski and CG is as follows (Figure 2).

SQRT ((Ski's X-CG's X)^2+(Ski's Y-CG's Y)^2).

The changes in distance between the move trajectory of the CG anteroposterior displacement and horizontal displacements and ski trajectory are described in Table 4. At the maximum inclination point (E3), skilled and unskilled skiers revealed 0.52 ±0.05 m and 0.45±0.03 m respectively. In fact E3 is important because it is the point where the ski-end and CG points were most maximized. At the up-start point (E1), unskilled skiers revealed higher numbers. Since the edge-change point (E2), skilled skiers' numbers started to rise. As a result, they were maximized at the maximum inclination point (E3). In terms of trajectory differences between such skilled and unskilled skiers, while there was proper inclination according to skiing velocity in skilled skiers, no such inclination was found in unskilled skiers.

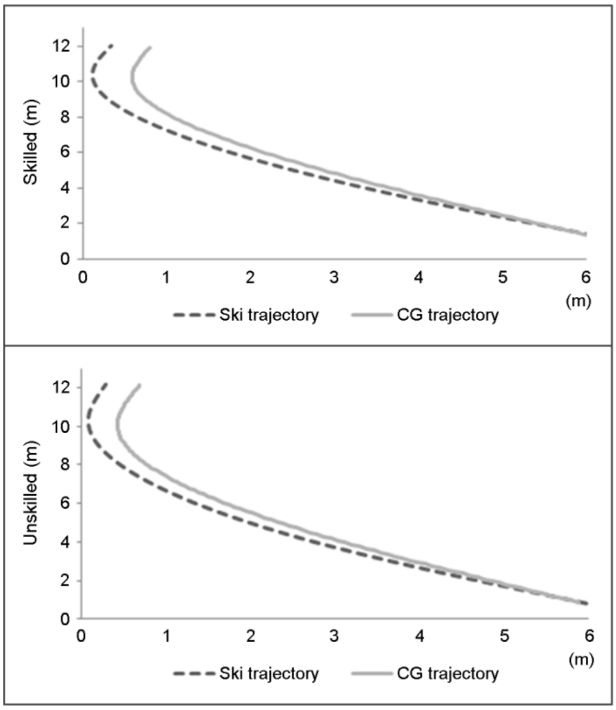

Figure 2. Trajectory comparison CG and ski

3. Velocity

Speed changes between skilled and unskilled skiers at a long turn are stated in Table 5. Specifically, skilled skiers were faster than unskilled ones. At the edge-change point (E3), skilled and unskilled skiers revealed 5.69±0.83 m/s and 4.58±0.33 m/s respectively. At the down-end point (E4), on the contrary, skilled and unskilled skiers were 5.01±1.02 m/s and 3.83±0.18 m/s each with statistical significance.

When distance difference and time difference were calculated, and the calculations were compared to velocity, no difference was found in time. In fact, there were no time differences in each phase, except for Phase 1 under a long turn. However, changes in velocity were observed in two events under a long turn. It appears that skilled skiers were fast because they were greater than unskilled skiers in terms of distance factors.

4. Lower limb angle

The lower limb joint angles are divided into a hip joint, a knee joint and the ankle joint, and the changes are stated in Table 6.

Under a long turn, skilled skiers were smaller than unskilled skiers in terms of the hip joint angle at the up-start point (E1) and edge-change point (E2). However, it was almost the same at the maximum inclination point (E3) and down-end point (E4) without any differences. In terms of a knee joint angle, in contrast, skilled skiers (146.7±8.2°) were greater than unskilled skiers (136.3±4.4°) at the up-start point (E1), showing a statistically significant difference. In the remaining phases after differences at the up-start point (E1), very similar patterns were found. In terms of the ankle joint angle as well, skilled skiers

Table 4. Trajectory comparison between CG and ski (m)

Subjects \ Event		E1	E2	E3	E4
Trajectory	Skilled (n=6)	0.11±0.15	0.10±0.14	0.52±0.05	0.48±0.04
	Unskilled (n=6)	0.21±0.17	0.01±0.04	0.45±0.03	0.44±0.08
	t-value	-1.11	1.37	2.74*	1.01

*$p<.05$, E1: The up-start, E2: The edge change, E3: The maximum inclination, E4: The down-end

Table 5. Velocity of ski (m/s)

Subjects \ Event		E1	E2	E3	E4
Velocity	Skilled (n=6)	8.87±1.19	8.97±0.76	5.69±0.83	5.01±1.02
	Unskilled (n=6)	8.83±0.62	8.51±0.43	4.58±0.33	3.83±0.18
	t-value	0.06	1.27	3.01*	2.75*

*$p < .05$, E1: The up-start, E2: The edge change, E3: The maximum inclination, E4: The down-end

Table 6. The angles of lower limb (deg)

Subjects \ Event		E1	E2	E3	E4
Skilled (n=6)	Hip	129.9±4.6	123.2±10.1	140.4±6.0	140.5±13.2
	Knee	146.7±8.2	127.4±10.4	141.8±5.8	129.7±13.2
	Ankle	124.1±6.2	95.5±11.6	121.8±7.0	100.6±10.21
Unskilled (n=6)	Hip	135.3±10.9	134.9±11.3	144.6±11.1	142.1±4.5
	Knee	136.3±4.4	130.9±4.1	145.5±6.5	129.2±9.6
	Ankle	114.1±5.9	103.7±6.1	121.2±8.3	94.2±12.3
t-value	Hip	-1.11	-1.88	-0.81	-0.26
	Knee	2.71*	-0.76	-1.04	0.08
	Ankle	2.82*	-1.52	0.12	0.97

*$p < .05$, E1: The up-start, E2:The edge change, E3:The maximum inclination, E4:The down-end

(124.1±6.2°) were greater than unskilled skiers (114.1±5.9°) at the up-start point (E1), similar to case of the knee joint. When the up-start point (E1) was compared by three different joints, no differences were observed. However, unskilled skiers were greater in a hip joint while skilled skiers were higher in knee and ankle joints with significant difference because up moves increase an angle by extending knees and ankles, compared to the motion of straightening the upper body at the up move. Large inclination happens at both edge-change point (E3) and down-end point (E4). In other words, proper pressure is applied to the skis, and decent inclination is maintained. After all, inclination is being formed to respond to centripetal force in a way to overcome ski trajectory-rotating centrifugal force. In terms of the moves for proper pressure on skis and an efficient next turn, there is an angulation move which reduces knee and ankle joint angles and put them toward the centripetal force direction. The knee-ankle joint angle differences between skilled and unskilled skiers further decrease knee and ankle joint angles at such angulation move. Even though it was predicted that they would increase the angle of the edge with inclination, no difference was found.

However, at the up-motion event (E1), unskilled skiers preformed an up move to reduce weight while skilled skiers took a down-move. Therefore, the knee and ankle joint angles were small, revealing a significant difference.

DISCUSSION

In terms of CG displacement changes against turns in skiing, horizontal displacement under a long turn moved to the left when skiers made a right turn from the left turn, showing decrease in numbers. A difference was found at the up-start point (E1). Skilled skiers leaned to the left further at the edge-change point (E2), revealing a significant difference. Regarding such differences between the two phases, because of influence of the previous move, the down-end of the previous turn shifted to the right farther in the skilled skiers than in unskilled skiers at the up-start point (E1). Such turn patterns revealed a difference until the edge-change point (E2). Then, a new turn was found from the maximum inclination point (E3) to the down-end point (E4). In the end, no difference was observed at the last phase (E4). It appears that skilled skiers were forced to go to the outside farther horizontally at the last turn, revealing no difference.

According to a study by Lee and Hyun (2003), vertical displacement under a long turn was 77.43±3.02 cm (up) and 62.6 ±3.27 cm (down) when carving long turn was analyzed, and the CG height difference was 17.02 cm. Therefore, in up-down moves, the CG difference is a measure to complete a turn with higher velocity. They also insisted that as the CG height differences are greater, it is easier to create more dynamic and flexible turns. Eun and Hyun (2010) insisted that The expert skiers minimized their center of mass height movement and maintained the width of between their feet after the passing the fall-line in comparison with the beginners and intermediate skiers. Min (1986) said that the CG should be increased to covert the CG in the beginning of turns, and that the CG height has to be the highest at the maximum inclination. He also insisted that the CG should be low to put body weight on the ski since then. Choi (1987) reported that CG changes are crucial in making turns in skiing. He also insisted that kinematic analysis is required on the range of motion for the CG shift. In addition, he analyzed the phase from the preparation for passing through a gate to the preparation for a next gate after completing the previous turn in analysis of turns in slalom. He said that reserve athletes would miss a next turn after failing to perform the CG shift smoothly. Moon (2003) discovered that in terms of up-down CG differences, parallel and carved turns were 16.8± 1.2 cm and 17.1±0.7 cm respectively. During an up-down turn, the CG differences were pretty same. In carved turns, however, the CG differences were large. He concluded that a complete carved turn can be made when the CG differences are large during an up-down move in making a carved turn. According to the above studies, vertical displacement was high at up moves and low during down-moves. When such differences were large, a natural and flexible move was completed. In addition, there were differences in vertical displacement. In this study, however, the CG between the two groups decreased little by little from the edge-change point (E2), but no significant difference occurred. In other words, there were no differences in vertical displacement. Even though such results were expected in a short turn, no differences in vertical displacement were observed in both short and long turns. It was originally anticipated that the CG displacement would rise by reducing weight upwardly, but no differences were found. The distance changes between the trajectory of the CG anteroposterior and horizontal displacement shifts and ski trajectory were greater in skilled skiers at the maximum inclination point, showing differences.

Sodeyama, Miura, Ikegami, Kitamura & Matsui (1979) found that the radius of CG curvature was small among skilled skiers but relatively large among unskilled skiers during a turn. Jo (2011) reported that in terms of a front turn rotating to the right during freestyle snowboard moves, skilled and unskilled skiers were 0.75±0.05 m and 0.45±0.07 m respectively, showing differences. In a back turn spinning to the left as well, skilled and unskilled skiers were 0.63±0.05 m and 0.36±0.04 m each, revealing differences.

To increase inclination, a certain level of velocity is required. As Kang (2000) insisted, the edge angle increases when inclination rises. To create larger edging, however, angulation is essential. It can be found in a knee joint angle. If both knee angle and inclination are large, the most appropriate arc can be drawn. In case velocity is also raised, the CG-trajectory difference becomes bigger, increasing the degree of inclination. Then, it would be idealistic to form an angulation form.

In term of velocity, skilled skiers were higher than unskilled skiers. In a long turn, the former was faster than the latter at the edge-change point (E3). At the down-end point (E4) as well, a significant difference was found.

Choi (1994) insisted that skiing speed is controllable depending on edging strength and degree of ski shaking. In addition, Kim and Lim (1996) concluded that there were speed differences because of resistance caused by vertical drag and friction and air resistance. Such speed is not like the speed of downhill in alpine skiing events. In fact, it is high enough to ignore air resistance. Therefore, it is reasonable to say that it is velocity difference resulting from friction. Min (1986) found that if the CG decreases, speed increases through kinetic analysis on turns in skiing. He said that speed can be increased if an upper body is bended forward, and the CG is lowered. Jo (2011) discovered that there were speed differences between skilled and unskilled skiers at the edge-change and maximum inclination points under a front turn and at the up-start, edge-change and the maximum inclination points under a back turn. In all cases, skilled skiers were faster.

Among velocity-related variables (air resistance, mass, friction), it is friction which can be discussed. Such friction factors include all turns except carving. It can also happen due to incorrect pivoting, sideslip or poor edge control. Furthermore, incorrect pressure control can cause sideslip and increase friction, reducing speed considerably. In terms of a hip joint angle under a long turn, skilled skiers were smaller than unskilled skiers at the up-start point (E1) and edge-change point (E2). It became almost same in both skiers at the maximum inclination point (E3), but no difference was found. Miura, Ikegami, Kitamura, Matsui & Sodeyama (1979) reported that during a turn, skilled skiers showed 158~170° in a hip joint angle, 140~142° in a knee joint angle and 165° in an ankle joint angle. In terms of the knee joint angle, skilled skiers (146.7±8.2°) were greater than unskilled skiers (136.3±4.4°) at the up-start point (E1) with a significant difference. It was mostly same in the remaining phases after the difference at the up-start point (E1). In terms of the ankle joint angle as well, skilled skiers (124.1±6.2°) were greater than unskilled skiers (114.1±5.9°) at the up-start point (E1). When the up-start point (E1) was compared with 3 different joints, no difference was found. However, a hip joint angle was greater in unskilled skiers while knee and ankle joint angles were greater in skilled skiers with a significant difference because such angles were increased by extending knee and ankle joints, instead of keeping the upper body straight during an up move. According to Ikegami, Miura, Kitamura, Matsui & Sodeyama (1979), the ankle joint-CG angle ranges from 25° to 30° when lined with the slope. In terms of torque generated during forward and backward leans, skilled skiers were greater than unskilled skiers. At both edge-change (E3) and down-end (E4) points, inclination is large, imposing a proper level of pressure on the skis. In addition, it is the down-move state where decent inclination is maintained. Furthermore, inclination is formed, responding to centripetal force to overcome trajectory-spinning centrifugal force. In terms of the moves for proper pressure on skis and an efficient next turn, there is an angulation move which reduces knee and ankle joint angles and put them toward the centripetal force direction. The knee-ankle joint angle differences between skilled and unskilled skiers further decrease knee and ankle joint angles at such angulation move. Even though it was predicted that they would increase the angle of the edge with inclination, no difference was found.

However, at the up-motion event (E1), unskilled skiers preformed an up move to reduce weight while skilled skiers took a down move. Therefore, the knee and ankle joint angles were small, revealing a significant difference.

Kim (1998) found that regarding the influence of ski move lessons on the coordinative structure of body fragments, hip, knee and ankle joint angles increased as those who haven't ever skied before practiced more. Hyun (1999) concluded that according to analysis of parallel turns, skilled skiers were greater than unskilled skiers in terms of the angle of ankle angulation during an up move while knee, hip and shoulder angulation angles were relatively low during a down move. He also found that during an up-down move, skilled skiers were greater than unskilled skiers in terms of differences in the CG height. He also reported that during an up move, skilled skiers were greater than less-skilled skiers in terms of the angle of ankle angulation at parallel movements. During a down move, on the contrary, shoulder, hip and knee angulation angles were small. During an up-down move, in addition, skilled skiers were greater than less-skilled ones in terms of differences in the CG height. Hyun (2000) also insisted that skilled skiers were far greater than less-skilled skiers in terms of the angle of ankle angulation during a pflug bogen down move. In a down move, on the contrary, less-skilled skiers were greater than skilled ones in terms of the ankle angulation angle. Furthermore, in terms of the shoulder, hip and knee angulation angles, skilled skiers were smaller than less-skilled skiers. In terms of differences in the CG height, in contrast, skilled skiers were greater than less-skilled ones. Jo (2011) found that in front turn, skilled and unskilled skiers were 125.3±17.1° and 146.1±8.3° respectively in terms of a hip joint angle at the up-start point. At the edge-change point, the angle was 137.3±8.6° (skilled skiers) and 153.7±7.8° (unskilled skiers). At the maximum inclination point, skilled and unskilled skiers were 152.6±5.2° and 160.3±2.2° each. At the down-end point, the angle was 130.4±12.1° (skilled skiers) and 147.4±10.0° (unskilled ones). In a back turn, on the contrary, the hip joint angle was 131.6±6.1° (skilled skiers) and 144.2±7.5° (unskilled ones). Lastly, in a back turn, an ankle joint angle was 74.0±4.9° (skilled skiers) and 92.8±14.0° (unskilled ones) at the down-end point. In terms of a hip joint angle, skilled skiers were smaller than unskilled skiers. During a back turn, the ankle angle was smaller in skilled skiers at the down-end point.

For edging, inclination is needed. Inclination should be given according to speed to stop the ski plate and produce edging. However, it is angulation which is more important than edging. In other words, angulation should be done first to produce bigger edging. The most critical element in producing angulation is lower limb joint angles. In other words, hip, knee and ankle joints should properly work in balance to produce angulation and increase the edge angle.

CONCLUSION

The study was started to promote understanding of ski turn behavior by describing it with kinematic analysis and to contribute to providing data for skiers and winter sports leaders to analyze ski turn posture systematically, rationally and scientifically. For this, a mean difference of kinematic variables (CG displacement, trajectory, velocity, Lower Limb Angle) was verified against a total of 12 skiers (skilled and unskilled, 6 persons each), regarding motions from the up-start to down-end points for long turns. First, the horizontal displacement of the CG during the ski turn was located on the right side at the point where the skilled begins the up at the long turn and the edge changes, and the difference between the CG and the ski trajectory differed greatly due to the large number of skilled persons. Second, the speed of the skis was fast at the point where the edges changed and at The maximum inclination point. Third, the angle of the hip joint was not different. In the knee joint, the angle was large at the point where the skilled began the up at the long turn. The ankle joint had a large angle at the beginning of the up-start point of the skilled at the long turn.

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