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ORIGINAL ARTICLE

Quality of sleep in patients with chronic low back pain: a case-control study

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Abstract Animal experiments and studies in humans clearly show that the relation between pain (acute and chronic) and sleep quality is two-way: sleep disorders can increase pain, which in turn may cause sleep disorders. Sleep disorders and chronic low back pain are frequent health problems and it is unsurprising that the two can co-exist. This study was conducted to evaluate if sleep disorders and chronic pain associated are more frequently than one would expect. The objective of the study was to compare sleep quality in a population of patients with chronic low back pain and a control population. Sleep quality was assessed in 101 patients with chronic low back pain (CLBP) and in 97 sex- and age-matched healthy control subjects using the Pittsburgh Sleep Quality Index [PSQI; score from 0 (no disorder) to 21]. The French version of the Dallas Pain Questionnaire (DPQ) was used to assess the impact of low back pain on patients' quality of life. This impact was taken as nil in the healthy controls. The patients with CLBP and the controls were comparable in age, sex, and height, but mean bodyweight was higher in the CLBP group (70.3 ± 14.5 vs. 61.8 ± 11.4 kg; $P < 0.05$). The patients with CLBP were also more frequently on sick leave than the controls (32.3%; $n = 31$ vs. 0.0% $n = 0$; $P < 0.001$). Coffee, tea, and cola intakes were comparable in the two groups. Patients with CLBP had statistically higher scores in all items of the PSQI than the healthy controls. The mean PSQI was 4.7 ± 3.2 for the healthy controls and 10.9 ± 7.9 for the patients with CLBP ($P < 0.0001$). Sleep disorders were greater when the impact of CLBP on daily life (the four aspects of the DPQ) was greater [$P < 0.0001$]). The sleep of the patients with CLBP was significantly altered compared with that of the healthy controls, in proportion to the impact of low back pain on daily life. Our findings do not indicate whether sleep disorders are a cause or a consequence of CLBP.

Keywords Chronic low back pain · Sleep disorders · Dallas Pain Questionnaire · Pittsburgh Sleep Quality Index · Case control study

The exoirements comply with the current laws of the country in which it was performed.

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Introduction

Animal experiments and studies in humans clearly show that the relation between pain (acute and chronic) and sleep quality is two-way: sleep disorders can increase pain, which in turn may cause sleep disorders [7, 11, 20, 23, 24]. Sleep

disturbances differ according to the pain syndrome with which they are associated [headache, migraine, osteoarthritis, rheumatoid arthritis, ankylosing spondylitis, chronic low back pain (CLBP), chronic fatigue syndrome, fibromyalgia, somatoform syndrome, irritable bowel syndrome]. The literature data about these disturbances are patchy [20, 4].

Sleep disorders and chronic pain (particularly CLBP) are frequent health problems and it is unsurprising that the two can co-exist [4, 14]. Yet their association raises several questions. Are sleep disorders and chronic pain associated more frequently than one would expect? Is one the consequence of the other or do they both have the same cause? What mechanisms underlie the putative relation between them?

Some studies have investigated relationships between CLBP and sleep disorders [3, 9, 12, 17, 19] but no case control study has been conducted to assess sleep disorders among patients with CLBP in regards of healthy patients. The aim of this study was to evaluate the prevalence of sleep disorders in a population of about 100 patients with CLBP compared with a population of about 100 age- and sex-matched healthy subjects without CLBP.

Materials and methods

This was an exploratory, epidemiological, cross-sectional case-control study.

Selection of patients

The following inclusion criteria were applied:

- Patients with CLBP: over 18 years of age, CLBP of nonspecific origin, not radiating below the knee, present for more than 12 weeks (categories 1 and 2 of the Paris Task Force) [1].
- Controls: over 18 years of age, sex- and age-matched (age difference <5 years) with the patients, no history of CLBP and no low back pain in the 3 months prior to the survey.

Patients or controls to whom the following criteria were applicable were not included in the study: characterized depressive state, concomitant disease apart from hypertension, hypercholesterolemia and noninsulin-dependent diabetes.

Assessment criteria

The assessment criteria were as follows:

- For all the patients: age, sex, weight, height, mean daily consumption of tea and coffee during the year preceding the survey, comorbidity (hypertension, hypercholesterolemia and noninsulin-dependent diabetes).

Sleep disorders during the month preceding the evaluation were examined using a French version of PSQI [6], which includes 19 questions completed by the subject. The 19 items were broken down into the following seven components: subjective sleep quality sleep latency, sleep duration, sleep efficiency, sleep disorders, use of hypnotics, and poor daytime functioning. Sleep latency is assessed by two questions rated according time to fall asleep, sleep duration by one question rated by a four Likert scale from <7 to <5 h and sleep efficiency by hours asleep divided by total of hours in bed. Use of hypnotics and poor daytime functioning are rated by a four kikert scale (not during the past month, less than once a week, once or twice a week, three or more times a week). Sleep disorders are assessed by 9 questions focused on: waking up in the middle of the night or early in the morning, getting up to go to the toilet, difficulty breathing properly, coughing or snoring loudly, being too cold, being too hot, having nightmares, experiencing pain, other reason disturbing sleep. Each question is rated by by a four kikert scale (not during the past month, less than once a week, once or twice a week, three or more times a week). Subjective sleep is evaluated by one question rated by a four Likert scale from very good to very bad. The seven components were each scored from 0 (no difficulty) to 3 (severe difficulty), and summed, to give an overall score ranging from 0 to 21.

For the patients with CLBP, the impact of pain was assessed using the French version of the Dallas Pain Questionnaire (DPQ) [13], which was validated for use with CLBP [18], and which comprises 16 questions that explore the impact of pain on 4 dimensions: daily activities (7 questions), work and leisure (3 questions), anxiety/depression (3 questions), social activities (3 questions). The daily activities area (items 1 though 7) evaluates pain severity, personal care, lifting, walking, sitting, standing and sleeping. The work leisure area (items 8 though 10) focuses on social life, traveling, and work related activities. The anxiety/depression area (items 11 though 13) investigates anxiety, mood, emotional control and depression. The social interest area (items 14 though 16) covers interpersonal relationships, social support and punishing responses. Each item is rated by the patient using a visual analog scale that has 0% with words such as “no pain” or “not at all” at one end and 100% with words such as “all the time” at the other end. Each scale is divided in five to eight segments. Each segment is assigned a value from 0 to 7 (0 to the left hand segment, 1 to the next segment and so on). In each area the sum of scores for each for each item is calculated and multiplied by a constant (3 for items 1–7, 5 for items 8–10, 11–13, and 14–16). This provides a percentage reflecting the impact of the pain on the area being considered.

The other assessment parameters were the length of time low back pain had been present, the duration of any sick

leave, and the mean low back pain intensity over the previous 2 weeks determined using a visual analog scale (VAS) from 0 to 100. Medication for back pain was assessed. Pain medication was classified according the 3 WHO levels.

Recruitment

Patients were recruited by rheumatologists of the Section Rachis de la Société Française de Rhumatologie. Healthy control subjects were recruited among professional staff, friends and family.

Statistical methods

The descriptions were made using means and standard deviations for the quantitative variables and frequency histograms for the qualitative variables. Means were compared by ANOVA and the Chi square test was used to compare the qualitative variables. SAS software version 6.8 was used for data analysis. A P value <0.05 was regarded as statistically significant.

As an exploratory study, the theoretical number of participants was fixed at 100 with CLBP and 100 controls (actual numbers 101 and 97, respectively), to allow detection with a power of 95 and a 5% risk, in a two-tailed situation, of a between-group difference of approximately half of the standard deviation of the observed PSQI.

Results

Patients

Sleep quality was assessed in 101 patients with chronic low back pain (CLBP) and in 97 sex- and age-matched healthy control subjects.

The patients with CLBP [women: 60.2% ($n = 59$); men: 39.8% ($n = 39$)] were of mean age 43.7 ± 10.3 years, weight 73.3 ± 14.5 kg, and height 170 ± 8 cm. Low back pain had been present on average for 53 ± 67 months (median 27 months), with a very large range (2 months–25 years), which explains the large standard deviation. One patient presented a minor deviation with a length-duration less than 12 weeks. Mean pain intensity on the VAS was 46 ± 26 mm (median 48). Forty-nine percent ($n = 47$) of the patients worked, 32.3% ($n = 31$) had jobs but were on sick leave, 14.6% ($n = 14$) were retired or unemployed, and 4.2% ($n = 4$) were on disability allowance. Mean daily beverage intake was 2.9 ± 2.7 cups of coffee, 0.8 ± 1.6 cups of tea, 0.4 ± 1.3 glasses of cola. Medication for low back pain was being taken by 84.4% ($n = 81$) of the patients: 51.9% ($n = 42$) level 2 analgesics, 42.0% ($n = 34$) level 1 analgesics, 38.3% ($n = 31$) NSAIDs, 22.2% ($n = 18$) sedative muscle relaxants, 7.4% ($n = 6$) nonsedative muscle relaxants, and 2.5% ($n = 2$) level 3 analgesics. The impact of low back pain on quality of life assessed by means of the DPQ was 69.1 ± 16.0% (median 70.5%) on daily activities, 62.2 ± 22.8% (median 66.3%) on work and leisure, 45.0 ± 25.2% (median 42.5%) on anxiety-depression, and 36.7 ± 24.1% (median 32.5%) on social interest. Items likely to affect low back pain or to alter sleep quality were compared with those noted in the controls (Table 1).

The patients with CLBP and the controls were comparable in age, sex, and height, but mean bodyweight was higher in the CLBP group (70.3 ± 14.5 vs. 61.8 ± 11.4 kg; $P < 0.05$). The patients with CLBP were also more frequently on sick leave than the controls (32.3%; $n = 31$ vs. 0.0% $n = 0$; $P < 0.001$). Coffee, tea, and cola intakes were comparable in the two groups.

Table 1 Patient characteristics

Variable	Patients with chronic low back pain $n = 101$	Matched controls $n = 97$	P
Age (years) mean, SD	43.7 (10.3) $n = 97$	43.3 (10.6) $n = 92$	NS
Sex (% F)	60.2% (59/98)	65.3% (62/95)	NS
Weight (kg) mean, SD	73.3 (14.5) $n = 95$	64.2 (11.4) $n = 92$	0.0214
Height (cm) mean, SD	170.1 (7.8) $n = 94$	168.3 (7.7) $n = 92$	NS
Occupational status			
Working	49% (47/96)	88.4% (84/95)	<0.004
On sick leave	32.3% (31/96)	–	
Not in work	14.6% (14/96)	10.5% (10/95)	
On disability allowance	4.2% (4/96)	1% (1/95)	
Coffee intake (cups/day) mean, SD	2.9 (2.7) $n = 92$	3.1 (2.5) $n = 95$	NS
Tea intake (cups/day) mean, SD	0.84 (1.6) $n = 84$	0.56 (1.3) $n = 76$	NS
Cola intake (glasses/day) mean, SD	0.4 (1.2) $n = 79$	0.4 (1.1) $n = 68$	NS

Table 2 Pittsburgh Sleep Quality Index[a] as a function of the French version of the Dallas Pain Questionnaire[b]

Dallas Pain Questionnaire[b]	Patients with chronic low back pain–mild impact (0–33%)	Patients with chronic low back pain–moderate impact (33–66%)	Patients with chronic low back pain–great impact (66–100%)	*P* value
Daily activities	5.5 (0.7)	9.1 (4.6)	12.8 (4.5)	$P < 0.001$
Work and leisure	6.3 (1.5)	8.6 (4.4)	13.8 (4.0)	$P < 0.001$
Anxiety-depression	8.3 (4.1)	11.6 (4.2)	15.3 (3.5)	$P < 0.001$
Social interest	8.6 (4.3)	12.4 (4.3)	16.1 (3.8)	$P < 0.001$

[a] Value between 0 (no difficulty) and 21 (severe difficulty)

[b] Each dimension score ranging from 0 (no impact) to 100 (maximal impact)

Comparison of the PSQI between the patients with CLBP and the controls

The PSQI was significantly higher in the patients with CLBP than in the controls (10.9 ± 4.9 vs. 4.7 ± 3.2; $P < 0.0001$). This difference in global score was apparent in a number of components and, in particular, the percentage of patients who:

- Took more than half an hour to fall asleep each night (39.6%; $n = 38$ vs. 5.2%; $n = 5$; $P < 0.0001$),
- had less than 6 h effective sleep per night (47.4%; $n = 46$ vs. 15.6%; $n = 15$; $P < 0.001$),
- woke in the middle of the night or early in the morning three or four times a week (63.0; $n = 58$ vs. 20%; $n = 19$; $P < 0001$),
- slept badly at least once a week over the previous month because of getting up to go to the toilet (46.1%; $n = 41$ vs. 21.1%; $n = 20$; $P < 0.01$), difficulty breathing properly (14.3%; $n = 13$ vs. 2.1%; $n = 2$; $P < 0.05$), coughing or snoring loudly (24.4%; $n = 22$ vs. 4.3%; $n = 4$; $P < 0.001$), being too hot (26.4%; $n = 24$ vs. 10.6%; $n = 10$; $P < 0.05$), having nightmares (29.7%; $n = 27$ vs. 7.5%; $n = 7$; $P < 0.001$), and experiencing pain (75.6%; $n = 68$ vs. 10.8%; $n = 10$; $P < 0.001$).

In all, 49.5% (48) of patients with CLBP considered their sleep quality as poor or very poor, compared with 10.4% ($n = 10$) in the controls ($P < 0.001$). As probable consequences of this poor quality sleep, 33.0% ($n = 31$) of the patients with CLBP had difficulty staying awake at least once a week while driving, during meals, or during a social activity, compared with 5.3% ($n = 5$) of the controls ($P < 0.001$), 36.5% ($n = 35$) versus 1.1% ($n = 2$) had to take hypnotics, and 52.1% ($n = 49$) versus 7.4% ($n = 7$) had motivational problems when working.

Variation in PSQI as a function of the impact of the low back pain assessed using the DPQ

The impact of low back pain was classified as weak for a DPQ score in the range 0–33, moderate for a score of 33–66, and strong for a score of 66–100. The controls who were not asked to complete the DPQ were introduced into the model by considering that, in the absence of low back pain, the impact was nil. Very significant alterations in sleep evaluated by the PSQI were noted as a function of the different components of the DPQ (Table 2).

Discussion

This case-control study clearly demonstrates an association between sleep disorders and CLBP, and also a correlation between the intensity of the impact of CLBP on daily life and the severity of sleep disorders.

The DPQ scores indicate that the impact of CLBP on daily life was considerable, and close to one-third of working patients with CLBP were on sick leave.

There was little correlation between bodyweight and low back pain, in agreement with several cross-sectional studies [5, 8, 15, 16, 21] showing a weak positive association between the frequency of obesity and low back pain. This relation is greater when the low back pain is long-standing [15], and is above all less marked than with knee, hip and back pain [2]. In an excellent review published in 2000 [16], Yde-Leboeuf could not establish a causal link between high body mass index and low back pain.

Some studies have investigated relationships between CLBP and sleep disorders [3, 9, 12, 17, 19].

Atkinson et al. [3] reported a 50% prevalence of sleep disorders in 51 patients with CLBP, a value similar to that observed in the general population [14], but the noncomparative nature of the study and the limited number of cases diminish the strength of these data. In the present study the median value of PSQI for CLBP patients was 11 meaning that at least 50% of patients had significant sleep disorders.

Harman et al. [9] noted no major anomalies in electroencephalograms recorded during 4 consecutive nights in 4 depressed patients with CLBP, 10 nondepressed patients with CLBP, and 11 controls, although the Pittsburgh Sleep Quality Index (PSQI) suggested an altered sleep quality in the patients with CLBP. Electroencephalographic differences were noted between the depressed and nondepressed

patients with CLBP. The electrical perturbations observed in the patients with CLBP were considerably smaller than those seen in other types of disorders with chronic pain. The PSQI values were as follows: controls ($n = 11$) 2.11 ± 1.17, nondepressed with CLBP ($n = 6$) 10.83 ± 1.41, depressed with CLBP ($n = 4$) 13.75 ± 1.73. These results on PSQI scores in CLBP patients were similar than those observed in the present study.

Marin et al. [17] reported a correlation between the severity of sleep disorders (measured with the PSQI) and pain in a cross-sectional survey in 268 patients with CLBP.

Lavie et al. [12] compared actigraphic recordings over four consecutive nights in female patients with rheumatoid arthritis (13 patients) or CLBP (9 patients), and nine healthy female controls. All the sleep quality measures were altered in the patients with rheumatoid arthritis, but the recordings did not differ significantly between the patients with CLBP and the controls. Sleep was clearly more fragmented in the patients with rheumatoid arthritis, but the data are weakened by the small number of subjects.

Meneffee et al. [19] demonstrated a close association between sleep disorders and functional disability caused by CLBP. The relation between chronic spinal pain and sleep disorders was studied with a multivariate analysis, in 167 patients attending a pain clinic because of spinal pain of nonspecific origin or postlaminectomy syndrome. The authors showed that sleep quality and the time taken to fall asleep were mainly affected by decreased physical functioning, and to a lesser degree by longstanding pain and young age. Pain intensity and mood were little associated with sleep disorders in this study.

The present study's main strengths are the inclusion of controls free of chronic or acute pain, and the use of validated questionnaires to investigate sleep disorders and CLBP. Its principal limitation is the absence of a multivariate analysis including factors that could explain the sleep disorders. The study's objective was to simply examine the relation between sleep disorders and CLBP, and the findings confirm previous data suggesting an association [17, 19].

Mechanisms, which underlie the relation between CLBP and sleep disorders were very complex and little understood [24].

No prospective study has shown whether sleep disorders cause CLBP or vice versa or if they both have the same cause, but we can go some way towards answering this question. A prospective, 28-year Finnish study has shown that poor sleep is predictive of admission to hospital for back disorders [10]. This study in 902 employees selected in 4 Finnish factories assessed whether sleep disorders (difficulty falling asleep and nightmares) in the 12 months preceding inclusion were predictive of first hospitalization for back disorders. Multivariate analysis showed that the patients with sleep disorders at inclusion were 2.4 (95% IC: 1.2–4.6) times more likely to be hospitalized for back disorders (8% of patients) than those without sleep disorders.

Experimental studies suggest that sleep deprivation may decrease the pain threshold in healthy subjects. Decrease in slow-wave sleep seems to be responsible for this effect, while the effects of reduction in rapid eye movement sleep are less clear [7, 11, 24]. The mechanisms of action of sleep disruption on pain are complex. Lack of sleep or poor quality sleep lower the pain threshold through neurobiological modifications. Decreased sensitivity of mu and delta opioid receptors or reduced secretion of endorphins may occur. Prolonged deprivation of rapid eye movement sleep may render the serotoninergic system unable to mediate the analgesic effects of the opioid system [11]. Sleep modulation and regulation seem to share neurobiological systems with chronic pain [11], and lack of sleep may diminish mental capacity to manage pain [11, 22].

Any extrapolation of these findings to patients with CLBP can only be hypothetical, but for certain patient's chronic pain, physical inactivity, sleep disorders, and depression seem to be interdependent [23, 24].

Conclusion

This case-control study clearly demonstrates an association between sleep disorders and CLBP, and a correlation between the magnitude of the impact of CLBP on daily life and the severity of sleep disorders. Whether cause or consequence, sleep disorders associated with CLBP (concomitant or not with depression, fibromyalgia, or another disorder) must be taken into account in the overall management of the patient, in the same way as pain. It is also necessary to consider all the factors potentially responsible for sleep disorders, such as excessive intake of stimulants (coffee, tobacco, alcohol, drugs), anxiety, poor sleeping conditions (air, temperature, partner, quality of bedding), sleep apnea syndrome, and co-morbidities.

Literature data suggest that cognitive-behavioral therapy can be effective in treating fibromyalgia and other chronic pain syndromes [24]. There is no lack of prospects for future research.

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