International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 21 (2017) pp. 11302-11305

Development of Diagnostic Device for Erectile Dysfunction

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Abstract

The erectile dysfunction, which is the most common disease in elderly men, is known to be caused by aging, smoking, drinking, diabetes, hypertension, and cerebrovascular disease. Causes of erectile dysfunction are very diverse, and the erectile dysfunction is common in men in modern society due to stress, anxiety, depression and other psychological and characteristic problems, and hormonal problems. Erectile dysfunction is a symptom that sufficient erection cannot be achieved or maintained, typically caused by inadequate blood flow. The treatment for erectile dysfunction has been developing since the development of Viagra, whereas the methods of diagnosing erectile dysfunction are marginal. For the methods of diagnosing erectile dysfunction, only questionnaires depending on the objective statement of patients, ultrasonography to determine the blood flow velocity of the penis, Rigi scan to obtain the objective data of the erection power through nighttime sleep erection and visual stimulation have been used until recent years. In this study, we developed a device that can detect accurate erection power and retention time through measuring data during strain and compression strain gage.

Keywords: erectile dysfunction, diagnostic device, rigiscan, strain gage

INTRODUCTION

Measuring the erectile performance of the penis is measuring the most basic abilities of a man, so it involves many potential patient groups and requires accurate, consistent, quantitative measurement and analysis methods. The measurement is usually performed through sleeping process, and many studies are underway to measure the degree of stiffness and expansion, etc., in the existing device Rigi Scan. Currently, Ridge Scan is the only device used to obtain objective diagnostic data of erection power in Korea. Ridge Scan, which is the only erectile measuring equipment in the world at present, was developed more than 30 years ago, and yet it is manufactured exclusively by one foreign company (DACOMED). Therefore, many physicians are experiencing inconveniences due to the fact that maintenance is not easy and the cost is high. Because of the size of the equipment, the patient feels uncomfortable with it in activities, urination and defecation, and the method of transferring the erection data from the device to the computer has not been improved and the old cable is used. In addition, since it is not a charging type, it is troublesome to purchase and replace a battery [1-6].

Therefore, in this study, we developed a device that makes it easy for the patient to be active during the examination, and can solve the physiological phenomena such as urination and defecation, so that it provides an environment to measure the actual erectile performance and can be miniaturized to carry, especially during vacation. In addition, the quality of the sensor attached to the penis has been improved, so it is possible to transmit the data conveniently through Bluetooth instead of cable for backing up data from the device. Also, rechargeable lithium ion battery saves the trouble of replacing batteries.

METHODS

Fig. 1. is the schematic diagram of the device, showing the data measurement procedure during strain and compression of strain-gauge. The data stored in the terminal can be easily transmitted to the desktop Through Bluetooth, not the cable, for analyzing the data conveniently. The proposed method adopts a method of scaling the data transmitted by the existing developed protocol which can transmit the stored or acquired data by using the serial port of the PC and replacing it with displacement and force. In order to simultaneously transmit the expansion and stiffness data using the PC serial communication, two pieces of data must be bundled into one continuous packet and transmitted. In the PC serial communication, the data is read by Window programs in multiples of 4, so that the degree of stiffness and expansion are represented in 2 bytes, respectively. By using 2 bytes, data from 0 to 216-1 can be expressed. In order to consider the

directionality of the data obtained from the encoder, the values from 0 to 215-1 displays the output in the clockwise direction and the values from 215 to 216- - 1 displays the output in the counterclockwise direction. The number of rotations of the transmitted encoder must be scaled to replace with the displacement. Since the method of measuring the degree of expansion and stiffness is a method of converting the displacement caused by the expansion of the penis to the number of rotations of the encoder, the transmitted data must be converted to the displacement again. The measured number of rotations of the encoder has positive and negative values. The controller must convert it into a positive value by adding a value of 215 to it and transmit 2 bytes of data.

To obtain the original number of encoder rotations considering directionality, it is required to first subtract 215 from the 2-byte data and multiply it by the displacement change scale (sf = 2 πr / encoder pulse per 1 rotation) corresponding to one rotation of the encoder, to obtain the final displacement required for the calculation of the degree of stiffness and expansion. The equation below is to convert into displacement and to calculate the degree of stiffness.

$$y^i = (x^i - 2^{15}) \times sf$$
$$sf = 2\pi r / (encoder\ pulse\ per\ 1\ rotation)$$
$$rigidity(\%) = y^i \times 100$$

The displacement change scale is intended to measure the diameter of the encoder and the connection part and input the measurement data into the program in advance. The transmitted data stiffness is expressed as a percentage (%) for a non-elastic solid, and the degree of expansion is expressed as an integer with mm units.

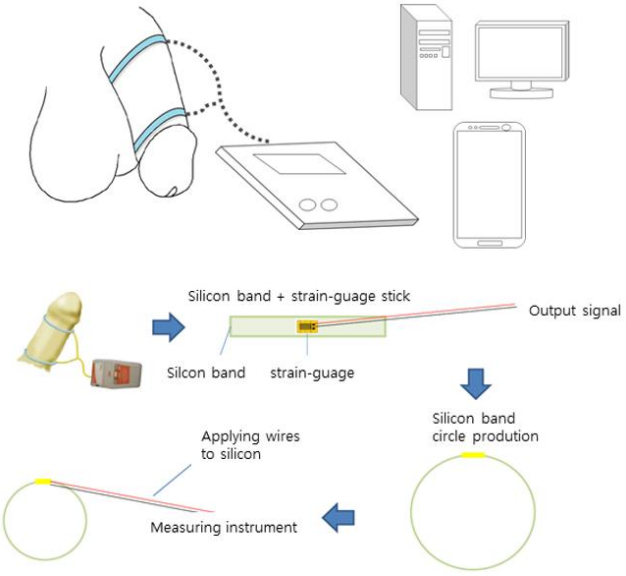

Figure 1: Device schematic diagram and data measurement procedure during strain and compression of strain-gauge

The operation and drive graph of the device are shown in Fig. 2, where the X axis represents time and the Y axis represents the size change of the penis. The graph shows the duration of erection, and can measure the number of erections during the experiment. In this experiment, we could obtain a strain-gauge graph by fabricating a prototype based on it, purchasing a substitute for a penis that expands and contracts in volume.

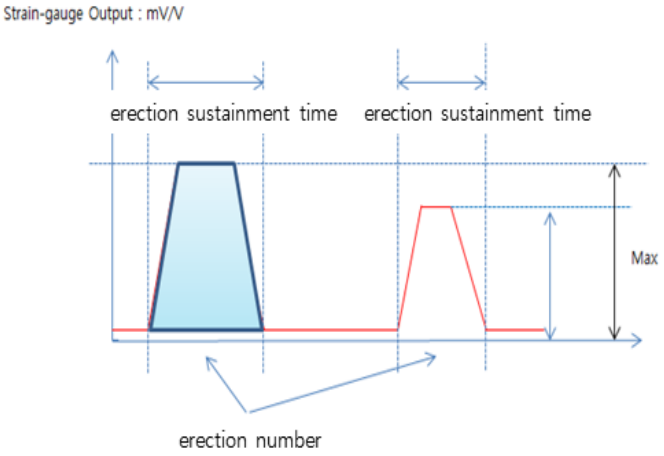

Figure 2: Device operation and drive graph

RESULTS AND DISCUSSION

Table 1 shows the characteristics of strain-gauge. We made a prototype by selecting natural rubber which has good tactile feel and mechanical properties and is harmless to human body. In order to obtain a strain-gauge graph according to the erection of the penis, we experimented using a penis substitute that expands and contracts in volume to see whether it can be used for a clinical trial with the patients. Therefore, we did not know the duration and number of erection, and schematically investigated the change of the Y axis value of the graph and the change of the X axis according to time. Figure 3 shows the shape and operation graph of the actual prototype. (a) is an actual photograph and a measured graph of a substitute for a penis indicating erection. It can be seen that there is no change in the Y-axis according to the change of the X-axis changes. (b) is an actual photograph and a measured graph of penis substitute indicating erection, and the change of the Y axis can be known as the volume of the substitute product expands, that is, as the penis erects.

Table 1: Characteristics of stain gauge

Type of rubber (ASTM)	Natural rubber (NR)	Styrene-butadiene rubber (SBR)	butadiene rubber (BR)	Chloroprene rubber (CR)	Nitrile rubber (NBR)	Butyl rubber (IIR)
Main features	Best tactile feel among all rubbers, Excellent mechanical properties	Good resistance to abrasion and aging compared to natural rubber	Good elasticity and excellent abrasion resistance compared to NR	Excellent resistance to weather, ozone and aging on an average basis	Good resistance to oil, abrasion, and aging	Good resistance to weather and ozone, and good permeability
Net rubber weight	0.92	0.93~0.94	0.91~0.92	1.15~1.25	1.00~1.20	0.91~0.93
Hardness (Shore A)	30-90	40-90	40-90	40-90	40-90	35-90
Tensile strength (kg / cm2)	70-280	50-230	50-230	60-250	50-250	50-150
Elongation (%)	100-600	100-500	100-500	100-500	100-500	100-600
Resilience (%)	A	B	A	A	A	
Maximum operating temperature (℃)	60	90	90	100	100	120
Minimum operating temperature (℃)	-40	-35	-45	-30	-25	-40
Abrasion resistance	B	A	A	B	A	C
Flexural crack resistance	A	B	C	B	B	A
Resistance to temperature	D	D	D	B	D	A
Resistance to deformation	B	B	B	B	B	C
Gas permeability	C	C	C	B	B	A
Resistance to salt	D	D	D	B	D	
Lubricant	D	D	D	B	A	D
Gasoline	D	D	D	C	B	D
Aliphatic hydrocarbon	D	D	D	B	A	D
Aromatic hydrocarbons	D	D	D	D	D	D
Chlorine solvent	D	D	D	D	D	D
Alcohol	A	A	A	A	A	A
Water	A	A	A	A	A	A
Dilute acid	B	B	B	A	B	A
Undiluted acid	D	D	D	C	D	B
Alkali	B	B	B	A	B	A
Purpose of use	Industrial and general rubber products such as car tires, industrial truck tires, shoes, hoses, belts, air springs, general and industrial goods	Industrial and general rubber products such as car tires, automobile parts, shoes, rubber tarpaulins, athletic articles, belts, etc.	Industrial goods such as automobile, aircraft tire, shoe, anti-vibration rubber, rubber roll, belt, hoses, etc.	Industrial and general rubber products such as wire cloth, conveyor belt, anti-vibration rubber, window frame rubber, adhesive, rubber tarpaulin, etc.	Oil resistance products such as oil seal, gasket, hose, conveyor belt, printing roll, Textile TOP-ROLL	Car tire tube, Curing bag, roofing, wire cloth, window frame rubber, steam hose, conveyor belt, etc.

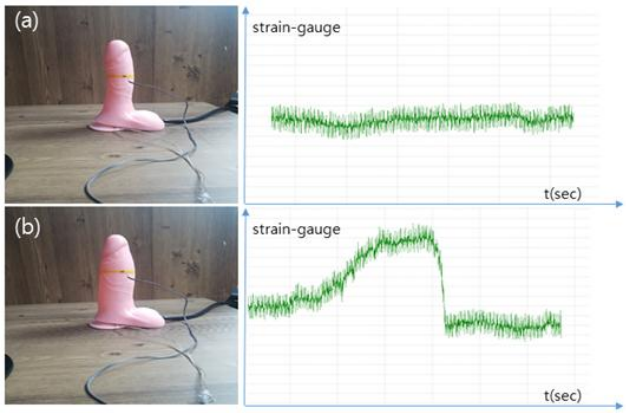

Figure 2: (a) before erection (b) after erection

CONCLUSION

This study was intended to measure the sexual dysfunction which is a problem for elderly men. We fabricated a device that provides data suitable for the purpose by measuring and analyzing the erectile abilities in males using strain-gauge, and tested it using a penis substitute. We also analyzed the strain-gauge characteristics by material.

1. We developed a device that can measure the erection ability through a strain-gauge.
2. We selected the materials that are harmless to human body through research.
3. The proposed device can detect the changes between before and after erection through the changes in X-axis and Y-axis, and measure the degree of expansion.
4. Based on the results of this study, we expect that it can measure the duration of erection and the number of erections when tested for actual penis.

REFERENCES

[1] Lakin MM. Montague DK. VanderBrug Medendorp S. Tesar L. Schover LR. Intracavernous injection therapy: analysis of results and complications. Journal of Urology. 143(6):1138-41, 1990 Jun.

[2] Fallon B. Intracavernous injection therapy for male erectile dysfunction. [Review] [68 refs] Urologic Clinics of North America. 22(4):833-45, 1995 Nov.

[3] National Institutes of Health (NIH) Consensus Conference. Impotence: NIH consensus development panel on impotence. JAMA 1993;270:83-90.

[4] Feldman Ha, Goldstein I, Hatzichristou DG, Krane RJ, Mckinlay JB. Impotence and its medical and

psychosocial correlates: results of the Massachusetts Male Aging Study. JUrol 1994;151(1):54-61

[5] Ansong Ks, Lewis C, Jenkins P, Bell J. Epidemiology of erectile dysfunction: a community-based study in rural New York State. Ann Epidemiol 2000;10(5):293-296.

[6] Thai Erectile Dysfunction Epidemiologic Study Group (TEDES). An epidemiological study of erectile dysfunction in Thailand(part 1: prevalence). J Med Assoc Thai 2000;83:872-879