Pillow use: The behaviour of cervical pain, sleep quality and pillow comfort in side sleepers

Susan J. Gordon a,*, Karen Grimmer-Somers b, Patricia Trott b

a School of Public Health, Tropical Medicine and Rehabilitation Sciences, James Cook University, Australia
b School of Health Sciences, University of South Australia, Australia

ABSTRACT

A random allocation single blind block design pillow field study was undertaken to investigate the behaviour of cervico-thoracic spine pain in relation to pillow use. Participants (N = 106) who reported preference for side sleep position with one pillow were recruited via a telephone survey and newspaper advertisement. They recorded sleep quality and pillow comfort ratings, frequency of retiring and waking cervical pain and duration of waking cervical pain while sleeping for a week on their usual pillow, polyester, foam, feather and rubber pillows of regular shape and a foam contour pillow.

Analysis was undertaken comparing sleep quality, pillow comfort, waking and temporal cervical pain reports, between the usual pillow and the trial pillows, between pillows of differing content and foam pillows of differing shape.

This study provides evidence to support recommendation of rubber pillows in the management of waking cervical pain, and to improve sleep quality and pillow comfort. The rubber pillow performed better than subjects’ own pillow in most instances. Subjects’ own pillow performed similarly to foam and polyester pillows, and there is no evidence that the use of a foam contour pillow has advantages over the regular shaped pillows. Feather pillows should not be recommended.

1. Introduction

Pillow performance research has largely involved testing pillows of novel shape and design (Erfanian et al., 1998; Persson and Moritz, 1998; Erfanian et al., 2004), comparing contour and non-contour shaped pillows (Lavin et al., 1997; Persson, 2006) and comparing contour pillows with the participants’ usual pillow (Hagino et al., 1998). Shields et al. (2006), who undertook a systematic review regarding the effect of contour or cervical pillow use on neck pain, highlighted the methodological flaws in these studies and concluded that there was insufficient evidence to support the use of contour pillows in the management of chronic neck pain. Helewa et al. (2007) reported that contour pillows were ineffective in the management of chronic neck pain unless combined with active neck exercises.

The paucity of research has caused health professionals to provide patient advice based on the anecdotal suggestions of expert colleagues and professional associations. This advice has included the use of malleable pillows (Maitland, 1986; McKenzie and May, 2006), a cervical roll (Elkind, 1987; Kramer, 1990; McKenzie and May, 2006), a contour pillow (Jackson, 1976; Emberson, 1985) or a down or urethane pillow (Australian Physiotherapy Association, 2008). Furthermore the range of marketing advice provided by pillow manufacturers is confusing for consumers.

This paper reports the performance of commonly used pillows and their association with cervical pain behaviour. A pillow field trial was undertaken to:

- Compare the frequency of waking cervical pain reported when subjects slept on their own pillow and on five trial pillows;
- Examine temporal symptom reports, to determine if pillow content or shape was related to overnight abolition of retiring symptoms or overnight production of waking symptoms; and
- Compare pillow comfort and sleep quality ratings for participants’ usual pillow and the trial pillows.

1.1. Preliminary research

A telephone survey of over 800 individuals randomly selected from a known population established that:
• Side sleeping position was most prevalent (71.9%) and this position protected individuals against waking cervical pain (odds ratio (OR) 0.6; confidence intervals (CIs) 0.4–0.9) (Gordon et al., 2007). Further it has been reported that adults spend 59–73% of their sleep in the side lying position (DeKoninck et al., 1992).

• Side sleepers, who slept on one pillow, used a variety of pillows including a polyester regular pillow (44.9%), rubber regular pillow (14.4%), foam contour pillow (12%), feather regular pillow (8.8%) and foam regular pillow (7.7%) (Gordon et al., 2007).

• 17.6% of subjects reported waking, at least once in a usual week, with cervical pain (Gordon et al., 2002, 2007).

A sleep laboratory study established the validity and reliability of self reports of sleep position (Gordon et al., 2004). Therefore, it seemed appropriate to test the effect of pillow use on cervical pain and sleep quality in side sleepers.

2. Method

2.1. Ethics approval

Ethics approval was provided by the University of South Australia Human Research Ethics Committee.

2.2. Pillows tested

Tontine, an Australian pillow manufacturer (Nicholson Street, East Brunswick, Victoria) provided polyester, synthetic fibre fill, pillows for the trial. Dentons, another Australian pillow manufacturer (Lewis Road, Wantirna South, Victoria) provided foam regular shape (Comfort Classic) and foam contour shape pillows (Medirest). Both foam pillows were molded from high density foam. Dunlopillo latex rubber pillows were provided by the University of South Australia and feather pillows were purchased by the principal author from Target, Australia. The pillows varied in length from 70 to 73 cm and in width from 45 to 46 cm. The depth of the foam regular pillow was 120 mm, the foam contour pillow varied between 120 and 142 mm across the contour, the latex pillow was 115 mm, the feather pillow was 120 mm and the polyester pillow was 118 mm. The study was conducted independently of any additional involvement of pillow manufacturers. Further information regarding the latex pillow can be found at http://www.dunlopillo.com.au/Products/Pillow-Range/Latex-Range.asp, the foam regular pillow at http://www.dentons.com.au/comfort.htm and the foam contour pillow at http://www.dentons.com.au/therap.htm.

2.3. Study design

A random allocation block design field study was undertaken in subjects’ homes, in a large rural town in South Australia, Australia. Subject blinding to pillow type was attempted, although the shape and feel of some of the pillows may have constrained this.

2.4. Participants

A sample of convenience was recruited from the respondents to the preliminary studies (Gordon et al., 2002, 2007) and additional subjects were recruited via local newspaper advertisements.

Inclusion criteria: Over 18 years, reported usually sleeping on their side, on one pillow, and were not actively seeking treatment for their neck during the period of the trial. Exclusion criteria: People who reported an accident or injury affecting the cervico-thoracic spine in the preceding year.

2.5. Sample size

No studies were available on which to base sample size calculations. We considered that 100 participants was the largest feasible sample size given study constraints of time and funding.

2.6. Study management

An independent trial office was established to co-ordinate subject allocation to pillows, pillow delivery and data collection. The five trial pillows were randomly allocated into a five-block administration order design. Subjects were randomly allocated into receiving one of the blocks. The trial pillows were de-identified by removing identifying labels and covers, numbering them and placing them in a plain pillow case. Pillows were re-used and not cleaned or laundered during the trial. For hygiene reasons participants were encouraged to use a second pillowcase on the pillow.

2.7. Data collection

Subjects initially provided their age and gender. No information was captured about subjects’ own pillow type. Outcome data was recorded on a seven day-night diary for each pillow. Subjects reported retiring and waking cervical pain, the duration of waking cervical pain, pillow comfort and sleep quality ratings.

Subjects also provided free-text comments regarding their perceptions of the trial pillows on the last day of the pillow trial. The diary is provided in Appendix 1.

2.8. Pillow intervention

The field trial took 10 weeks. Data was initially captured on subject’s own pillow for a week, to establish baseline ‘usual’ symptoms. The subjects’ own pillow was chosen as the comparison ‘gold standard’ pillow on the assumption that it was likely to be the most comfortable pillow subjects had encountered. Over the next nine weeks, subjects tested each of the randomly allocated trial pillows for seven consecutive nights, interspersed by seven night’s sleep on their own pillow. Returning to their own pillow after each pillow trial provided a ‘washout period’ (Yin, 2003) which allowed subjects to return to their ‘normal’ sleeping state. Subjects were encouraged to test each trial pillow for the whole seven nights’ sleep unless they believed that symptom production or lack of sleep necessitated cessation of the trial of that pillow.

2.9. Data management

Each subject could potentially provide seven nights’ data from each six pillows (42 observations each).

2.9.1. Invalid data

Throughout the trial, the occasions on which subjects reported the presence of waking symptoms associated with identifiable causes (other than the pillow) were excluded from analyses, in order to retain a homogenous set of subjects for whom there was no other identifiable reason for waking pain except the pillow.

2.9.2. Drop-outs

Subjects who dropped out of any week’s trial of a particular pillow were identified, and their ‘missing’ data removed from analysis once they had ceased providing data for that pillow. This left only valid waking pain scores for analysis. It was important to
count those subjects who did not complete the week’s trial, as this was believed to reflect dislike of that particular pillow. Thus the number of subjects who completed the trial was reported, as well as the number of ‘valid’ days of data collection.

2.9.3. Temporal pain
To analyse temporal pain patterns and pillow performance subjects who provided valid data were sub-classified into four groups:

1. going to bed and waking with no pain (pillow did not produce symptoms)
2. going to bed with pain and waking with no pain (a positive effect of the pillow)
3. going to bed with no pain and waking with pain (a negative effect of the pillow), and
4. going to bed with pain and waking with pain (pillow had no effect on symptoms).

2.9.4. Cumulative waking pain score
A cumulative numeric pain frequency and duration score was developed to provide a per-week waking pain frequency–duration score per pillow using the seven day sum of pain frequency and duration values as indicated:

- subjects who woke without any pain on any day were assigned a score of 0
- subjects who woke with pain lasting up to 30 min on any day were assigned a score of 0.5 (half an hour)
- subjects whose waking pain on any day lasted half a day were assigned a score of 12 (12 h) and
- subjects whose waking pain on any day lasted all day were assigned a score of 18 (18 h).

These arbitrary scores were assigned to investigate the extent of waking pain.

2.9.5. Clusters of waking pain cumulative scores
It was hypothesized that there would be clusters of cumulative waking pain scores for each pillow. These would be classified as No pain (0 score), Occasional short term pain (1–3 days of pain lasting 30 min), Regular short term pain (4–7 days of pain lasting 30 min), Occasional half day pain (1–3 days of pain lasting half a day), Regular half day pain (4–7 days of pain lasting half a day) and Longer term pain (regular pain lasting for longer).

2.10. Analysis
The challenge in this analysis was to make sense of multiple categories of information on temporal pain change and waking pain, and to determine per pillow changes between pain categories for each day that subjects remained in the study. Descriptive analysis was used to report frequency distributions in terms of the percentage of subjects in each category of waking pain, temporal pain change, quality of sleep and pillow comfort for each pillow.

A survival analysis approach was used to describe drop-outs throughout each of the trial pillow weeks, as subjects who refused to continue in the trial were considered to be those who sustained adverse effects of sleeping on the pillow in question. This was important to flag as evidence of ‘treatment harm’.

Differences in percentage of subjects in each category of waking pain, and the categories of temporal pain change over a night of sleeping, were tested using Chi Square test of proportions. The entire dataset, and gender and age subgroups where appropriate, were described and tested in this manner. Significance for tests of proportion was set at \( p < 0.05 \).

The cumulative waking pain scores over the trial pillow weeks were examined for pillow type, subject age and gender effects using ANOVA models. Tests for differences were significant at \( p < 0.05 \). Descriptive analysis of the cumulative scores was by means and standard deviations.

ORs (95% CIs) were calculated to detect differences between pairs of pillows for waking pain (compared with no waking pain). The comparator in each case was subjects’ own pillow. \( 2 \times 2 \) tables (StatCalc in Epinfo Version 10) were used to calculate ORs and 95% CIs. When 95% CIs did not encompass 1, the finding was deemed to be significant. Where required, multivariate logistic regression analysis (SAS Version 8.02) was used to test associations between pillows and pain categories, and to test the confounding effects of age group and gender. As for the \( 2 \times 2 \) table comparisons, 95% CIs which did not encompass 1 indicated a significant finding. Significant confounding effects were indicated by \( p \) values < 0.05 for each independent variable in the model.

3. Results

3.1. Demographics

Of the 106 participants who commenced the own pillow trial 33 were male (average age 49.0 years (SD 14.3 years, range 23–76 years)); and 73 were female, (average age 49.9 years (SD 13.9 years, range 20–81 years)). Fifty-eight participants had participated in the previous telephone survey and a further 48 participants were recruited via newspaper advertisement.

3.2. Pillow trial completion

3.2.1. Study withdrawals
Seven participants withdrew from the study at various points throughout the ten weeks; three due to production of cervico-thoracic symptoms while trialling the feather pillow, and single participants due to emergency lumbar spine surgery following a fall, transfer from town for work purposes, a loss of interest in participating while trialling their usual pillow, and death of a spouse. Given the random allocation block design, this influenced the number of subjects who commenced each trial pillow week. Considering the total number of starters (male, female), 105 subjects commenced the polyester pillow trial (72, 33), 101 commenced the foam regular pillow trial (69, 32), 103 commenced the foam contour pillow trial (71, 32), 101 commenced the feather pillow trial (71, 30) and 100 commenced the rubber pillow trial (70, 30).

3.2.2. Invalid data
Subjects whose data was excluded for any one day of the trial because of a known cause for waking pain are outlined in Table 1, with the number of observations excluded. Reasons for waking pain included the effects of alcohol, prescription medication, illness, wakeful spouse, children or pets, or external noises. There was no significant difference between pillows, gender or age groups regarding the excluded observations.

The daily reports of known reasons for waking pain were greatest for subject’s own pillow, followed by the feather pillow (Fig. 1). As the own pillow comparison data was provided first, this suggests that subjects were perhaps most aware of classifying reasons for waking pain on their own pillow, than on any others.

The number of subjects who completed each pillow trial varied, with the feather pillow having the lowest percentage of completers and rubber pillow having the highest. All subjects completed the
‘own pillow’ trial week. Overall, 100 subjects completed the polyester pillow trial week (95.4% of commencers), 95 completed the foam regular pillow trial week (94.1% of commencers), 91 completed the foam contour pillow trial week (88.3% of commencers), 68 completed the feather pillow trial week (67.3% of commencers) and 97 completed the rubber pillow trial week (97.0% of commencers).

3.3. Symptom behaviour

3.3.1. Waking pain

The percentage of subjects with valid observations who reported any waking pain on any pillow is reported in Fig. 2. The feather pillow was by far the most problematic pillow.

Considering the overall data, no significant differences were found between proportions in waking pain categories, despite apparent differences from visual inspection. The lack of significance is possibly attributed to the variability within any one category of waking pain across the pillows. Chi square tests of proportions identified a significant effect for young women (aged under 40 years) ($p < 0.05$). Further exploration using ANOVA models showed that women aged under 40 years reported on average significantly more events of waking pain than any other group of subjects (average 0.6 (SD 0.5)) (women 40–59 years average 0.2 (SD 0.4)), women over 59 years (average 0.3 (SD 0.5)), compared with men under 40 years average 0.3 (SD 0.4), men 40–59 years (0.2 (SD 0.4)) and men over 59 years (0.1 (SD 0.4)).

3.3.2. Duration of waking pain

At least 30% subjects recorded no waking pain on any pillow throughout the trial. Using the pain frequency–duration classifications, different waking pain category profiles were identified for each pillow. Table 2 outlines the overall percentage of subjects with the different pain profiles.

Examining the data of only those subjects who reported no waking pain on their own pillow, we considered their responses to the trial pillows (see Fig. 3). The polyester, foam contour and rubber pillows were most likely to continue the pattern of no waking pain reports. The regular foam and feather pillows produced more frequent events of waking pain.

3.3.3. Comparing the percentage change in pain symptoms between pillows

Considering all subjects with valid data patterns of waking pain change between own pillow and trial pillows were compared. Table 3 outlines the percentage of subjects who remained the same, improved or worsened. There was no significant gender or age effect on change in symptom distribution between own pillow and the trial pillows.

Fig. 4 reports a survival analysis of subjects who remained free of waking pain on their own and each of the trial pillows throughout the seven day trial. The subjects’ own pillow and the feather pillow produced the greatest loss in the sample to cervical waking pain, whilst the rubber pillow was clearly superior.

There was variable probability of subjects’ waking with pain on their own pillow, compared with each of the trial pillows. Accumulated valid data from all subjects who commenced each trial, found no difference in odds (95% CI) when comparing own

Table 1

Data excluded per pillow.

<table>
<thead>
<tr>
<th>Pillow</th>
<th>Total possible obs</th>
<th>Total completed obs</th>
<th>N subjects providing reasons for exclusion</th>
<th>Total excluded obs (invalid)</th>
<th>Total valid obs</th>
<th>Dropouts</th>
<th>Total obs lost through dropouts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own</td>
<td>742</td>
<td>742</td>
<td>50 [12 men, 38 women]</td>
<td>107</td>
<td>635</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Polyester</td>
<td>732</td>
<td>713</td>
<td>33 [11 men, 22 women]</td>
<td>66</td>
<td>647</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>Foam regular</td>
<td>736</td>
<td>706</td>
<td>19 [4 men, 15 women]</td>
<td>37</td>
<td>669</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>Foam contour</td>
<td>730</td>
<td>682</td>
<td>15 [3 men, 12 women]</td>
<td>45</td>
<td>637</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>Feather</td>
<td>707</td>
<td>563</td>
<td>14 [3 men, 11 women]</td>
<td>18</td>
<td>545</td>
<td>33</td>
<td>144</td>
</tr>
<tr>
<td>Rubber</td>
<td>700</td>
<td>691</td>
<td>21 [5 men, 16 women]</td>
<td>40</td>
<td>651</td>
<td>3</td>
<td>9</td>
</tr>
</tbody>
</table>

Obs – observations.
pillow with polyester (1.1 (0.7–1.6)), foam regular (1.1 (0.8–1.6)) or foam contour (1.4 (0.9–2.0)). The odds were significantly doubled for feather (1.9 (1.3–2.7)) and significantly halved for rubber (0.6 (0.4–0.9)).

Considering those subjects who reported occasional pain on their own pillow, there was no difference in probability of waking pain when comparing own pillow with polyester (0.9 (0.4–2.0)), foam regular (0.9 (0.4–2.0)) or foam contour (1.0 (0.5–2.1)). Again the odds were significantly doubled for feather (2.4 (1.2–4.9)) and trended towards significantly halved for rubber (0.4 (0.1–1.0)).

Considering those subjects who reported frequent pain on their own pillow, there was no difference in probability when comparing own pillow with polyester (0.8 (0.5–1.4)), foam regular (1.3 (0.8–2.2)) or foam contour (1.2 (0.7–2.0)). The odds were almost significantly doubled for the feather pillows (1.7 (1.0–2.9)). The effect of the rubber pillow was not significant (0.8 (0.5–1.4)).

### 3.3.4. Temporal symptoms and pillow use

The rubber pillow was the best of all pillows at ensuring that subjects who went to bed without cervical pain woke without any, whilst the feather pillow was the worst. The pillow shape (contour compared with regular) appeared to make little difference to temporal patterns. Fig. 5 outlines the performance of the trial pillow with polyester (1.1 (0.7–1.6)), foam regular (1.1 (0.8–1.6)) or foam contour (1.4 (0.9–2.0)). The odds were significantly doubled for feather (1.9 (1.3–2.7)) and significantly halved for rubber (0.6 (0.4–0.9)).

### Table 2

<table>
<thead>
<tr>
<th>Pillow</th>
<th>No pain</th>
<th>Occasional short term pain</th>
<th>Regular short term pain</th>
<th>Occasional half day pain</th>
<th>Regular half day pain</th>
<th>Longer term pain</th>
<th>Excluded obs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own pillow</td>
<td>42.5% (37.8%, 62.2%)</td>
<td>3.8% (75%, 25%)</td>
<td>1.9% (0%, 100%)</td>
<td>3.8% (25%, 75%)</td>
<td>0% (0%, 0%)</td>
<td>0.94% (0%, 100%)</td>
<td>47.1</td>
</tr>
<tr>
<td>Polyester</td>
<td>51% (37.3%, 62.8%)</td>
<td>7% (14.3%, 85.7%)</td>
<td>1% (0%, 100%)</td>
<td>5% (0%, 100%)</td>
<td>1% (0%, 100%)</td>
<td>2% (0%, 100%)</td>
<td>33.0</td>
</tr>
<tr>
<td>Foam regular</td>
<td>54.2% (36.5%, 63.5%)</td>
<td>11.5% (27.3%, 72.7%)</td>
<td>0% (0%, 0%)</td>
<td>11.5% (27.3%, 72.7%)</td>
<td>2.1% (0%, 100%)</td>
<td>1% (0%, 100%)</td>
<td>19.7</td>
</tr>
<tr>
<td>Foam contour</td>
<td>59.4% (40.4%, 59.7%)</td>
<td>7.3% (0%, 100%)</td>
<td>1.0% (0%, 100%)</td>
<td>12.5% (25%, 75%)</td>
<td>3.1% (33.3%, 66.7%)</td>
<td>1.0% (0%, 100%)</td>
<td>15.7</td>
</tr>
<tr>
<td>Feather</td>
<td>48.2% (35.9%, 64.1%)</td>
<td>12.4% (20%, 80%)</td>
<td>1.2% (0%, 100%)</td>
<td>17.3% (42.9%, 57.1%)</td>
<td>3.7% (33.3%, 66.7%)</td>
<td>0% (0%, 0%)</td>
<td>17.2</td>
</tr>
<tr>
<td>Rubber</td>
<td>66.3% (33.5%, 6.2%)</td>
<td>7.1% (42.9%, 57.1%)</td>
<td>0% (0%, 0%)</td>
<td>4.1% (0%, 100%)</td>
<td>1% (0%, 100%)</td>
<td>0% (0%, 0%)</td>
<td>21.5</td>
</tr>
</tbody>
</table>

### Table 3

<table>
<thead>
<tr>
<th>Own pillow compared with</th>
<th>Worse (%)</th>
<th>Remained the same (%)</th>
<th>Improved (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyester</td>
<td>10.4</td>
<td>77.1</td>
<td>12.5</td>
</tr>
<tr>
<td>Foam regular</td>
<td>16.9</td>
<td>60.4</td>
<td>22.7</td>
</tr>
<tr>
<td>Foam contour</td>
<td>9.3</td>
<td>79.6</td>
<td>11.1</td>
</tr>
<tr>
<td>Feather</td>
<td>16.0</td>
<td>62.0</td>
<td>22.0</td>
</tr>
<tr>
<td>Rubber</td>
<td>6.0</td>
<td>82.0</td>
<td>12.0</td>
</tr>
</tbody>
</table>
pilows in terms of changing temporal patterns. The odds (OR, 95% CI) of subjects waking worse than they retired in terms of cervical pain, when compared with their own pillow, were not significant for the polyester (1.3 (0.6–2.6)), foam regular (1.3 (0.6–2.7)) and foam contour (1.4 (0.7–2.9)), and rubber pillows (0.7 (0.3–1.7)). The odds of this occurring were significantly elevated with the feather pillow (2.4 (1.2–2.7)). There was a significant difference in the proportion of subjects across the temporal pain categories when comparing the feather pillow and own pillow. There was no difference in proportions when comparing the other pillows.

### 3.4. Sleep quality and pillow comfort

The percentages of participants’ valid observations who reported high sleep quality and high pillow comfort ratings are presented in Table 4. In Table 5, in comparison to their usual pillow, subjects were significantly more likely to report low pillow comfort on all trial pillows except the rubber pillow, which significantly protected subjects from a low pillow comfort rating. The foam contour and the feather pillows were significantly more likely to produce low sleep quality, whilst the rubber pillow significantly protected subjects. The comfort and quality ratings for the feather pillow were significantly lower when compared with own pillow. The remaining pillows did not differ significantly from the ratings provided for subjects’ own pillow.

### 4. Discussion

This study provides the first reports that pillow type can be recommended by health practitioners to alter the behaviour of cervical pain in side sleepers. It provides the basis for further investigation of pillow performance with specific groups of people (with known musculoskeletal problems or other sleeping positions) and a basis for evidence-based prescription of pillows for individuals suffering from regular waking pain, reduced pillow comfort or sleep quality.

The study findings are in direct conflict with historically held anecdotal advice regarding pillow selection in the management of cervico-thoracic symptoms.

#### 4.1. Pillow performance

Subjects’ own pillow performed similarly to the polyester and foam pillows in terms of production of waking symptoms and maintenance of retiring pain. The shape of the foam pillow appeared to make no difference to waking pain or abolition of night pain. However the contour pillow was less comfortable and provided poorer quality sleep. Thus the contour pillow is less efficacious for these reasons. Contour shaped foam pillows were initially developed to support the cervical lordosis in the supine sleep position. Hence further investigation of the association between contour pillow shape and symptom behaviour in supine sleepers is indicated. Moreover, contour pillows of different heights require examination with respect to subject anthropometry, symptom behaviour, sleep quality and pillow comfort ratings.

The feather pillow was a consistent poor performer in all outcome measures and therefore cannot be recommended as an alternative should subjects request a pillow which is better than their own. However the rubber pillow performed consistently well, and was a better performer than subjects’ own pillow in all outcome measures and should be recommended as an alternative should subjects seek a better performing pillow than their own.

#### 4.2. Pillow trial period

Seven days appears to be a suitable period for a pillow trial as all drop-outs occurred before the fifth trial day. The ‘washout period’ of own pillow use for seven days between pillow trials also appeared to be appropriate to reduce trial pillow symptoms, to catch up on sleep from poor quality sleep from the trial pillows and to retain the interest of the study sample.

#### 4.3. Anthropometry

The fit of pillow-to-human form has not been reported in the literature, and was not investigated in this study. Anthropometric studies may thus provide useful information regarding if, and what, anatomical parameters will ensure a comfortable, symptom free union between person, mattress and pillow.

#### 4.4. Study limitations

There were several limitations in this study including an inability to completely blind subjects for pillow type, reliance on daily self-report measures of pain occurrence and duration, sleep quality and pillow comfort, and a lack of information on subjects’ own pillows. There was a surprisingly high number of waking pain reports on subjects’ own pillows, questioning our assumption that these were the most comfortable pillows ever used by subjects. Although there was no difference in subject reports of known reasons for waking pain between the trial pillows, there was a noticeably high percentage on subjects’ own pillows in the first trial week. This could lead to questions such as ‘Did this occur because subjects were anxious about the trial, or perhaps more aware of waking pain?’ If this is so, it must be considered that reports of cervical waking pain on the trial pillows may well have been related to known reasons other than the pillow, but were perhaps ascribed to the pillow itself, in error (Sackett, 1979). The potential for over- and under-reporting of symptoms during the trial pillow weeks must be considered.

### Table 4

<table>
<thead>
<tr>
<th>Own (%)</th>
<th>Polyester (%)</th>
<th>Foam regular (%)</th>
<th>Foam contour (%)</th>
<th>Feather (%)</th>
<th>Rubber (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>85</td>
<td>81</td>
<td>80</td>
<td>71</td>
<td>41</td>
<td>91.5</td>
</tr>
<tr>
<td>71</td>
<td>71</td>
<td>72</td>
<td>63</td>
<td>40</td>
<td>81</td>
</tr>
</tbody>
</table>

### Table 5

<table>
<thead>
<tr>
<th>Compared to usual pillow OR (95% CI)</th>
<th>Polyester</th>
<th>Foam regular</th>
<th>Foam contour</th>
<th>Feather</th>
<th>Rubber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low comfort rating</td>
<td>1.4 (1.1–1.9)</td>
<td>1.5 (1.1–2.0)</td>
<td>2.4 (1.8–3.1)</td>
<td>8.4 (6.4–11.0)</td>
<td>0.5 (0.4–0.8)</td>
</tr>
<tr>
<td>Low sleep quality</td>
<td>1.0 (0.8–1.3)</td>
<td>1.0 (0.8–1.3)</td>
<td>1.5 (1.2–1.8)</td>
<td>3.7 (3.0–4.8)</td>
<td>0.6 (0.5–0.7)</td>
</tr>
</tbody>
</table>
5. Conclusion

This study provides evidence to support recommendation of rubber pillows in the management of waking cervical pain and to improve sleep quality and pillow comfort. The rubber pillow performed better than subjects’ own pillow in most instances. Subjects’ own pillow performed similarly to foam and polyester pillows and there is no evidence that the use of a foam contour pillow has advantages over the regular shaped pillows. Feather pillows should not be recommended.

Appendix 1. Diary

As you were preparing to go to bed tonight did you have:-

<table>
<thead>
<tr>
<th>Please tick</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck pain</td>
</tr>
<tr>
<td>Neck stiffness</td>
</tr>
<tr>
<td>Headache</td>
</tr>
<tr>
<td>Aching between your shoulder blades</td>
</tr>
</tbody>
</table>

Morning 1 (after Night One)

1. Please choose one of the categories below to describe the quality of your sleep last night.

<table>
<thead>
<tr>
<th>Please tick one box only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
</tr>
<tr>
<td>Very good</td>
</tr>
<tr>
<td>Good</td>
</tr>
<tr>
<td>Fair</td>
</tr>
<tr>
<td>Poor</td>
</tr>
</tbody>
</table>

2. Please choose one of the categories below to rate the comfort of your pillow last night.

<table>
<thead>
<tr>
<th>Please tick</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfectly comfortable</td>
</tr>
<tr>
<td>Very comfortable</td>
</tr>
<tr>
<td>Quite comfortable</td>
</tr>
<tr>
<td>Barely comfortable</td>
</tr>
<tr>
<td>Uncomfortable</td>
</tr>
</tbody>
</table>

3. This morning did you wake with any of the following symptoms? How long did the symptom/s last? Please rate how bad the symptom was on a scale from 1 to 10 with 1 being slight pain and 10 severe pain

<table>
<thead>
<tr>
<th>Please rate</th>
<th>1–10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck pain</td>
<td></td>
</tr>
<tr>
<td>Stiff neck</td>
<td></td>
</tr>
<tr>
<td>Headache</td>
<td></td>
</tr>
<tr>
<td>Aching between the shoulder blades</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Please rate</th>
<th>1–10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck pain</td>
<td></td>
</tr>
<tr>
<td>Stiff neck</td>
<td></td>
</tr>
<tr>
<td>Headache</td>
<td></td>
</tr>
<tr>
<td>Aching between the shoulder blades</td>
<td></td>
</tr>
</tbody>
</table>

4. Cause of symptoms

If you woke, this morning, with any of the symptoms listed above can you think of anything, apart from your pillow that may have caused the symptoms?

<table>
<thead>
<tr>
<th>Please tick</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If yes please describe what caused your symptoms.

Additional questions

1. Alter pillow

During the trial of this pillow did you need to alter the pillow in any way to make it more comfortable for you to sleep on? e.g. double it over

If yes, please describe how you altered the pillow?

2. Change sleep position

During the trial of this pillow did you need to change your sleep position in any way to allow you to sleep more comfortably on this pillow?

If yes, please describe how you changed your sleep position?

3. Comparable Comfort

Now that you have slept on this pillow for four weeks, would you please rate the comfort of this pillow compared to your usual pillow.

Please tick one box only

<table>
<thead>
<tr>
<th>Please tick</th>
</tr>
</thead>
<tbody>
<tr>
<td>Much more comfortable</td>
</tr>
<tr>
<td>More comfortable</td>
</tr>
<tr>
<td>Same</td>
</tr>
<tr>
<td>Less comfortable</td>
</tr>
<tr>
<td>Uncomfortable</td>
</tr>
</tbody>
</table>

4. Comments

Do you have any comments you would like to make about sleeping on this pillow over the last four weeks?
References

DeKoninck J, Lorrain D, Gagnon P. Sleep positions and position shifts in five age
Erfanian P, Hagino C, Guerriero R. A preliminary study assessing adverse effects of
a semi-customized cervical pillow on asymptomatic adults. Journal of the
Erfanian P, Tenzif S, Guerriero RC. Assessing effects of a semi-customized experi-
mental cervical pillow on symptomatic adults with chronic neck pain with and
without headache. Journal of the Canadian Chiropractic Association
Gordon SJ, Trott P, Grimmer KA. Waking cervical pain and stiffness, headache,
scapular or arm pain: gender and age effects. Australian Journal of Physio-
Gordon SJ, Grimmer K, Trott P. Self-reported versus recorded sleep position: an
observational study. Internet Journal of Allied Health Sciences and Practice(1),
http://ijahsp.nova.edu, 2004;2.
Gordon S, Grimmer K, Trott P. Sleep position, age, gender, sleep quality and waking
cervico-thoracic symptoms. Internet Journal of Allied Health Sciences and
Hagino C, Boscariol J, Dover L, Letendre R, Wicks M. Before/after study to determine
the effectiveness of the align-right cylindrical cervical pillow in reducing
chronic neck pain severity. Journal of Manipulative and Physiological Thera-
exercise and sleeping neck support on patients with chronic neck pain:
Kramer J. Intervertebral disk diseases: causes, diagnosis, treatment and prophyl-
Lavin RA, Pappagallo M, Kuhlemeyer K. Cervical pain: a comparison of three
McKenzie R, May SW. The cervical and thoracic spine: Mechanical diagnosis and
Persson L. Neck pain and pillows – a blinded study of the effect of pillows on non-
specific neck pain, headache and sleep. Advances in Physiotherapy 2006;8:122–7.
Shields N, Capper J, Polak T, Taylor N. Are cervical pillows effective in reducing neck
Yin RK. Case study research: design and methods. In: Applied social research