**Ergonomically Designed Folding Chair to Promote Correct Spinal Alignment**

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**Abstract**—The purpose of this project was to alter the position of the common folding chair. This chair is catered to the comfort of the spine while sitting. Many common folding chairs have a slight inclined seat angle with the horizontal. This project increased the seat angle as well as the back rest angle. A comfortable rocking chair position was applied to the folding chair. A novel implementation of a telescoping back rest system was added to allow each user to adjust for their own comfortability.

**Keywords**—folding chair, angle, anterior pelvic tilt, steel, welding

I. INTRODUCTION

Estimates say that up to 85% of men and 75% of women suffer from a condition called “Anterior Pelvic Tilt” [1]. Many Americans have developed bad posture due to sitting for many hours of the day at work and at home. Workers are using chairs that while comfortable, are not optimal for the human body in terms of posture and ergonomics. The common workplace and the advancement of technology has led to many people sitting hunched over staring at a computer screen for most of the workday without moving. This can have major ill side effects on the human body. This phenomenon has gotten so bad that it is recommended that workers take a break every hour from sitting and stand up, walk around to help stretch and work their unused muscles. Standing desks are an alternative to seated desks and are becoming more popular to promote better posture. Sitting for extended periods of time can lead to the weakening of the glute muscles and tightening of the hip flexors. When the hip flexors become tighter it can pull on the muscles in the lower part of the spine and this is part of what creates the tilt in the pelvis. Weak glutes can lead to the pelvis being anteriorly tilted or tilted forward. This is known as anterior pelvic tilt.

The goal of this project would be to combat anterior pelvic tilt by designing a folding chair that puts the pelvis in a more posterior pelvic tilt position. By posteriorly tilting the pelvis, or tilting backwards, the spine is put in a more neutral position. This can align the spine and take the pressure off the lumbar section relieving lower back pain. This can be accomplished by altering the seat and back rest angle with the horizontal. Another goal was to produce a rough prototype model that could be further optimized for a relatively low cost through mass production.

II. METHODOLOGY

According to a recent study [2], a seat angle of 5° helped relieve lumbar disc pressures. A back rest angle of 110° helped to reduce forward head posture as well. By having a posteriorly rotated seat angle, this rotates the hips backwards. When the hips are rotated backwards, the lumbar section of the spine flexes less and aligns the spine. Taking these considerations into account, a rocking chair provides optimal comfort as well. When in the rocking position, a rocking chair provides a seat angle of 8° and a back rest angle of 116°, see Figure 1 below.

The chair features a sliding bar mechanism on the bottom of the seat as shown in figure 2. This serves two purposes. The first being that it allows the chair to fold up and lay flat. This allows for ease of storage and transportation. The other purpose is that it will set the default angle for the chair.
The angle of the chair is the most important part of this whole project. This angle that the team will set will achieve the goal of fixing the anterior pelvic tilt. The sliding mechanism shown in the figure below will have a “hard stop” in order to stop the chair at the appropriate angle. The cross member that the leg bars will slide on will be made of aluminum along with the frame of the seat on the chair. It is welded to the bottom of the chair’s seat frame. This is to allow for the chair to be as strong as possible, as to not change any angle. Welding and common fasteners hold the project together. The chair is made out of low carbon steel and 3-D printed parts.

III. RESULTS

Performing Finite Elemental Analysis on the legs, bolts, and the chair as a whole, our team finds that most of the stress is concentrated on steel bolts that pass through the steel leg tubing. This is advantageous to us because the bolts will be made of the strongest material on the entire chair. All other excess forces are placed on the steel tubing for the legs which appears to hold up exceptionally well. The assembly was created using class 5 bolts and nylon locking nuts. In the FEA performed they exceeded expectations with no failures present. FEA models are illustrated in figures 3 and 4.

IV. CONCLUSION

Overall, the design was proven to be acceptable for the desired task or correcting spinal alignment and fixing anterior pelvic tilt. The chair’s strength performs exceptionally well the design parameters set in place. The prototype was produced, and mass production of the model would reduce unit cost.

V. ACKNOWLEDGMENT

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VI. REFERENCES


Sitting in the chair feels good. The rocking chair position is nice and applies well to the folding chair. The chair can fold up and users can alter the back rest support position. Lower initial setting of the back rest will accommodate the average height for adults greater than 20 years of age in the US is 69.1 inches (175.4 cm) in men and 63.6 inches (161.5 cm) for women. While the next adjustment up will be able to extend to help support for above average heights by adding a couple more inches of adjustment. The back rest adjustment is created by using telescoping tubing with holes for a detent pin to allow for sliding. The holes will be drilled to fit the size of the button pin. Then the detent pin will be slid in the tube. The tube on the back rest will have a slightly larger outer diameter to fit around the original tubing and allow for sliding.