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Original Research

A preliminary design of new corrective and wireless thoracolumbar bracing for individuals with functional thoracolumbar kyphosis

Milad Piran Hamlabadi, AmirAli Jafarnezhadgero* and Sajad Anoushirvani

Department of physical education and sport sciences, University of Mohaghegh Ardabili, Ardabil, Iran.

ABSTRACT

The aim of the present study was to design a new corrective and wireless thoracolumbar bracing for individuals with functional thoracolumbar kyphosis. For designing a new corrective and wireless thoracolumbar bracing, we used elastic thoraco-lumbo-sacral support. The support structure of the present brace formed by six straps to adjust, two metals to hold, support structure in electronic form, and two local stabilizers with bending sensor. The software of this brace designed to be able to find out the bending angle of the bending sensor. Electronic system connects through mobile App using Bluetooth connection. To do this, the researcher must turn on the electronic circuit, then device and mobile phone connects with Bluetooth. After that, the bending sensor data transform to the mobile software and the software shows the amount of bending on the mobile phone. The new corrective and wireless thoracolumbar brace designed in the present study could be used in the corrective training programs and also during daily activities. The alarm system of this brace made it a suitable and user-friendly brace for corrective aims of kyphosis malalignment. In patients with the all grade of abnormal kyphosis or lordosis, we mount the wireless thoracolumbar brace strapped to the hip and chest. Bending sensors send information of the kyphosis or lordosis angle in sagittal plane to the microcontroller. When angle is greater than the normal angle, microcontroller switch on the vibration switch to alarm patient to correct his/her posture. The current wireless device deemed to use in the corrective training programs and also during daily activities in patients with some postural abnormalities.

Keywords: Kyphosis, Brace, Alarm, Mobile App.

Introduction

Kyphosis is defined as an abnormal dorsal curvature of the vertebral column in the sagittal plane [1]. As reported by a previous study, the prevalence of kyphosis in adolescent patients was estimated at 11% [2]. The thoracic kyphosis curve can be assess through several methods such as radiography and photogrammetry [3, 4].

The gold-standard method for measuring kyphosis angle is radiography [5]; however, the cost of this method is high and exposes the individual to ionizing radiation, on the other way, it impossible to evaluate this angle during dynamic daily activities such as walking, running, and cycling [6]. The other method for measuring kyphotic angle is photogrammetry. Even though, the photogrammetry method is a non-invasive way that enables quantification of the thoracic angle without any harm [7], our method is able to quantify thoracic angle during static condition. As the matter of fact, it is essential to measure this angle during dynamic activities such as walking. Furthermore, it was not possible for different researchers or individuals to perform the similar procedure with the photogrammetry studies because of the great discrepancy in methods and angle calculations [8]. Thus, for evaluating the kyphosis angle during daily dynamic activities, it is necessary to design a new device such as wireless thoracolumbar brace.

One of the non-invasive treatment methods for thoracic kyphosis is corrective exercises [9]. If the researchers be able to design a new brace for assessing kyphosis angle, this brace also be able to alarm the individuals when this angle is excessive. The researchers and coaches are able to use this brace with the aim of corrective device during daily activities for individuals with functional thoracolumbar kyphosis. The aim of the present study was to design a new corrective and wireless thoracolumbar bracing for individuals with functional thoracolumbar kyphosis.

Material and Methods

Participants

For designing a new corrective and wireless thoracolumbar brace, we made a thoraco-lumbo-sacral support (Figure 1). Its triangular design provided a good distribution of pressure on the shoulder, suitable for all ages, and adjustable hook and loop closure facilitates proper fastening.

Figure 1. The thoraco-lumbo-sacral brace

The support structure of the present brace is consist of six straps to adjust, electronic enclosure, and two local stabilizers in which there is a bending sensors (Figure 2).

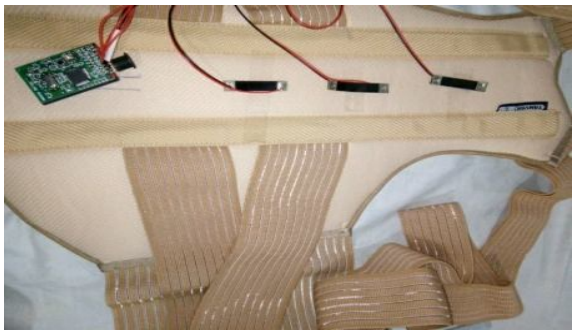

Figure 2. Bending sensors and their location

The Mobile Application Software (mobile App) of designed brace is able to find out the bending angle and signal to the patient if the angle is more than the predefined angle by the vibration switch (Figure 3). To do this, the researcher must turn on the electronic circuit, then software and mobile phones connect with Bluetooth. After that, the bending sensor data transform to your mobile App and its shows the amount of bending on your mobile phone.

Figure 3. The mobile App menu

The electronic parts were as follows: bending sensor (Artman Company, Iran), Vibration sensor (SW-18010P, Mobicon), Full electronic circuit for coordinating sensors (Made by authors), and rechargeable battery (Samsung, South Korea) (Figure 4).

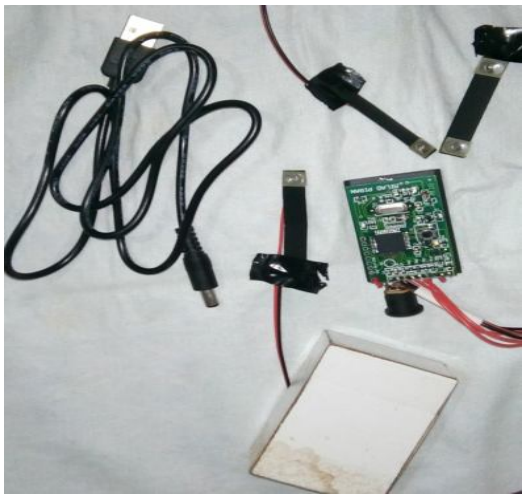

Figure 4. The electronic parts

Block diagram of the new designed wireless brace demonstrated in Figure 5.

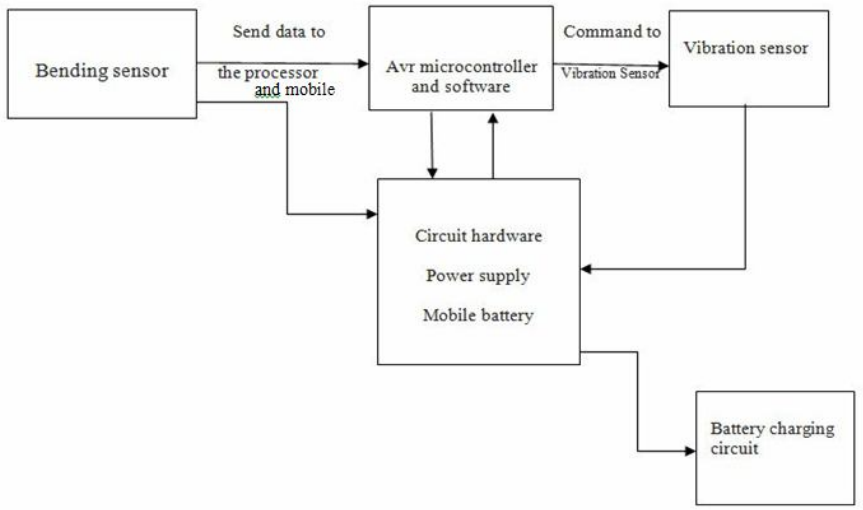

Figure 5. Block diagram of the new designed wireless brace

Results

The aim of the present study was to design a new corrective and wireless thoraco-lumbo-sacral brace for individuals with functional thoracolumbar kyphosis.

A recent study demonstrated that after initiation of brace treatment, the thoracolumbar kyphosis gradually resolved [10]. Normal vertebral morphology was also completely restored in the sagittal plane [10]. However, the brace used in the study of Ibrahim, et al. had not automatic sensors and had a rigid structure [10]. A new corrective and wireless thoracolumbo-sacral brace designed in the present study include: suitable for assessing any degree of curvature (0-90 degree) in different people, its washable, is possible to use in two simple and electronic forms, adjust the curvature range (0-90 degree) using the software. Moreover, unlike previous inventions, in the present brace, special attention has been given to alert and demonstrate the vertebral alignment angle. Furthermore, the new corrective and wireless thoracolumbo-sacral brace have rechargeable electronic battery.

The new corrective and wireless thoracolumbo-sacral brace designed in the present study can be used in the corrective training programs. The one of the most advantages of this brace is that the examiners can use it with different kyphosis intensities. Therefore, this brace had this ability to apply the overload principle in

training periods. In the other hand, this brace has an alarm system that informs the person when he/she has a kyphotic angle greater than 40 degree.

Conclusion: The new corrective and wireless thoracolumbo-sacral brace designed in the present study can be used in the corrective training programs and also during daily activities. The alarm system of this brace made it a suitable and user-friendly brace for correction of kyphosis misalignment.

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Corresponding Author: AmirAli Jafarnezhadgero, Department of physical education and sport sciences, University of Mohaghegh Ardabili, Ardabil, Iran, Email: amiralijafarnezhad@gmail.com, Telephone Number:+984531505649