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Original Research

Designing Foot Orthoses with the Aim of Pain Reduction

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ABSTRACT

The purpose of this study was to design shoe insoles for people with neck pain. In this study, elastic polymers and elastomers matrials were used to design the insole body. In the specific part, a polymer ring with emollient materials was used. Fifteen male students with neck pain were volunteered to participate in the present study. The pain intensity was measured after 120 mile walking with and without designed foot orthoses. Visual analog scale (VAS) index was used for pain assessment. Shapiro-wilk test affirmed the normal distribution of the data. Paired sample t-test was used for statistical analysis using SPSS software version 26. A significant level of $P \leq 0.05$ was considered for all tests. The results of the present study showed that the designed insole reduced pain in people with neck pain ($P=0.006$). Overall, further studies were needed to better establish this issue.

Keywords: Shoe insole, Polymer, Neck pain

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INTRODUCTION

Walking is the human main movement. A person walks an average of 5,000 to 15,000 steps during the day [1]. The ability to walk through was done through neuromuscular and musculoskeletal coordinations [2]. Walking is done continuously as a result of integrating all the innumerable information received to control the center of mass in this situation [3]. Natural walking is a movement with the aim of transmision [4]. In the absence of pathology,walking is a coordinated, efficient, and effortless activity; however, illness or trauma can affect its accuracy, coordination, speed, and adaptability [1]. Daily foot care should be a part of our health concerns, just as we take care of the face and other parts of the body [5]. In fact, uncomfortable and inappropriate shoe soles can tilt your body forward. This factor causes the center of mass to move forward. When your foot is in the wrong posture, your walking, standing and even sitting will be different. In addition, this unfavorable situation causes back pain and neck pain [6]. The discussion of gait symmetry is important because the limbs must be in perfect harmony to achieve a smooth movement [3]. By using a forceplatform, the amount of ground reaction forces could be recorded while walking [7-10]. Also, high loading rate while running increases the risk of musculoskeletal disorders. Since human body tissues are viscoelastic, their loading response is time-dependent. Therefore, they are less susceptible to damage at lower loading rates [11]. Shoe soles with inappropriate elasticity increase the amount of shock to the soles of the feet while walking. In other words, increasing the load on the tissues causes musculoskeletal disorders in different parts of the body [12]. One of the ways to change the amount of loading is to use suitable shoe soles [10, 11].

Conventional medical insoles have a poor performance in improving and regulating the amount of load on the soles of the feet, this factor reduces their ability to reduce pressure on joints, ligaments and tendons [8]. Previous studies have shown that the use of medical insoles change the position of the center of mass [13] and even change the vertical ground reaction force [14]. Moreover, another study has shown that the use of insoles can shift the center of mass and reduce the vertical ground reaction force during running [12]. Therefore, the purpose of this study was to design a foot orthoses with the ability to reduce the intensity of pain in people with neck pain.

MATERIAL AND METHODS

To design this insole, three separate sections of upper insole, lower insole and ring were used. First, polyisoprene, an elastomer, was used to make the bottom insole, which shows an extremely large amount of elastic deformation when applied to a force. The property of this material is to return original state with the rapid loss of tensile force. Then, in addition to the main materials of the polymer and fillers, 20% of dictyl phthalate was added to achieve softness. The material used to make the upper part is polyisoprene. which has been added with 40% of diethyl phthalate. Polysiloxane, which is a type of polymer, was also used to make the ring.

The dimensions and thickness of the insole sections vary according to their condition and efficiency. The upper part of the insole, which is in direct contact with the sole of the foot, has a thickness of 7 mm, a length of 28 cm, and a transverse arch of 8 cm (Figure 1).

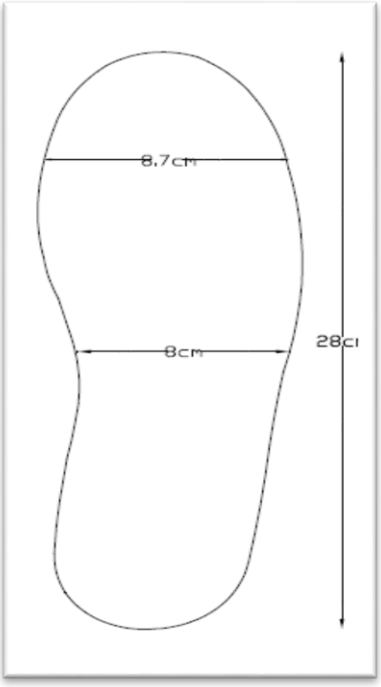

Figure 1. Appearance characteristics of the insole

The 6-cm-long, 3-mm-diameter polysilucan ring, at an angle of approximately 60 degrees is placed tangentially to the bottom insole just below the thumb. This location and dimensions for the ring were chosen because it causes the least amount of disruption to the person's walking (Figure 2).

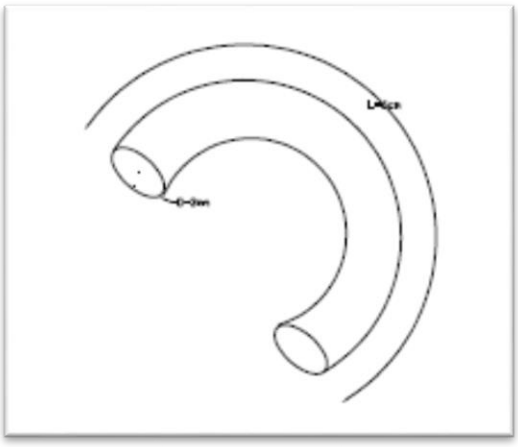

Figure 2. Appearance characteristics of polysilucan ring

In the insole of the right foot, the left end of the ring is placed outside the insole with a hole with a diameter of 3 mm to allow a small amount of air to pass inside the ring (Figure 3).

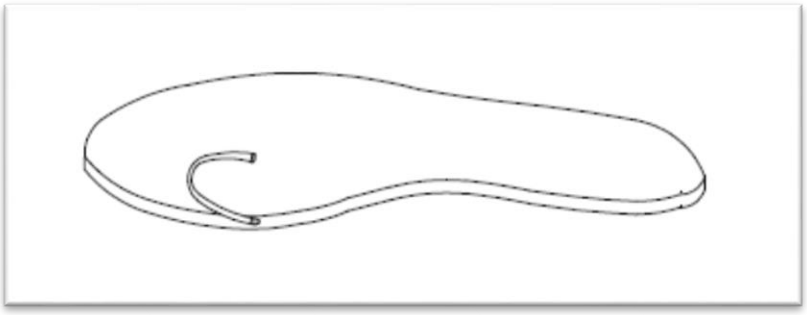

Figure 3. The location of polysilucan ring

The sole of the upper part, which is in direct contact with the sole of the foot, is like the sole of the lower part, 28 cm long and has a transverse arch of 8 cm. with the difference that in order to create proper pressure and contact by the polysilicon ring, the thickness of the sole of the upper part is 2 mm less than the sole of the bottom (Figure 4).

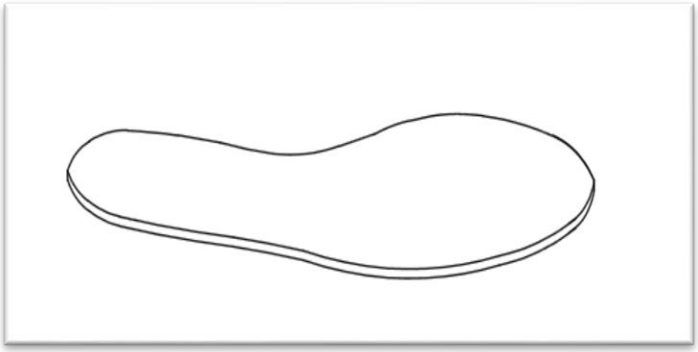

Fig .4. Appearance of the upper insole

Finally, the upper sole and the lower sole are placed on top of each other with adhesives between a special layer of polymer materials. The final sole has a length of 28 cm, a transverse arch of 8 cm and a thickness of 12 mm (Figure 5).

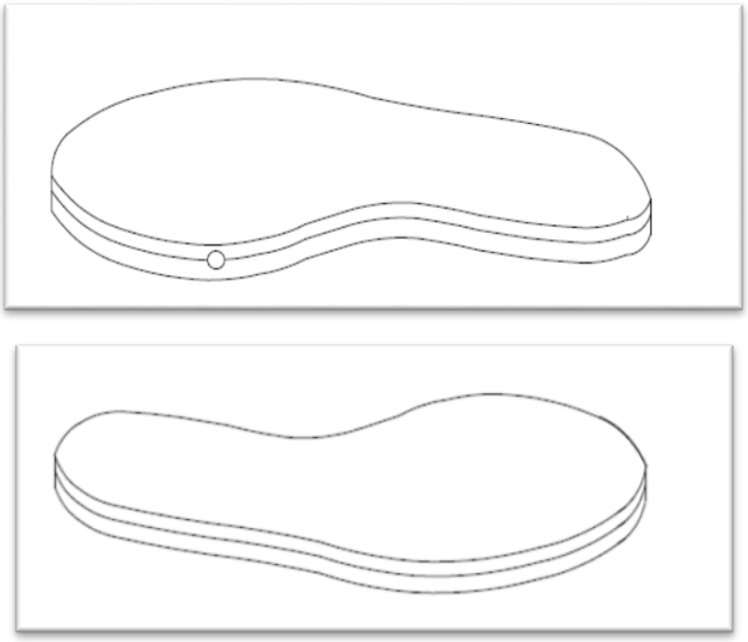

Figure 5. Final left/ right insole profile

Then the Nordic questionnaire was used to determine and find neck pain sufferers. The statistical sample included 15 male students with neck pain. The demographic information of the subjects provided in the Table 1. Inclusion criteria included: no severe injuries in the last 12 months, no medical prohibition to participate in physical activity. VAS index was used to aasess pain intensity after 120 miles of walking with and without foot orthoses. Written informed consent were received from all individuals.
Shapiro-wilk test affirmed the normal distribution of the data. Paired sample t-test was used for statistical analysis using SPSS software version 26. A significant level of $P \leq 0.05$ was considered for all tests.

RESULTS

Demographic characteristics of the participants were demonstrated in the Table 1. Findings demonstrated lower neck pain after using designed foot orhtoses (P=0.006, Table 2).

Table 1. Demographic characteristics of participants

Variable	Experimental group
Age (years)	24.22±3.1
may (cm)	1.83±0.16
Weight (kg)	82.36±11.22
Body mass index (kg / m^2)	23.93±2.22

Table 2. Neck pain severity during pre-test and post-test

Group	Pre-test	Pos-test	P
Experimental	4.21±0.83	3.11±0.04	0.006*

*P ≤ 0/05

DISCUSSION

The purpose of this study was to design shoe insoles for people with neck pain. The present results showed that the designed insole caused significant reduction in the amount of neck pain when walking. In general, the results of the present study showed that the insole factor has caused the effective displacement of the body mechanics. A previous study reported that the use of insoles improved the function of the injured foot in the patients with knee osteoarthritis [15]. Another study showed that sloping external insoles significantly reduced peak knee adduction torque in healthy subjects during running [16]. Also, another study reported that the effect of custom insoles was similar to that of regular shoes [17]. As a result, the insole reduces the internal pressure of the heel by transferring pressure from the inner heel area to the inside of the midfoot. In other areas, however, there is an increase and transfer of pressure. In this study, a positive effect of the designed insole was observed in reducing the severity of neck pain during the walking phase.

There are limitations in the present study that should be considered during the generalization. One of the limitations of this study is the lack of use of laboratory devices to measure the ground reaction forces before and after using insoles. This study was also done on male subjects only. Therfore, our results could not be generalized to both gender.

CONCLUSION

Based on the findings of the present study, the use of insoles had a significant effect on the severity of pain in participants with neck pain. Overall, further studies were needed to better establish this issue.

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Institutional Review Board Statement:

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study

Data Availability Statement: Data will be available at request.

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طراحی کفی کفش با قابلیت کاهش شدت درد در افراد مبتلا به گردن درد

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چکیده: هدف از این پژوهش طراحی کفی کفش در افراد با درد گردن بود. در این پژوهش و برای طراحی بدنه‌ی کفی از پلیمرهای الاستیک و الاستومرها استفاده شد. و در قسمت مورد نظر نیز حلقه‌ای از جنس پلیمر همراه با مقداری ماده‌ی نرم‌کننده استفاده شد. ۱۵ دانشجوی پسر با درد گردن داوطلب شرکت در این پژوهش شدند. شدت درد بعد از ۱۲۰ مایل راه رفتن با و بدون کفی ثبت شد. از مقیاس بصری درد جهت سنجش درد استفاده شد. آزمون شپرووِیلک نرمال بودن توزیع داده‌ها را تایید نمود. آزمون تی زوجی جهت تحلیل آماری با استفاده از نرم‌افزار SPSS نسخه ۲۶ مورد استفاده قرار گرفت. سطح معناداری برابر ۰/۰۵ بود. نتایج مطالعه حاضر نشان داد که کفی طراحی شده باعث کاهش درد گردن در افراد مبتلا به گردن درد می شود (P=۰/۰۰۶). به طور کلی، مطالعات بیشتری جهت اثبات هرچه بهتر این موضوع وجود ندارد.

واژه‌های کلیدی: کفی کفش، پولیمر، درد گردن