Pillow Design and Evaluation of Shoulder and Neck Surface Pressure to Sleep Quality

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Abstract. Factors that affect sleep, compression of the body as one of the factors that affect sleep. Therefore, this study is to explore the head and neck parts of the surface pressure, sleep posture change and the interaction between the pillow and shoulder pressure changes in the degree of impact on sleep quality. Proposed pillow reduction pressure innovative design, whether to enhance sleep quality. This study from the understanding of sleep during the shoulder and neck postural changes and the degree of surface pressure. Focus on observation of the results of collective law and set out the design criteria. During the experimental evaluation, the degree of compression of the shoulder and neck can be measured using the Arduino pressure sensor to understand the subjects during sleep in various parts of the muscle pressure and postural changes in pressure. Sleep quality assessment. Can be measured through the main signal of the brain waves measured by the brain waves measured in the degree of sleep in the decompression process of whether the impact of sleep quality. Watch the frequency of the brain waves Theta and Delta waves to enter the deep sleep period. To assess the mental state of subjects to do the assessment of sleep quality and the correlation between sleep quality and degree of compression. Experimental evaluation of the expected results. Sleep quality and compression degree of relevance. Through different materials to ease the shoulder with the degree of pressure. Reduce the overall shoulder and neck compression can help improve sleep quality. In this study, innovative pillow design helps to relieve head and neck surface stress and improve sleep quality.

Keywords: Pressure · Sleep posture · Pillow design · Sleep quality

1 Introduction

1.1 Background

Factors that affect sleep, compression of the body as one of the factors that affect sleep. Research shows that one in the shoulder and neck during sleep oppressed by pressure or poor sleeping position. Cause shoulder and neck pain and other effects of disease and sleep quality. Poor neck posture during sleep, Turn oversleeping on your side the oppression of the shoulder may produce pain for patients, and oppression for a long time will not only affect sleep quality in elderly people, even severe shoulder pain. Have up to 80% of people have tight shoulders and neck pain symptoms. Neck and shoulder pain

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and sleep position are relevant. In a State of compression set. Head and neck by the surface under the influence of pressure will cause problems with sultry for a long time. Should choose the right pillow designs. The shoulder reduces compression in the neck and cervical spine is properly supported. To understand the position of the shoulder and neck position changes in the distribution from sleep process.

1.2 Purpose

Therefore, this study is to explore the head and neck parts of the surface pressure, sleep posture change and the interaction between the pillow and shoulder pressure changes in the degree of impact on sleep quality. Proposed pillow reduction pressure innovative design, whether to enhance sleep quality.

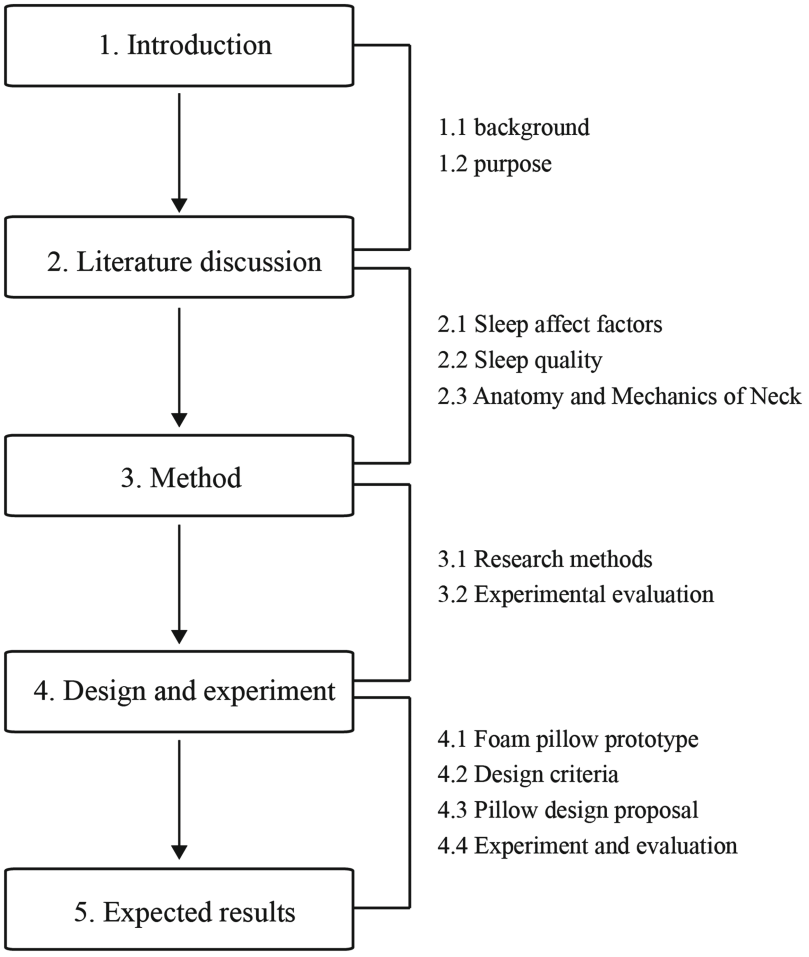


Fig. 1. Research flow chart

Follow-up groups using the Focus Group Law to conduct interviews for data analysis. To solve the above-mentioned literature to explore the shoulder and neck compression can improve the sleep when the solution, to design in the sleep position can be appropriate to support the shoulder and neck muscles and spine, Appropriate dispersion of pressure area, and thus improve the body surface pressure and pressure caused by the process of ventilation problems, and slow down muscle tension, restore muscle elasticity, promote blood circulation. Can be used to assess the frequency of brain waves to improve sleep quality results. The research structure is shown in Fig. 1. The purpose of the study can be divided into the following four points:

(1) To explore the impact of sleep and neck during the shoulder and the impact of the activities of the location, sleep posture transformation.
(2) Analysis of the body's shoulder and neck muscle parts in the sleep process of mechanical activity changes.
(3) To sleep on the market to reduce sleep pillow sleep assessment of whether the improvement of sleep quality.
(4) Focus groups to design a new type of pillow designed to improve the quality of sleep validation.

2 Literature Discussion

2.1 Sleep Affect Factors

Body Pressure Distribution. In the sleep process, the pressure is mainly the body parts of the surface contact with bedding, resulting in stress concentration, a long time will cause muscle tension and blood circulation deterioration of the situation occurred. Will also cause the main sweat glands position hot and affect the quality of sleep. The body is heavily compressed in the back of the head when the back of the head, the back, buttocks, thighs, heels, these parts are mainly under pressure [21]. The main pressure on the side of the body when the body concentrated in the shoulder and thigh [15].

The body torso sleep angle also affects the surface pressure. The angle of the side sleep affects the pressure on the surface of the body and the bed. The surface pressure on the 30° side of the slope is lower than the 90% side of the surface pressure [5].

Sweat Glands Hot Position. Sleep process, a long time to focus on the site will cause the heat to affect the quality of sleep. The back is mainly the most parts of the body of the sweat glands [22]. So there is a positive correlation between the amount of sweat in each region of the body and the proportion of total sweat.

The body's sweat glands can be divided into four separate body parts area: (1) head and neck (2) arms and legs (3) trunk (4) hands and feet [10].

Posture transformation and Distribution position. There will be countless sleep posture changes during sleep. The replacement of the posture makes the body pressed for a long time in the same position. But a long time to sleep posture to increase the neck and other related parts of the pain problem. During the sleep process, you can see the placement of the body parts throughout the posture, left, and right posture [24]. To the

side of the sleeping position, the best vertebral shape is supported by a straight line, while the shoulder area must be soft to prevent lateral scoliosis [6].

In the process of sleep, you can use the experimental test to measure the size of the pressure distribution area and the body posture of the main movement of the size of the relationship between the size of the muscle to do research.

2.2 Sleep Quality

The definition of sleep quality can be divided into two aspects [3]: Qualitative aspects: Subjective statement on the evaluation of sleep, sleep depth and adequate feeling. A number of aspects: The length of sleep time, sleep occurred, the length of sleep latency and sleep efficiency.

Most of the current studies use this definition for sleep quality assessment, which should cover their own sleep assessment and sleep duration. Parrott with Hindmarch in a sequential manner that sleep quality should be assessed for three major aspects: Easy to sleep, sleep cycle integrity, and get up after the behavior and rest. In addition to including conscious sleep-related feelings, as well as sleep time and integrity. Can increase the behavior and performance after getting up.

Sleep process and Brain waves. The sleep process is divided into (1) Rapid Eye Movement, (2) Non-Rapid Eye Movement, accounting for 25% and 75% of all night's sleep [20].

The sleep process is four stages.

(1) The first stage: shallow sleep (5–10 min). The brain waves present the Theta wave. The body is half awake.
(2) The second stage: shallow sleep (10–20 min). Compared to the first stage, it is easier to wake up.
(3) The third stage: deep sleep (about 40 min). The brain waves present a delta wave and a slow wave. Heartbeat and breathing become slow, body temperature drop, muscle relaxation. The body begins to undergo tissue repair with cell regeneration.
(4) The fourth stage: rapid eye movement (about 50 min): This stage is dreaming, the brain is active. The brain waves present theta, Delta waves.

In the sober when the insomnia patients will have a higher Theta wave. Normal subjects are more than those with insomnia in the Delta wave [1, 13]. Insomnia patients have more Beta waves and fewer alpha waves than normal sleepers before going to sleep [8, 9].

This experiment can be through the brain wave signal instrument to measure the subjects of brain waves in the sleep process of sleep quality is good or bad. To observe the frequency of brain waves to assess the mental state of subjects [20] to do the assessment of sleep quality. Mainly view Delta and Theta wave. For the frequency of sleep in the sleep process for the sleeping, shallow sleep state of consciousness.

2.3 Anatomy and Mechanics of Neck

Shoulder Joint and Cervical Spine, Mechanical Operation. During the sleep process, the shoulder and neck parts of the activity, the scapula, and the humeral humerus is the main two major components of the shoulder joint. In the sleep posture process activity, the body posture transformation movement mainly of the spine to move. Mainly support the body weight, head, trunk, limbs and other structures and weight. Also affect the body posture, movement. The above is the main shoulder and neck parts within the scope of the study of sleep.

Shoulder Joint. The shoulder joint is the largest part of the human body.

Which the scapula is the shoulder movement of the bracket. There are four main modes of operation:

(1) Provide shrinking and prolonging functions in different stages of throwing action.
(2) Arm shoulders will be relative to the shoulder when the abduction.
(3) Glenohumeral activities like a bearing-like action.
(4) For the deltoid, biceps and triceps activity when the platform.

During the sleep, the movement of the scapula can be divided into six basic actions: the elevation, the depression, the abduction, the adduction, medial rotation, lateral rotation.

Cervical Part of the Mechanical Operation. The main cervical spine is composed of seven bones (C1–C7). The main movement for the Flexion and Extension, Lateral Bending, Axial Rotation and other three kinds of movement, a total of six directions of freedom.

Because the shape of the cervical spine is special, a single type of movement is often accompanied by other directions of movement (Coupled Motion).

Such as Rotation and Axial translation, Lateral bending and Rotation [16].

So the analysis of cervical movement is often more difficult.

When the neck part of the fixed collar, the cervical spine will become a smaller range of activities.

3 Method

3.1 Research Methods

The purpose of this study is to study the compression and postural changes of the shoulder and neck in the sleep process. And then designed to meet the shoulder and neck parts of the ergonomic pressure to improve the quality of the new sleep pillow design guidelines and planning. This experiment sets the pillow to detect the size of the shoulder and neck compression pressure to improve the quality of sleep.

The first stage: design criteria and assessment methods

To collect literature on the effects of sleep factors on muscle movement related to shoulder and neck. The follow-up to the existing soothing pressure sleep with no

improvement in sleep quality. Summed up the design criteria, and then design proposals. Selection of a suitable sleep experiment proposal.

The second stage: the sleep pressure test

The purpose of this stage is to discuss the compression between the body's shoulder and neck and sleep bedding. Finishing the shoulder and neck parts of the surface pressure, the position of the degree of compression and posture transformation and finishing data. The results of the experiment to the body part of the image and compression of the relationship between the corresponding, The establishment of surface compression image. Analyze whether the original compression surface is consistent or different. Apply this compressed image to the new pillow bedding design. The Perform a validation from sleep brain waves to see if there is no improvement in sleep bedding.

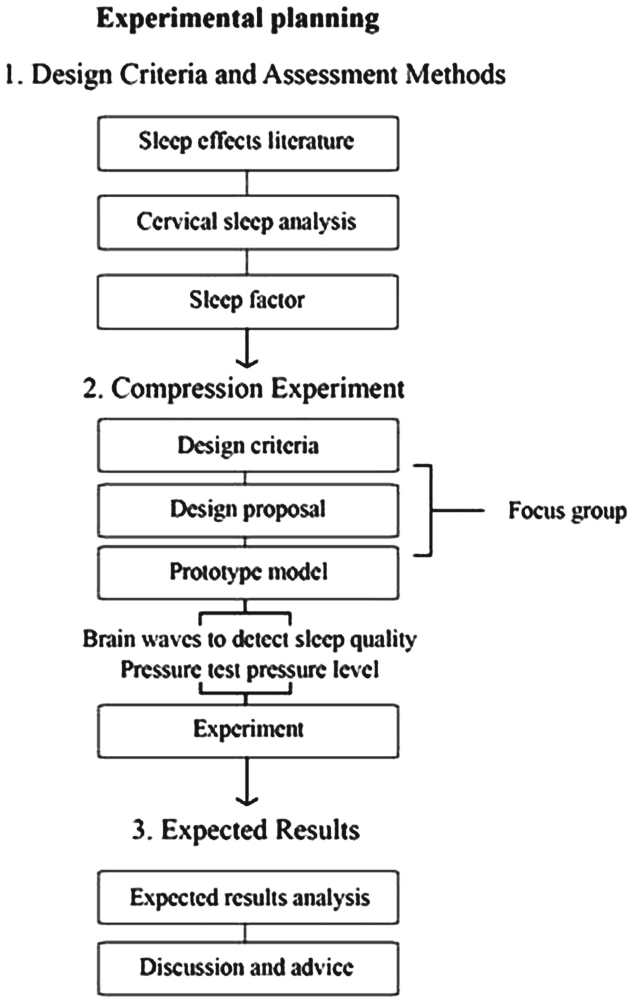


Fig. 2. Experimental process

The third stage: pillow design and evaluation

Extract design guidelines and experiments as well as focus ethnic group design proposals for pillow design. Through the design, proposal bedding to carry out experiments to assess the analysis of shoulder and neck pressure, and put forward the conclusions of the proposal. Given follow-up pillow design reference use,The experimental process is shown in Fig. 2.

3.2 Experimental Evaluation

Ardunio pressure sensor. In this study, an Arduino pressure sensor was used to produce an instrument that evaluates the size of the body's surface as shown in Fig. 3.

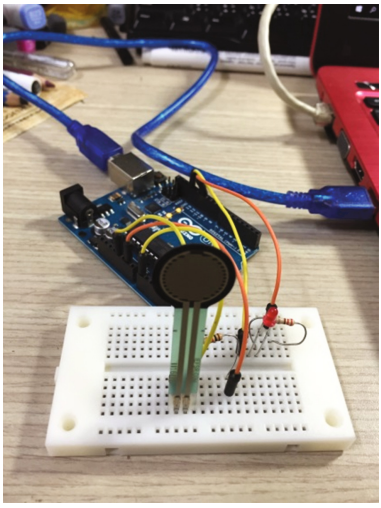


Fig. 3. Ardunio pressure sensor

Its main structure is to USB interface connected to the computer, to receive the signal, and transferred to the relevant software. The main pressure sensor is mainly woven into the sleep bedding sponge fabric material inside. Through the body pressure to sense the size of the surface compression data shown in Fig. 4.

Brain Wave Signal Instrument. The experimental brain wave signal instrument mainly measured subjects brain waves that sleep quality is good or bad. Measure the amount of surface pressure. Verify that the body is in contact with the surface of the bed with little or no improvement in sleep quality. Through the instrument to watch the frequency of Alpha, Beta, Theta and Delta waves to assess the mental state of subjects in Fig. 3 to do the assessment of sleep quality.

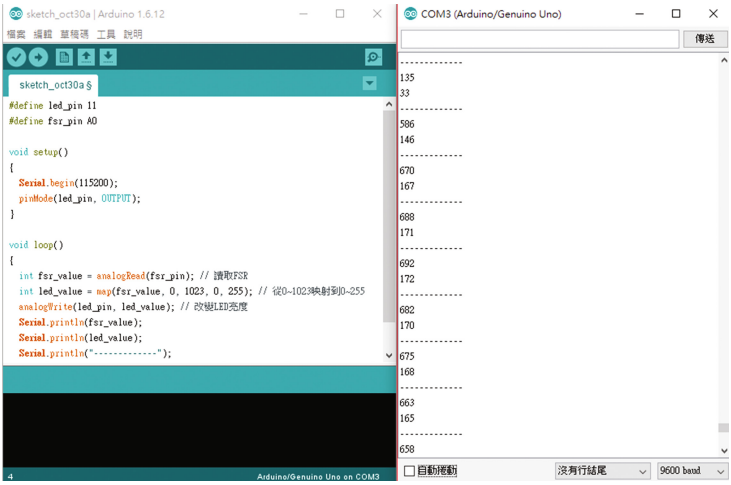
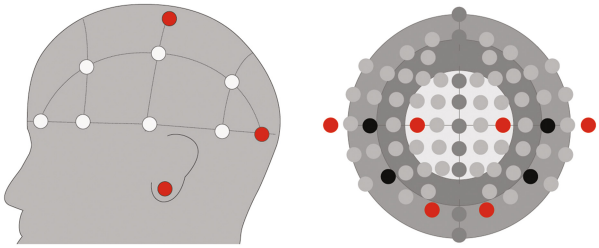


Fig. 4. Pressure data



4 Design and Experiment

4.1 Design Criteria

To collect literature on the effects of sleep factors on muscle movement related to the shoulder and neck. The follow-up to the existing soothing pressure sleep with no improvement in sleep quality. Summed up the design criteria, and then design proposals. Subsequent selection of the appropriate sleep experiment proposal.

Pillow design proposal

The design proposal will carry out the focus group method through the design criteria. The focus group method design process is:

(1) Experimental purposes.
(2) Sleep in the head and neck changes in the analysis of the results.
(3) Discuss each other's ideas.
(4) Reduce the head and neck parts of the pressure, breathable to think.
(5) Reduced pressure pillow design.
(6) Discuss the design.

5 Expected Results

Experimental evaluation of the expected results. Sleep quality and compression degree of relevance. Through different materials to ease the shoulder with the degree of pressure. Reduce the overall shoulder and neck compression can help improve sleep quality. In this study, innovative pillow design helps to relieve head and neck surface stress and improve sleep quality.

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