THE EFFECT OF TAPING ON MOTION AND PLANTAR PRESSURE DURING ANKLE INVERSION

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Abstract: In the field of the sports science and the clinical medicine, taping of ankle joint has been often applied to prevent the injury of ankle sprain by fixing the ankle joint tightly. While the motion of ankle joint would be limited and changed with taping, there are quite a few reports about the change. In order to clarify effects of the taping and to examine characteristics of the ankle taping, we had constructed a system to measure the distance between the metatarsus first head and the floor with a 3D motion analysis system, and to measure planter pressure pattern during the ankle inversion with pressure monitoring system. When the subjects were instructed to ankle inversion as much as possible, obvious differences were found in the distances and pressure patterns.

1 INTRODUCTION

In the field of the sports science and the clinical medicine, ankle taping is one of the most common methods for supporting the chronically unstable ankle. Not only the medical techniques but also the engineering science techniques have been associated with evaluating the ankle inversion mechanism.

There are various reports conserving ankle sprain occurrence. Focusing on the high rate of ankle sprain occurrence in athletes, Katherine (2007) investigated useful information for analyzing the acute and chronic lateral ankle injuries. Gleen (2009) investigated methods of evaluating both the injure and the optimal treatment, and deciding the time when athlete could return to play. On the other hand, Willems (2005) had indicated that it is necessary to pay the special attention to gait patterns and foot biomechanics for effective prevention and rehabilitation of subjects at the risk of sprain.

Computer simulations were performed using the muscle model, to evaluate the mechanism of ankle sprain and the relationship between ankle sprain occurrence and foot position at touch-down phase (Wright, 2000). In addition, Chung-Li Wang, (1995) investigated how foot position and ankle arthrodesis could affect the characteristic of subtalar joint by measuring the pleasure of this joint in specimens of amputated lower legs. Moreover, the supination of ankle is associated with joint motion of three planes. Yue-Yan (2008) had examined the experiments where subjects were instructed to performed simulated ankle sprain trials with five different degree of ankle joint angle. In the index for injure prevention and rehabilitation of ankle sprain, Wei-Hsiu Lin (2009) studied the comparison of unilateral eversion to inversion strength ratio. On the other hand, Patrick J. (2007) examined the idea that the strain of the peroneal nerve caused by nerve traction is sufficient to cause nerve injure, with increasing the weight of anterior talofibular ligament.

With respect to ankle taping, the scientific evidence of taping in the preventation of injure to the lateral ligament ankle was studied with interview of any number of athletes (Firer, 1990). The taping effect during the gait phase was tested using both insole plantar pressure and 3-D motion analysis (Kieran, 2008). On the other hand, anecdotal reports suggested a role of the belief among athletes that taping will protect from injury, so there is a study to determine whether there was a placebo effect with ankle taping in individuals with ankle instability (Kate, 2007).

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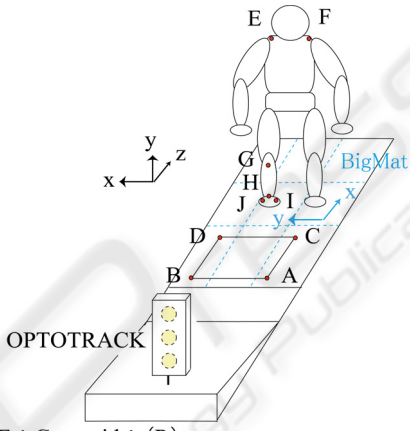
Although ankle taping is effective in the prevention of ankle injuries, the characteristic of ankle taping have not been fully understood, in particular, by considering the distance between the metatarsus first head and the floor as well as the planter pressure during the ankle inversion. It is necessary to measure these items for investigating quantitatively the effectiveness of ankle taping.

In the present study, we focus on the condition or the physical state of causing the sprain easily, considering the possibility that the taping could play the role of taking the place of the ligament. We construct a system to measure the distance between the metatarsus first head and the floor with a 3D motion analysis system, and to measure planter pressure pattern during the ankle inversion with pressure monitoring system.

2 METHOD

A convenience sample of 3 healthy subjects volunteered to participate in this study. Subjects with an adverse skin reaction, with a lower limb injury in the past six months, or who were unable to walk pain free were excluded. Taping was applied only to the right foot of each subject. The subjects were instructed to expand the foot at the breadth of their shoulders level in standing position. For overextending their ankle with inversion of the foot, their inversion of the foot increased. They had kept their ankle at the maximum joint angle until the end of measurement. The measurement time was ten seconds. The effectiveness of the ankle taping was examined with the measurement equipment (Fig. 1).

Kinematic data was acquired using a OptoTrack motion analysis system. This system calculates joint angles based on skin marker positions. Markers were positioned on four points (A,B,C,D) in the floor plane, right and left coracoides (E,F) measuring the shake of the body, 10 cm under the center of patella measuring the movement of the knee joint (G), the middle point of medial malleolus and lateral malleolus which measured the shake of foot joint (H), metatarsus-fourth head (J) and metatarsus-first head which marker measured the varus extent of foot joint (I). Subjects were instructed to look at a distant to prevent them from looking down at the floor. The subject performed 3 cycles with the tape and 3 cycles without the tape. 3D motion data was collected at 50 Hz for 10 seconds while the subject was performing the instructed motion. Data analysis plantar pressure data was collected and analysed using Matlab software. The coordinate system in an optotrack was explained: The direction that moves from the left to the right is *x* axis. A vertical direction to ground is *y* axis. The direction going directly to *x* axis and *y* axis is *z* axis. In this system, motion of the ankle was measured with a motion analysis, this one calculate the distance between the light source of OptoTrack and markers. In that case, if the OptoTrack was located on vertical position to the ground, the marker was sometimes not recognized, so the OptoTrack was placed at slope.



E：Coracoid：(R)
F：Coracoid：(L)
G：Patella-Center under 10 cm
H：Center of Medial malleolus and Lateral malleolus
I：Metatarsus first head
J：Metatarsus fourth head
Optotrack marker

Figure 1: Outline of measurement apparatus.

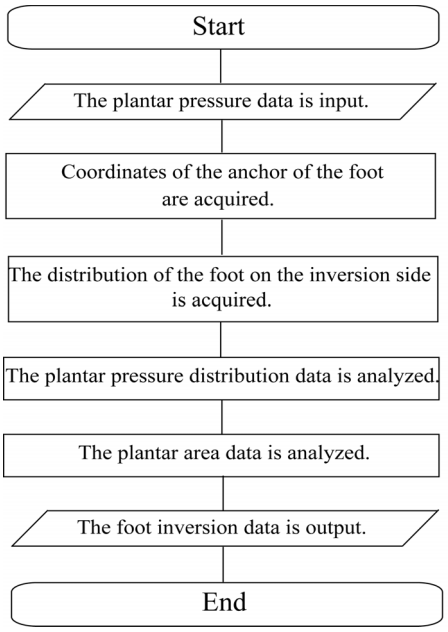
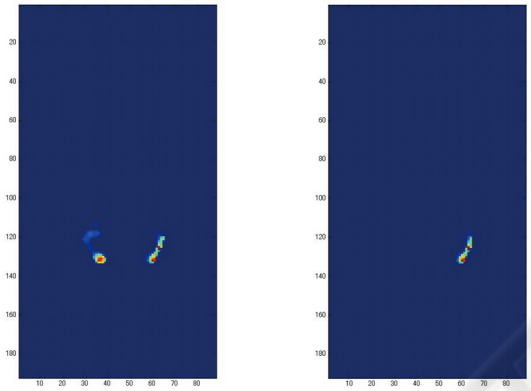


Figure 2: Algorithm of distribution analysis of planter pressure.

The BigMat, a computerised sensor system, was used to measure planter pressure. Planter pressure data was collected at a frequency of 50 Hz. Figure 2 shows the outline of analytical processing that uses BigMat. We used Matlab to analyze the planter pressure. All data of the planter pressure measured for ten seconds is added. We confirm the anchor of x axis and y axis by using this added data. We make the function. This function extracts only the part of the changing planter pressure by mask processing. Figure 3 shows this processing. We use this function. This function outputs the change in planter pressure distribution and that of planter area. The object is a side where a reactionary work in foot joint was done.



(a) (b)

Figure 3: Analytical processing of planter pressure distribution.

3 RESULT

Motion of unilateral right ankle is shown in Fig. 4. The not taped motion of the metatarsus-first head (I) is shown at Fig. (a). The tapted motion of the metatarsus-first head (I) is shown at Fig. (b).

In Fig. (a), without using the ankle taping, increasing the ankle inversion angle causes increasing the distance from the marker (I) of the ankle to the plane of the floor. The maximal distance from the marker point of I to the plane of the floor (A, B, C, D) is 3.0 cm. In Fig. (b), with using the ankle taping, increasing the ankle inversion angle causes small increasing the distance from the marker (I) of the ankle to the plane of the floor. The maximal distance from marker point of I to the floor (A, B, C, D) is only 1.5 cm.

The peak planter pressure on the right ankle is shown in Fig. 5. About planter pressure distribution of experimental results without using ankle taping, increasing the ankle inversion angle caused

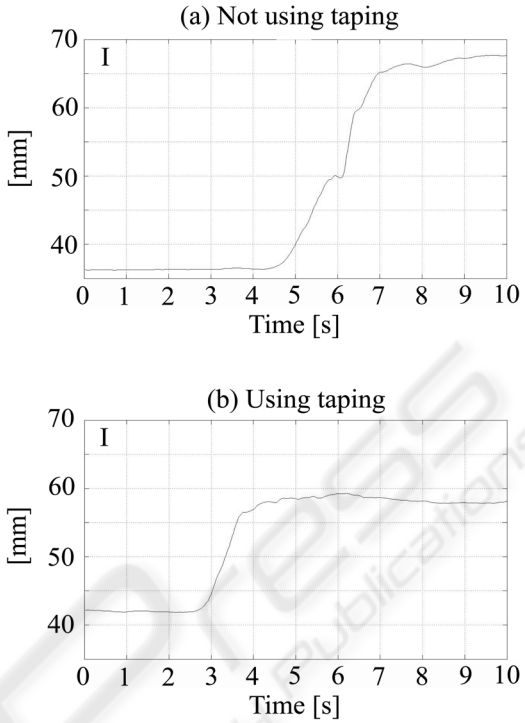


Figure 4: The measurement result of the joint angle where OptoTrack was used.

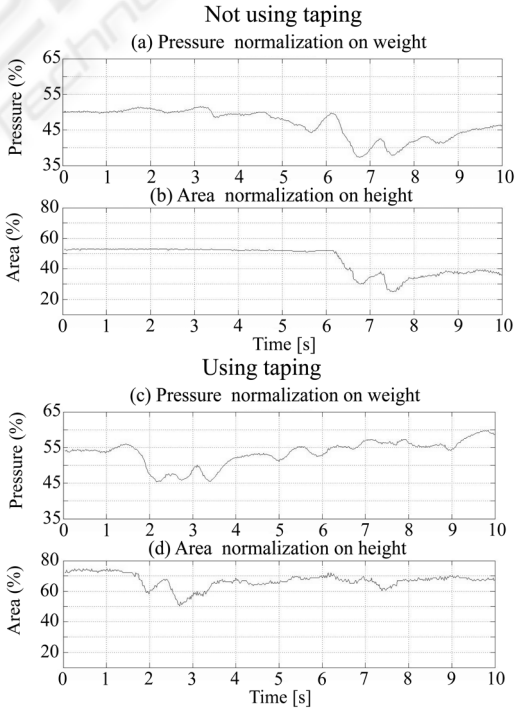


Figure 5: Change in foot pressure distribution that uses BigMat.

decreasing both the pressure and planter area of right ankle (Fig. (a), (b)). On the other hand, with using ankle taping, increasing the ankle inversion angle caused small decreasing the planter area of right ankle, and the pressure distribution change is too small (Fig. (c), (d)).

On the experiment of absence and presence of ankle taping during the motion of ankle inversion, we could recognize the distinction of planter pressure distribution and there are little shift of planter area

4 CONCLUSIONS

In order to examine the taping effect on the ankle inversion sprain, we developed a method of measuring both height of the ankle with the 3-D motion analysis system and planter pressure patterns with the pressure sensing mat. We showed that the distance between the ankle and the floor in maximum voluntary ankle inversion varied from non-taping to taping; the distance was approximately 3.0 cm in the absence of the ankle taping, and 1.5 cm in the presence of taping. On the experiment of absence and presence of ankle taping during the motion of ankle inversion, we could recognize the distinction of planter pressure distribution and there are little shift of planter area

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