

An Ergonomic Flexible Girdle Design for Preteen and Teenage Girls with Early Scoliosis

Pak-Yiu Liu^a, Joanne Yip^{a,*}, Kit-Lun Yick^a, Chun-Wah Marcus Yuen^a
Sun-Pui Ng^b, Chi-Yung Tse^c, Derry Law^a

^a*Institute of Textiles and Clothing, The Hong Kong Polytechnic University, Hung Hom, Hong Kong*

^b*Hong Kong Community College, The Hong Kong Polytechnic University, Hung Hom, Hong Kong*

^c*Centre for Orthopaedic Surgery, Suite 1118, Bank of America Tower, Central, Hong Kong*

Abstract

Adolescent Idiopathic Scoliosis (AIS) is a three-dimensional (3D) deformity of the spine that can occur in children aged 9 and older. It is more commonly found in girls. This paper presents an ergonomic flexible girdle or brace design for preteen and teenage girls who have early scoliosis with a spinal curve that is less than 20 degrees, which reduces the chances of further aggravation of their scoliosis by exerting corrective forces onto their torso and improving their posture. During the design and development process, it was found that the key factors that affect the efficiency of the flexible girdle are the design and fit of the garment, corrective force mechanism employment, material selection and application, and aesthetic and convenience of the product that affect compliance. The results of ergonomic design process in this project can be applied to related product development projects in the future and used as reference for doing so.

Keywords: Ergonomic Garment Design; Flexible Girdle; Scoliosis

1 Introduction

AIS is a 3D deformity of the spine. The main risk factors of curve progression are skeletal immaturity, female gender and large curve magnitude [1-2]. It has been found that nearly 10% of all adolescent have some degree of spinal curve or deformity after their tenth year [3]. As a result, it is important to monitor and control the situation once curvature is found. Generally, different treatments are suggested to patients according to the stage of scoliosis with consideration of their spine situation. Surgery is suggested for patients with spinal curves that are greater than 41 to 50 degrees, bracing is the non-invasive treatment suggested for patients with spinal curves between 21 and 40 degrees, and only observation with periodical spine re-examination is suggested for those with early scoliosis which means a spinal curve between 6 and 20 degrees [4-5]. Traditional treatment may also include exercises, physiotherapy, rehabilitation, etc. [2].

*Corresponding author.

Email address: tcjyip@polyu.edu.hk (Joanne Yip).

With regards to rigid brace treatment, traditional braces are made of rigid plastic materials, for example, the Thoraco-lumber-sacral-orthosis (TLSO) brace and the Cervico-thoraco-lumbo-sacral Orthosis (CTLSSO) brace [5-7]. A three-point pressure system is applied, in order to make corrections to the spinal curve and reduce the possibility of curve progression [7, 8]. Patients need to wear the traditional rigid brace for 23 hours on a daily basis during the treatment, which means that their torso will be tightly covered and compressed by a thick layer of non-breathable plastic for a lengthy amount of time. Apart from the discomfort and skin irritation, breathing would also be affected [9]. Asher and Burton (2006) also found that the self-images of wearers during the rigid brace treatment are negatively affected [10].

The flexible brace treatment was developed due to the low compliance of the traditional rigid brace and one example is the Dynamic SpineCor Brace. It is applied to patients who have relatively normal neuromuscular systems [11]. The treatment that is applied in the SpineCor system is known as spinal coupling, which corrects deformities by reversing abnormal posture and body shape into their opposite position so that the abnormal alignment of the spine can be corrected [12]. Patients need to wear the brace for 20 hours every day during their rapid growth period. The Dynamic SpineCor brace is a relatively new method for AIS, however its efficacy is still controversial [2, 12]. Its acceptance is also one of the concerns due to issues encountered when going to the bathroom [13].

On the other hand, special orthosis wear and garments have been developed to assist with posture correction [14]. The garment types are mainly made of fabric materials that support with the bones and adjustable accessories that can adjust for tightness. The Babaka U9 posture corrector back straightener is one example. It is a corset and vest liked garment that improves the wearer's indolent posture of the upper torso with a double-Y strap design which holds the shoulders and the bones that support the back [15]. However, it is commonly believed that the functions of the Babaka U9 are exaggerated [13]. The garment may help to improve poor posture, like hunchback, but does not seem to be able to improve spinal deformities.

As flexible brace products in the market for adolescents with early scoliosis are limited and there are still many existing problems, the purpose of this study is to apply a design process framework proposed by LaBat and Sokoowski (1999) [16], and ergonomics design approach, systematic steps and methods to design and develop a flexible girdle for preteen/teenage girls aged 9 to 13 who have early stages of scoliosis.

2 Methodology

2.1 Design Process Stage Framework

The design process framework proposed by Labat and Sokoloeski (1999) is recommended for use in textiles product design and development [16]. In this study, this framework is applied and shown in Fig. 1. This study was conducted by researchers with different backgrounds, including an apparel designer, textiles expert, prosthetist-orthotist, and mechanical engineer. The wear trial of the flexible girdle was tested in the laboratory to determine how well the garment performed in posture improvement, comfort maintenance and health issue minimization.