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The Influence of Compression Stocking on Jumping Performance of Athlete

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Abstract. Evidence of compression stocking effectiveness are mixed, with some researchers suggests that the stocking can enhance performance while others dispute the finding. One of the factors that are thought to cause the mixed results is level of pressure used in their studies. This research had organized a test on fourteen athletes. Their body was scanned and a customized compression stocking which can exert pressure correspond to the intended one was developed. An experiment was conducted to measure the effect of wearing compression stocking on jumping performance. The results show mixed outcomes. For the female athlete, there is a significant difference between wearing and not wearing compression stocking ($p<0.05$) on knee power. However, there is no significant difference for male athletes whether wearing or not.

1. Introduction

A compression stocking is a garment that is used to enhance the performance of athlete, to prevent injury and to improve their recovery process. It works by enhancing lactate removal, reducing muscle oscillation and positively influencing psychological factors. Although there are journal papers have discussed their effectiveness on enhancing performance (i.e. [1] [2][3][4]), others researchers dispute the finding (i.e. [5][6]). [7] suggests that the level of pressure used in the experiments as the cause for the variation. This is because all the conducted experiments used compression stocking that is made by mass production method. The drawback of the stocking developed by this method is the level of pressure that the compression stocking applies on the leg is sometimes too high or too low because it was made based on common size. The problem can affect the performance of the stocking and consequently to the athlete. Fitting is important in a compression stocking, as it determines the pressure for effective performance. Even though there is no agreement between researchers as to the exact pressure that needs to be applied by a compression stocking, most believe that pressures between 20 mmHg to 40 mmHg are required [7]. [8] had developed a method to design a customized compression stocking using body scanner. This research used the method to develop a customized graduated compression stocking (Figure 1) and investigated the effect of wearing it on jumping performance.

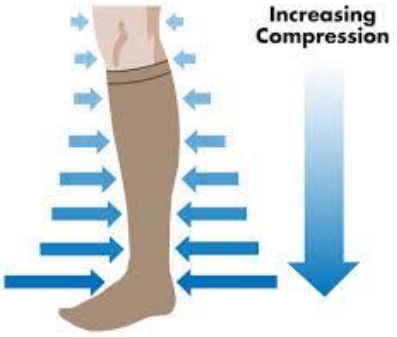

Figure 1: Graduated Compression Stocking (GCS)

2. Methodology

Fourteen active and healthy male and female subjects (7 male and 7 female) were selected from Universiti Utara Malaysia (UUM). They were scanned by using a three dimensional $[TC]^2$ NX12 body scanner. Then, a compression socks for the scanned body parts was constructed. The socks were designed to exert 37.5 mmHg (5000 Pa) at the ankle and gradually reduce to 22 mmHg (3000 Pa) at knee. Method to develop the compression stocking is explained in [8]. Basically, a 3D horizontal type body scanner is used to extract 3D (x, y, z coordinates) raw data of the athlete's body. Then, the data is processed and a 3D compression stocking model is developed. A 2D stocking's pattern was generated from the 3D model. The pattern model was printed out and compression stockings with an exact shape and size were cut from the fabric with margins for sewing purposes. Before the pattern was cut, the paper patterns were aligned on the fabric so that the fabric pattern was mostly made from straight yarn. The pattern has then been sewn together to make the compression stockings.

The exercise experiments were conducted at Biomedical Laboratory, School of Mechatronics Engineering, University Malaysia Perlis (UniMAP). Before the experiments, the subject's anthropometric data were collected to make sure they fulfill the criterion needed. Kinematics data throughout the trial were collected using 5 Oqus cameras (Qualisys Motion Capture System, Gothenburg, Sweden) sampling at 120 Hz. 15 numbers of passive-reflective markers were placed on subject's both lower limbs. The subjects were briefly explained about the purposed of the study and experimental procedure according to the protocol. Before each trial, the subjects were asked to perform an adequate stretching exercise and warming up. Then, a practice session of the jumping exercise was held for each subject prior to experiment until they feel comfortable with the movement. The practice is to ensure that the jumping exercise is conducted in a correct manner. A two seconds static trial was recorded with the subject standing still to create an anatomical reference frame for each limb segment. Markers placed on bony landmarks (medial and lateral malleolus, lateral and medial tibial plateau, lateral and medial femoral condyles, greater trochanter, anterior and posterior superior iliac spine, and the iliac crest) during the static trial were used to establish the tibial, femoral and pelvic anatomic coordinate systems. In dynamic trials, some of the markers used in the static trial were removed except markers at the foot and cluster markers were placed at the thigh and leg for motion tracking purposes. Subjects were asked to jump three times with and without the compression stockings. A clear verbal instruction was given to start the jumping. Three output parameters were analyzed to understand the effect of wearing compression stockings on athlete jumping performances. There are knee powers, geometric entropy and ratio of maximum vertical over maximum travelled jumping distance.

3. Results

a) Knee power

Comparison between the effect of wearing compression stocking on knee power for male and female athlete are shown in Figure 2. Figure 3 shows the comparison effectiveness of wearing compression stocking on mean knee power output for male and female athlete.

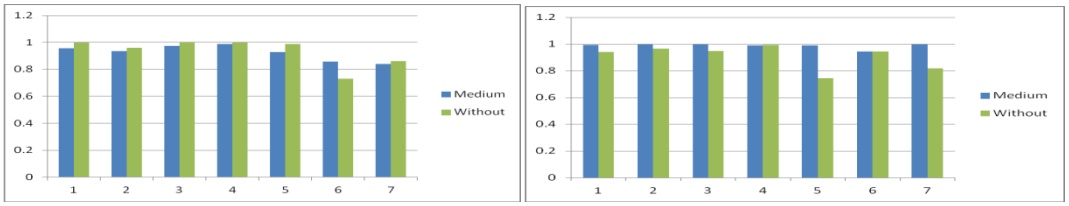

Figure 2: Comparison between the effects of wearing compression stocking on knee power for male and female athlete

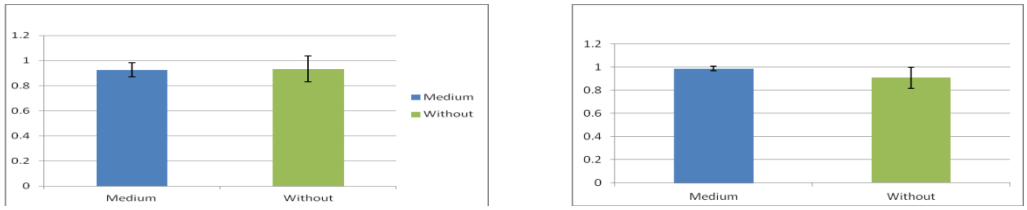

Figure 3: Mean knee power output for male and female athlete

b) Geometric entropy in XY plane

Figure 4 shows the geometric entropy for male and female athlete. Figure 5 shows the mean of the entropy.

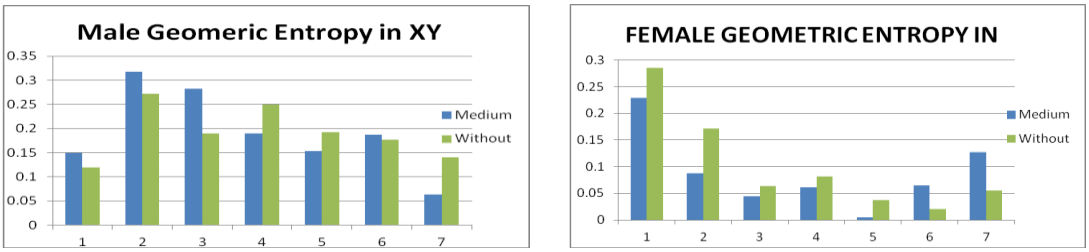

Figure 4: Comparison between the effects of wearing compression stocking on geometric entropy for male and female athlete

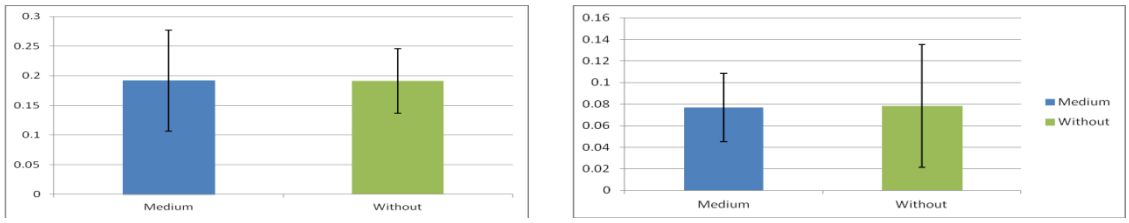

Figure 5: Mean geometric entropy output for male and female athlete

c) Ratio of maximum vertical over maximum travelled jumping distance

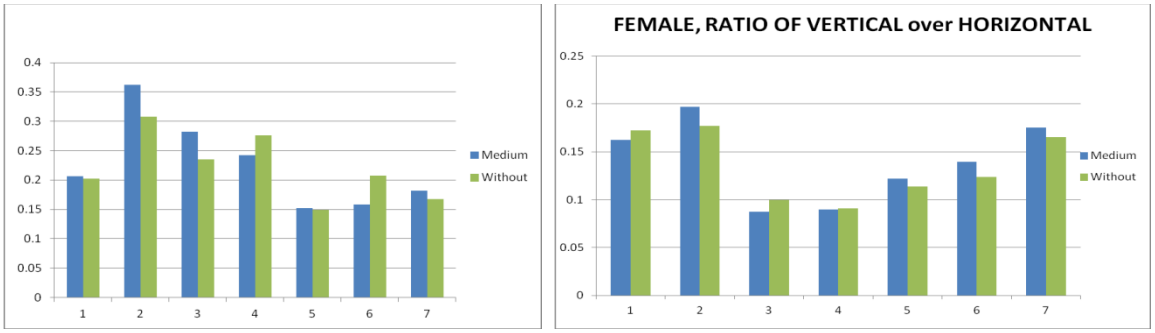

Figure 6: Comparison between the effects of wearing compression stocking on maximum vertical over maximum travelled jumping distance for male and female athlete

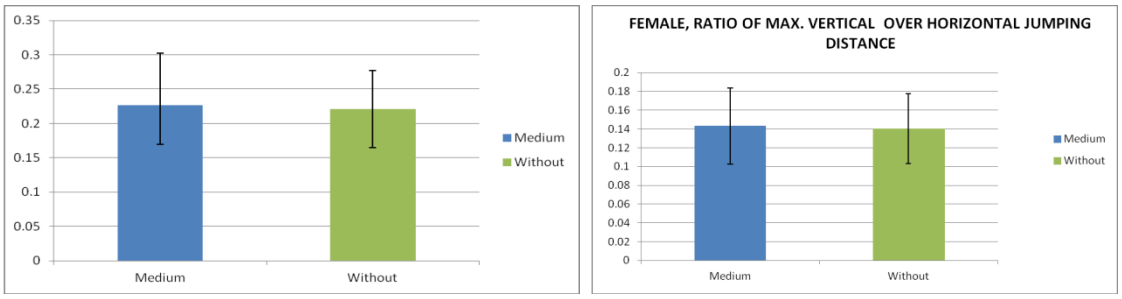

Figure 7: Mean ratio of maximum vertical over maximum travelled jumping distance output for male and female athlete

4. Discussion

There is no significant differences between wearing and not wearing compression stocking ($p<0.05$) on knee power for male athletes. However, for the female athlete, there is a significant difference between wearing and not wearing compression stocking ($p<0.05$) on knee power. The reason is thought to be because for male athlete, the muscle contour is relatively less changes compared to female athlete. Thus, consequently there is less difference between wearing and not wearing compression stocking on knee power of male athlete. However, for female athlete, since by wearing the compression stocking will reduce their muscle movement, thus it will increase their knee power. Perhaps it also relate to the perception of the athlete since their feel more comfortable to jump when their muscle are grip.

Comparing male and female athlete, there is less value of geometric entropy in female athlete than male which shows that less chaotic movement of female athlete shank during jumping. Perhaps, the chaotic movement was influenced by the initial jumping stage momentum where male shows higher initial momentum compare to female case. Although there is a difference value in geometric entropy between genders, however, there is no significant different of geometric entropy between wearing and not wearing compression stocking. The reason is perhaps because the pressure provided by the stocking did not influence the movement of shanks.

Meanwhile, the ratio of maximum vertical over maximum travelled jumping distance in male athlete is relatively higher than female athlete. The reason is thought to be cause by the higher initial jumping momentum and muscle strength in male subjects. In term of wearing and not wearing compression stocking, there is no significant different ($p<0.05$) of ratio of maximum vertical over maximum travelled jumping distance. The reason is perhaps the pressure provided did not influence the ratio much.

5. Conclusion

This research has studied the effect of wearing customized compression stocking on jumping performance. The stocking was designed and constructed for individual athlete using a developed system and then, experimentally tested. The results show wearing the stocking may help increase female athlete's knee power, but it not affected male athlete as well. Other analysis on geometric entropy and ratio of vertical and horizontal jumping also show no significant difference between wearing and not wearing the stocking.

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