Sleep after laparoscopic cholecystectomy

S. ROSENBERG-ADAMSEN, M. SKARBYE, G. WILDSCHIØDTZ, H. KEHLET AND J. ROSENBERG

Summary
The sleep pattern and oxygenation of 10 patients undergoing laparoscopic cholecystectomy were studied on the night before operation and the first night after operation. Operations were performed during general anaesthesia and postoperative analgesia was achieved without the administration of opioids. There were no significant changes in the total time awake or the number of arousals on the postoperative night compared with the night before operation. During the postoperative night, we found a decrease (P = 0.02) in slow wave sleep (SWS) with a corresponding increase in stage 2 sleep (P = 0.01). SWS was absent in four of the patients after operation, whereas in six patients it was within the normal range (5–20% of the night). The proportion of rapid eye movement (REM) sleep was not significantly changed after operation. There were no changes in arterial oxygen saturation on the postoperative compared with the preoperative night. Comparison of our results with previous studies on SWS and REM sleep disturbances after open laparotomy, suggests that the magnitude of surgery or administration of opioids, or both, may be important factors in the development of postoperative sleep disturbances. (Br. J. Anaesth. 1996; 77: 572–575)

Key words
Sleep, Oxygen, saturation, Hypoxaemia, Surgery, laparoscopy.

Sleep disturbances have been described after major abdominal surgery1–5 and herniorrhaphy;6 the disturbances include decreases in total sleep time, proportion of rapid eye movement (REM) sleep and slow wave sleep (SWS). These changes are most pronounced on the first and second postoperative nights, with a subsequent rebound on the following nights.1156 The magnitude of surgery (the surgical stress response), the surroundings (noise, nursing procedures, etc.), pain and administration of opioids are all factors that may influence postoperative sleep, but the relative importance of these factors is still unknown.

The aim of this study was to evaluate postoperative sleep in patients undergoing minimally invasive surgery (laparoscopic cholecystectomy) without administration of opioids during the postoperative period.

Patients and methods
The study was approved by the local Ethics Committee and patients participated in the study after giving informed consent. We studied 10 patients (eight females; median age 51 (range 34–72) yr, weight 83 (55–105) kg and height 167 (158–172) cm) undergoing laparoscopic cholecystectomy. None of the patients was receiving regular medication before operation and exclusion criteria included known sleep apnoea syndrome, neurological, cardiac or respiratory diseases, oxygen administration during the study nights and use of sedatives or hypnotics during the past 2 months at home or during hospitalization. All patients underwent elective surgery with no recognized risk factors and received routine postoperative analgesic.

Anaesthesia was induced and maintained with thiopentone, isoflurane, low-dose fentanyl, midazolam, suxamethonium, atracurium and nitrous oxide in oxygen. After operation, including the first postoperative night, all patients received ibuprofen 600 mg every 8 h. Opioids were not used for postoperative analgesia.

Patients were studied in the surgical ward in a quiet single bedroom for 1 night before operation and on the first postoperative night, from 22:00 to 06:00. For sleep staging, patients were monitored with a Somnolog System (Ventec Aps, Hellerup, Denmark) which records continuously the electroencephalogram (EEG) (alpha and delta activity by one-channel EEG—a modified F3-A2 lead), electromyogram (EMG) (electrodes placed under the base of the mandible), single lead ECG, eye and hand movements (by movement sensors placed on the upper eyelid and dorsally on the proximal joint of the left index finger) and noise level (by a standard microphone placed 1 m above the patient’s head). Data were stored in the internal memory of the Somnolog with subsequent downloading to a

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personal computer. The variables in the Somnolog were analysed manually for sleep stage using 6-s epochs throughout the night, according to the criteria of Rechtschaffen and Kales.6 7

During the study nights, arterial oxygen saturation (SpO2) was measured with a pulse oximeter (Nellcor N-200, Nellcor Inc., Pleasanton, CA, USA) with an adhesive finger probe.10 SpO2 data were sampled at 1-s intervals into a bedside personal computer with subsequent data print-out the following morning. Episodic hypoxaemia was defined as a decrease in oxygen saturation of more than 4% from baseline occurring within a 2-min period.11 Analysis of oximetry data was performed without knowledge of the sleep data except when calculating the frequency of hypoxaemic episodes during periods of REM sleep.

For statistical analysis we used the Wilcoxon signed rank test. *P < 0.05 was considered significant. Group data are given as median (range).

### Results

Median duration of surgery was 85 (range 36–100) min. Duration of anaesthesia was 120 (75–140) min, during which the patients received a total of 1500 (600–2000) ml of isotonic saline. During operation, patients received a total dose of fentanyl 0.4 (0.25–0.50) mg. There was no correlation between fentanyl dose and magnitude of change in sleep pattern. None of the patients received perioperative blood transfusions and none developed postoperative complications.

There were no significant changes in the total time awake or the number of arousals on the postoperative night compared with the night before operation (table 1). During the postoperative night, we found a significant decrease in SWS (P = 0.02) with a corresponding increase in stage 2 sleep (P = 0.01). SWS was absent in four patients (fig.1), whereas in six of our patients SWS was within the normal range (5–20% of the night) on the postoperative night. The proportion of REM sleep was not significantly changed after operation (fig.1). One patient showed a postoperative increase in SWS and REM sleep (fig.1).

Mean arterial oxygen saturation (SpO2) and number of desaturations were not significantly changed after operation (P = 0.2 and P = 0.5). In order to assess the relationship between postoperative REM sleep and episodic hypoxaemia, we used the previously defined index of hypoxaemic episodes during REM sleep for individual patients (number of hypoxaemic episodes in REM sleep divided by total number of hypoxaemic episodes) divided by (REM sleep time divided by total sleep time) (table 1). Thus an index of 1 indicates that the distribution of hypoxaemic episodes was equal between REM and non-REM sleep corrected for duration of REM sleep, and an index >1 indicates that episodic hypoxaemia was more frequent in REM than in non-REM sleep for that night. If the patient had no REM sleep on the study night, the index was 0. There were no significant changes in this index between the two study nights (P = 0.67).

### Table 1

<table>
<thead>
<tr>
<th>Sleep stages and arterial oxygen saturation (median (range))</th>
<th>Preoperative night</th>
<th>First postoperative night</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total time awake (%) of night</td>
<td>9 (0–33)</td>
<td>13 (0–38)</td>
</tr>
<tr>
<td>REM sleep (%) of night</td>
<td>17 (10–31)</td>
<td>14 (0–31)</td>
</tr>
<tr>
<td>Arousal (n)</td>
<td>21 (8–34)</td>
<td>15 (7–100)</td>
</tr>
<tr>
<td>Mean SpO2 (%)</td>
<td>95 (94–98)</td>
<td>96 (93–96)</td>
</tr>
<tr>
<td>Index of episodes in REM sleep</td>
<td>10 (2–19)</td>
<td>10 (1–51)</td>
</tr>
</tbody>
</table>

### Figure 1

Individual values for the proportion of time spent in slow wave sleep (SWS) and rapid eye movement (REM) sleep on the preoperative and postoperative nights. Values are given as percentages of the study night.

### Discussion

This study is the first to describe the sleep pattern after laparoscopic cholecystectomy. We found a slight decrease in SWS, but REM sleep on the first night after operation was unchanged. Also, arterial oxygen saturation (constant and episodic hypoxaemia) was unchanged.

Postoperative sleep disturbances in patients undergoing non-cardiac surgery have been described after major abdominal surgery,1 5 and herniorrhaphy.2 6 The investigators found a marked reduction in SWS during the first 1–4 postoperative nights,1–4 and in a previous study from our group, SWS was absent in all 10 patients on the first night after major abdominal surgery.3 In our study there was only a slight decrease in SWS, and in six of our 10 patients, SWS was within the normal range on the first night after operation. It may be argued that recovery from a “first night effect” with impaired sleep on the preoperative night might have contributed to the relatively small changes seen from the
preoperative (first night) to the postoperative night. However, we have shown previously that when monitoring surgical patients for 2 nights before operation and with the same monitoring equipment and experimental set-up, a first night effect was not present.³

After major surgery, REM sleep is usually absent on the first and sometimes the second and third postoperative nights,¹⁻⁶ followed by an increased duration of REM sleep and density (rebound) during the subsequent 2–4 nights.¹¹⁻¹⁶ In a previous study, performed after major abdominal surgery, there was a significant decrease from a median of 17% to 5% in the proportion of REM sleep on the first night after operation.³ In this study, however, there were no significant changes in the proportion of REM sleep after minimally invasive surgery.

Our patients did not have decreased total sleep time. Previous studies in patients undergoing major abdominal surgery or herniorrhaphy have found that total sleep is reduced by up to 80% on at least one of the first postoperative nights,⁷⁻⁶ and fragmented with numerous movement arousals and spontaneous awakenings.¹² In our study, however, patients were awake for a total of 13% (range 0–38%) of the first postoperative night, but without an increase in the number of arousals on the postoperative compared with the preoperative night (table 1). As sleep duration and fragmentation are important determinants for the subjective restorative capability of sleep,¹⁰ our patients should have been less affected by their postoperative sleep changes than patients undergoing major abdominal surgery or herniorrhaphy, although we did not ask for subjective sleep quality.

The clinical consequences of postoperative sleep changes are unknown, although there may be several potential important implications.⁷ Experimental deprivation of SWS produces a feeling of physical discomfort,¹² characterized by a depressive and hypochondriacal reaction.¹² This may contribute to the feeling of fatigue in postoperative patients, although a relationship between postoperative sleep disturbances and postoperative fatigue has yet to be demonstrated.⁷ Postoperative REM sleep deprivation may be a factor in the development of postoperative impairment of mental function.¹⁴ The postoperative rebound of REM sleep may contribute to the development of sleep-disordered breathing and nocturnal hypoxaemia,¹⁵ as episodic hypoxaemia is more frequent in periods of REM rebound than during other sleep stages in the postoperative period.¹⁶ Furthermore, postoperative REM sleep rebound may be associated with haemodynamic instability and increased mean arterial pressure.¹⁷⁻¹⁸ In the postoperative period, these haemodynamic changes may be related to hypoxicemic episodes,³ and the simultaneous decrease in myocardial oxygen supply (hypoxaemia) and increase in myocardial oxygen demand (tachycardia and hypertension) may lead to postoperative myocardial ischaemia¹⁹ and infarction.

Several factors may contribute to the disturbed sleep in postoperative patients. The magnitude of surgery seems to be important, as the reduction in REM sleep, SWS and the lack of inherent rhythmicity were more pronounced after major (gastrectomy or vagotomy) compared with minor (hernia repair) surgery.² In addition, morphine, in doses of 0.1 and 0.2 mg kg⁻¹ i.m. in healthy volunteers, disrupted sleep in a dose-dependent manner.¹⁸ There are no studies on the effect of systemic or extradural morphine on sleep in postoperative patients.

This study has shown a slight decrease in SWS as the only significant sleep disturbance on the first postoperative night in patients undergoing minimally invasive surgery without administration of opioids during the postoperative period, thus supporting the hypothesis that the magnitude of surgery, administration of opioids, or both, may be important factors in the development of postoperative sleep disturbances. The anaesthetic technique per se does not appear to be an important factor as similar degrees of sleep disturbances have been found after general or regional anaesthesia for herniorrhaphy⁶ or minor surgery.¹⁹ A study in volunteers anaesthetized for 3 h with isoflurane found no significant disturbances in the post-anaesthetic sleep pattern other than a slight decrease in SWS on the first night;¹⁹ this is comparable with the sleep pattern in our patients after laparoscopic cholecystectomy.

Acknowledgements

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References

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