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Design and Implementation of Pressure Measurement System for Pressure Garments

[1]Tso-Liang Teng, [1]Kun-Ta Chou and [2]Chien-Han Lin
[1]Department of Mechanical and Automation Engineering, Da-Yeh University, 112. Shan-Jiau Rd., Da-Tsuen, Changhua 515, Taiwan, Republic of China
[2]Department of Electrical Engineering, Hsiu-Ping Institute of Technology, No. 11, Gongye Rd., Dali City, Taichung County 412, Taiwan, Republic of China

Abstract: Pressure garment therapy has been demonstrated to be an effective method of preventing or treating of hypertrophic scars and contractures. For pressure to be effective in correcting scars, a pressure measurement system for garments is essential tool to determine the amount of pressure actually provided. To determine the amount of pressure that should to be applied to the garment/scar interface by pressure garment, this study develops a measurement system for measuring the garment/scar internal pressures. The present measurement system provides much needed information in the areas of the burn garment assessment. Physical therapists can guarantee that the desired pressure has been achieved and that the garments are properly fitted.

Key words: Garment/scar internal pressures, garment, measurement system

INTRODUCTION

A burn is an injury that damages and destroys skin layers. A scar is a mark left on the skin after the healing of a wound or surgical incision. Hypertrophic scars and contractures are the main types of burn related scars. The scars can cause deformities and restrict normal movement. Pressure garment therapy has been demonstrated to be an effective method of preventing or treating of hypertrophic scars and contractures. A pressure of at least 24 mmHg is considered the benchmark for effective treatment (Baur *et al*., 1984). Manufacturers of pressure garments are specifically designed and made for patients after obtaining theirs measurement. However, the questions of whether custom-fitted pressure garments provide adequate pressure, how to decide the need to change a new garment and which areas of body may require proper padding with sponges are key concerns in pressure garment therapy. For pressure to be effective in correcting scars, a pressure measurement system for garments is essential tool to determine the amount of pressure actually provided. The pressure garment therapy in preventing or treating scars has been extensively studied (Larson *et al*., 1971; Robertson *et al*., 1980; Sawada, 1993; Leung *et al*., 1984), but few studies state the amount of pressure actually provided (Mann *et al*., 1997; Giele *et al*., 1997; Harries and Pegg, 1989; Allen *et al*., 1993). To determine the amount of pressure that should to be applied to the garment/scar interface by pressure garment, this study develops a measurement system for measuring the garment/scar internal pressures. The present measurement system provides much needed information in the areas of the burn garment assessment. Physical therapists can guarantee that the desired pressure has been achieved and that the garments are properly fitted.

PRESSURE MEASUREMENT SYSTEM

A pressure measurement system was developed in this study. Microcontrollers were used as a control unit in measurement system design. This system consists of a pressure sensor unit, microprocess unit and output display unit. Figure 1 shows the sketch of the pressure measurement system. The pressure sensor unit comprised of AMI Ψ 20/2 m air-pack type pressure sensor and KYOWA PGM-02KG pressure transducer, as displayed in Fig. 2 and 3. The microprocess unit comprised Plilips P89C51RD2 microcontroller, Analog Devices AD7893 analog to digital converter and National Semiconductor OP-07 operational amplifier. Meanwhile, the output display unit comprised of DM74LS47 LED display decoder and seven segments display, as displayed in Fig. 4. This pressure measurement system was designed to measure the garment-scar interface pressure with a range of 0 to 50 mmHg and with an accuracy of ±1 mmHg.

Corresponding Author: Tso-Liang Teng, Department of Mechanical and Automation Engineering, Da-Yeh University, 112. Shan-Jiau Rd., Da-Tsuen, Changhua 515, Taiwan, Republic of China
Tel: +886-4-8511221 Fax: +886-4-8511224

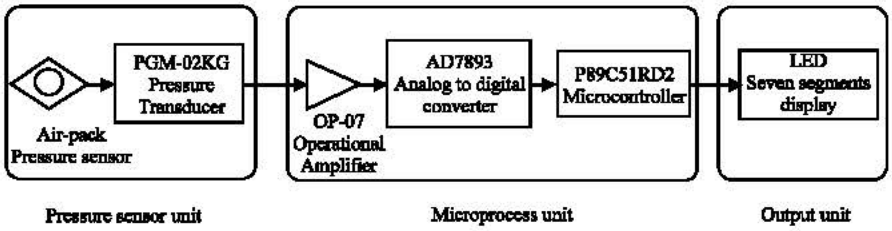


Fig. 1: The sketch of the pressure measurement system

Fig. 2: AMI Ψ 20/2 m air-pack type pressure sensor

Fig. 3: KYOWA PGM-02KG pressure transducer

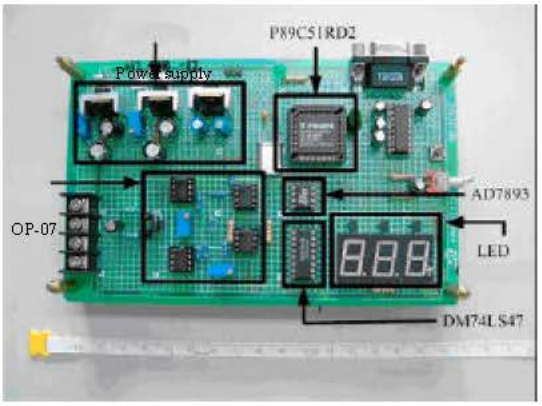


Fig. 4: Microprocess unit and output display unit

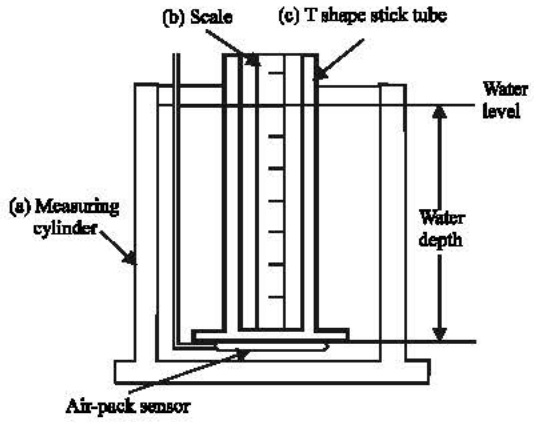


Fig. 5: Arrangement for calibrating measurement system

CALIBRATION OF MEASUREMENT SYSTEM

The calibration of the present measurement system was checked. The correctness of that measured value can be certified by the water pressure calibration method Fig. 5 shows the calibration arrangement used in this study. The procedures of calibration are as follows:

- Pour water into the measuring cylinder unit;
- Insert air into the air pack by a air cylinder;
- Check the zero pressure is indicated on the measurement system;
- Fix the air pack at the bottom of the T shape stick;
- Dip the T shape stick into to the measuring cylinder unit;
- Measure sinking depth of the air pack on the scale of the T shape stick.

A pressure on the horizontal plane corresponding to the water pressure can be got by measuring the water depth. Figure 6 displays the pressure indicated on the measurement system at various depth. The present measurement system was found to have a calibration offset error of 1.5%.

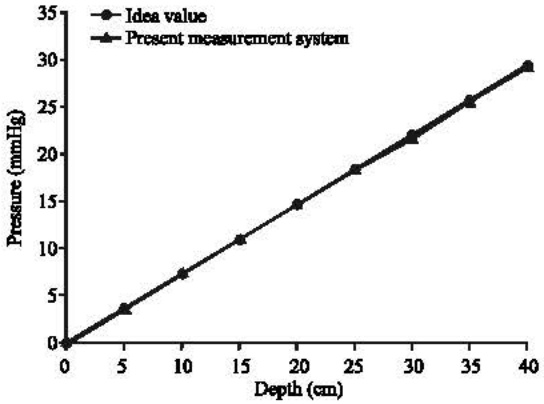


Fig. 6: The pressure indicated by the present measurement device with various depth of the air pack

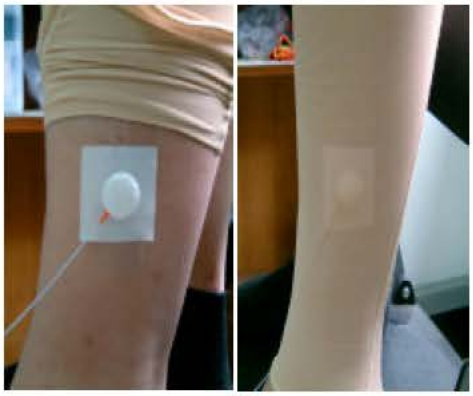
Fig. 7: AMI A0101-G35K pressure measurement device

PERFORMANCE OF MEASUREMENT SYSTEM

To measure the pressure applied to the garment/scar interface by pressure garments and confirm the accuracy of the measurement system presented in this study, clinical pressure measurements were investigated. Furthermore, the results of the present measurement system are compared to those obtained using the A0101-G35K pressure measurement device developed by EMI companies. A0101-G35K is a commercially available system for interface pressure measurements in burn patients, as shows in Fig. 7. This system has measurements ranging from 0 to 225 mmHg and an accuracy of ±0.90 mmHg in 23°C environment.

This study measured the arm and leg of a single victim (male; 24 years old). The measurements were taken at four different positions located on the lateral of arm and leg. In processing the pressure measurements, the air-pack sensor was first positioned on the measuring point and then the sensor was covered with the pressure garment, as shown in Fig. 8. All measurements were repeated five times using two different systems. Figure 9

(a)



(b)

Fig. 8: The clinical pressure measurement on the (a) arm and (b) leg

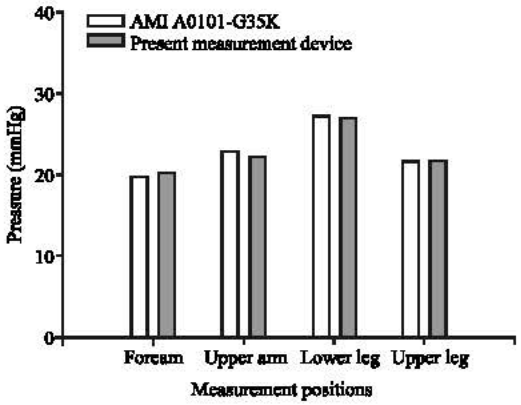


Fig. 9: The interface pressure measured by the present measurement device and A0101-G35K pressure measurement device

shows the interface pressure on different areas of the arm and leg. Figure 9 shows that, the interface pressure measured using the present measurement device proposed displayed very good agreement with the measurements taken with the A0101-G35K pressure

measurement device. The present measurement device was shown to be extremely accurate for measuring the pressures generated under garments.

CONCLUSIONS

In pressure treatment, to apply adequate and effective pressure is essential. However, to determine the amount of interface pressure between pressure garments and scars is even more important. The design and implementation of pressure measuring system has been achieved in this study. This measurement system indicated that the amount of pressure applied to the garment/scar interface by pressure garment in real-time. The validity and reliability of the system is confirmed herein. The present measurement system is an available and accurate system for measuring the interface pressure. The information for the amount of pressure should be useful in clinical therapy involving the use of pressure garments to treat scars.

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