Journal of Novel Applied Sciences
Available online at www.jnasci.org
©2013 JNAS Journal-2013-2-9/335-339
ISSN 2322-5149 ©2013 JNAS

Assessment of an arm-positioning pillow to prevent waking paresthesia symptoms related to side sleepers: using echo-Doppler imaging

Karim Leilnahari[1] , Hamidreza Ghasemi Bahraseman[2*] and Mostafa Sadeghy[1]

1- Department of Biomedical Engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran
2- Science and research branch, Islamic Azad University, Golzare.1, Adl Blvd, Poonak, Tehran, Iran

Corresponding author: Hamidreza Ghasemi Bahraseman

ABSTRACT: The aim of this study was to assess arm positioning pillow to prevent waking paresthesia symptoms related to side sleepers arms. This problem resulted from pressure of head weight on arm. This pressure obstructs the blood flow to nerve fibers in some part of anatomy. The ergonomic arm positioning pillow includes an upper portion having a top part for supporting the head of a sleeper and a bottom part having a space to protect the arm from head weight pressure. Blood's volumetric flow of brachial artery was measured by echo-Doppler imaging while the subjects slept on their arms (stage 1) and next stage was with applying arm-positioning pillow (stage 2) for 16 healthy subjects. When head pressure was considered (stage 1), the measured blood volumetric flow of brachial artery was lower on average by 77.25% than the case in which the subjects applied an arm positioning pillow (stage 2). Despite the use of a simplified model of an arm positioning pillow, releasing from head weight pressure and subsequent paresthesia symptoms was achieved for side sleepers arms considering of the elimination of arm's blood flow reduction.

***Keywords*:** Arm positioning pillow, echo-Doppler, waking paresthesia symptoms.

INTRODUCTION

Normally, the quality and quantity of sleep affects mental and physical health and feelings of wellbeing (Gordon and Grimmer, 2011). Health care professionals are frequently asked by patients to suggest pillows that will ameliorate the quality of their sleep as well as relaxation (Wellings, 2007). However, this has not directed to obvious suggestions on the best adaptation between individuals, pillows and matters (DeVocht and Wilder, 2005; Lahm and Iaizzo, 2002; Keller and Lubbert, 2004 and Shields et al., 2006). Many individuals would like to sleep on their side instead of in a complete prone or complete supine position (Gordon et al., 2009). Many people present with waking paresthesia symptoms related to their arms. In most occasions, paresthesia occurs when pressure from sleeping posture obstructs the blood flow to nerve fibers in some part of anatomy (Adam and Hadhazy, 2008). There remains an ongoing need to give a sleeper improved and greater flexibility in side sleeping posture as long as maintaining and improving comfort.

Taking to account a lot of pillow designs together with plights of not verified information about different pillow kinds, not only patients but also health care providers might be confused regarding which pillows to select, in addition to unexpected waking symptoms after common night's sleep (Gordon and Grimmer, 2011). Recent studies have shown a gradually raising body of proof on sleeping position, pillow performance and coziness, and waking symptoms (Ambrogio et al., 1998; Boyd et al., 2006; Buckle and Fernandes, 1998; Hagino et al., 1998; Lavin et al., 1997; Gordon et al., 2002; Gordon et al., 2007; Miller, 1984; Persson et al., 1998 and Persson, 2006). Up to date of this study, most of investigations have focused on symptoms involved with the cervico-thoracic spine including headache, pain, stiffness, and scapular pain (Bernateck et al., 2008; Bland and Boushey, 1987; Gordon et al.,

2009; Gordon and Grimmer, 2010; Gordon and Grimmer-Somers, 2011; Grieve, 1988; Hagino et al., 1998; Jackson, 1976; Kramer, 1990; Lansam, 1992; McDonnell, 1946; Persson, 2006).

This paper is intended to assess the performance of an ergonomic, arm-positioning pillow designed to release the arm from the head weight pressure while side sleeping. It an upper portion having a top surface for supporting the head of a sleeper and a bottom portion having a lower surface for supporting the arm-positioning pillow. This assessment is done for 16 subjects by measuring the blood volumetric flow of brachial artery using echo-Doppler for 16 healthy participants at two stages. At stage 1the subjects sleep on their arms and at stage 2 they apply arm-positioning pillow.

MATERIALS AND METHODS

Method

Design of experiments

16 healthy men were subjected to measure the brachial artery flow at two aspects of study included (stage 1) without applying any pillow in which the subjects' arm is under head pressure for 10 minutes, (stage 2) applying a An arm positioning pillow.

The pillow top portion for supporting a sleeper's head includes a top surface and a planar lower surface and the pillow top portion was made from a materials included foam, latex or polyester. Polyester fibers are often arranged in three-dimensional clusters that help the pillow hold its shape and provide optimal neck support. Synthetic materials have some benefits over natural fibers; they are allergy and odor free (Kilpiö et al., 1998), they tend to last longer and they are generally more affordable. The pillow dimensions are 40 cm (length), 30 cm (wide) and 12.5 cm (height).

Informed consents were gotten for the participators in accordance with accepted procedures approved by the medical ethics committee of Kurdistan University of medical sciences. The final approval letter reference No. is 17926/4021. Following physical examination, having normal cardiovascular performance of the subjects were found via Doppler ECG. Their head weights varied from 5.8 kg to 6.9 kg with mean weight of 78.1 kg, They were roughly aged 23 years.

A commercially common ultrasonograph (Maylab, 60, BIOSOUND ESAOTE Inc., USA) was applied for echo-Doppler exams. A 4 MHz phased-array probe was placed at the position of the brachial artery to record Blood volumetric flow, brachial artery section area by B-mode. Echo-Doppler images were digitally saved and next analyzed by using Maylab-desk analyzer (Maylab, BIOSOUND ESAOTE Inc., USA). Only high-quality images were applied to analyze. All tests were acquired in side sleeping position. The brachial artery flow for all subjects calculated at stage 1 and stage 2 as provided in table 1.

The subjects were asked to locate their head at the upper part of their arm (at the bottom of the brachial artery). After 10 minutes that surely affected on the blood flow of vessel, the echo-Doppler tests were carried out.

Flow measurements

Blood volumetric flow of brachial artery was computed using equation 1:

$$\text{Blood volumetric flow} = \text{Stroke volume} * \text{Heart rate} \quad (1)$$

In the equation which the stroke volume was measured from echo-Doppler using equation 2:

$$\text{Stroke volume} = \text{Velocity integration} * \text{Brachial artery section area} \quad (2)$$

in what location the velocity integration was automatically calculated by tracing the Doppler flow from echo-Doppler imaging. The brachial area was obtained using equation 3:

$$\text{Area} = \pi(\frac{D}{2})^2 \quad (3)$$

where D is the measured brachial artery diameter.

RESULTS AND DISCUSSION

Blood volumetric flow measurement of brachial artery

As shown in table 1and figure 1, without applying any pillow that the subjects' arm is under head weight pressure (stage 1), the blood volumetric flow of brachial artery varied between 91 (ml/min) to 282 (ml/min) for the whole subjects. The mean blood volumetric flow of brachial artery was 154 (ml/min) at stage 1. As provided in table 1 and figure 1, with applying an arm positioning pillow (stage 2), the blood volumetric flow of brachial artery varied between 626 (ml/min) to 753 (ml/min). The mean blood volumetric flow of brachial artery was 681 (ml/min) for the whole subjects at stage 2. As shown in figure 2, the reduction percent of blood volumetric flow of brachial artery

ranged between 61 and 86 at the stage 1. Moreover, the average of reduction percent of blood volumetric flow of brachial artery for the whole subjects was 77.25 and five subjects' reduction percent were lower than the average of reduction percent of blood volumetric flow of brachial artery. Regarding the data performed in table 1, the difference of blood volumetric flow of brachial artery ranged from 407 (ml/min) to 618 (ml/min) at two stages. furthermore, average of this difference was 526.6 (ml/min) for the whole subjects.

Table 1. blood's volumetric flow of brachial artery for the subjects (stage 1) without applying any pillow that the subjects' arm is under head pressure for 10 minutes and (stage 2) with applying an arm positioning pillow

Subject	Volumetric flow of blood for stage 1 (ml/min)	Volumetric flow of blood for stage 2 (ml/min)	Difference of Volumetric flow of blood for two stages (ml/min)	Percentage of difference of two stages
1	260	667	407	61
2	282	753	471	62
3	108	738	630	83
4	139	633	494	78
5	201	704	503	71
6	194	633	439	69
7	100	654	554	85
8	112	626	514	82
9	103	721	618	86
10	204	714	510	71
11	91	557	466	84
12	104	657	553	84
13	102	647	545	84
14	129	646	517	80
15	142	700	551	79
16	193	846	653	77

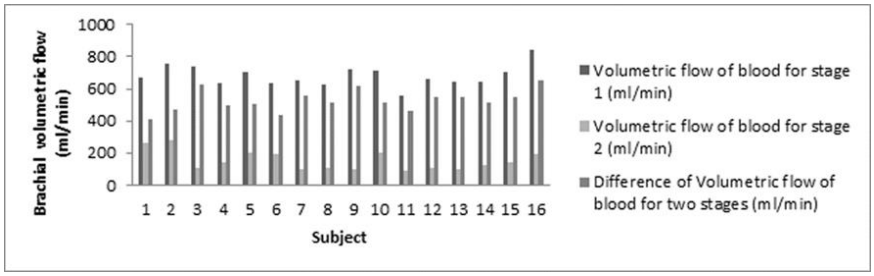

Figure 1. reports of blood volumetric flow of brachial artery for each subject, (stage 1) without applying any pillow that the subjects' arm is under head pressure for 10 minutes and (stage 2) with applying an arm positioning pillow

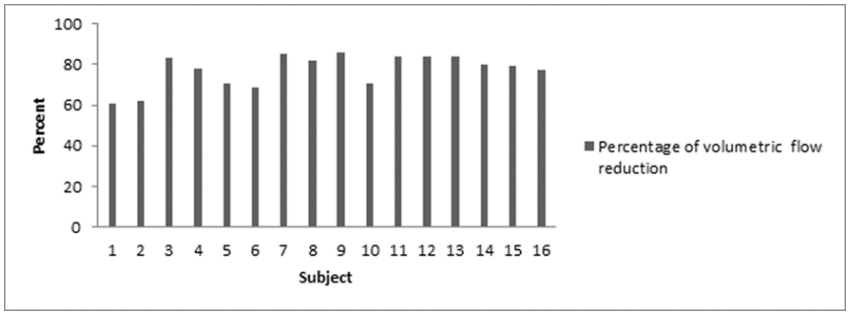

Figure 2. reports of percentage of blood volumetric flow of brachial artery for each subject while their arm is under head pressure for 10 minutes

Discussion:

Many people suffer waking paresthesia symptoms of their arms due to occuring paresthesia when pressure of head weight obstructs the blood flow to nerve fibers in some part of anatomy. This study was intended to assess ergonomic arm-positioning pillow that can be used for reducing the pressure on a user's left or right arm (and both) in order for preventing waking paresthesia symptoms. The pillow has an upper portion including a top surface for supporting the head of a sleeper and a bottom portion having a lower surface for supporting the arm-positioning pillow. The blood volumetric flow of brachial artery was measured by echo-Doppler imaging while the subjects slept

on their arms (stage 1) and applied arm-positioning pillow (stage 2) for 16 healthy subjects. To our knowledge this is the first time that echo-Doppler technique has been used to assess a the relationship of pillow design and waking paresthesia symptoms. When the head weight pressure was accounted for (stage 1), the measured blood volumetric flow was lower on average by 77.25% than subjects applied an arm positioning pillow in which such pressure was not accounted for (stage 2). In spite of the use of a simplified model of an arm positioning pillow, releasing from head weight pressure and subsequent paresthesia symptoms for any subject because of eliminating 77.25% of blood flow reduction (Figure 2).

Following a literature search we have not found a previous comparable study concentrating on eliminating waking paresthesia symptoms with a suitable pillow. Our arm positioning Sleepers can use in multiple positions. Uneasiness and restlessness are reduced by the arm positioning pillows. It also improves relaxing attributes of sleep. The fit of pillow to human form would be developable in this study. For example, the height and angle of pillow can be categorized regarding gender, anthropometry, body weight distribution and sleeping habits. The height and angle of pillow are adjustable regarding the body scale of sleepers. Considering these parameters will ensure a comfortable, symptom free union between person and pillow. Further research concerning anthropometry, support surfaces, and spinal slope is required to product an arm positioning pillow with the advantages of fitting the height and angle of pillow. Adjusting the height and angle can also be a further objective to provide arm-positioning which are multi-functional to give various sleeper positions.

The use of surfaces with different elastic properties can be a future trend of this study. It should be mentioned that the commercially available ultrasonograph (Maylab, 60, BIOSOUND ESAOTE Inc., USA) used for our study, however is used clinically, has an accuracy of $\pm 11\%$ for the volumetric flow (Maylab advanced operation, 2008). But this error would be ignorable. Because our study concentrated on releasing arm of head weight pressure that was well achieved.

CONCULSION

The findings of this study suggest that ergonomic arm-positioning pillow would be used for reducing the head weight pressure on a user's arms. It prevents waking paresthesia symptoms. Despite the use of a simplified model of an arm positioning pillow, releasing from head pressure and subsequent paresthesia symptoms were achieved for side-sleepers respecting to eliminating the blood volumetric flow reduction of the arm.

REFERENCES

Adam T. Hadhazy. 2008. What happens when your arm “falls asleep?” [Internet]. Scienceline. Available from: http://scienceline.org/2008/11/ask-hadhazy-arm-falls-asleep/

Ambrogio N, Cuttiford J, Lineker S, Li L. 1998. A comparison of three types of neck support in fibromyalgia patients. Arthrit Care Res 11:405–10.

Bernateck M, Karst M, Merkesdal S. 2008. Sustained effects of comprehensive inpatient rehabilitative treatment and sleeping neck support in patients with chronic cervicobrachialgia: a prospective and randomized clinical trial. Int J Rehabil Res 31(4):342–346.

Bland JH and Boushey DR. 1987. Disorders of the cervical spine: diagnosis and medical management. Saunders.

Boyd D M. 2011. U.S. Patent No. 7,937,238. Washington, DC: U.S. Patent and Trademark Office.

Buckle P and Fernandes A. 1998. Mattress evaluation: assessment of contact pressure, comfort and discomfort. Appl Ergon. 29:35–9.

DeVocht JW and Wilder DG. 2006. Biomechanical evaluation of four different mattresses. Appl Ergon 37:297–304.

Gordon S, Grimmer K and Trott P. 2007. Sleep position, age, gender, sleep quality and waking cervico-thoracic symptoms. Internet J Allied Health Sci Pract 5:1.

Gordon S, Grimmer K and Trott P. 2009. Pillow use: the behaviour of cervical pain, sleep quality and pillow comfort in side sleepers. Man Ther 14(6):671–678.

Gordon SJ, Trott P and Grimmer KA. 2002. Waking cervical pain and stiffness, headache, scapula or arm pain: gender and age effects. Aust J Physiother 48:9–15.

Gordon SJ and Grimmer-Somers K. 2011. Your Pillow May Not Guarantee a Good Night's Sleep or Symptom-Free Waking. Physiother Can 63(2):183-90.

Gordon SJ, Grimmer KA and Trott PH. 2010 .Pillow use: the behaviour of cervical stiffness, headache and scapular pain. J Pain Res 3:137–145.

Gordon SJ and Grimmer-Somers K. 2011. Your pillow may not guarantee a good night’s sleep or symptom-free waking. Physiother Can 63(2): 183–190.

Grieve GP, Newman P H. 1988. Common vertebral joint problems (p. 401). Edinburgh: Churchill Livingstone.

Hagino C, Boscariol J, Dover L. 1998. Before/after study to determine the effectiveness of the align-right cylindrical cervical pillow in reducing chronic neck pain severity. J Manipulative Physiol Ther 21:89–93.

Hagino C, Boscariol J, Dover L, Letendre R, Wicks M. 1998. Before/after study to determine the effectiveness of the Align-Right cylindrical cervical pillow in reducing chronic neck pain severity. J Manip Physiol Ther 21:89–93.
Jackson R. 1976. The cervical spine. (3rd ed). Springfield Illinois: Charles C Thomas.
Keller BP, Lubbert PH. 2005. Tissue-interface pressures on three different support-surfaces for trauma patients. Injury 36:946–8.
Kilpiö K, Mäkinen-Kiljunen S, Haahtela T, Hannuksela M. 1998. Allergy to feathers. Allergy. 53(2):159-64.
Krämer J. 2008. Intervertebral disk diseases: causes, diagnosis, treatment and prophylaxis. Thieme.
Lansam R. 1992. Pillow talking. Care in the Home 1(2):15.
Lavin RA, Pappagallo M, Kuhlemeier KV. 1997. Cervical pain: a comparison of three pillows. Arch Phys Med Rehabil. 78:193–8
Lahm R, Iaizzo PA. 2002. Physiologic responses during rest on a sleep system at varied degrees of firmness in a normal population. Ergonomics 45:798–815.
Maylab Users Manual. 2008. Maylab advanced operation. Newyork: BIOSOUND ESAOTE Inc.
McDonnell J. 1946. Sleep posture: its implications. Br J Phys Med 9:46–52.
Miller R. 1984. The prone sleeper's spine. Brit Osteopath J, 16, 61-8.
Persson L, Moritz U. 1998. Neck support pillows: a comparative study. J Manip Physiol Ther 21:237–40.
Persson L. Neck pain and pillows. 2006. a blinded study of the effect of pillows on non-specific neck pain, headache and sleep. Adv Physiother.8(3):122–127.
Persson L. 2006. Neck pain and pillows: a blinded study of the effect of pillows on non-specific neck pain, headache and sleep. Adv Physiother 8:122–7.
Shields N, Capper J, Polak T, Taylor N. 2006. Are cervical pillows effective in reducing neck pain? New Zeal J Physiother 34:3–9.
Wellings H. 2009. Choosing the right pillow [Internet]. Today Tonight; 2007 Nov 13. Available from: http://au.news.yahoo.com/today-tonight/consumer/article/-/41403/choosing-right-pillow/