Human Fundamental Upward Movement; Spiral Trajectory and Walking of 3D + 1D Space and Time

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Abstract

Background: There are few biomechanical studies on the physical transfer of a person lying on a floor or bed perpendicular to the direction of gravity. Basic biomechanics research can be an important source. This study aimed to analyze the biomechanical properties of the upward movement of the floor in the supine position.

Methods: Healthy volunteers were recruited by snowball sampling. The movement from the supine position to upward movement on the carpet floor was repeated three times. The three procedures were analyzed with an 11 segments model using a 3D motion analysis Move Tr 3D (Library©) under the 4 CCD cameras. The analysis of the motion trace was examined. The movement of the reflection marker with respect to the Z-axis was analyzed with the vertical direction of the gravity as the Z-axis. It was observed from the XY plane, XZ plane, ZY plane, and how many dimensions the reflection marker took was analyzed.

Results: Five healthy volunteers (Medium age 27 years, Female) who received written consent to the study were investigated. A spiral motion was observed in the trajectory of all reflection markers. A walking motion was observed in which the right and left sides of the body alternately swam to the back. Each reflex marker body site was moving headward as if contacting the floor with either the left or right side having 0 to the vertical Z-axis of gravity; the opposite left or right side walked with repeated movements floating from the floor and raising the Z coordinate. 3D Space + 1D time were observed in the human fundamental upward movement.

Conclusion: The Human Fundamental Upward Movement on the floor was observed Spiral Trajectory and the Walking of 3D+1D Space and Time.

Keywords: Human Fundamental Movement, Upward movement, Positioning Change, Transfer, Biomechanics

INTRODUCTION

Many studies of fundamental human movements have classically focused on a person standing upright in the direction of gravity. Old materials are left for the analysis of animals, children, men and women, the elderly, babies and dancers from standing to walking [1,2]. As a characteristic of human beings, interest in bipedal walking is very high, and there are many papers on the mechanism of walking [3,4]. Since biomechanical analysis machines cannot analyze the reflection markers because they are hidden from the camera, motion analysis such as standing and walking is particularly preferred, and the number of papers may be very large. There are few biomechanical studies on the movement of a person lying on a floor or bed in a position perpendicular to the direction of gravity. The recumbent position is categorized as a restricted posture for the motion analysis because of the difficulty to put markers on the back side.

The reflective markers tend to be hidden in complex motion. Hospitals and institutions provide an environment where many patients and older people spend most of their time in bed as a recuperation environment. The problems of pressure sores and joint contractors are still a global concern, affecting the health and quality of life of patients and families and the cost of national health care [5-10]. Basic biomechanics research can be an important source. In this study, the biomechanical analysis was performed, focusing on the upward movement in a supine position on the floor. Biomechanics is a method of objectively understanding human movement. In this study, a biomechanical analysis was performed focusing on the upward movement in a supine position on the floor.

METHODS

Healthy volunteers were recruited by a snowball sampling. After the researchers performed 3D spatial calibration, the subjects

were fitted with reflection markers using an 11 segments model. The subjects performed upward movements from lying position on the floor for three times each. The three procedures were analyzed using a 3D motion analysis MoveTr 3D (Library©) under the 4 CCD cameras. The motion traces were examined. The movement of the reflection marker to the Z axis was analyzed with the vertical direction of the gravity as the Z axis. It was observed from XY plane, XZ plane, ZY plane, and how many dimensions the reflection marker took was analyzed.

RESULTS

Five female volunteers aged 30's who finished the training was analyzed in Spiral and Parallel movements for 5 times each.

As a result of observing the trajectory of upward movement from the supine resting position, Spiral Trajectory was observed

(Figure 1). All reflection markers were spiral locus.

Motion trace to Z axis (Head) was moving up and down (Figure 2).

Motion trace to Z axis (Shoulders) was moving up and down alternately (Figure 3). When either side of the floor was in contact with the floor, the opposite side was in the space, and when the side that was in the space was in contact with the floor, the opposite side floated in the space. Motion trace to Z axis (Elbows, Iliac crest, Knees, Feet and Fingers) showed the same as Shoulders (Figure 4,5,6 and 7).

These movements were like Walking on the floor using each body parts (Figure 8). Checking the camera from each side of the three-dimensional space shows that these motions were three-dimensional (Figure 9).

Figure 1: Spiral Trajectory (Whole Body)

Figure 2: Motion trace to Z axis (Head)

Figure 3: Motion trace to Z axis (Shoulders)

Figure 4: Motion trace to Z axis (Elbows)

Figure 5: Motion trace to Z axis (Iliac crest)

Figure 6: Motion trace to Z axis (Knees)

Figure 7: Motion trace to Z axis (Feet and Fingers)

Figure 8: Walking Upward movement

XZ PLANE **XY PLANE** **YZ PLANE****Figure 9: XZ plane, XY plane, and YZ plane**

DISCUSSION

Previous studies on nursing textbooks have reported that upward movement is supported by pulling the patient up in a straight line with a sheet or the like [11-13]. Nurses hold their hands under the patient's body and pull the patient up in a straight line toward the head [11-13]. During this movement process, the patient physically and passively moved upward while remaining in a recumbent position, suggesting that the patient's state dimension may be 1-2 dimensions of the circle. However, biomechanics observed that when the upward movement of the human body was observed, everybody part showed a spiral movement trajectory, which was not linear. The study also showed that people move step by step like walking on the floor, rather than moving physically from a bed rest to a destination point with a big move. In the walking motion, the left or right side repeatedly moved to the destination while making a circle in the space while one on the right or left side touched the floor and supported the weight. The camera observed three-dimensional motion, suggesting that 3D + 1D space and time as well as the time dimension are upward motions.

Support for repositioning is usually provided for people who cannot move themselves. It has also been proven that the use frequency is high even in the nursing technology [14-21]. Many studies have shown that decubitus ulcers and limited range of motion are still major clinical problems [10,14-21]. The development of environment devices is important, but it is also necessary to reconsider the support for movement itself. This study is likely to serve as a reference. The spiral motion of each marker suggests that each joint is in a circular motion. Including natural and basic exercise support in daily care is likely to function as a range of motion preventer for contractions, pressure ulcers, and other disorders. If a healthy person who does not have pressure sores or joint contractures is constantly taking care of himself, it is necessary to observe the movements of a healthy person. Rather than applying special movements to patients, the elderly and the disabled, it may be possible to prevent them by basing them on the movements and characteristics of healthy people. If motion is related to the living dimension, applying the 3D + 1D motion support observed in this study would place the patient's life state in the 3D + 1D dimension. Maintaining a higher level of life in the clinic may also contribute to health and longevity.

CONCLUSION

Biomechanical properties of the human fundamental upward movement of the floor in the supine position was Spiral Trajectory and the Walking of 3D+1D Space and Time.

ETHICS APPROVAL

The study was conducted with oral and written consent and ethical considerations based on the Declaration of Helsinki and the Medical Research Ethics Guidelines.

COMPETING INTERESTS

The author declares no competing interests.

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