

# THE IMPACT OF CORE TRAINING IN FIGURE SKATING ON THE LOWER EXTREMITY KINEMATICS OF LOOP AND TOE LOOP JUMPS

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Received: 18.04.2017  
Accepted: 03.10.2017

## ABSTRACT

This study aims to investigate the impact of core training performed by figure skaters on the lower extremity kinematics of loop and toe loop jumps. Eight-figure skaters from the age group of 10-15 have participated in the study. The loop and toe loop jumps of participants were recorded by two Basler 100 Hz. cameras. 8,5,7. Simi motion analysis program was used for the analysis of movements. The calibration of the area was done by using the DLT method. The knee angle at the beginning of a movement, the knee angle after the jump and horizontal jump distance were taken into consideration. The participants have gone through one-hour core training three days per week, for a total eight weeks. The measurements were repeated after each training and pre- and post-training data were compared by Wilcoxon test in SPSS 20.0 package program.

Results show that the exit angle and exit distance of the loop jump have decreased after training ( $p < 0,05$ ). The movement made by narrower knee angle appeared to support the increase in the vertical jump, rather than horizontal jump. Therefore the use of core training in land-based training has a positive impact, especially in hitless jumps.

**Keywords:** Core training, Kinematics, Loop, Toe Loop Jump

## KOR BÖLGESİ ANTRENMANLARININ ARTİSTİK BUZ PATENİNDE LOOP AND TOE LOOP SIÇRAMALARDAKİ ALT EKSTREMİTE KİNEMATİĞİNE ETKİSİ

### ÖZ

Araştırmamızda artistik buz patencilere yaptırılan kor bölgesi antrenmanlarının Loop ve Toe loop sıçramalardaki alt ekstremitte kinematiğine etkisinin incelenmesi amaçlanmıştır. Araştırmamıza 10-15 yaş grubu 8 artistik buz pateni sporcusu katılmıştır. Deneklerin loop ve toe loop sıçramaları 2 adet Basler 100 Hz. kamera ile kaydedilmiştir. Hareketlerin analizlerinde 8.5.7 Simi hareket analiz programı kullanılmıştır. Alanın kalibrasyonu DLT yöntemiyle yapılmıştır. Harekete giriş esnasındaki diz açısı, sıçrama sonrası düşüşteki diz açısı ile yatayda sıçrama mesafesi değerlendirmeye alınmıştır. Denekler 8 hafta boyunca Kor bölgesine yönelik haftada 3 gün 1 er saat antrenman yapmışlardır. Antrenman sonrasında da ölçümler tekrar edilerek, antrenman öncesi ve sonrası dataların karşılaştırması SPSS 20.0 istatistik paket programında Wilcoxon Testi ile yapılmıştır. Loop sıçramasındaki çıkış açısı ve çıkış mesafesinin antrenman sonrasında azaldığı tespit edilmiştir( $p<0.05$ ). Daha dar bir diz açısıyla yapılan hareket ile yataydan çok dikey düzlemde sıçramanın artışına destek olmaktadır. Dolayısı ile kor bölgesi antrenmanlarının kara antrenmanlarında kullanılması özellikle vuruşsuz sıçramalarda olumlu yönde bir etki yaratmaktadır.

**Anahtar Kelimeler:** Kor Antrenman, Kinematik, Loop, Toe Loop Sıçrama

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## INTRODUCTION

The figure skating is a branch of sport that requires artistic skills, speed, power and applying techniques gained by intensive training over the years besides the physical force and condition<sup>6</sup>. The figure skating that is both an art and a sports branch is also evaluated in technical abilities and artistic expression<sup>1</sup>. There are six jumps in the Figure Skating<sup>4</sup> gathering the aesthetics and high-level technical skills in performance besides the physical and cognitive requirements which several sports branches include. These jumps are; axel, lutz, flip, loop, salchow and Toe loop. The jumps are performed as single, double, triple and quadruple. Furthermore, these numbers are the numbers of spinning in the air as well as accepted as an indicator of the progress. In addition to the exercises on the ice, different land training are performed to increase the number of spins<sup>6</sup>.

One of these training methods is the core area exercises. Core, namely the center area, is used to name the part consists of 29 different muscles including waist-pelvis-hip and belly and the balance of the body<sup>17</sup>. Being strengthened this area

mentioned affects the sports performance<sup>3</sup> core training can be performed individually and also it is a technique that provides the body stability and to strengthen the muscles in the lumbo pelvic area, while the deep muscles balance the spine<sup>24</sup>. Core muscles include the muscles in low abdominal and back regions and they are responsible for the transfer of power between the lower and upper half of the body. Core muscles play an important role in daily activities with respect to the health of low-back region, and furthermore, in fixing the spine during the weight lifting exercises<sup>7</sup>.

Providing control and continuity of the body stability is pretty essential to become perfect in the Figure skating. The biomechanical studies focused on improving the jump positions. Some of these studies deal with the effects of the training<sup>8,11,16</sup> while the others evaluate the contribution of the body positions to the jumping<sup>10</sup>.

The goal of our research is to review the effects of core area exercises performed in figure skating on the lower extremity kinematics in Loop and Toe loop jumping.

## MATERIAL AND METHOD

### Participants

The participants of the research is composed of 8 figure skating athletes in the 10-15 age group from Kocaeli Seka Kağıtspor. The mean age of the participants is  $11.42 \pm 1.55$  year; average weight is  $36.73 \pm 6.87$  kg; average height is  $1.39 \pm 0.1$ . Participants are selected carefully on the basis of having no disabilities that prevent the movements. Plus, the requirements of 1975 Helsinki Declaration have been met.

### Motion Analysis

After 15 minutes warm-up period on the ice, Loop and Toe loop jumps of the

participants before and after the eight weeks training were recorded by 2 Basler 100 Hz. cameras. DLT method actualized the area calibration by a Calibration cube with 0.3 m x 0,3 m x 0,5 m dimensions. The markers were placed on the 'Trochanter Major, Malleolus Lateralis, Epicondylus Lateralis' parts of the athletes and the athletes were asked to perform the Toe loop and loop jumps respectively. 8,5,7 Simi Motion analysis program was utilized to test the movements and the exit angle of the knee while entering to the move, drop angle of the knee after the jump, and the jump distance on a horizontal platform.



**Figure 1.** Calibration area

## Core Area Training

The participants performed core area exercises for 1 hour in every three days for a total eight weeks period. After all athletes participated in the study have completed pre-tests, they were informed about the Core-Stability Exercises and the application of the technique of the movements. All athletes performed Core-Stability exercises so as to be three exercises in a week during eight weeks in total. The training started at 16.00. After 10 minutes warm-up running, one unit exercise was performed for 45 minutes in addition to the 5 minutes warm-up exercises towards the Artistic Skating. Eight moves were organized as a station. These moves are; the plank (figure 2), oblique plank (figure 3), putting down and holding up the leg (figure 4 and figure 6), static leg and back (figure 5), superman (figure 7), supine bridge / back bridge (figure 8) and lunges with crossover (figure 9). An assistant was present during the exercises in each station. The assistant controlled the practices of the athletes and guided them as well.

**Table 1. Core-Stability Training Program**

	1st-2nd Weeks	3rd-4th Weeks	5th-6th Weeks	7th-8th Weeks
<b>The Plank</b>	30sec X 3set	45sec X 3set	1min X 3 set	1min X 3 set
<b>Oblique Plank Sağ</b>	30sec X 3set	45sec X 3set	1min X 3 set	1min X 3 set
<b>Oblique Plank Sol</b>	30sec X 3set	45sec X 3set	1min X 3 set	1min X 3 set
<b>Static Leg and Back Sağ</b>	30sec X 3set	45sec X 3set	1min X 3 set	1min X 3 set
<b>Static Leg and Back Sol</b>	30sec X 3set	45sec X 3set	1min X 3 set	1min X 3 set
<b>Lowering and Raising Legs</b>	30sec X 3set	45sec X 3set	1min X 3 set	1min X 3 set
<b>“Superman” Sol</b>	30sec X 3set	45sec X 3set	1min X 3 set	1min X 3 set
<b>“Superman” Sağ</b>	30sec X 3set	45sec X 3set	1min X 3 set	1min X 3 set
<b>Supine Bridge</b>	30sec X 3set	45sec X 3set	1min X 3 set	1min X 3 set
<b>Lunges with Crossover Sağ</b>	7figuresX 3set	15figures X 3set	20figures X 3set	20figures X 3set
<b>Lunges with Crossover Sol</b>	7figuresX 3set	15figuresX 3set	20figurest X 3 set	20figures X 3set



Figure 2. The Plank

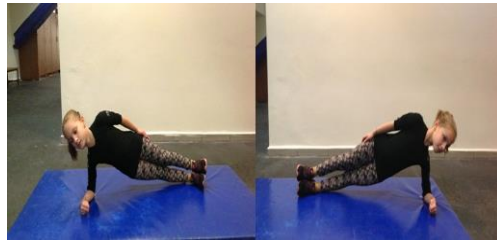


Figure 3. Oblique Plank



Figure 4. Putting down and holding up the leg



Figure 5. Static Leg and Back



Figure 6. Putting down and holding up the leg



Figure 7. Superman



Figure 8. Supine Bridge. Back Bridge.



Figure 9. Lunges with Crossover

### Statistical Method

By SPSS 20.0 statistical package software the pre- and post- test results

before and after of the core-stability exercises were compared. Moreover, Wilcoxon was utilized to determine the differences between the groups.

### RESULTS

Table.2 The results of exit knee angle while entering to Toe loop jump move (EKA), drop angle of the knee after the jump, and the jump distance on a horizontal platform.

	N	Mean±Std. Dev	p
TDistance1 (m)	8	0.91±0.14	
TDistance2 (m)	8	0.82±0,19	0.161
TExit angle 1(°)	8	131.1±9.81	
TExit anhle 2(°)	8	126.9±7.38	0.484
TAngle of knee 1(°)	8	125.9±13.16	
TAngle of knee 2(°)	8	128.2±16.05	1

As shown in Table 2, there is no significant difference in parameters in Toe loop jumps ( $p < 0.05$ ). According to the comparison of the situation after and before the training, there is a decrease in the exit angle of knee and the jump distance on the horizontal in Loop technique.

Table.3. The results of exit knee angle during entering to Ritthberger (loop) move, drop angle of the knee after the jump, and the jump distance on a horizontal platform.

	N	Mean±Std. Dev	p
LDistance1 (m)	8	1.01±0.27	0.036*
LDistance2 (m)	8	0.74±0.25	
LExit angle 1(°)	8	123.4±6.99	0.036*
LExit angle 2(°)	8	112.0±11.64	
LExit angle 1(°)	8	121.6±6.7	0.575
LExit angle 2(°)	8	122.8±9.17	

As shown in Table 3, there is found a statistically significant in the exit angle of knee and the jump distance in Loop jump. According to the comparison of the

## DISCUSSION AND CONCLUSION

This paper reviews the impact of the core area exercises on the lower extremity kinematics in Loop and Toe loop jumps of the artistic ice skaters. The decrement is determined in the exit angle knee and jumping on the horizontal in Loop technique ( $p<0.05$ ). This result shows that the movement performed by a narrower knee angle increases the jump on the vertical platform rather than the horizontal one.

King et al., (1994) compared the jumping distances single, double and triple axels jump and found that the jumping distance of triple axel is shorter in comparison with others. The jump distance for the triple axel is 15% shorter than the double axel. Similarly, the jump distance for the triple axel is 28% smaller than the single axel<sup>12</sup>. According to the study of Sharp, (1999), the biomechanical comparison of single toe loop and single loop jumps and differences are found in lower extremity between these two jumps during the exit and in flight. Considering this research, the movement width of the left knee and ankle is higher in Toe loop jump than the loop jump. There is no significant

situation after and before the training, there is a decrease in exit angle of knee and the jump distance on the horizontal platform in the Loop technique ( $p<0.05$ ).

difference in angular momentum and circular velocity in the maximum jump height<sup>20</sup>.

The results of the study indicate a positive relationship between jump stability and core muscle control. Moreover, the core area training is important for the jump performance in figure skating<sup>5</sup>. Akdeniz et. al. (2016) have investigated the impact of core training on vertical jump in ice skating and they found a statistically significant difference, implying that core training increases vertical jump distance ( $p<0.05$ )<sup>1</sup> In addition to this, the effect of 8 weeks core training for football players on the physical and physiological parameters have been analyzed in the research of Doğan et al., (2016). The results show that the core exercises have a positive impact on the vertical jump ( $p<0.05$ )<sup>8</sup>.

In the literature, the impact of core training on jump have been investigated through several branches. While some of these studies have not showed any significant effect<sup>9</sup>, the results of other studies indicate a positive impact on the performance<sup>3</sup>. In their study on core stability exercises and jumping performance, Sannicandro and Cofano

G., (2017) acknowledge the effect of the core training on 6 m jumping<sup>16</sup>. According to Sharma et al. (2012), the core training improves body stability and vertical jump parameters<sup>19</sup>. Yapıcı (2016) mentioned that the core exercises have a positive influence of running speed and jump performance<sup>24</sup>. One more constructive contribution to the core training on the long jump and vertical jump is stated<sup>21</sup>. Willson et al., (2005) argue that the core training programs can decrease the ratio of injuries. They also pointed out that maintaining the strength core area is essential for rebalancing after the perturbation and lumbopelvic hip complex to prevent the torsio<sup>23</sup>. In the study of Leetun et al. (2004), the weakness of core area appears to cause to the lower extremity injuries mostly in female athletes<sup>14</sup>. Another study by Sato and Mokha (2009) states that the core area training is an important method to avoid the lower extremity injuries in the long-distance runners<sup>18</sup>. The literature also underlines the importance of training exercises that emphasize eccentric or concentric muscle movements and are adaptable as asymmetric or as single-sided, for figure skaters<sup>13</sup>. Considering the structure of core area training, these exercises are claimed to have a positive impact on the performance of figure skaters. In their study on relative age effect, Baker et. al. (2014) found no significant difference between figure skaters born in the same year with respect to relative age effect<sup>4</sup>. Therefore, core training is

expected to have a similar positive impact on all figure skaters within each age group.

In a study on rehabilitation, Wang et. al. (2012) argue that core exercises are more useful compared to the general exercises<sup>22</sup>. Similarly, in a study on rehabilitation, Akuthota and Nadler (2004) assert that core exercises are capable of improving the performance<sup>2</sup>. The significant difference in loop jump can be considered parallel to these findings. On the other hand, the reason why there is no significant difference for toe loop jump can be related to the acquiring body stabilization with the hit. Porter et. al. (2007) study health problems of figure skaters and point out that problems can be considered in three categories, these are: acute musculo-skeletal injuries, chronic overuse injuries and medical problems especially in foot, ankle, leg, knee, hip, low back and upper extremity areas<sup>15</sup>. For this reason, core training is not only important for strengthening loop and toe loop jumps but also for providing an opportunity to athletes to maintain their sport life in a healthy manner.

As a result, core training leads to a decrease in the center of gravity by narrowing down the knee angles in loop jump. Core training also decreases the horizontal distance, hence it leads to an increase in vertical jump height. Transferring power to vertical rather than horizontal will make it easier for athletes to perform the movement as well as it will be effective in increasing the return tours.

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