Biomechanical Analysis of the Physical Effects of Riding the X-lider

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Abstract

The purpose of this study was to assess 5 different types of fundamental movements with X-slider and inline skate, through an examination of muscle activity patterns and kinematics. Visol DV Express program was used to capture the data, Kwon 3D 3.1 for windows was used to quantify the kinematical variables.

1) Straight motion exercise: rectus femoris, tibialis anterior, and gastrocnemius were active with the X-slider at the pushing leg phase. At the pulling leg phase, levels of hamstring and gastrocnemius activities increased. Inline skate used tibialis anterior and gastrocnemius as agonist muscles instead of quadricep groups. 2) Figure-8 exercise: X-slider produced high level of rectus femoris, tibialis anterior, and gastrocnemius activities. 3) Slalom exercise: X-slider activated many kinks of lower leg muscles especially crossing legs motion produced high adductor muscle activity. Tibialis anterior and gastrocnemius were mainly used for inline skate. 4) Rotation exercise: X-slider used most of lower leg muscles as if performing slalom. Gathering the legs together led to greater adductor muscles activity. Adductor muscle, tibialis anterior and gastrocnemius were used as agonist for inline skate. 5) While stopping: rectus femoris was highly used with X-slider and tibialis anterior and gastrocnemius were largely used with Inline skate.

Keywords: *X-lider, Inline skate, Kinematic, Motion analysis, EMG.*

1. Introduction

1.1 Need for Research

Nowadays health has become a major concern of the general public and so there is a huge interest in the various ways of exercising. Especially due to the modern lifestyle where people don't have the opportunity to do enough exercise, i.e. people are either sitting down at their desks or driving a car etc. Therefore fitness and diet have become major issues in America. Exercise must not only have the effect of losing weight improve the cardiovascular and skeletal-muscular system but enhance a person's aesthetic beauty and shape.

As people want excitement X-sports have became very popular, sports like inline skating and snow boarding are having increasing large numbers of people at their events. For example at the Seoul Inline competition there were over 50,000 people participation. One of the major drawback of these sports is the constant possibility of injury. However by riding the X-lider compared to other X-sports this risk of injury is hugely reduced. As riders feet are not fixated to the X-lider unlike other equipment, there is a huge increase in range of motion which strengthens the legs and the stabilizer muscles in the ankle and hip. This freedom of movement increases the ability of the rider to be able to ride and rotate in small areas.

Therefore, this study has been performed to verify the X-lider's safety and to investigate the effects of exercising with the X-lider.

1.2. Aim of Research

The purpose of this study was to compare muscle activity while straight riding, the figure of 8, Slalom, rotating on the spot and stopping for the inline skating and the X-lider. Through this the effects of exercising with the X-lider can be demonstrated.

2. Research Methods

2.1. Subjects

After explanation of the research and getting consent, 6 healthy males participated in this study, 3 with experience of riding the X-lider and 3 with experience in inline skating.

2.2. Experimental Equipment

1) **Digital Video Camera**: In order to calculate the kinematic variables 6 video cameras (3 HDR-FX1, 3 DCR-VX2100, Sony Corporation) recorded at 60 frames/sec with a shutter speed of 1/250 per sec.
2) **Electromyograph System**: The muscle activity was recorded by Noraxons wireless EMG system (NORAXON MyoResearch, USA) during the 5 different conditions.
3) **Analysis System**: Visol DV Express program was used to capture the data, Kwon 3D 3.1 for windows was used to quantify the kinematical variables. The level of muscle activity was analyzed by MR XP 1.04. (MyoResearch, NORAXON Corporation)

2.3. Experimental Procedure

Figure 1. Experiment in Action

Before attaching the surface electrodes the subjects the skin was appropriately prepared by shaving and the cleaning with alcohol. Then the electrodes were attached to the following muscles; rectus femoris, biceps femoris, adductors, gluteus medius, tibialis anterior and gastrocnemius. After enough practice each condition was performed three times and the motion was recorded by 6 video cameras.

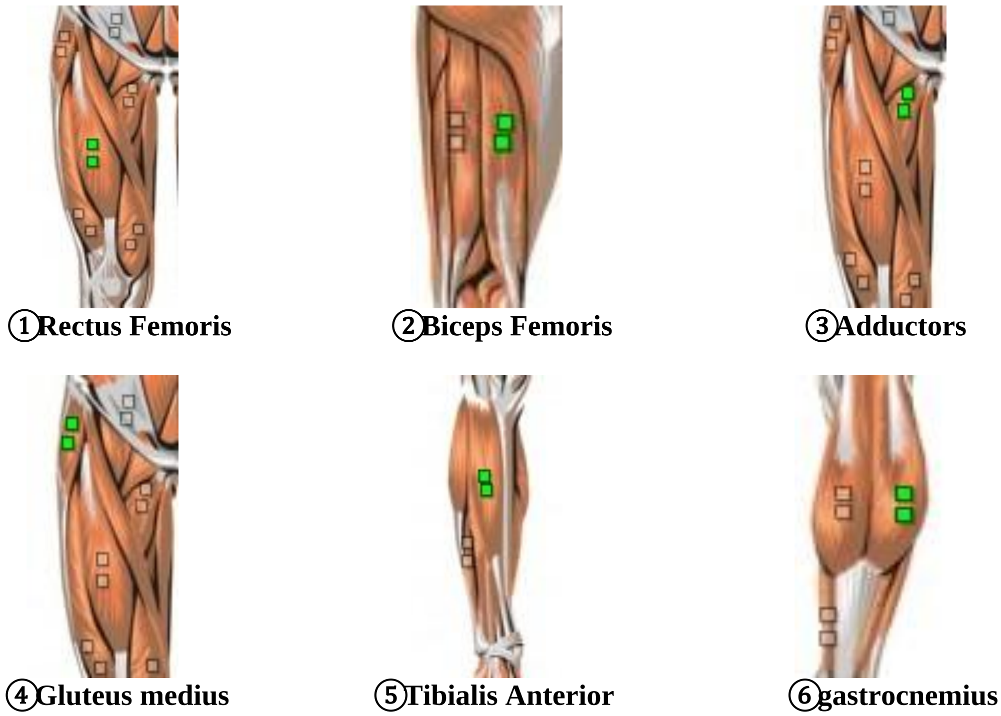


Figure 2. Positions of Electrodes

2.4. Data Processing

The data were processed by Kwon 3D V.3.1, MS Office Excel 2003 and Noraxon MR XP V.1.04.

1) Establishment of phases: Phases had to be established in order to analyze the 5 motions of going straight, figure of 8, slalom, rotating on the spot and stopping.

(1) Going straight - Phase 1: pushing with the right foot

Phase 2: pulling with the right foot

(2) Figure of 8 - Phase 1: The first half of the figure of 8

Phase 2: The second half of the figure of 8

Each figure of 8 was performed in the same direction.

(3) Slalom - Phase 1: The forward pushing and pulling motion of the right foot

Phase 2: The backward pushing and pulling motion of the right foot

(4) Rotation on the spot - From the start to the end of the rotation

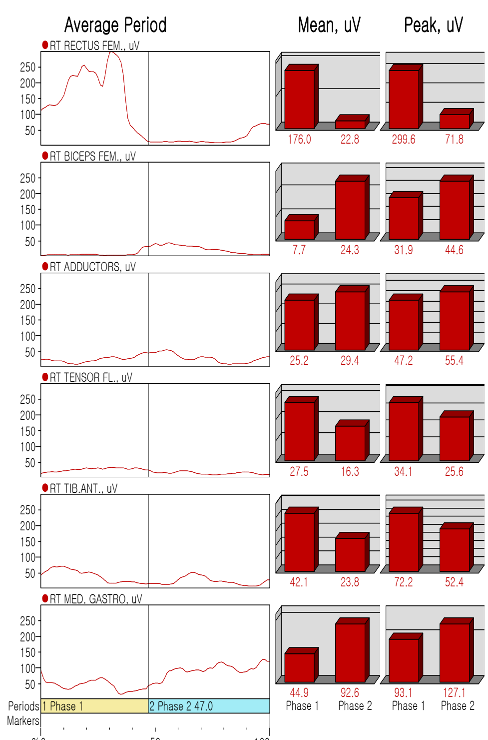
(5) Stopping - The initialization of the stopping procedure until the full stop.

3. Results

The EMG focused on the muscle's activity and the video was used to qualify the motion for the five conditions. The average period point on the graph divides the muscle activity into the two phases as mentioned above. The Y axis portrays the voltage recorded by the EMG and the higher this voltage the more active the muscle is. The bar chart on the right side of the figure shows average and peak value of the voltage.

3. 1. Going Straight

First by observing the X-lider muscle activation pattern during the first phase while the leg is pushing the rectus femoris is most active. Also the shanks muscles i.e. the gastrocnemius and tibialis anterior are used a little for the stability of the ankle. It can be seen that in the second phase, while the leg is pulling the biceps femoris and the gastrocnemius that there is a increase in muscle activity. This shows the characteristic of the X-lider it's pulling and pushing of the leg forward and back and so the major muscle goups are the rectoris femoris and biceps femoris. In addition the stability while standing on the X-lider is controlled by the gastrocnemius and the tibialis anterior. However, while inline skating the major muscle groups are the gastrocnemius and tiabilis anterior. The reason for this is the way in which the inline skates wrap around the lower leg and ankle and are fixated and so the muscle around the shank are constantly in tension. The inline skates are faster but if they are going at the same speed the X-lider requires more energy consumption.



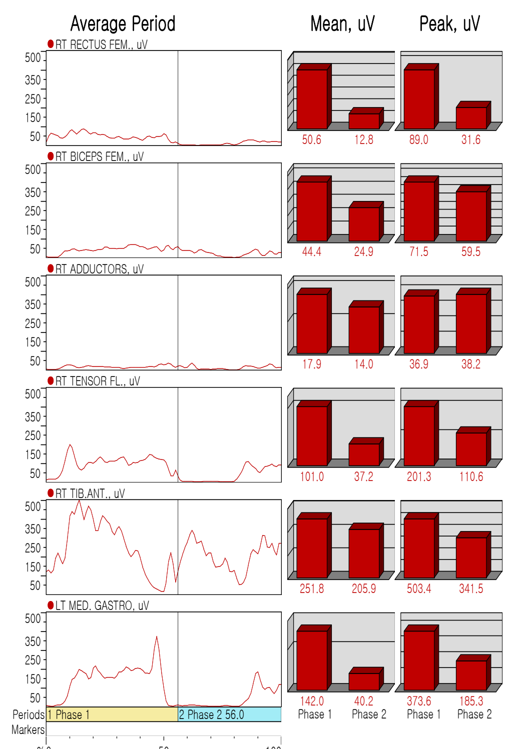
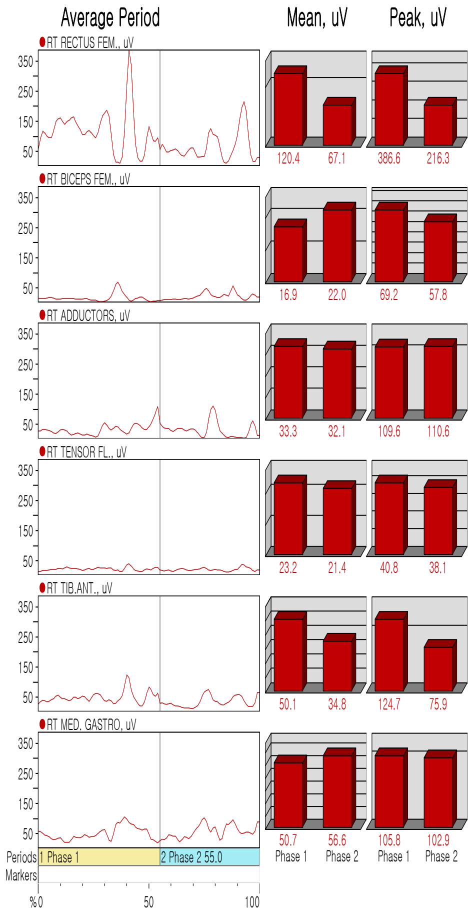


Figure 3. Muscle Activity Pattern while Going Straight Riding the X-lider

Figure 4. Muscle Activity Pattern while Going Straight Inline Skating

3.2. Figure of 8

Similar to going straight, the figure of 8 mainly uses the rectus femoris and biceps femoris for the X-lider and the gastrocnemius and tibialis anterior for the inline skating.



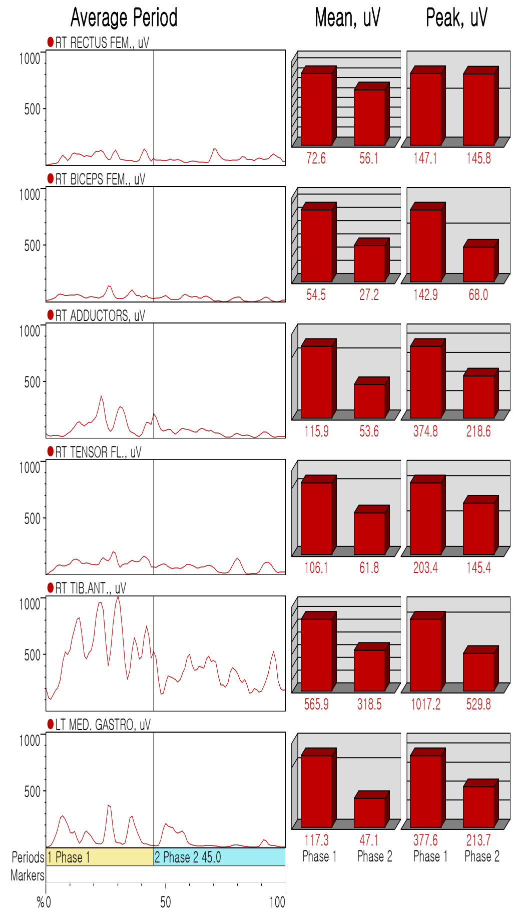
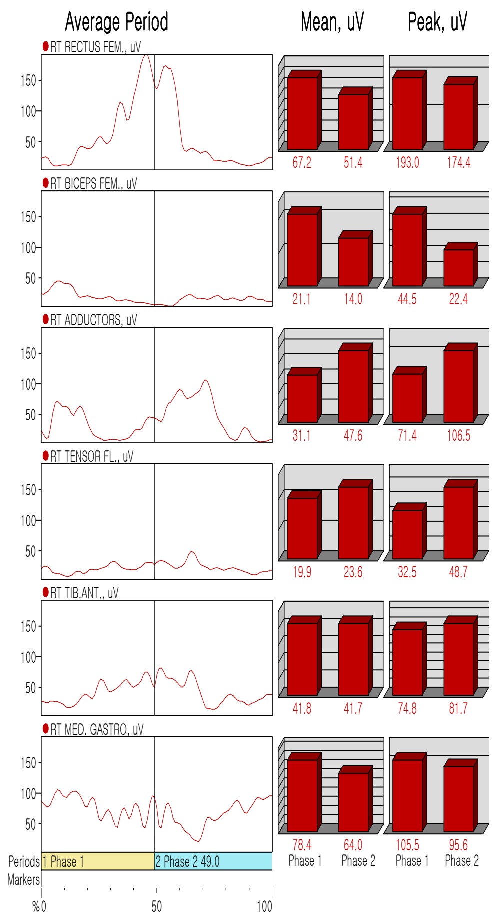


Figure 5. X-lider's Muscle Activity Pattern while Performing the Figure of 8

Figure 6. Inline's Muscle Pattern while Performing the Figure of 8

3.3. Slalom

Again similar to the going straight and the figure of 8, the slalom's muscle pattern shows that the adductors were highly activated the while the legs are moving forward and back in a crossing fashion. For inline skating the tibialis anterior was the major muscle involved in the motion, whereas for the X-lider both the thigh and shank muscles were in a state of high activation. For the Slalom motion balance must be sustained so as to be able to continue the motion. It was observed from the activation patterns that while inline skating there is a high muscle activation in the lower leg and so the subject feels tired quicker, whereas while riding the X-lider there is a more overall usage of both the shank muscles and the thigh muscles and so the rider doesn't feel as tired.



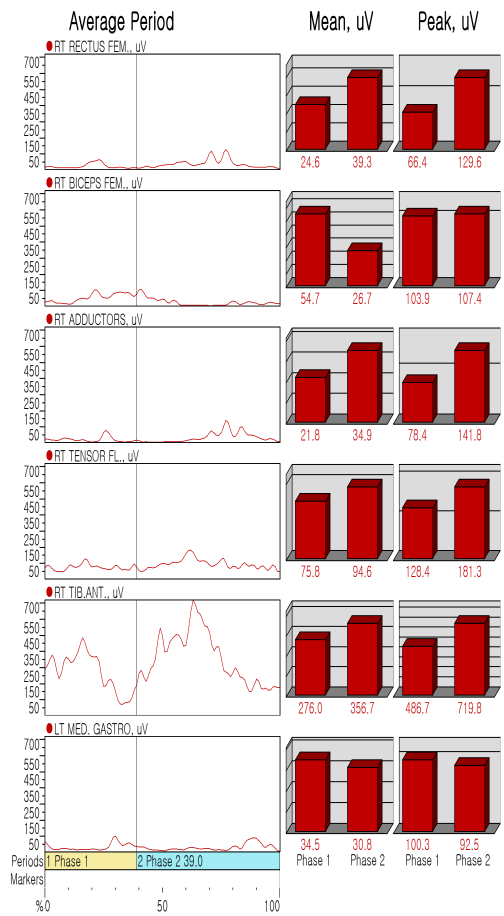
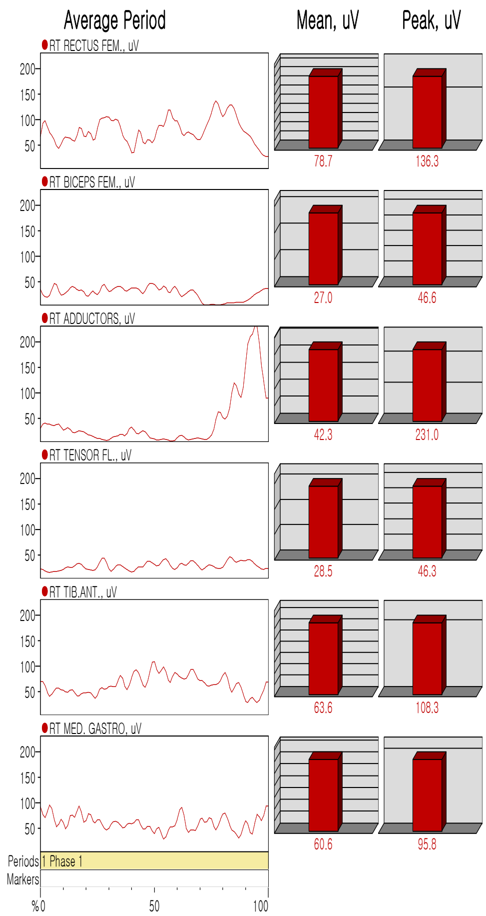


Figure 7. X-lider's Muscle Activity Pattern while Performing the Slalom

Figure 8. Inline's Muscle Pattern while Performing the Slalom

3.4. Rotating on the Spot

Again like the Slalom, the rotating on the spot's muscle pattern shows that while inline skating the muscles required are mainly the shank whereas for the X-lider both the shank and the thigh's muscles are involved. At the end of the rotation on the spot, the adductors muscle activation rapidly increases so as to prevent the spreading of the legs. For the rotating on the spot wearing the inline skate the motion was deemed to be unstable and dangerous. In comparison with the X-lider this motion could not be performed properly by any of the subjects. However with the X-lider the rotation on the spot with the minimum radius of rotation was performed smoothly and with stability.



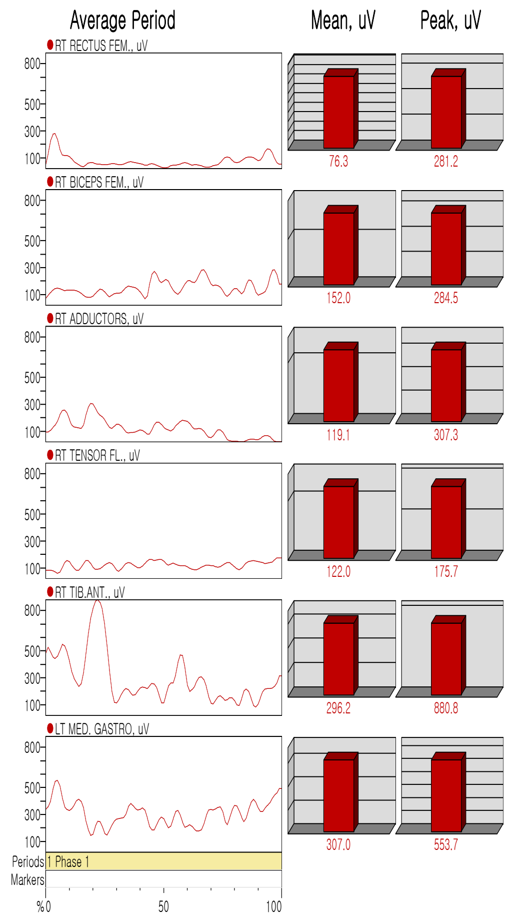
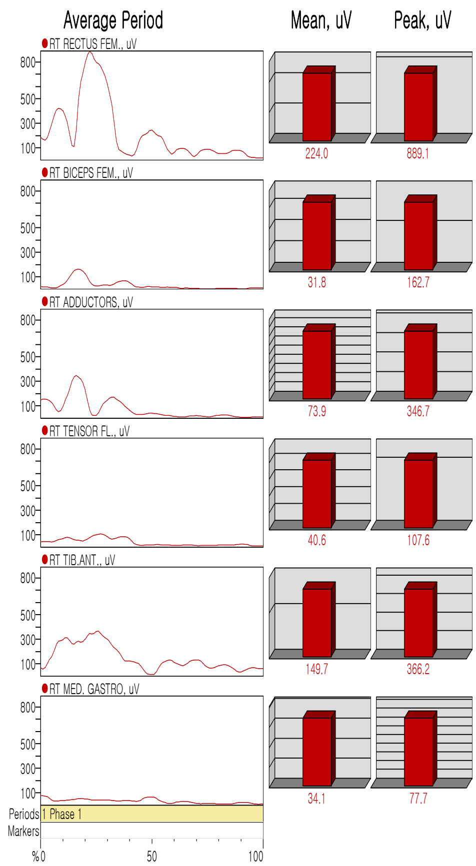


Figure 9. X-lider's Muscle Activity Pattern while Performing the Rotation on the Spot

Figure 10. Inline's Muscle Activity Pattern while Performing the Rotation on the Spot

3.5. Stopping

Again like the other motions the stopping muscle pattern shows that while inline skating the muscles required are mainly the shank whereas for the X-lider both the shank and the thigh's muscles are involved. For the inline skating the stopping procedure was not performed sufficiently due to the sliding before the complete stop. It was therefore deemed to be dangerous as abrupt breaking couldn't be performed. But for the X-lider the two feet came together and the stopping motion was completed very quickly. So by initiating the stopping procedure, the muscle activation rapidly increased for the rectus femoris, adductors, gluteus medius and tibialis anterior.



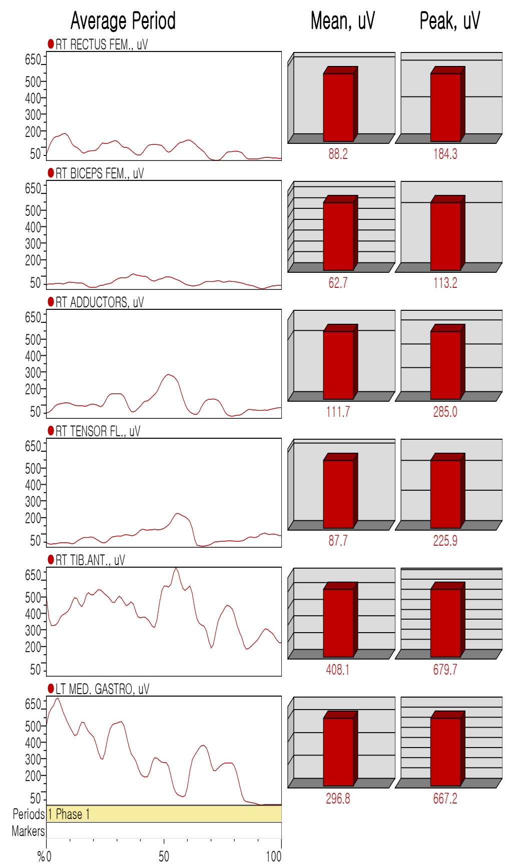


Figure 11. X-lider's Muscle Activity Pattern while Stopping

Figure 12. Inline's Muscle Activity Pattern while Performing Stopping

4. Conclusion

In general conclusion for the 5 motions, the X-lider required all the muscles of the lower extremities. As the foot is fixated to the inline skates the shank muscle are in tension and so they are highly activated. So it was concluded that inline skating was an exercise that depends mainly on the shank muscles, gastrocnemius and anterior tibialis. It is suggested that due to this focus of muscle activation a subjects will feel tired quicker and their balance will be restricted. In comparison the X-lider uses both the thigh's and the shank's muscles especially the muscles that are not used in daily living like the adductors and gluteus medius. Therefore this activation can create a good body shape and improve balance.

Additionally the X-lider compared with the inline skate's rotation on the spot and the figure of 8 motion was performed with a smaller radius of rotation, smoother and deemed to be more stable. With the X-lider more diverse motions similar to figure skating can be performed without the consideration of the place where to ride. Therefore a superior balance system can be developed similar to the performance of figure skating.

By using the X-lider diverse motions can be performed more easily and safer than other extreme sports.

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Significant Area of Interest: Sport Biomechanical analysis, Development and verification of sports equipment

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