Recall during intermittent propofol anaesthesia

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Summary
We discontinued temporarily an infusion of propofol for surgical reasons in 20 patients undergoing incontinence surgery. The patients, who had not received neuromuscular blockers, were allowed to regain consciousness to a level enabling them to cough on command, open their eyes, and identify and verbally confirm a randomly assigned digit shown on paper. Thereafter, 5–14 min after discontinuation of the propofol infusion, anaesthesia was reinstituted. Memory of the request to cough, a standard conversation and the digit shown was tested 1 h after anaesthesia and on the following day. Only 35 % of patients were able to recall one or more of the stimuli presented during wakefulness or were even able to recall having been “awake”, and there were very few differences in memory on the day after surgery compared with 1 h after anaesthesia. In comparison with corresponding stimuli given before anaesthesia, memory of material learned during wakefulness was significantly impaired (P < 0.0001). Thus patients temporarily capable of cognitive action during propofol anaesthesia may have no subsequent explicit recall of intraoperative events. (Br. J. Anaesth. 1996; 76: 699–701)

Key words

Drug-induced amnesia for events during anaesthesia is often considered beneficial as it is a common belief that post-traumatic neurosis caused by intraoperative cognition during general anaesthesia is more likely after awareness than where there is no explicit recall. However, this assumption is speculative as there are no data, not only on the incidence of significant cognitive capacity during general anaesthesia, but also on the incidence of awareness and subsequent post-traumatic disorders.

In a case report, Rupreht described a woman who opened and closed her eyes on command during propofol anaesthesia but she had no subsequent recall [1]. Purposeful movements identified by the isolated forearm technique were found in 72 % of patients given midazolam and alfentanil, despite the fact that no subsequent recall was evident [2]. Memory impairment for material learned during steady-state propofol infusion in subhypnotic doses has been described previously [3–6]. In the present study, we investigated amnesia for visual and auditory material presented during a period of wakefulness which was preceded, and also followed, by what seemed to be clinically adequate anaesthesia, thus simulating the sequence of events evident in the 14 published cases of awareness during propofol anaesthesia [7–10].

Patients and methods
The study was approved by the Ethics Committee of the University Hospital, Linköping, Sweden. After obtaining informed consent, we studied 20 female patients, ASA I–II, undergoing intra-vaginal sling operation [11]. Median age was 62 (range 49–85) yr, weight 65 (so 3) kg and height 162 (6) cm.

Preoperative information included the fact that the patients were to be “awakened” during surgery and requested to cough, and also that after anaesthesia they would be questioned about possible memories. No other information on the nature of memory testing was given. Immediately before anaesthesia, the unpremedicated patients were addressed in a standard way and were shown a randomly assigned digit, 0–9 (128 pt Courier font, black on white background). Patients were requested to confirm verbally the digit. Anaesthesia was induced by i.v. infusion of propofol 0.5 mg kg⁻¹ followed by incremental doses of 20 mg every 20 s until loss of response to verbal command and loss of the eyelid reflex. The propofol infusion was continued at 0.17 mg kg⁻¹ h⁻¹ and subsequently adjusted to clinical needs. Prilocaine 2.5 mg ml⁻¹ (100 ml) with adrenaline 2.5 μg ml⁻¹ was infiltrated under the symphysis, and 20 ml of bupivacaine 2.5 mg ml⁻¹ with adrenaline 2.5 μg ml⁻¹ was used for infiltration of the skin over the symphysis. Oxygen 3 litre min⁻¹ was administered via nasal cannulae.

In this type of surgery, suspension of the urethra is examined to prevent leakage during coughing but allow voluntary passing of urine. Thus it is necessary for the patient to cough on command. When the first part of surgery was completed (phase 1), the infusion of propofol was discontinued and the bladder was filled with approximately 300 ml of saline. The patient’s name, followed by a request to open the eyes was repeated until this was obeyed. Thereafter, the patient was encouraged to cough. After sufficient coughing for evaluation of surgery, the patient was presented with a second randomly assigned digit.
0–9 (not the same as that shown before anaesthesia) and asked to confirm verbally the actual digit. Anaesthesia was again induced and surgery was completed (phase 2).

One hour after surgery patients were asked if they remembered anything immediately before anaesthesia. If this answer did not include the digit shown and the standard conversation, specific questions were asked (“did I show you anything?”, “do you remember what I said?”). Thereafter patients were asked if they remembered anything during surgery. If this answer did not include the digit shown, coughing and the standard conversation, specific questions were asked (“did I show you anything?”, “did I ask you to do anything?”, and—in the event of negative answers—“do you remember having been awake during operation?”). Thereafter patients were asked about dreams during surgery. This questioning was repeated the morning after surgery (approximately 24 h). If at this time patients were unable to recall the stimulus presented, they were given the correct answers and asked if they now could remember.

Until the first memory evaluation 1 h after anaesthesia, no caffeine or drugs other than propofol and local anaesthetics were used on the day of surgery, and only mild non-opioid analgesics were required thereafter.

The incidence of memories for stimuli presented before and during anaesthesia was compared using the Wilcoxon signed rank test. Comparison of doses of propofol and duration of the different phases of anaesthesia in patients who recalled something compared with those who did not was performed by the Mann–Whitney U test. 0.05 was considered significant.

### Results

No patient had explicit recall of intraoperative events during propofol infusion. In the period of intraoperative wakefulness, one patient (No 10; table 1) reported having had a bad dream. No other patient reported dreaming.

One hour after surgery, all 20 patients remembered the digit shown before anaesthesia and only one patient could not remember the standard conversation before induction. Seven patients remembered something from the period of wakefulness (table 1). The day after surgery, patient No. 11 had forgotten about the coughing, and the patient who 1 h after anaesthesia could not remember the standard conversation before induction now recalled this. Otherwise, memory testing on the day after surgery was identical to that 1 h after anaesthesia. The reductions in memory for the standard conversation and the digit shown during the period of wakefulness were both significant compared with corresponding types of memory before anaesthesia ($P < 0.0001$). Patients, who during the interview on the day after surgery were unable to remember any of the presented stimuli, were given the correct answers. This did not lead to recall in any patient.

The duration of phase 1, duration of discontinued infusion of anaesthetic (time to induction 2), duration of phase 2, administered doses of propofol and elapsed time from discontinuing the propofol infusion to coughing and verbal confirmation of the digit shown are given in table 2. There were no significant differences between patients with explicit recall and those who could not remember any intraoperative event.

### Discussion

In the present study, patients were allowed to regain consciousness and perform cognitive actions during propofol anaesthesia. However, after anaesthesia, 65% of patients were unable to remember having been "awake" and significantly better memory was found for both verbal and visual stimuli when learning occurred immediately before induction compared with that in the period when the propofol fusion was discontinued temporarily.

The true incidence of explicit recall of events experienced during general anaesthesia is not known. Limited data indicate an incidence of approximately 2 per 1000 if neuromuscular block is used in both total i.v. [10, Nordström, unpublished observations] and other types of general anaesthesia [12]. However, most anaesthetics are associated with at least some anterograde amnesia [13] and the question may arise as to whether patients may suffer from intraoperative wakefulness despite a lack of explicit recall. Indeed, as assessed by the isolated forearm technique, Russell found that midazolam and alfentanil, in addition to neuromuscular block, were associated with purposeful movements on command without any subsequent explicit recall in 72% of patients [2]. In a
case report by Rupreht, a similar situation was found during i.v. anaesthesia based on propofol (opening and closing of the eyes on command without recall) [1]. Amnesia for visual and verbal stimuli presented during propofol infusion has been described previously. In some of these studies, the amnesic effect for visual stimuli was minimal unless patients were sedated profoundly [3, 5, 6], while Veselis and colleagues found a significant amnesic effect for verbal material that was statistically independent of the degree of sedation [4]. In that study, using subhypnotic doses of propofol, partial amnesia for complex visual stimuli was also evident.

However, in previous studies, amnesia has been tested for material presented during maximal drug concentration, where the period of drug infusion has been preceded, and also followed, by no drug administration. This may not be entirely similar to the situation in which most published cases of awareness during propofol anaesthesia have occurred. In these cases, the induction dose was sufficient for rendering the patient unconscious while subsequent administration of anaesthetics some time thereafter was insufficient to meet the patient’s needs because of misjudgement or technical errors. Therefore, we investigated post-anaesthesia recall for visual and auditory stimuli presented to patients capable of cognitive action (coughing and opening eyes on command, verbal confirmation of a digit shown) where the period of wakefulness (in order to mimic awareness during maintenance of “anaesthesia”) was preceded, and also followed, by a level of anaesthesia where no response to verbal commands or eyelid reflexes were evident. The present study is not entirely similar to clinical cases of awareness as our patients were not distressed by the experience of being aware and paralysed. However, if distress is important for promoting learning, it should be noted that the rapid filling of the bladder during wakefulness seemed to be invariably unpleasant.

Thus patients may be awake and capable of cognitive action during propofol anaesthesia despite a lack of explicit recall. The fact that 65 % of patients were unable to remember anything during surgery can be interpreted in different ways. First, it is a common belief that prevention of explicit recall in case of cognition and distress during general anaesthesia reduces significantly the risk of post-traumatic neurosis. Thus the amnesic action should be beneficial for the patient’s mental outcome. On the other hand, it is unacceptable that patients may suffer during neuromuscular block anaesthesia while being incapable of conveying this.

References