QUANTITATIVE MEASUREMENT
AND ANALYSIS OF BALANCE

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\textbf{INTRODUCTION}

Under normal experimental conditions, for the balance control in upright and standing with either right or left leg only
position, experimentation was conducted to evaluate the balance control. The difference in magnitude of

\textbf{METHODS}

System Configuration

Overall equipment setup for the measurement of balance control for data processing.

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QUANTITATIVE MEASUREMENT AND ANALYSIS OF BALANCE

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Abstract – The experiment was designed to develop a system to evaluate patients’ performance for the balance control in upright position and to feedback those information to the patients to improve the therapeutic effect. Results showed that the number of zero crossings showed no significant differences when the subject stands with both legs. While standing with one leg, movement in right/left direction appeared more than that in front/rear direction. Ratio of the area appeared higher for standing with both legs than with one leg. The results show no significant differences between the ratios standing with one leg.

INTRODUCTION

Brain-injured patients have balance impairment including poor equilibrium reaction, lower extremity weakness, and uncoordinated muscle contraction. In most cases, movement won’t be purposeful and coordinated until balance control is accomplished, and it is essential for the patients to maintain balance in standing position prior to walking[1,2]. If accurate comparisons are made over time and among subjects, more qualitative treatment could be achieved. Therefore, development of a system which provides precise evaluation and effective treatment to the patients calls for the quantitative assessment of physical parameters[3,4].

The objectives of this experiment were to develop a system providing quantified information which could be used to evaluate the patients’ performance for the balance control in upright position and to feedback those information to the patients to improve the therapeutic effect.

METHODS

System Configuration

Overall equipment setup for the experiment is shown in Fig. 1. System was composed of force plate, multiplexer circuit, A/D converter, and IBM PC. Force plate contains an array of 20 FSRs (force sensing resistors) for each foot, and produces output according to the force applied to the sensors. Analog signals from the force plate was input to the multiplexer and then to the A/D converter for quantitative processing of the information.

![Fig. 1. Overall equipment setup for the experiment.](image)

Data Collection and Analysis

Data were collected from 20 healthy normal subjects without neuromuscular abnormalities. Subjects were standing on the force plate under two different conditions, standing with both legs and standing with either right or left leg only. Outputs from analog multiplexer were obtained at 2Hz of sampling rate for the duration of 50 seconds and 10 seconds in case of standing with both legs and with only one leg, respectively. Data were on-line processed and the parameters were calculated and saved for further statistical analysis. Fig. 2 showed the representative computer display for data processing.
sensor reflects the force applied to the radial artery based on the output of the force sensing resistor.

**Data Collection**

Three signals, radial artery pulse, FSR output and intra-arterial pressure pulse, were collected from five patients during surgery. Each signal was sampled at a sampling rate of 200 Hz for 10 seconds through the 12-bit A/D converter, and saved on the computer. Conditions for the data collection were divided into five categories by setting the output of the FSR from 1.2 volts to 2.0 volts with 0.2 volts interval.

**Data Processing and Analysis**

Stored data were used to derive systolic, diastolic and mean blood pressure by comparing parameters of two waveforms, radial artery pressure pulse and intra-arterial pressure pulse for each experimental condition. Parameters extracted were the maximum and minimum absolute values and the peak-to-peak amplitude of the waveform. Descriptive statistics and t-tests were performed to find the p-values and correlation coefficients.

**RESULTS AND DISCUSSION**

Radial artery pressure pulse was changed as the output levels of FSR varies, but the intra-arterial pressure was maintained at a constant level. Maximum value of the peak-to-peak amplitudes among five experimental conditions for radial artery pressure pulse, 0.490 ± 0.010 volts, was obtained when the output of the FSR was set at 1.6 volts. At the same condition, intra-arterial pressure pulse showed 0.488 ± 0.018 volts which is the closest value to that of the radial artery pulse. That is, wrist strap should be fastened until the point when the radial artery pulse shows a maximum peak-to-peak amplitude to obtain reliable and accurate blood pressure.

The results showed that the correlation coefficients between peak-to-peak amplitudes of two waveforms appeared to have significant relationship with an \( a = 0.05 \) significant level.

**CONCLUSION**

Noninvasive and continuous blood pressure monitoring system using piezoelectric sensor appeared to provide a reliable information if more stable and accurate controlling mechanism for the placement and tightening of the transducer is achieved. Moreover, the study could be further explored to establish an algorithm for the determination of blood pressure not only from normal subjects, but also from the patients with unstable blood pressure fluctuation.

**REFERENCES**


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