FOUNDATIONAL RESEARCH FOR DEVELOPING SMART ANKLE BAND TYPE WEARABLE TO CORRECT UNEVEN LANDING WHILE JUMPROPING

[1]KYUNG-OCK YI, [2]NAM-JEONG SON, [3]HYUN-JUNG JUN

Collage of New Industry and convergence, EwhaWomans University
E-mail: [1]yikok@ewha.ac.kr, [2]namjeong.son@gmail.com, [3]synergy017@naver.com

Abstract - The purpose of this study was to develop smart ankle band type wearable to inform uneven landing while jump-roping. Subjects were five elementary school students who did not have muscularskeletal diseases within six months. Two IMU(CubeMotion,Korea) used todevelop "smart" ankle band type wearable. Peak acceleration of the right and left foot, right and left shank angle, and timingbetween two feet landings recorded. Students did jump-rope exercises while wearing theankle wearables for a five-minute period at 120bpm. There were three types of uneven landing: the difference between right and left shank angles, peak acceleration difference between right and left ankle, and the time difference between right and left toes touch the ground.Which of the three pieces of information will be effective for uneven landing correction will be a future task.

Index Terms - Smart ankle band wearable, jump-roping,unevenlanding, injury

I. INTRODUCTION

In schools, physical education classes and extra-curricular sports programs often incorporate jump-rope exercises. Jump-rope exercises have a number of health benefits, including increasing muscle strength, endurance, power, agility, and coordination within the wrists, erector spinae and lower extremities.This, in turn, promotes a more robust global and local core (Sangwan, Green, &Taylor, 2013). Additionally, it can help participants to correct poor posture (Kim 2015, Han, 2014, & Jung, 2016) and improve coordination between the upper and lower extremities.

As a communal exercise, jump-roping can foster positive peer-to-peer interactions in children through play (Goodwin, 1985). Positive social interactions and cognition (Kim, 2014) improve the psychological well-being of pre-adolescent and adolescent youth.
However, a pilot test in this project of 50 elementary school students revealed that over 95% of students jump unevenly, which suggests overall low levels of coordination. In addition, repeated uneven landings have been correlated with weak posture, pain, and discomfort after exercise completion. The possibility of injury also exists. Jump-roping in a forward direction while facing a mirror provides students with more visual information. This information can help students correctly align their right and left shoulder joints, RCSP (resting calcaneal stance position) (Han, 2014, Jung, 2016) and lower extremities (kim, 2015). That can improve efferent and afferent neurons through visual information. This results in control and coordination among muscles, tendons, and ligaments in the upper and lower extremities, especially the feet. This mechanism also develops muscle balance, including muscle force and muscle growth. These studies reflect that visual information and effective coordination between the four extremities were all vital for jump-roping properly. Jump-rope exercises also promote muscle recruitment, development, and strength in the feet and around the ankle joints.

As a result, the proprioceptive system and mechano-receptors may recruit more muscles, tendons and ligaments in the feet when jump-roping while barefoot. In recent years, people have begun wearing sports wearables. There are many kinds of sports wearables, including heart-rate monitors, pedometers, calorie monitors, and even devices which promote proper posture and sleeping habits. Of the various devices available on the market, wrist-wearables are the most common.

The purpose of this study was to analyze uneven landing with ankle wearables while jump roping.The results of this study could be used to develop self - training exercise and sports-related exercise applications. These studies will contribute to posture correction through jump roping. It will also contribute to enhancement of the fun of the exercise alone.

II. METHOD

1. Subject

Subjects were five elementary school students who did not have muscular-skeletal diseases withinsix months.Students wore ankle wearables which include IMU (CubeMotion, Korea). Students did jump-rope exercises while wearing the ankle wearables for a five-minute period at 120bpm.

2. Ankle wearable

The width, height, height and weight of IMU are 4cm, 3.3cm, 1.5cm, and 20g, respectively (Fig.1). The length and width of the band are 30 cm and 8 cm, respectively, and the IMU can fit into it by putting it in

the middle of the band (Fig.2)



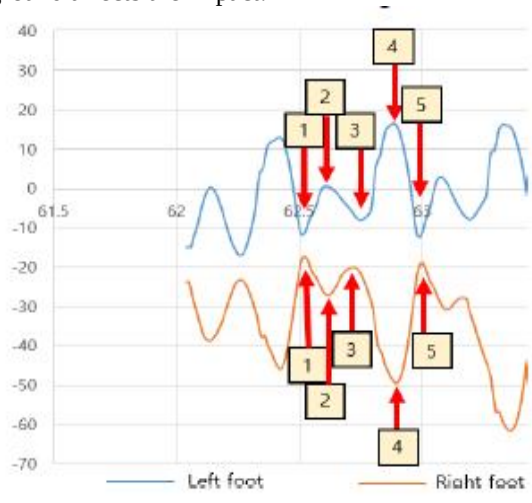
Fig 1. IMUFig 2. Band with IMU

3. Variable

Two IMU were used to develop "smart" ankle bands in order to determineuneven landing during jump rope activities. Shank angle and timing between the right and left foot at the moment of toes touch the ground during landings were recorded. Maximum acceleration between the right and left foot at the moment of heel touch the ground during landings were recorded.

4. Shank angle definition

Right and left shank angles in the sagittal plane were measured. On the sagittal plane, when the vertical line was drawn with respect to the center of the lateral malleolus of the ankle against the ground, the angle of the shank was presented every time. From the angle graph, two imbalances and fatigue phenomena can be predicted from the difference between the maximum and minimum bending angles of the right and left shank, and the pattern difference. Graph 1 showed that two peaks appear continuously (2,4 in Graph 1). The first peak (2) was small and the second peak (4) was large. The first angle (2) was the maximum angle of the shank pressed down before it jumps. The second peak (4) was the maximum angle of the shank in the air. The angle at which the toe touches (5 in the Graph 1) the ground surface was shown on the screen. This was because the moment when the toe touches the ground affects the impact.



Graph1. Shank angle during jumping rope

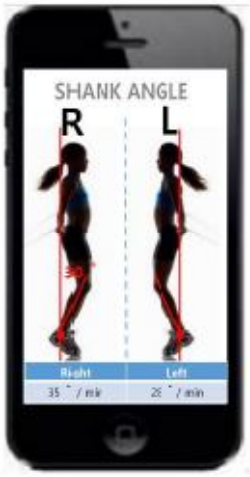
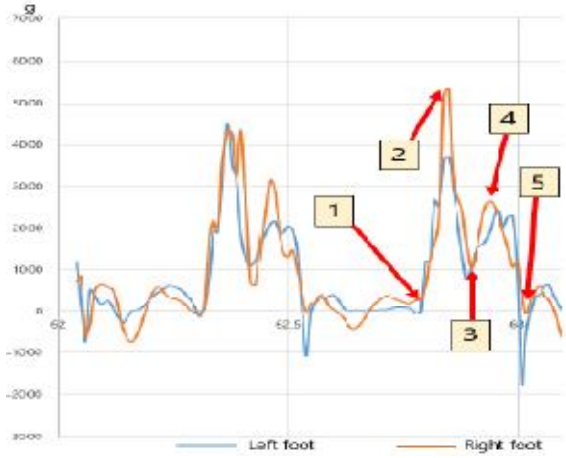


Fig3. Example for the shank angle at the moment toes touch the ground

5. Acceleration

The asymmetric behavior was explained by showing the difference in the maximum accelerationvalue (2 in Graph2) of the two feet at the moment of heel touch on the ground during landing (Graph2). The maximum acceleration value of the feet was calculated as a ratio and displayed as a bar graph (Fig 4).



Graph 2. Acceleration during jumping rope

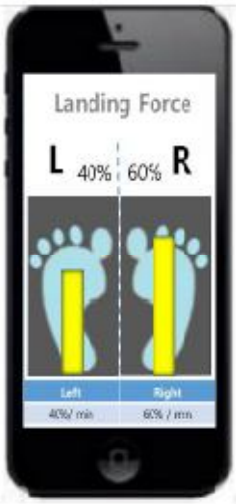


Fig 4. Example of the landing force ratio between two foot

6. Landing time difference

The time difference of the moment when two toes hit the ground was calculated from the acceleration graph. During the jump rope, the number of foot touching the ground first was displayed on the screen at intervals of one minute.



Fig 5. Number of feet first touching the ground per minute

7.Smart ankle band design, functionality, and emotional evaluation

Smart ankle band design, functionality, and emotional evaluation were performed for uneven landing correction during jumping rope via questionnaire.

III. RESULT

1. There were three types of uneven landing: the right and left shank angle difference, right and left ankle maximum acceleration difference, and the time difference between right and left toes touch the ground.

2. Which of the three pieces of information will be effective for uneven landing correction for thestudents will be a future study.

3. These data will be useful as a basis for developing applications. Application development will be done in a follow-up study.

4. Smart ankle band design, functionality, and emotional evaluation were performed for uneven landing correction during jumping rope. The students evaluated that the weight of the band was heavy, thick, and large so it was uncomfortable because of high frictional force when they were jumping rope. Later, it is necessary to develop wearable ankle band type that is lighter, thinner and smaller in size.

REFERENCES

[1] Y. N. Kim, “The Immediate Effects of Jumping Rope on the Posture and Dynamic Balance According to Visual Information”, Major in Exercise and Sport Science, Graduate School, EwhaWomans University, 2015.

[2] J. Y. Jung, “The Immediate Effects of Jump Rope with or without visual feedback on Foot deformation and Lower extremity alignment correction of a flatfeet, Theses, Master”,EwhaWomans University, 2016.

[3] H. J. Kim, “The Effects of Jumping Rope According to Surface Type on Physical Fitness and Concentration in Intellectually Disabled Adolescents”,Major in Exercise and Sport Science, Graduate School, EwhaWomans University, 2014.

[4] Y. R. Han, “Immediate effect of jumping rope on upright posture alignment”Korean Association of physical Education and Sports for Girls and Women, pp.127-128, 2014.

[5] Marjorie Harness Goodwin Source, “The Serious Side of Jump Rope: Conversational Practices and Social Organization in the Frame of play”, The Journal of American Folklore , Vol. 98, No. 389 pp. 315-330, 1985.

[6] S. Sangwan, R. A. Green, N. F. Taylor , “Characteristics of Stabilizer Muscles: A Systematic Review”, Physiotherapy Canada,vol. 66, No. 4, 2013.

★★★