21307 Research on relationship between muscle and sitting position with rehabilitation device

リハビリ装置における着座位置が筋力に与える影響に関する研究

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Because of a growing proportion of elderly and a declining birthrate, more elderly are needed to care for, the doctor's evaluation load is growing heavier. Therefore, it's necessary to save labor by using device. In our lab, there is a device called Patakoro that can stretch and flex the knee joint, plantar flex and dorsiflex the ankle joint. With Electromyogram and Patakoro Device we constructed a system that can value people's walking ability in motivation exercise. This motivation exercise can help paralytic people to practice their paralytic side through the non-paralytic foot. Moreover, we found that there is a relationship between the muscle and the seating position when using Patakoro Device. To help the people to improve the rehabilitation efficiency, we take the experiences of 10 people, and analysis this relationship by the knee angle in two seating positions compared with the standard position.

Key words: Electromyogram(EMG), Sitting Position, Rehabilitation Device

1. INTRODUCTION

In China because of a growing proportion of elderly people and a declining birthrate, more elderly are needed to care for. Therefore, it is necessary to spread rehabilitation and save labor of training and guide. The quantification judgment of the walking ability is a solution. In our research, some feet parameters which have a high relation with the walking ability score were found and construct a system that can quantitatively judge the walking ability [(1)] .

In addition, we observed that different samples of people with different height used the same chair. And, the knee joint as a important factor, its movement also effects the muscle's some function.

Therefore, in this research, to aim at making the knee angle device, testing the subject's knee angle change and find the relationship between the subject's muscles effect and the different sitting positions(with different chair heights) when they are using the Patakoro Device.

2. EXPERIMENT

2-1. Sitting Movement

The subject did the training of Koro Movement in different position (Seen in Fig.1). Koro Movement is to move feet back and forth. (a) Minus 5cm is the sitting position which is to reduce 5cm from the standard position. (b) Standard position is the sitting position that the upper legs are horizontal. (c) Plus 5cm is the sitting position which is to raise 5cm from the standard position.

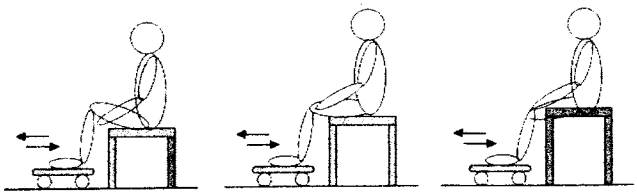

Fig.1 Training of Koro Movement in different sitting position
(a) Minus 5cm　(b) Standard position　(c) Plus 5cm

2-2.Device

(1). Electromyogram;(Fig.2 Electromyogram and muscle tested)
(2). Patakoro Rehabilitation Device
(3). Knee Angle Device;(Fig.3 Knee Angle Device)

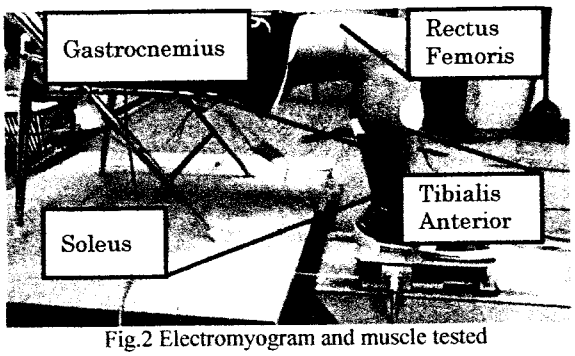

Fig.2 Electromyogram and muscle tested

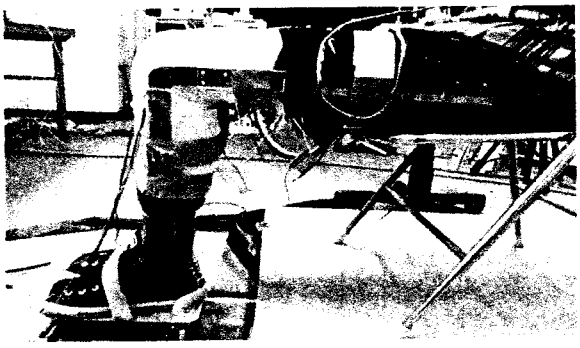

Fig.3 Knee Angle Device

2-3.Subjects

2-3-1.Subject number: 10 people (10 young people without any leg illness)

2-3-2.The test part

(1). Test the right leg's four muscles, Rectus femoris, Soleus, Tibialis anterior, Gastrocnemius (Fig.2 Electromyogram and muscle tested) when using the EMG.

(2). Test the left leg when using the knee angle device.

2-4.Experience Sequence

2-4-1.Personal Record

We record the subject's Name, Sex, Lower leg length L_1, Upper leg length L_2, Ankle joint length L_3, Patakoro Device height X_1, Length from a great trochanter to ground X_2.

2-4-2.Koro Movement

(1). According to the Personal Record, calculate the Δx, raise the chair Δx cm, to make the knee angle standard 90 degree(The upper leg is horizontal, the lower leg is vertical).

$$\Delta x = L_1 + L_3 + X_1 - X_2 \quad \cdots (1)$$

(2). Do the muscle standard EMG test (muscle's max EMG).

(3). Do the Koro Movement 1 time every two seconds for 15 times starting the starting line and ending the starting line, move forward as far as possible, and move back and bent the knee as possible as one could.

(4). Raise the chair height 5cm, do the Movement as (3) mentioned.

(5). Reduce the chair height 5cm, do the Movement as (3) mentioned.

3.ANALYSIS AND RESULTS

3-1.EMG

Figure 4 shows the measurement result of subject NO.6. We can get two parameters in the experiment, they are raw EMG and knee angle.

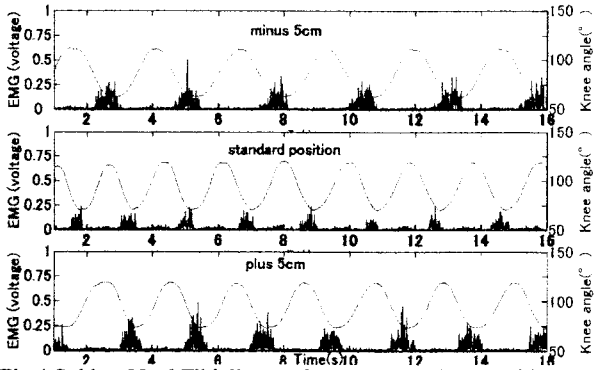

Fig.4 Subject No.6 Tibialis anterior EMG and three positions

For subject No.6, when sitting in three different positions, the muscle's amplitude is different (Seen in Fig.4). When moving forward, the knee angle becoming large, the subject did not use Tibialsis anterior. When moving back, the knee angle becoming small, the subject used the Tibialsis anterior. The cycle of the movement is divided into two sections, Tibialsis anterior muscle is contraction in the section1, and is relaxation in section 2(Seen in Fig.5).

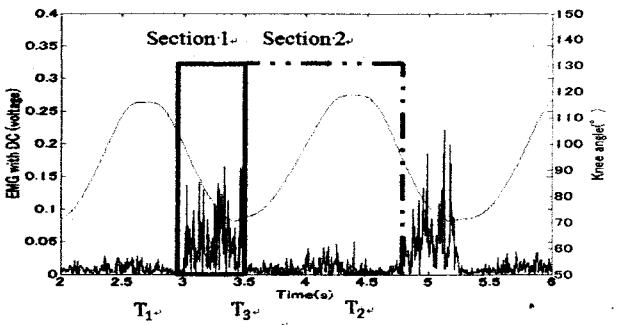

Fig.5 Subject No.6 Tibialis anterior EMG movement

(1). C

We define section one (contraction state) and section two (relaxation state) is one cycle.

(2). average ω is the average value of velocity of knee angle.

$$\text{average } \omega = \frac{\omega_j + \omega_{j+1} + \cdots + \omega_m}{m-j+1} \quad \cdots (2)$$

(3). average α is the average value of acceleration of knee angle

$$\text{average } \alpha = \frac{\alpha_k + \alpha_{k+1} + \cdots + \alpha_n}{n-k+1} \quad \cdots (3)$$

(4). IEMG

IEMG is the integration of EMG with time, it is a measure of the overall muscle effort.

(5). ARV is defined as this,

$$ARV = \frac{IEMG}{T_3 - T_1} \quad \cdots (4)$$

ARV is the average voltage amplitude of the muscle.

(6). nARV

$$nARV = \frac{ARV}{\text{standard EMG}} \quad \cdots (5)$$

Standard EMG is max voltage amplitude of the muscle.

3-2.Results

We choose ten circles movement from second cycle to the eleventh cycle to analysis, Figure 6 shows the subject's Tibialis anterior analysis index.

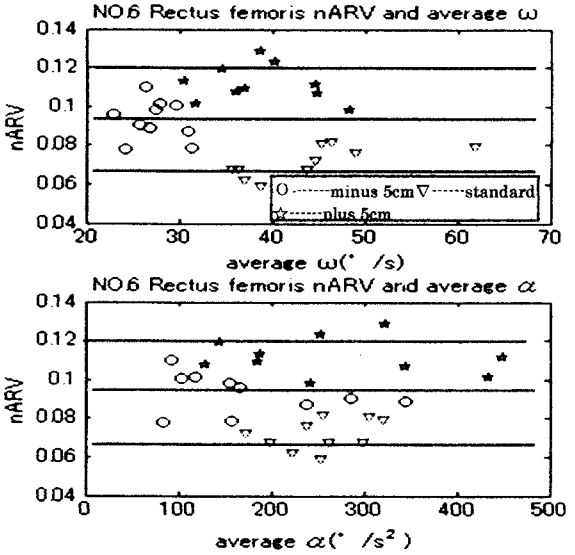

Fig.6 Subject No.6 Tibialis anterior EMG and three positions

For the same subject, when the chair height is in position minus 5cm, standard position, plus 5cm, the muscle's nARV are different at the same average velocity and average acceleration of knee angle. For subject No.6, using multiple comparison analysis method (SPSS analysis software), we know that, significance probability is from 5.848E-09 to 0.00025(less than 0.05), nARV value in three positions are significant difference (Seen in Fig.6). For this subject, nARV value 0.1119 in the position plus 5cm is higher than in the position standard (nARV value 0.0716) when at the same velocity of knee angle. For subject No.6, the standard position is better than other positions. it indicates that the muscle effect by the chair height is obvious. In addition, we analysis the other people's data, and found that, different people, the same muscle, the best chair height is different. Therefore, the chair height is important factor which should not be ignored. And adjusting chair height is a method to help people to change muscle nARV with Patakoro Device.

Reference

(1) Hajime TAKADA, Gonta TANAKA, Quantitative Evaluation of Walking Ability of the Elderly in Rehabilitation, The 5th Beijing International Forum Oct.29-Nov.1(2011) Beijing China, p.818-820.