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Original Research

A Preliminary Design of New Kyphosis Backpack with the Ability to Show Pressure and Maintain the Curvature of the Spine

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Abstract

The aim of this study was to design a kyphosis backpack with the ability to show the pressure and maintain the curvature of the spine for people who use backpacks for a long time. This backpack is designed with tracholambosacral brace. It is designed to distribute good pressure on the shoulder, which is suitable for all ages and has two metals to maintain the natural alignment of the spine and adjustable straps on the front of the trunk and front of the abdomen. The backpack consists of three fabric bands, an electrical circuit consisting of three bending sensors and a pressure sensor, as well as two stabilizing metals. Designed to communicate between sensors in a mobile backpack (mobile app) that displays information about its degree of curvature through bending sensors. In order to display the amount of pressure, the pressure sensor also shows this information on the mobile phone. The design of this circuit and application is such that if the amount of curvature and pressure is more than the allowable limit, it informs the person through vibration so that it can maintain the normal level of the spine and also adjust the bag load. To use this feature, the application must turn on the electronic circuit, then connect to the circuit via Bluetooth to establish a connection between the circuit and the mobile application. The kyphosis backpack with the ability to measure pressure and maintain the curvature of the spine designed in the present study can be used in correctional training programs, carrying classroom equipment as well as sports equipment. The warning system and display of the pressure on the spine, makes this backpack a comfortable and user-friendly backpack.

Keywords: Kyphosis, Brace, Mobile App, Backpack.

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Introduction

The use of backpack among community people especially students and athletes are very common to transport proper load (1). Also, using heavy backpack can result in a change in the body structure, and physiological problems (2). Previous studies have been reported that the use of heavy backpacks leads to premature fatigue, body misalignments, and injuries (3).

Negative effects of carrying heavy backpacks include kyphosis, scoliosis (4, 5) and forward head (6). In addition to the type of bag, its weight and time duration of carrying, as well as the placement of the bag on the back of the user can be important in causing such problems (7). A previous study showed that most musculoskeletal disorders related to the backpack weight are present in the shoulders and lower back (8). Rampersad (2010) examined the effect of backpack weight on curvature angle of the spine in adolescents and concluded that non-standard backpack weight significantly increases the curvature angle of spine and eventually it causes skeletal disorders (9). According to this research, the suitable weight ranges for backpacks are 10 to 15% of body weight (4). Another study showed that the appropriate weight for these people is 8% of body weight (10).

Despite many studies about weight range and ergonomic features of backpacks, very few studies have been done on its design and construction. One of the studies that designed backpacks with a user-centered design approach based on individual needs is Tarkam's research (11). Therefore, in order to pay attention to the weight of the backpack and maintain the alignment of the spine during daily activities, it is necessary to design a novel backpack bag such as a kyphosis backpack. The purpose of this study is to design a kyphosis backpack with ability to measure imposed force for people who use backpacks for a long time. We hypothesized that flexion and pressure sensors could give us information on the amount of load on the spine, based on which we could determine the weight of the bag for people with kyphosis so that the curvature of their thoracic spine would not increase.

Material and Methods

To design a bag with the ability of a brace, we have made a bag by restraining the parts of the spine in the thoracic-lambo-sacral region (Figure 1). Its unique design creates a good distribution of pressure on the shoulder that is suitable for all ages, and has two metals to maintain the natural alignment of the spine and adjustable arms in the front of the trunk and front of the abdomen.

Figure 1. The bars embedded in the backpack make it look like a bracelet.

The structure of the bag consists of three fabric bands, an electrical circuit consisting of three bending sensors and a pressure sensor, as well as two stabilizing metals (Figure 2).

Figure 2. Backpack structure in two modes with brace capability and sensor

Mobile-designed software (mobile app) displays the amount of curvature of the spine through bending sensors. In order to display the amount of pressure, the pressure sensor also displays this information at the mobile. The design of this circuit and application are such that if the amount of curvature and pressure is more than the allowable level, it informs the person through vibration to maintain the natural alignment of the spine and also to adjust the bag load (Figure 3). To use this feature, individuals must turn on the electronic circuit, and then connect to the circuit via Bluetooth to communicate between the circuit and the mobile app.

Figure 3. Software

Electronic components are as follows: Bending sensor (Artman, Iran), Vibration sensor (SW-18010P, Mobicon), Pressure sensor (FSR402, Hagler, Germany), Electronic circuit for sensor coordination (made by the authors) and rechargeable battery (Samsung, South Korea) (Figure 4).

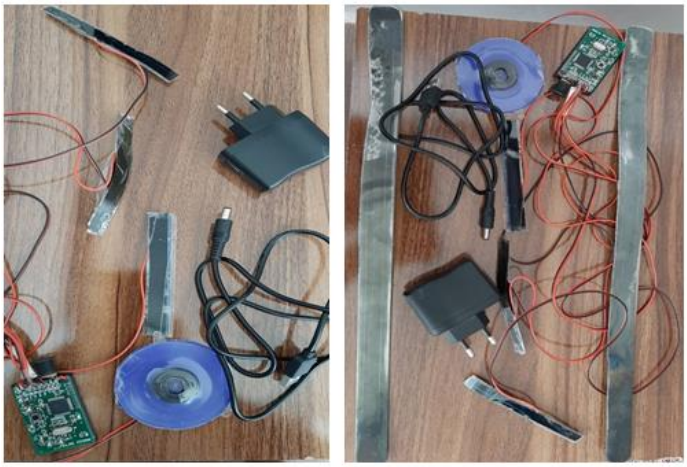

Figure 4 - Electronic circuit, bending sensors and pressure sensors

The block diagram of the newly designed kyphosis bag is shown in Figure 5.

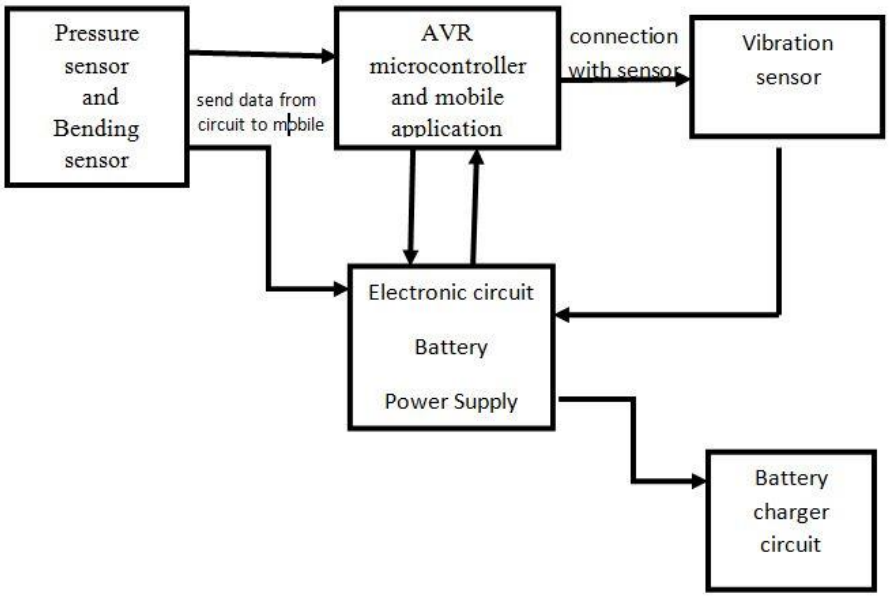

Figure 5- The block diagram

Results and Discussion

The aim of this study was to design a kyphosis backpack with the ability to show pressure and maintain the curvature of the spine for all people and use the backpack for a long time. On the other hand, it can be used to eliminate kyphosis and lordosis anomalies, and it has the ability to adjust (increase or decrease the arches according to the improvement or severity of the anomaly using mobile app).

Body malalignments altered body mechanics during daily activities (12-18). Previous studies have shown that a proper backpack can reduce back, knee and shoulder pain (19) and also help with ventilation in lung function (20). The type of bag used in the study of Tarkam design is different from the study of Norman and Draper (11), which is selected based on the taste and ergonomic characteristics of the individual. The designed kyphosis backpack was able to show the pressure and

maintain the curvature of the spine, such as the wireless thoracolumbo-sacral brace with the ability of vibration and mobile control (21), which was made by the researcher. The designed kyphosis backpack have a pressure sensor to know the assess pressure values on the spine, suitable for people with kyphosis (degree 0-90), washability, use of two simple and electronic forms. Unlike previous designs, this design is suitable for all people who use backpacks and have abnormality in the spine area. In this design, special attention is paid to the type of bag (sports and classroom), the amount of force and also equipped with an alarm system to maintain the natural alignment of the spine and the ability to access the electronic system instantly.
Focusing on kyphosis and not focusing on people with scoliosisis one of the limitations of this study.

Conclusion

The kyphosis backpack with the ability to show the pressure and maintain the curvature of the spine designed in the present study can be used in correctional training programs, class items as well as for carrying sports equipment. The warning system and the amount of pressure on the backbone of this backpack make it a convenient and user-friendly backpack. However, it should be noted that further studies on this backpack is nessory to establish it's effeciency.

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چکیده فارسی

طراحی اولیه کوله پشتی کیفوز جدید با قابلیت نمایش فشار و حفظ انحنای ستون فقرات

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هدف از این مطالعه طراحی کوله پشتی کیفوز با قابلیت نشان دادن فشار و حفظ انحنای ستون فقرات برای افرادی است که به مدت طولانی از کوله پشتی استفاده می کنند. این کوله پشتی مانند بریس تراکولامبوساکرال طراحی شده است. طراحی آن به نحوی می باشد که فشار را به طور مناسب و یکنواخت بر روی شانه ها توزیع می کند و برای همه سنین مناسب می باشد این کیف دارای دو فلز برای حفظ انحنای طبیعی ستون فقرات و بند های قابل تنظیم در قسمت جلوی تنه و جلوی شکم است. کوله پشتی از سه باند پارچه ای، یک مدار الکتریکی متشکل از سه سنسور خمش و یک سنسور فشار و همچنین دو فلز پایدار کننده ستون فقرات تشکیل شده است. برای برقراری ارتباط بین سنسور های کوله پشتی، اطلاعات مربوط به درجه انحنای را از طریق سنسورهای خمش و برای نمایش فشار وارده، سنسور فشار این اطلاعات را در برنامه تلفن همراه طراحی شده (موبایل آپ) نشان می دهد. طراحی این مدار و کاربرد آن به گونه ای است که اگر مقدار انحنا و فشار بیش از حد مجاز باشد، از طریق سنسور ویبره به فرد اطلاع می دهد تا انحنای طبیعی ستون فقرات را حفظ کند و میزان بار کیف را طبق وزن مشخص شده تنظیم کند. برای استفاده از این قابلیت، باید مدار الکترونیکی را روشن شود، سپس از طریق بلوتوث به مدار متصل شود تا ارتباطی بین مدار و برنامه تلفن همراه برقرار شود. کوله پشتی کیفوز با قابلیت اندازه گیری فشار و حفظ انحنای ستون فقرات طراحی شده در مطالعه حاضر می تواند در برنامه های آموزشی اصلاحی، حمل تجهیزات کلاس و همچنین تجهیزات ورزشی مورد استفاده قرار گیرد. سیستم هشدار و نمایش فشار بر روی ستون فقرات، این کوله پشتی را به یک کوله پشتی راحت و کاربر پسند تبدیل کرده است.

واژه‌های کلیدی: کیفوز، بریس، برنامه موبایلی، کوله پشتی