Tohoku J. Exp. Med., 2014, **233**, 183-188

Improving the Quality of Sleep with an Optimal Pillow: A Randomized, Comparative Study

Mi Yang Jeon,[1] HyeonCheol Jeong,[2] SeungWon Lee,[3] Wonjae Choi,[3] Jun Hyuck Park,[3] Sa Jin Tak,[3] Dae Ho Choi[4] and Jongeun Yim[3]

[1]Department of Nursing • Institute of Health Science, Gyeongsang National University, Jinju, Korea
[2]Department of Nursing, Sahmyook University, Seoul, Korea
[3]Department of Physical Therapy, Sahmyook University, Seoul, Korea
[4]Department of Life Science, Sahmyook University, Seoul, Korea

Because sleep comprises one-third of a person's life, using an optimal pillow for appropriate neck support to maintain cervical curve may contribute to improve quality of sleep. Design of orthopedic pillow conforms to orthopedic guidelines to ensure the right support of the cervical curve. The aim of this study was to investigate effect of different pillow shape and content on cervical curve, pillow temperature, and pillow comfort. A feather pillow is regarded as a standard pillow, and a memory foam pillow is one of the most popular pillows among pillow users. We, therefore, compared these two pillows with an orthopedic pillow. Twenty healthy subjects (10 men and 10 women; age range, 21-30 years) participated in the study. Each subject was asked to assume the supine position with 3 different pillows for 30 minute in each trial and then cervical curve, pillow temperature, and pillow comfort were measured. When comparing the cervical curve of the 3 different pillows, that of the orthopedic pillow was significantly higher than that of the other 2 pillows ($p < 0.001$). The degree of temperature increase was significantly lower for the orthopedic pillow than for the memory foam and feather pillows ($p < 0.001$). The visual analog scale (VAS) score of pillow comfort was significantly higher in orthopedic pillow than the other 2 pillows. This study shows that pillow shape and content plays a crucial role in cervical curve, pillow temperature, and pillow comfort and orthopedic pillow may be an optimal pillow for sleep quality.

Keywords: cervical lordosis; comfort; pillow; sleep; temperature
Tohoku J. Exp. Med., 2014 July, **233** (3), 183-188.

Introduction

Because sleep comprises one-third of a person's life, sufficient sleep of high quality is essential and required for human beings. Sleep maintains homeostasis, immunity, and integrity of an organism. Additionally, sleep regulates daily living and the cognitive ability, judgment, and memory that are needed at work (Schutz et al. 2009; Chen and Cai 2012). Kyle et al. (2010) stated that the quality of sleep is directly related to human health as well as standard of living.

The nighttime sleeping posture is strongly related to quality of sleep. Specifically, poor cervical posture during sleep, which is believed to increase biomechanical stresses on cervical spine structures, can produce cervical pain and stiffness, headache, and scapular or arm pain, resulting in low-quality sleep (Gordon et al. 2010). Thus, an appropriate selection of pillows can optimize the sleeping posture and help facilitate high-quality sleep (Bernateck et al. 2008).

A factor critical to a suitable pillow is proper support for cervical lordosis (Ambrogio et al. 1998). The main role of a pillow during sleep is to support the cervical spine in a neutral position. A neutral position of the spine prevents loss of cervical spine curvature and cervical waking symptoms by minimizing end-range positioning of spinal segments (McDonnell 1946; Gordon et al. 2011). In addition, proper support can increase the contact area between the neck and the pillow so that the pressure exerted upon the muscles can be evenly distributed (Chen and Cai 2012). A previous study tested 6 different pillows and their effect on neck pain and quality of sleep. Fifty-five subjects tested all of the pillows in random order over the course of 3 weeks (3 consecutive nights per pillow). The authors concluded that pillows with firm support for cervical lordosis could be recommended for the management of neck pain and improvement of sleep quality (Persson and Moritz 1998). Moreover, Hannon (1999) showed that most people could

Received April 9, 2014; revised and accepted June 11, 2014. Published online July 9, 2014; doi: 10.1620/tjem.233.183.
Correspondence: Jongeun Yim, DSc, Department of Physical Therapy, Sahmyook University, Hwarangro 815, Nowon-gu, Seoul 139-742, Republic of Korea.
e-mail: jeyim@syu.ac.kr

not fall asleep when the neck was stiff and shoulder muscles were not relaxed. He reported 14 unique postures that can help relax the joints and loosen stiff muscles with proper support (Hannon 1999).

Another critical characteristic of a suitable pillow is one that reduces the temperature of the head. A pillow that helps reduce core and head temperatures during nighttime sleep is important for deep sleep (Liu et al. 2011). According to the study by Kawabata and Tokura (1996), the reason subjects using a pillow made of a material that helps the pillow surface stay cool could fall asleep more easily and sleep well is strongly related to lowered core and head temperatures and slowed heart rate. These results indicated that reduced core and head temperatures could induce deeper sleep (Kawabata and Tokura 1996). Moreover, Okamoto-Mizuno et al. (2003) showed that a pillow design that helped reduce the temperature of the head can reduce sweating and whole body temperature, and indirectly improve sleep quality.

Because studies on the effect of different pillow types on cervical lordosis and temperature have been limited, appropriate recommendations cannot be made unless the manner in which the spine responds to specific pillow content and shape is better understood. Therefore, the purpose of this study was to investigate the effects of three types of pillows with different contents on cervical lordosis, pillow temperature, and pillow comfort. Our hypotheses were that each pillow would support the cervical lordosis differently, and that the change of pillow temperature and pillow comfort rating would be different for each pillow type.

Methods

Subjects

Twenty healthy subjects (10 men and 10 women; age range, 21-30 years) participated in the study. They did not have a known neurological disorder, scoliosis or other deformity, inflammatory or degenerative arthropathy, connective tissue disease, or a history of spinal surgery. The general characteristics of the subjects are listed in Table 1. All protocols and procedures were approved by the Institutional Review Board of Sahmyook University, and all subjects signed a statement of informed consent.

Pillows tested

Three pillows were tested in this study (Fig. 1). The orthopedic pillow (Venygood, Seoul, Korea) is a roll-shaped pillow containing multiple polypropylene capsules which are pill-shaped and open-ended. The size of this pillow was 50 cm length × 45 cm width, and the depth varied from 8 cm to 4 cm across the pillow. The memory foam pillow (Sinomax, China) is a contoured pillow consisting of polyurethane foam. The size of this pillow was 50 cm length × 38 cm width. The depth of this pillow varied from 10 cm to 6.5 cm across the contour. The feather pillow (Doadream, Chuncheon, Korea) is a regularly shaped pillow filled with 100% goose feathers. The size was 60 cm length × 45 cm width × 17 cm depth. Pillow suppliers were independent of the conduct of the study, and the interpretation and reporting of the results. According to the previous studies, the feather pillow is regarded as a standard pillow (Lavin et al. 1997; Hur and Yang 2006). The memory foam pillow is one of the most popular pillows among pillow users (Gordon et al. 2009; Gordon and Grimmer-Somers 2011). Therefore, we had chosen these two pillows to compare with the orthopedic pillow.

Measurement

Cobb angle: Based on the lateral radiographs of the cervical spine in the supine position, the sagittal alignment of the cervical spine was evaluated using the Cobb angle between C2 and C7. The Cobb angle of the subjects was measured from a radiograph. One line is drawn on the inferior end plate of C2 and the other line on the superior end plate of C7. Perpendicular lines to each of these 2 lines are drawn, and the angle formed by the crossed lines becomes the degree of the curve (Cote et al. 1997; Harrison et al. 2000) (Fig. 2). Positive values higher than 5° were considered to be indicative of cer-

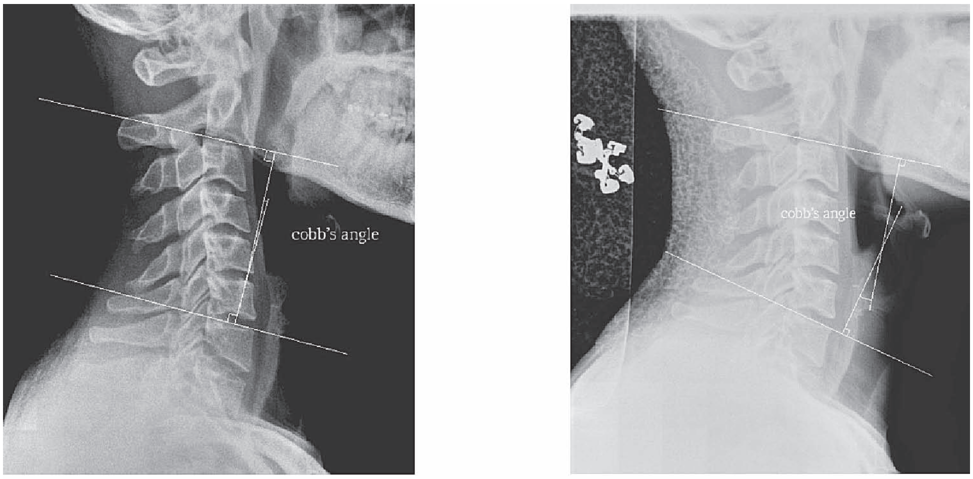
Table 1. General characteristics of the subjects. ($N = 20$)

	Men	Women
Sex (male/female)	10	10
Age (years)	27.90 (8.66)	20.14 (0.90)
Weight (kg)	71.50 (10.33)	52.43 (6.91)
Height (cm)	178.10 (4.63)	162.29 (6.85)

Values indicate mean (standard deviation).

a. Orthopedic pillow b. Memory foam pillow c. Feather pillow

Fig. 1. Tested pillows.



a b

Fig. 2. Measurement of the Cobb angle.
The Cobb angle was measured in a standing position (a) and a supine position with orthopedic pillow (b).

vical lordosis. Negative values below 5° indicated cervical kyphosis (Noriega et al. 2013).

Pillow temperature: In the study, the variations in pillow temperature were measured using an infrared thermometer (−35°C ~ 560°C ± 2%, TPI, Incheon, Korea), temperature range of −35°C ~ 560°C and accuracy of ± 2%, before and after the 3 different pillows were used. The pillow region touched the subject's neck and the temperature was measured immediately after the subject assumed a sitting position.

Visual analog scale (VAS): To obtain a subjective measure of comfort, subjects were asked to complete VAS regarding their overall comfort with 3 different pillows. They reported their level of comfort according to VAS after lying on the bed with each of the pillows. Subjects were asked to mark their level of comfort at that time along a 100-mm line, 0 mm being "worst" and 100 mm being the "best".

Procedures

Subjects agreed to refrain from performing any unusual exercises/activities in the days prior to the experiment. Subjects provided their personal information before the experiment and were required to wear shirts without collars. The room temperature was maintained at 25°C during the experiments. The experiments were conducted on 2 different days. On the first day, for determining the Cobb angle, a radiograph of the cervical spine obtained before and after the 3 different pillows was used. Before using the pillows, subjects were asked to stand in a neutral position for the baseline radiograph and then subjects lay down on the x-ray table with each trial pillow for 30 minutes respectively. After 30 minutes, radiographs were taken in the supine position with the 3 different pillows. Administration order was randomized and each subject could sit up and take a rest for 30 minutes between each pillow trial. On the second day, the variations in pillow temperature and pillow comfort were measured. Before the subject began lying on the pillows, pillow temperature was measured. Then, subjects were asked to assume the supine position on the treatment table with each trial pillow for 30 minutes. After 30 minutes, each subject sat up so that VAS score could be obtained for pillow comfort, and pillow temperature was measured immediately.

Data analysis

SPSS Version 18.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for statistical analysis of the results. Descriptive statistics were used for general history of subjects. Analysis of variance and paired *t*-test were performed for comparison of neck Cobb angle, pillow temperature, and VAS score. The alpha level was set at 0.05 for all analyses.

Results

Comparison of cervical lordosis with Cobb angle

In this study, 3 different pillows were compared for cervical lordosis by measuring the Cobb angle on a lateral cervical radiograph. When comparing the pre Cobb angle in a standing position and the post Cobb angle in a supine position with the use of the 3 different pillows, it was found that the angle was significantly increased with the orthopedic pillow ($p = 0.001$). However, there were no significant changes with the memory foam and the feather pillows. The orthopedic pillow significantly increased the Cobb angle from −3.83° at baseline to 7.70° an increase of 11.53°. The memory foam pillow also increased the Cobb angle from −3.83° to −0.33° an increase of 3.66°, but this finding was not significant. The feather pillow, however, decreased the Cobb angle from −3.83° to −6.20°. When comparing the Cobb angles of the 3 different pillows, that of the orthopedic pillow was significantly higher than that of the other 2 pillows ($p < 0.001$) (Table 2).

Comparison of the degree of increased pillow temperature

The temperatures of each of the 3 pillows increased significantly after 20 minutes of lying on the pillows. However, the degree of temperature increase was significantly lower for the orthopedic pillow (1.53°C) than for the memory foam (3.13°C) and feather pillows (3.39°C) ($p < 0.001$) (Table 3).

Table 2. Comparison of the cervical Cobb angles. ($N = 20$)

	Pre (standing)	Post (pillow use)	Post-Pre	p
Orthopedic pillow	−3.83 (9.17)	7.70 (8.70)	11.53 (4.65)	0.000*
Memory foam pillow	−3.83 (9.17)	−0.33 (8.42)	3.50 (4.88)	0.090*
Feather pillow	−3.83 (9.17)	−6.20 (9.68)	−2.37 (4.61)	0.500
$F = 7.744$, $p = 0.000$				

Values indicate mean (standard deviation).
*Independent t-test value, $p < 0.05$.

Table 3. Changes in pillow temperature. ($N = 20$)

	Pre	Post	Post-Pre	p
Orthopedic pillow	27.64 (0.85)	29.17 (1.13)	1.53 (0.83)	0.000*
Memory foam pillow	27.72 (1.14)	30.85 (1.38)	3.13 (0.82)	0.000*
Feather pillow	27.81 (0.89)	31.20 (1.34)	3.39 (1.09)	0.000*
$F = 14.366$, $p = 0.000$				

Values indicate mean (standard deviation).
*Independent t-test value, $p < 0.05$.

Table 4. Comparison of the visual analog scale score among the 3 pillows. ($N = 20$)

	Orthopedic	Memory foam	Feather	F	p
VAS score	7.92 (1.17)	6.41 (2.02)	5.77 (2.76)	3.358	0.047

Values indicate mean (standard deviation).
VAS, visual analog scale.

Comparison of pillow comfort with the VAS

Comparison of the VAS scores for each pillow identified a significant difference across the 3 pillows ($p < 0.05$) (Table 4). However, there was no significant difference in comparison of pairs of pillows in the *post hoc* analysis.

Discussion

It is widely believed that using an optimal pillow for appropriate neck support to maintain cervical lordosis during sleep can lead to high-quality sleep (Chen and Cai 2012). However, many people appear to have made poor pillow choices, which leads to adoption of more end-range cervical spine postures during sleep, resulting in increasing biomechanical stress on cervical spine structures (Persson and Moritz 1998). Use of the wrong type of pillow can compromise pain-sensitive structures and produce waking symptoms, such as cervical pain and stiffness, headache, and arm pain; hence, low sleep quality. Therefore, a suitable pillow, which supports a neutral cervical lordosis, may prevent cervical waking symptoms, and increases sleep quality by optimizing the sleeping position (Gordon et al. 2011; Liu et al. 2011).

In the current study, we investigated the effects of 3 different pillows on cervical lordosis, pillow temperature, and pillow comfort and found that cervical lordosis was significantly increased by the roll-shaped orthopedic pillow with a capsule when compared to memory foam and feather pillows. Additionally, pillow temperature was significantly less after lying on the orthopedic pillow than in the other 2 pillows. Regarding pillow comfort, there was a significant difference among the 3 groups.

Most pillow studies have focused on pillow support to restore cervical lordosis (Hagino et al. 1998; Persson and Moritz 1998; Erfanian et al. 2004; Jackson 2010; Liu et al. 2011). According to a previous case study using lateral radiographs of the cervical spine with and without exposure to regular and roll-shaped pillows, the roll-shaped pillow restored cervical lordosis and decreased neck pain and discomfort while sleeping (Jackson 2010). Additionally, Persson and Moritz (1998) tested neck pain and quality of sleep with 6 different pillows in 55 subjects and concluded that the cervical pillow with firm support for cervical lordosis could be recommended for the management of neck pain and improved quality of sleep. In this study, 3 different pillows were compared for cervical lordosis by measuring the Cobb angle on a lateral cervical radiograph. This angle measures cervical lordosis and is the result of the intersection of 2 perpendicular lines (one perpendicular to the superior end plate of C7 and the other perpendicular to the inferior endplate of C2) (Cote et al. 1997; Harrison et al. 2000). Positive values higher than 5° were considered to be indicative of cervical lordosis. Negative values less than 5° indicated cervical kyphosis (Noriega et al. 2013). The results of this study showed that the orthopedic pillow significantly increased the cervical lordosis repeating results when compared to the baseline cervical lordosis measured with the neck in a neutral position while standing. The memory foam pillow also increased the cervical lordosis while the feather pillow reduced the cervical lordosis however these were not significant. The orthopedic pillow was composed of 7 segments, each containing multiple capsules. The capsules play a special role in providing firm yet comfortable support, as well as helping to conform to the curvature of the cervical spine by decreasing the space between the capsules. In addition, the lower portion of the pillow was a round shaped semicircle which consisted of five pieces of a triangle shaped pocket containing multiple capsules. Vertexes of each pocket are focusing on a focal point so that the pressure converges on the focal point and it provides a firm surface to maintain cervical lordosis. The memory foam pillow also has a round-shaped design and supports cervical lordosis, but was not as firm as the orthopedic pillow. Therefore, when a person lies down on the pillow, the round shape tends to compress, and thus, not enough support is provided to maintain cervical lordosis. In contrast, the feather pillow, which was the softest and highest of the pillows and supported the head more than the neck and caused the cervical spine to bend forward, causing cervical kyphosis. This type of position may also cause narrowing of the airway, resulting in obstructed breathing and sometimes snoring, which can hinder sleep (Liu et al. 2011).

The cooling of the head by the pillow during sleep seems to be relevant to sleep depth (Cote et al. 1997; Liu et al. 2011). A previous study assessed the thermal characteristic of a pillow and showed that a pillow made of a material that helps the surface stay cool lowered rectal, forehead, and whole body temperatures and slowed the heart rate of subjects, suggesting that sympathetic nervous system innervation was less excited with a cool pillow (Kato et al. 1995). It also enabled the subjects to fall asleep more easily and sleep better. These results suggested that reducing the temperature of the pillow may improve the quality of sleep (Kawabata and Tokura 1996). Furthermore, the research of Okamoto-Mizuno et al. (2003) showed that a pillow designed to reduce temperature can reduce sweating and whole body temperature, and indirectly improve the quality of sleep. These findings suggest that the thermal characteristic of pillows may alter the physiological depth of sleep. In this study, the temperature of the 3 pillows increased after 30 minutes of lying on the pillows. However, the degree of temperature increase was significantly lower for the orthopedic pillow (1.53°C) than for the memory foam (3.13°C) and feather pillows (3.39°C). It is likely this is because the capsules in each segment of the orthopedic pillow are open-ended, which helps to evenly distribute the heat of the pillow as well as promote air circulation. Therefore, it prevents an increase in temperature and may improve sleep quality. In contrast, the memory foam pillow is more dense and molds to the neck and head closely. Therefore, it gives a feeling of comport and stability, but decreasing air circulation and preventing thermal dissipation to the surroundings, ultimately increasing the temperature of the pillow. Duck or goose feathers are good at holding heat; thus, the feather pillow showed the highest temperature among the 3 pillows. Moreover, these pillows can emit an unpleasant odor because of poor air circulation. These findings indicate that the orthopedic pillow might be more effective in preventing an increase in neck and head temperatures, which may improve sleep quality, and maintain sanitary conditions compared with the other 2 pillows.

In addition to neck support and temperature, pillow comfort is another critical characteristic of a suitable pillow. Several studies have shown that most patients found cervical pillows uncomfortable initially, however, patients who continued to use them eventually experienced positive results (Hagino et al. 1998; Shields et al. 2006; Liu et al. 2011). Moreover, Gordon and Grimmer-Somers (2011) suggested that there is a strong and significant association between reported poor-quality sleep and waking with cervical stiffness and scapula pain in side sleepers, however, there was no association between pillow comfort and waking symptoms, which suggests that participants' perceptions of pillow comfort and their reports of waking symptoms are independent. In this study, there was a significant difference in the VAS scores for pillow comfort among the 3 pillows. However, there was no significant difference between pairs of pillows each group in the *post hoc* analysis. As mentioned above, firm support plays an important role in cervical lordosis. Even though the orthopedic pillow increased cervical lordosis with firm support, the feeling of firm support might not provide positive results in pillow comfort to begin with. However, based on previous studies, after an extended use, it may eventually be acceptable at the end (Hagino et al. 1998; Gordon et al. 2011). Thus, the time required for adaptation is an important factor that determines pillow comfort.

The main limitation of this study is that the long-term effects of 3 pillows were not monitored. Therefore, long-term effect of 3 pillows should be determined in a future study. Another limitation of this study is the relatively small number of subjects. Regarding sleep quality with different pillows, sleep quality should be measured using polysomnography or Pittsburgh sleep quality index.

Conflict of Interest

The authors declare no conflict of interest.

References

Ambrogio, N., Cuttiford, J., Lineker, S. & Li, L. (1998) A comparison of three types of neck support in fibromyalgia patients. *Arthritis. Care Res.*, **11**, 405-410.

Bernateck, M., Karst, M., Merkesdal, S., Fischer, M.J. & Gutenbrunner, C. (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**, 342-346.
Chen, H.L. & Cai, D. (2012) Body dimension measurements for pillow design for Taiwanese. *Work*, **41** Suppl 1, 1288-1295.
Cote, P., Cassidy, J.D., Yong-Hing, K., Sibley, J. & Loewy, J. (1997) Apophysial joint degeneration, disc degeneration, and sagittal curve of the cervical spine. Can they be measured reliably on radiographs? *Spine* (*Phila Pa 1976*), **22**, 859-864.
Erfanian, P., Tenzif, S. & Guerriero, R.C. (2004) Assessing effects of a semi-customized experimental cervical pillow on symptomatic adults with chronic neck pain with and without headache. *J. Can. Chiropr. Assoc.*, **48**, 20-28.
Gordon, S.J. & Grimmer-Somers, K. (2011) Your Pillow May Not Guarantee a Good Night's Sleep or Symptom-Free Waking. *Physiother. Can.*, **63**, 183-190.
Gordon, S.J., Grimmer-Somers, K. & Trott, P. (2009) Pillow use: the behaviour of cervical pain, sleep quality and pillow comfort in side sleepers. *Man. Ther.*, **14**, 671-678.
Gordon, S.J., Grimmer-Somers, K.A. & Trott, P.H. (2010) Pillow use: the behavior of cervical stiffness, headache and scapular/arm pain. *J. Pain Res.*, **3**, 137-145.
Gordon, S.J., Grimmer-Somers, K.A. & Trott, P.H. (2011) A randomized, comparative trial: does pillow type alter cervico-thoracic spinal posture when side lying? *J. Multidiscip. Healthc.*, **4**, 321-327.
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. Manipulative Physiol. Ther.*, **21**, 89-93.
Hannon, J. (1999) Pillow talk: the use of props to encourage repose. *J. Bodyw. Mov. Ther.*, **3**, 55-64.
Harrison, D.E., Harrison, D.D., Cailliet, R., Troyanovich, S.J., Janik, T.J. & Holland, B. (2000) Cobb method or Harrison posterior tangent method: which to choose for lateral cervical radiographic analysis. *Spine* (*Phila Pa 1976*), **25**, 2072-2078.
Hur, J. & Yang, Y. (2006) The Effect of Ergonomic Pillow in Patient with Chronic Neck Pain. *Journal of the Ergonomics Society of Korea*, **25**, 17-25.
Jackson, R. (2010) The classic: the cervical syndrome. 1949. *Clin. Orthop. Relat. Res.*, **468**, 1739-1745.
Kato, M., Ando, T., Yamashita, Y. & Tokura, H. (1995) Thermophysiological effects of two different types of clothing under warm temperatures. *Appl. Human. Sci.*, **14**, 119-124.
Kawabata, A. & Tokura, H. (1996) Effects of two kinds of pillow on thermoregulatory responses during night sleep. *Appl. Human. Sci.*, **15**, 155-159.
Kyle, S.D., Morgan, K. & Espie, C.A. (2010) Insomnia and health-related quality of life. *Sleep Med. Rev.*, **14**, 69-82.
Lavin, R.A., Pappagallo, M. & Kuhlemeier, K.V. (1997) Cervical pain: a comparison of three pillows. *Arch. Phys. Med. Rehabil.*, **78**, 193-198.
Liu, S.F., Lee, Y.L. & Liang, J.C. (2011) Shape design of an optimal comfortable pillow based on the analytic hierarchy process method. *J. Chiropr. Med.*, **10**, 229-239.
McDonnell, J. (1946) Sleep posture; its implications. *Br. J. Phys. Med.*, **9**, 46-52.
Noriega, D.C., Kreuger, A., Brotat, M., Ardura, F., Hernandez, R., Munoz, M.F. & Barrios, C. (2013) Long-term outcome of the Cloward procedure for single-level cervical degenerative spondylosis. Clinical and radiological assessment after a 22-year mean follow-up. *Acta Neurochir.* (*Wien*), **155**, 2339-2344.
Okamoto-Mizuno, K., Tsuzuki, K. & Mizuno, K. (2003) Effects of head cooling on human sleep stages and body temperature. *Int. J. Biometeorol.*, **48**, 98-102.
Persson, L. & Moritz, U. (1998) Neck support pillows: a comparative study. *J. Manipulative Physiol. Ther.*, **21**, 237-240.
Schutz, T.C., Andersen, M.L. & Tufik, S. (2009) The influence of orofacial pain on sleep pattern: a review of theory, animal models and future directions. *Sleep Med.*, **10**, 822-828.
Shields, N., Capper. J., Polak, T. & Taylor, N. (2006) Are cervical pillows effective in reducing neck pain? *NZ Journal of Physiotherapy*, **34**, 3-9.