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Dreaming during Anesthesia and Anesthetic Depth in Elective Surgery Patients

A Prospective Cohort Study

Kate Leslie, M.B., B.S., M.D., M.Epi., F.A.N.Z.C.A., Hannah Skrzypek,† Michael J. Paech, M.B., B.S., D.R.C.O.G., F.R.C.A., F.A.N.Z.C.A., F.F.P.M.A.N.Z.C.A., D.M.,‡ Irina Kurowski, M.B., B.S., F.A.N.Z.C.A.,§ Tracey Whybrow, M.B., B.S., B.Sc. (Hons.), M.R.C.P.‖*

Background: **Dreaming reported after anesthesia remains a poorly understood phenomenon. Dreaming may be related to light anesthesia and represent near-miss awareness. However, few studies have assessed the relation between dreaming and depth of anesthesia, and their results were inconclusive. Therefore, the authors tested the hypothesis that dreaming during anesthesia is associated with light anesthesia, as evidenced by higher Bispectral Index values during maintenance of anesthesia.**

Methods: **With approval, 300 consenting healthy patients, aged 18–50 yr, presenting for elective surgery requiring relaxant general anesthesia with a broad range of agents were studied. Patients were interviewed on emergence and 2–4 h postoperatively. The Bispectral Index was recorded from induction until the first interview. Dream content and form were also assessed.**

Results: **Dreaming was reported by 22% of patients on emergence. There was no difference between dreamers and nondreamers in median Bispectral Index values during maintenance (37 [23–55] *vs.* 38 [20–59]; $P = 0.68$) or the time at Bispectral Index values greater than 60 (0 [0–7] *vs.* 0 [0–31] min; $P = 0.38$). Dreamers tended to be younger and male, to have high home dream recall, to receive propofol maintenance or regional anesthesia, and to open their eyes sooner after surgery. Most dreams were similar to dreams of sleep and were pleasant, and the content was unrelated to surgery.**

Conclusions: **Dreaming during anesthesia is unrelated to the depth of anesthesia in almost all cases. Similarities with dreams of sleep suggest that anesthetic dreaming occurs during recovery, when patients are sedated or in a physiologic sleep state.**

DREAMING is a common, enduring, and fascinating part of the anesthetic experience, but its cause and timing remain elusive. Patients typically report that they were dreaming during anesthesia, but the actual timing of anesthetic dreaming is unknown. The following evidence supports the hypothesis that dreaming occurs intraoperatively and is related to light or inadequate anesthesia: (1) The incidence of dreaming has decreased as anesthetic techniques have improved[1–4]; (2) dreamers exhibit more clinical signs of light anesthesia[1,5] or report more awareness[4,6] than nondreamers; (3) dreamers may receive lower doses of anesthetic drugs than nondreamers[2,7,8] and emerge more rapidly from anesthesia[9]; (4) the content of dreams may involve surgical topics or events occurring during anesthesia[1,2,9,10]; and (5) in one study, the incidence of dreaming was lower in Bispectral Index (BIS)–monitored patients.[9] Alternatively, dreaming may occur during emergence from anesthesia, when the brain is still affected by sedative concentrations of anesthetic drugs and the patient enters a sleep state.[11]

Few studies have assessed the relation between dreaming and depth of anesthesia, and their results were inconclusive.[8,10,12–15] Most recently, in the B-Aware Trial, no differences in depth of anesthesia, as measured by BIS, were detected between dreamers and nondreamers.[9] However, the patients were at high risk of awareness, and BIS data were collected manually and were only recorded in the BIS group and during maintenance.[4] No studies investigating the relation between dreaming and depth of anesthesia during recovery were identified.

Why is the investigation of dreaming during anesthesia important? Dreaming is one of the most common side effects of anesthesia[6,13,16–19] but remains puzzling and requires explanation. Dreaming is sometimes distressing to patients[2,20,21] and may decrease satisfaction with care.[9] Some patients who report dreaming fear that their anesthetic was inadequate and that their experience was, in fact, awareness. Indeed, in a minority of cases, dreaming may truly represent near-miss awareness.[1,2,9]

We therefore tested the hypothesis that dreaming during anesthesia is associated with light or inadequate anesthesia, as evidenced by higher median BIS values during maintenance of anesthesia. We also explored the depth of anesthesia until emergence, the form and content of dreams, the predictors of dreaming during anesthesia, and the effect of dreaming on quality of recovery and satisfaction with anesthetic care.

Materials and Methods

This prospective cohort study received prospective ethics committees approval (Royal Melbourne Hospital,

* Head of Research, Department of Anaesthesia and Pain Management, Royal Melbourne Hospital. Honorary Associate Professor, Department of Pharmacology, University of Melbourne. † Medical Student, Department of Anaesthesia and Pain Management, Royal Melbourne Hospital. ‡ Professor of Obstetric Anaesthesia, School of Medicine and Pharmacology, The University of Western Australia. Head of Research, Royal Perth Hospital, and King Edward Memorial Hospital for Women. § Clinical Lecturer, Department of Anaesthesia and Pain Medicine, Royal Perth Hospital. ‖ Research Fellow, Department of Anaesthesia, King Edward Hospital for Women.

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Address correspondence to Dr. Leslie: Department of Anaesthesia and Pain Management, Royal Melbourne Hospital, Parkville, Victoria, 3050, Australia. kate.leslie@mh.org.au.

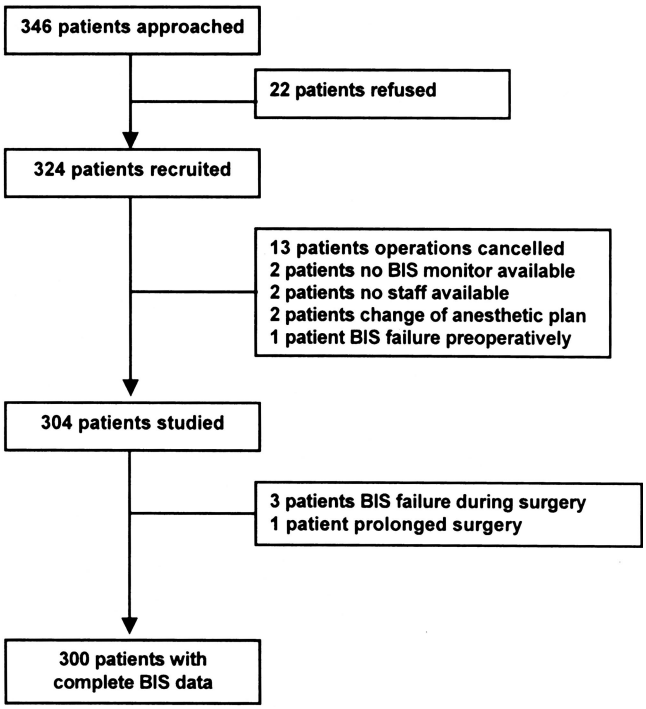

Fig. 1. Recruitment profile. BIS = Bispectral Index.

Parkville, Victoria, Australia; Royal Perth Hospital, Perth, Western Australia, Australia; and Women's and Children's Health Service, Perth, Western Australia, Australia). With written informed consent, 300 patients, aged 18–50 yr and of American Society of Anesthesiologists' physical status I–III, presenting for elective surgery during relaxant general anesthesia, were recruited. Exclusion criteria included (1) inadequate English comprehension due to a language barrier, cognitive deficit, or intellectual disability; (2) diagnosis of a psychotic disorder, major affective disorder, or major drug dependence disorder; (3) inability to monitor BIS because of the site of surgery; and (4) planned postoperative ventilation or anticipation of unavailability for postoperative interviews (fig. 1).

The primary endpoint was the difference in median BIS values during maintenance of anesthesia between patients who reported dreaming and those who did not report dreaming at the first postoperative interview. Secondary endpoints included duration of BIS greater than 60 during maintenance of anesthesia and preoperative and anesthetic factors associated with dreaming.

Procedure

Intravenous access was established and premedication was administered if indicated. Routine monitoring and BIS monitoring (BIS-XP® Version 4.0, A2000 monitor, 15-s smoothing; Aspect Medical Systems Inc., Newton, MA) were commenced. Relaxant general anesthesia was induced and maintained with the drugs of the anesthesiologist's choice (see table 2 for drugs chosen). Combined general and regional anesthesia was permitted. After tracheal intubation, intermittent positive-pressure ventilation was commenced. Anesthesiologists were encouraged to titrate anesthesia with the aim of a rapid recovery (*i.e.*, using clinical signs and a BIS of 40–60 during surgery[22]). At the conclusion of surgery, neuromuscular blockade was reversed, the patient's trachea was extubated, and the patient was transferred to the postanesthesia care unit. BIS monitoring continued until the first postoperative interview was completed.

Patients were interviewed by a blinded observer as soon as they were orientated to time, place, and person and again at 2–4 h postoperatively. At both interviews, patients were asked,[1] "What was the last thing you remember before going to sleep?" "What was the first thing you remember when you woke up?" "Can you recall anything between?" and "Did you have any dreams during your anesthetic?" If dreaming was reported, a narrative report was collected, and the characteristics of the dream were assessed (see Data Collection). If any evidence of awareness was encountered, this was managed according to hospital protocol, and an awareness report was completed for subsequent assessment by three independent and blinded anesthesiologists. Awareness was defined as "unlikely," "possible," or "probable" by each adjudicator. Patients were also interviewed in person or by telephone 24 h after anesthesia about quality of recovery (see Data Collection).

Data Collection

Baseline data included demographic and surgical details, preoperative medications, preoperative quality of recovery scores (a validated nine-item questionnaire on quality of recovery with a minimum score of 0 and a maximum score of 18; collection of a preprocedure baseline score is also validated[23]), hospital anxiety and depression scores (HAD; range: each section 0–21, total 0–42[24]), educational level (1 = all or some of primary school; 2 = all or some of secondary school; 3 = some university education), home dreaming recall frequency (0 = never; 1 = less than once a month; 3 = two or three times a month; 4 = about once a week; 5 = several times a week; 6 = almost every morning[25]) and risk factors for awareness, including a history of awareness, heavy alcohol use, the use of jet ventilation, and anticipated difficult intubation.[4]

Intraoperative data included times of anesthetic induction, first surgical incision, and completion of wound closure; drug doses and concentrations; and clinical signs of inadequate anesthesia. Postoperative data included times to eye opening, eligibility for postanesthesia care unit discharge (Aldrete score ≥ 9[26]) and each postoperative interview (all defined from the time of completion of wound closure), quality of recovery score, satisfaction with anesthetic care (100-mm visual analog scale at 2–4 h postoperatively), and HAD score at 24 h postoperatively.

Dreaming during anesthesia was defined as any experience that was described by the patient as dreaming and was thought by the patient to have occurred between the induction of anesthesia and the first moment of consciousness after anesthesia.[27] Awareness was defined as postoperative recall of intraoperative events. All patients who reported dreaming were considered to be "dreamers" for the purpose of the analyses, whether or not they could remember the narrative of the dream. However, only dreaming reports where the narrative was remembered were classified using five-point Likert scales as follows[28]:

- Emotional content (1 = very negative; 5 = very positive)
- Memorability (1 = can't remember narrative of dream; 5 = most memorable ever)
- Visual vividness (1 = not at all vivid; 5 = most vivid ever)
- Amount of sound (1 = no sound; 5 = most sound ever)
- Emotional intensity (1 = not at all intense; 5 = most intense ever)
- Meaningfulness (1 = not at all meaningful; 5 = most meaningful ever)
- Amount of movement (1 = no movement; 5 = most movement ever)
- Strangeness (1 = not at all strange; 5 = most strange ever)

Bispectral Index and signal quality data were recorded from anesthetic induction until completion of the first postoperative interview. The data downloaded from the BIS® monitor's memory were the averages of all the displayed BIS values (*i.e.*, values with signal quality > 15) over the minute before the time stamp. The phases of anesthesia were then defined in each patient as follows (fig. 2):

- Induction: from induction of anesthesia to the lowest BIS value following the initial rapid decrease in BIS after induction
- Maintenance: from the end of the induction phase to the time of completion of wound closure
- Recovery: from the time of completion of wound closure to the time of the first postoperative interview
- Following phase definition, recordings with signal quality below 50 were excluded. The percentage of total data excluded from the maintenance and recovery phases was calculated for each patient.

Statistical Analyses

A sample size of 300 allowed an adequate sample of dreaming patients at both interviews, based on an incidence of dreaming of 5% at 2–4 h[4] and with anticipation of a higher incidence at the immediate postoperative interview, giving 96% power to detect a difference of 5 BIS units and 85% to detect a difference of 4 BIS units (SD = 5) between dreamers and nondreamers.

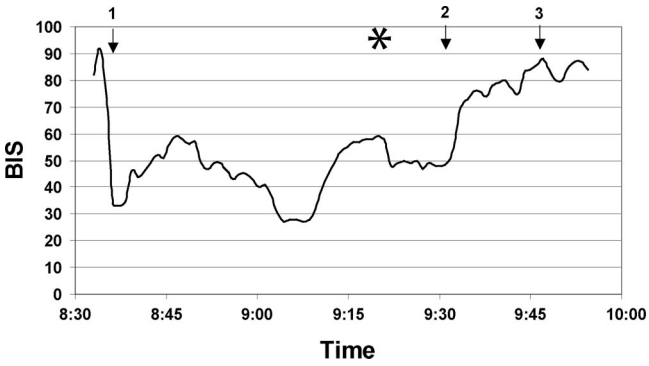

Fig. 2. Bispectral index (BIS) profile of a representative patient. The phases of anesthesia were defined in each patient. Event marker *1* on the graph identifies the end of induction, event marker *2* identifies the completion of wound closure, and event marker *3* identifies the postoperative interview. The gradient of recovery was defined as the change in BIS between wound closure and the postoperative interview. The asterisk (*) indicates the point at which this patient moved and developed tachycardia during anesthesia. At this time, the anesthesiologist administered propofol and told the patient, "Everything is okay."

The data analyses were planned prospectively and were performed using Stata 8.2 (Stata Corporation, College Station, TX). Continuous variables were graphed to determine their distribution. Normally distributed variables were described using mean and SD and compared using the Student *t* test. Skewed variables were described using median and range (or interquartile range) and compared using the Wilcoxon rank sum test. Survival data (time to an event) were described using median and range (or interquartile range) and compared using the log-rank test. Categorical variables were described using number and percentage and compared using the chi-square or Fisher exact test. Clinically significant predictors of dreaming from the univariate analyses with *P* values less than 0.2 were included in multivariate logistic regression models. Clinically significant interactions were tested, and significant interactions were included in a final parsimonious model. $P < 0.05$ was considered statistically significant.

Results

Three hundred patients finished the study with complete BIS data (fig. 1). The signal quality of the BIS data was above 50 for 95% of recordings. The median amount of data removed for signal quality less than 50 from the maintenance phase in each patient was 1.7% (0–62%), and that from the recovery phase was 0.001% (0–100%). The baseline, intraoperative, and postoperative characteristics of these patients are presented in tables 1–3.

Sixty-five (22%) of the 300 patients reported dreaming during anesthesia at the first interview, and 74 (25%) of the 300 patients reported dreaming during anesthesia at the second interview. Fifty-three patients reported dreaming at both interviews, 33 patients reported

Table 1. Baseline Characteristics of Patients Reporting Dreaming at an Immediate Postoperative Interview

	Total (n = 300)	No Dream (n = 235)	Dream (n = 65)	*P* Value
Age, yr	35 ± 9	35 ± 9	31 ± 8	0.003
Weight, kg	76 ± 18	76 ± 18	76 ± 15	0.75
Sex, male	112 (37)	85 (36)	27 (42)	0.43
ASA physical status				
I	145 (48)	99 (42)	46 (71)	< 0.0001
II, III	155 (52)	136 (58)	19 (29)	
Preoperative medications				
SSRIs	18 (6)	17 (7)	1 (2)	0.14
Analgesics	76 (25)	59 (25)	17 (26)	0.88
Other psychotropics	33 (11)	28 (12)	5 (8)	0.50
Type of operation				
Pelvic/abdominal/thoracic	167 (56)	134 (57)	33 (51)	0.69
Head and neck	82 (27)	64 (27)	18 (28)	
Orthopedic	51 (17)	37 (16)	14 (21)	
Education				
Some primary or secondary	170 (57)	138 (59)	32 (49)	0.17
Some tertiary	130 (43)	97 (41)	33 (51)	
Home dream recall frequency				
Never	13 (4)	12 (5)	1 (1)	0.02
Less than once per week	75 (25)	66 (28)	9 (14)	
Several times per week	155 (52)	118 (50)	37 (57)	
Almost every day	57 (19)	39 (17)	18 (28)	
Risk factors for awareness	30 (10)	26 (11)	4 (6)	0.23
QoR score	16 (7–18)	16 (7–18)	16 (9–18)	0.61
HAD score				
Anxiety	7 (0–18)	7 (0–18)	6 (1–16)	0.14
Depression	3 (0–17)	3 (0–17)	2 (0–17)	0.01
Total	10 (1–34)	11 (1–34)	9 (2–28)	0.02

All patients, patients reporting dreaming, and patients not reporting dreaming at the first postoperative interview. Data are expressed as mean ± SD, median (range), or number (%).

ASA = American Society of Anesthesiologists; HAD score = Hospital Anxiety and Depression score (range: each section 0–21, total 0–42); QoR = Quality of Recovery score (range: 0–18); SSRI = selective serotonin reuptake inhibitor.

dreaming at one interview, and 214 patients did not report dreaming at either interview. A dream narrative was provided by 47 patients (16%) at the first interview and 53 patients (18%) at the second interview. Of the 35 patients who reported dream narratives at both interviews, 31 patients reported the same dream at both interviews, and 4 patients reported different dreams at each interview.

Median BIS values (median of medians, 37; range of medians, 20–59; interquartile range of medians, 32–41) during anesthesia were lower than recommended in the protocol. However, BIS values during maintenance of anesthesia in dreamers and nondreamers (37 [23–55] *vs.* 38 [20–59]; $P = 0.68$) and the time at BIS values greater than 60 (0 [0–7] *vs.* 0 [0–31] min; $P = 0.38$) were similar (fig. 3 and table 4). There were no significant differences in BIS values between patients under general anesthesia (n = 280) and those under combined general–regional anesthesia (n = 20), except that the BIS values at eye opening were higher in the combined general–regional anesthesia group (83 [60–98] *vs.* 87 [78–98]; $P = 0.02$).

Most dreams were pleasant, were not strange, and were meaningful to the patient (*i.e.*, the dream involved family, friends, work or recreation) (fig. 4 and table 5). Few dreams were unpleasant (identified by bold type in table 5). Often, patients reported that they were dreaming just before they "woke up" and some said that their dream was interrupted by their anesthesiologist "trying to wake them up." Although only a few dreams concerned hospitals and surgery, many dreams contained people talking or standing around the patient.

Only two dreams resulted in awareness reports. A female patient remembered dreaming about "driving on a road. The road just swallowed her up. The doctor said she was okay but the car was wrecked. She couldn't move—she was trying to tell the driver to stop but he couldn't hear her. . . ." This patient moved and developed tachycardia during abdominal closure, coinciding with less than 1 min of BIS values near 60 (fig. 2). At this time, the anesthesiologist administered propofol and told the patient, "Everything is okay." Although the patient believed that she had been dreaming, an awareness report was completed, and all three adjudicators believed that awareness was "possible." Another female patient thought that she woke up briefly during the surgery and was asked a question. All three adjudicators believed that awareness was "unlikely." A further female patient dreamed about being a fish. For most of the operation, the surgical team had been discussing fishing trips. This episode did not result in an awareness report.

Univariate factors associated with dreaming during anesthesia at the first interview were younger age, lower

Table 2. Intraoperative Data of Patients Reporting Dreaming at an Immediate Postoperative Interview

	Total (n = 300)	No Dream (n = 235)	Dream (n = 65)	*P* Value
Midazolam	209 (70)	165 (70)	44 (68)	0.70
mg	2.0 (1.0–6.0)	2.0 (1.0–6.0)	2.0 (1.0–3.5)	0.71
Propofol induction*	290 (97)	226 (96)	64 (98)	0.36
mg	200 (50–400)	200 (50–400)	200 (100–250)	0.89
Sevoflurane	183 (61)	146 (62)	37 (57)	0.47
ET%	2.0 (0.7–4.1)	2.0 (0.7–4.1)	2.0 (0.9–3.0)	0.40
Desflurane	93 (31)	74 (31)	19 (29)	0.76
ET%	5.2 (2.8–10)	5.2 (2.8–10)	5.2 (4.0–6.7)	0.77
Nitrous oxide	23 (8)	20 (9)	3 (5)	0.43
ET%	58 (38–70)	56 (38–70)	66 (60–66)	0.15
Propofol TCI	33 (11)	21 (9)	12 (18)	0.03
μg/ml	4.0 (0.4–6.5)	4.0 (0.4–6.5)	3.9 (2.0–5.5)	0.28
Fentanyl	274 (91)	215 (91)	59 (91)	0.85
μg	100 (20–750)	100 (20–750)	100 (25–700)	0.37
Remifentanil	36 (12)	25 (11)	11 (17)	0.17
mg	2.0 (0.3–9.0)	2.0 (0.4–9.0)	2.0 (0.3–3.4)	0.31
Morphine	68 (56)	32 (56)	36 (55)	0.91
mg	10 (2–25)	10 (2–25)	10 (3–20)	0.94
Regional anesthesia	20 (7)	11 (5)	9 (14)	0.01
Signs of awareness	35 (12)	29 (12)	6 (9)	0.49
Movement	13 (4)	12 (5)	1 (1)	0.46
Autonomic signs	22 (7)	17 (7)	5 (8)	
Duration of anesthesia (min)	96 (8–593)	95 (8–593)	99 (28–230)	0.71

All patients, patients reporting dreaming, and patients not reporting dreaming at the first postoperative interview. Data are expressed as mean ± SD, median (range), or number (%).

* Seven patients induced with sevoflurane inhalation and three with thiopentone bolus.

ET = end-tidal. TCI = target-controlled infusion.

American Society of Anesthesiologists physical status, higher home dream recall frequency, and lower HAD scores (table 1). The differences in HAD scores were not considered to be clinically significant. Dreamers were more likely to have received propofol maintenance and regional anesthesia but were no more likely to have displayed intraoperative signs of inadequate anesthesia than nondreamers (table 2). Dreamers opened their eyes sooner than nondreamers, but there were no differences in the time to the first interview or the time to postanesthesia care unit discharge. There were no clinically significant differences between dreamers and nondreamers in satisfaction with anesthetic care, postoperative quality of recovery or HAD scores, or changes in quality of recovery or HAD scores (table 3).

In a multivariate model, factors associated with dreaming were younger age, male sex, lower American Society of Anesthesiologists physical status, dreaming at home

Table 3. Postoperative Data of Patients Reporting Dreaming at an Immediate Postoperative Interview

	Total (n = 300)	No Dream (n = 235)	Dream (n = 65)	*P* Value
Time to eye opening, min	14 (2–143)	14 (2–143)	12 (2–41)	0.04
Time to first interview, min	22 (4–156)	22 (6–156)	21 (4–96)	0.31
Time to Aldrete score ≥ 9, min	75 (24–310)	76 (24–242)	75 (40–310)	0.42
Time to second interview, h	2.7 (1.6–21)	2.7 (1.7–21)	2.8 (1.9–7.6)	0.90
Satisfaction, mm*	100 (0–100)	100 (0–100)	100 (34–100)	0.93
Postoperative QoR*	12 (4–18)	13 (4–18)	12 (6–18)	0.13
Change in QoR*	−2 (−11 to 5)	−2 (−11 to 5)	−3 (−11 to 4)	0.12
Postoperative HAD†				
Anxiety	5 (0–19)	5 (0–19)	6 (0–16)	0.43
Depression	5 (0–17)	5 (0–17)	4 (0–15)	0.11
Total	10 (0–35)	10 (0–35)	10 (1–23)	0.80
Change in HAD†				
Anxiety	−1 (−14 to 15)	−1 (−14 to 15)	0 (−9 to 6)	0.01
Depression	1 (−11 to 15)	1 (−11 to 15)	1 (−6 to 12)	0.99
Total	0 (−23 to 29)	−1 (−23 to 29)	1 (−15 to 12)	0.04

All patients, patients reporting dreaming, and patients not reporting dreaming at the first postoperative interview. Data are expressed as median (range). One female patient did not open her eyes on command for 143 min after anesthesia, was very drowsy at the first interview at 156 min, and did not complete the second interview until 21 h after surgery.

* n = 297. † n = 290.

HAD score = Hospital Anxiety and Depression score (range: each section 0–21, total 0–42); QoR = Quality of Recovery score (range: 0–18).

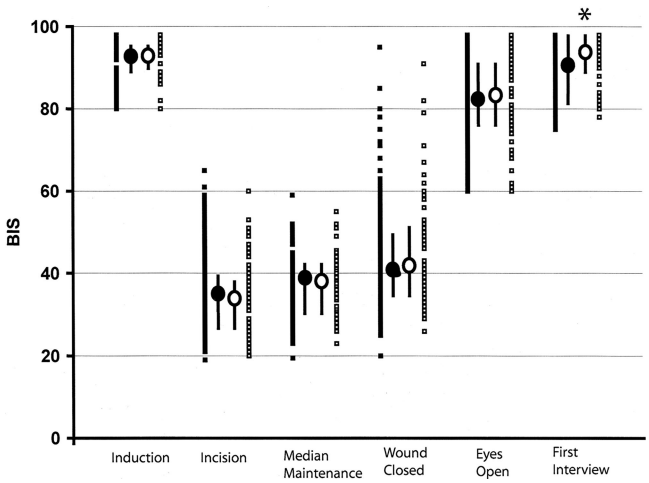

Fig. 3. Bispectral Index (BIS) values at time endpoints during anesthesia. *Closed squares* = individual nondreamer values; *open squares* = individual dreamer values; *closed circles* = median nondreamers values; *open circles* = median dreamer values; *bars* = interquartile ranges. * $P = 0.03$ between nondreamers and dreamers. All other comparisons not statistically significant.

almost every day, receiving propofol maintenance or regional anesthesia, and having a shorter time to eye opening after anesthesia (table 6). Interactions between variables were assessed, and a significant interaction between sex and time to eye opening was found: 20% of women reported dreaming regardless of the time at which they opened their eyes after anesthesia. In contrast, 36% of men who opened their eyes less than 14 min after surgery reported dreaming, whereas only 12% of men who opened their eyes more than 14 min after surgery reported dreaming.

Discussion

Our study is the first large-scale and detailed investigation of the relation between depth of anesthesia and dreaming, using a widely validated monitor of anesthetic depth.[22] Dreaming during anesthesia was not usually related to BIS values indicating light anesthesia, nor was it associated with clinical signs of light anesthesia.[9] In fact, dreaming occurred despite relatively deep anesthesia, and there were few arousals to BIS levels usually associated with awareness during anesthesia.[4]

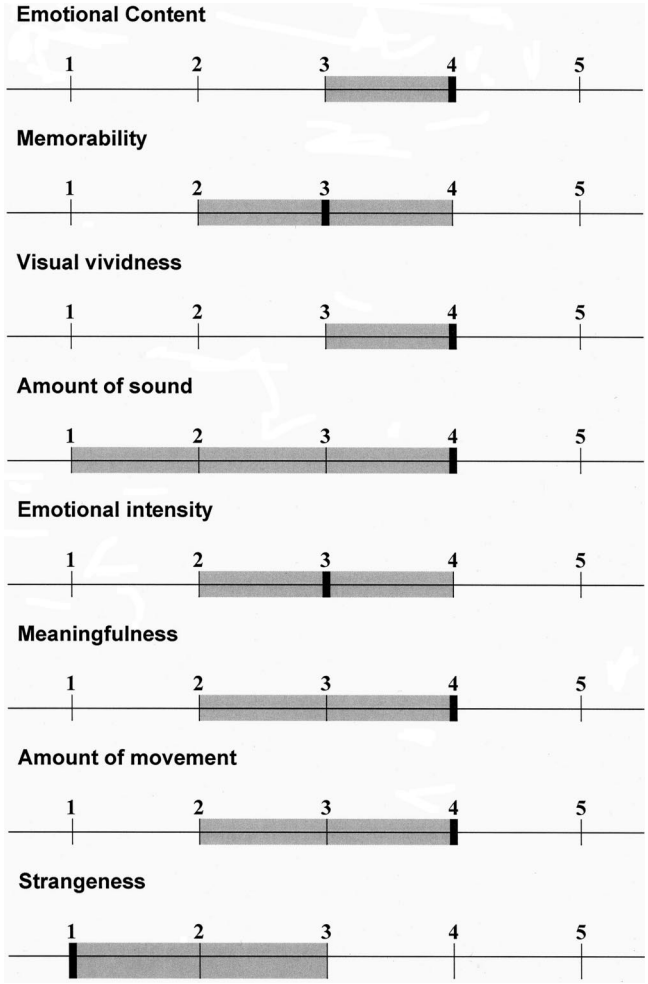

Fig. 4. Visual analog scale values for narratives of dream reports at an immediate postoperative interview (45 of the 65 dreams reported). *Shaded areas* represent interquartile ranges of the visual analog scale values, and the *bold line* represents the median of the visual analog scale values. Emotional content (1 = very negative; 5 = very positive), memorability (1 = only remember dreaming; 5 = most memorable ever), visual vividness (1 = not at all vivid; 5 = most vivid ever), amount of sound (1 = no sound; 5 = most sound ever), emotional intensity (1 = not at all intense; 5 = most intense ever), meaningfulness (1 = not at all meaningful; 5 = most meaningful ever), amount of movement (1 = no movement; 5 = most movement ever), strangeness (1 = not at all strange; 5 = most strange ever).

Incidence and Characteristics of Dreaming

The incidence of dreaming among patients interviewed immediately upon emergence from anesthesia was 22%. This is consistent with previous studies in

Table 4. BIS Values during Maintenance and Recovery

	All Patients (n = 300)	No Dream (n = 235)	Dream (n = 65)	*P* Value
% Maintenance > BIS = 60	0 (0–31)	0 (0–31)	0 (0–7)	0.38
% Maintenance BIS = 40–60	33 (0–100)	33 (0–100)	33 (0–96)	0.32
% Maintenance BIS < 40	66 (0–100)	66 (0–100)	65 (2–100)	0.90
↑ BIS per min during recovery	2.1 (0–7.3)	2.1 (0–7.3)	2.3 (0.7–5.7)	0.45

Bispectral index (BIS) data for all patients, and patients reporting or not reporting dreaming at the first postoperative interview. Data are presented as median (range). BIS gradient between wound closure and first interview. Dreams reported at immediate postoperative interview.

Table 5. Dream Reports Recorded at Immediate Postoperative Interview

Age, yr	Sex	Operation	Reported Experience
28	F	Hip osteotomy	Caving in an old mine. Was pretty cool. Was scary when the lights went out. On the edge of the cave. Lots of colors too. Smell of violets.
33	M	ORIF calcaneal fracture	Camping on beach, went for a walk, saw a dam on the river high above the river. Was checking out the dams because the river was dammed up. It was still beautiful and he was with nice people.
19	F	Laparoscopic cholecystectomy	Was playing with daughter and her dad was there.
28	M	C6–C7 laminectomy and E/O tumor	Catching a few fish on a river in the city. Took some friends out into the bay, the water was really rough, was happy he caught a few fish. One was a snapper.
49	M	Thoracic outlet exploration	He dreamt about his mother and his father.
20	M	Parathyroidectomy	Dreamt about Spiderman, he thinks.
28	F	Laparoscopic cholecystectomy	Lots of people talking—a social event. Can't remember the location but was listening. Can't remember what was said, just lots of people standing around talking.
46	F	Parathyroidectomy	Remembers dreaming about a holiday and thinking of her sister and talking to her.
38	M	Septoplasty	**Remembers something sad happening with his relationship with his partner; quite sad; he dreamt about consciously trying to remember his dreams.**
46	F	Lumbar laminectomy	Dreamt about having a barbecue with lots of sausages. But she hates sausages. But she was really hungry.
18*	M	ORIF right ankle fracture	Went on a school trip to the beach. It was lots of fun.
33	M	Endoscopic repair CSF leak	Was at work driving his truck. Can't remember any more.
40	M	L2–L4 laminectomy and E/O tumour	A scrambled jumbled dream of people that he couldn't recognize.
32	F	Laparoscopic cholecystectomy	Dreamt that her boyfriend was by her side talking to her.
45	F	Right hepatectomy	Dreamt that her family was surrounding her and supporting her.
33	F	SAME	Dreamt about a fish in a tank and seaweed surrounding her. Splashing around and the color blue.
34	M	L4 laminectomy	Was dreaming about teaching karate classes.
21	F	Right thyroid lobectomy	Dreamt about being at her old workplace.
21	F	Left breast reduction	Dreamt that she was at work serving meals. People were chatting around her, she was taking orders.
33	F	L3–L4 microdiscectomy	Remembers dreaming about going out somewhere with others. There were a few people. But for some reason something happened and they couldn't go.
32	M	Donor nephrectomy	Was dreaming about playing cricket with some people that he did not know.
32	M	Completion proctectomy	Was playing with his firstborn son with a ball.
34	M	Anterior cervical fusion	Remembers dreaming about a day's activities—vague—it was him and his fiancée.
28*	M	Left popliteal artery decompression	Remembers dreaming. Was talking to the staff. That's it, can't remember much more. Remembers turning over in the dream.
27*	F	Right thyroid lobectomy	**Dreamt about teaching. She was teaching a junior class and she was in pain and wanted her mother.**
22	F	Laparotomy and removal of adhesions	**Remembers dreaming about driving on a road. The road just swallowed her up. That's it. The doctor said she was okay but the car was wrecked. She couldn't move—she was trying to tell the driver to stop but he couldn't hear her.**
29	F	Laparoscopic appendectomy	Dreamt about work.
23	F	Tonsillectomy	Remembers being outside in a garden by herself. Remembers a swing and her sister being there. She hasn't seen her sister in 9 yr.
33	M	Reversal of ileostomy	Was at work fixing gearboxes. There was one to go. "But I was in hospital, I knew that. A friend was there (an operating room orderly). I don't want to go back to work."
23	M	ORIF # femur	**He shot some men. His sister was shot.**
30	F	Laparoscopic cholecystectomy	"Was in my house with my baby."
49	M	Modified radical parotidectomy	Was dreaming that he was in V8 super cars.
30	F	Thyroid isthmectomy	"I was dreaming about piercing my girlfriend"—she kept on repeating this.
24	M	Right vitrectomy and repair retinal detachment	Fishing with his friends—was standing on the shoal. "A nice dream."
38	F	Repair of rectocele	At work at a client's house. Trying to organize something.
26	M	Appendicectomy	Had a dream about a friend. Something good was about to happen but got woken up. Remembers talking.
26	M	Tonsillectomy	Dreamt of his girlfriend. He had lost her and was trying to find her. He was in his house at the time. Visually, things were not vivid, but sounds were remembered well. He didn't feel he moved much in the dream. He was quite upset that he couldn't find her.
31	F	Appendicectomy	Dreaming about her puppy. Was cuddling it and walking it. Also dreamt of her mother. Was a nice dream.
42*	F	Laparoscopic excision of endometriosis	Thinks she dreamt about talking to her husband. They were in a cave just talking. They were talking about how they weren't taking any photographs. They were in a magazine—a very bad magazine—and she was talking in a foreign language so "they" couldn't understand her.
40	F	Laparoscopy and hysterectomy	Dreaming of a game of cricket. Was playing with her three children and four grandchildren. She was bowling. She didn't know the oval. It was a beautiful day, a pleasant dream.
36	F	Laparoscopic sterilization	**"A tiger was chasing me. I was in a glass room and felt scared. Every glass door I went through, the tiger was there. It kept roaring and chasing me, I was running."**
42	F	Laparoscopic ovarian cystectomy	Dreamt she was at home with children making sherbet. She was doing house duties, nothing out of the ordinary.
32	F	Total laparoscopic hysterectomy	Dreamt she was doing a bridal waltz with husband—she had been listening to the waltz music on the way to the hospital yesterday.
22	F	Laparoscopic ovarian cystectomy	Remembers dreaming. Not exactly sure about what. She remembers walking and talking. She can't remember what the talking was about.
19	F	Laparoscopic excision endometriosis	Thinks she remembers dreaming about talking to her friend.
40	F	Laparoscopy and hysterectomy	Dreamt about gardening. Pulling out weeds, doing a bit of weeding. "It was a pleasant dream." Remembers taking the turkey out of the fridge and cooking it, then wrapping it in foil and putting it back in the fridge.
27	F	D&C + hysteroscopy and laparoscopy	Thinks she dreamt of a wedding (she was about to be married). She was the bride getting married in a church. Couldn't remember much more than that.

Some names and place names have been omitted to preserve anonymity. Unpleasant dreams are identified by bold type.

* Indicates patients who reported a different dream at the second postoperative interview.

CSF = cerebrospinal fluid; D&C = dilatation and curettage; E/O = excision of; ORIF = open reduction internal fixation; SAME = surgically assisted maxillary expansion.

Table 6. Predictors of Dreaming Report at Immediate Postoperative Interview

Characteristic	n (%)	Univariate OR (95% CI)	*P* Value	Adjusted OR* (95% CI)	*P* Value
Age					
< 35 yr	46 (30)	1.00		1.00	
> 35 yr	19 (13)	0.35 (0.19–0.62)	< 0.0001	0.43 (0.22–0.84)	0.01
Sex					
Male	27 (24)	1.00		1.00	
Female	38 (20)	0.79 (0.45–1.39)	0.43	0.30 (0.13–0.70)	0.005
ASA physical status					
I	46 (32)	1.00		1.00	
II, III	19 (12)	0.30 (0.17–0.40)	< 0.0001	0.29 (0.15–0.57)	< 0.0001
Home dream recall					
Less than once per week	10 (11)	1.00		1.00	
Several times per week	37 (24)	2.45 (1.15–5.20)	0.02	1.94 (0.84–4.47)	0.13
Almost every day	18 (32)	3.60 (1.52–8.54)	0.004	3.04 (1.13–8.15)	0.03
Propofol TCI					
No	53 (20)	1.00		1.00	
Yes	12 (36)	2.31 (1.07–4.99)	0.03	3.42 (1.40–8.37)	0.007
Regional anesthesia					
No	56 (20)	1.00		1.00	
Yes	9 (45)	3.27 (1.29–8.28)	0.01	3.43 (1.11–10.66)	0.03
Time to eye opening					
< 14 min	41 (26)	1.00		1.00	
> 14 min	24 (17)	0.59 (0.34–1.04)	0.07	0.17 (0.06–0.52)	0.002
Sex × time to eye opening interaction		4.09 (1.23–13.59)	0.02	5.57 (1.42–21.78)	0.01

Predictors of reports of dreaming during anesthesia at the first postoperative interview (n = 65). Sex × time to eye opening represents an interaction between these variables.

* Adjusted for age, sex, and American Society of Anesthesiologists (ASA) physical status, and clinically significant predictors with univariate odds ratio (OR) less than 0.2.

CI = confidence interval; TCI = target-controlled infusion.

which patients were interviewed immediately after emergence.[13,16–19] We attribute the high incidence of dreaming at our 2–4 h interview[3,9] to reinforcement of memories of dreaming produced by the first interview, because dreams are usually hard to remember unless actively recalled.[25,29] Dreams reported by patients at the second interview, and not the first, may have occurred between the two interviews and not during anesthesia at all, although residual anesthetic effects at the first interview may have impaired memory retrieval in some cases. We believe that, to most accurately assess the incidence of dreaming during anesthesia, patients should be interviewed immediately after they emerge from anesthesia.

Despite the high incidence of dreaming, patients do not often spontaneously disclose that they have been dreaming when they emerge from anesthesia.[30] This may be because patients equate anesthesia with sleep and therefore do not find dreaming remarkable; or because they quickly forget their dreams, are embarrassed by their content, or are preoccupied with the outcome of the surgery, pain, or vomiting.

The form of anesthetic dreams has not been assessed in detail before. Most dreams in our study were similar in form to the dreams of rapid eye movement sleep, except that they were shorter and less strange.[28,29] In this respect, they more closely resembled the dreams of sleep onset and slow-wave or non–rapid eye movement sleep.[29] Most dreams were pleasant,[14,15,17,31] unpleasant dreams were unusual, and dreams that included surgical themes or events occurring during anesthesia were rare. Some patients could not remember the narratives of their dreams, which is consistent with previous studies[13,16] and the dreams of sleep.[29]

Types of Dreaming

Our findings suggest that there are two types of dreams associated with anesthesia. The first are rare "near-miss awareness" dreams, and the second, which are much more common, are "recovery" dreams that occur during emergence from anesthesia. Both can be identified in this study.

The first type of dream is well illustrated by the patient whose dream included the anesthesiologist's voice and a sensation of paralysis. Just as dreams of sleep can incorporate contemporaneous sensory input (such as an alarm clock), near-miss awareness dreams may also incorporate auditory and sensory stimuli, as both the primary and secondary auditory cortex remain responsive to auditory stimuli during anesthesia.[32] This type of dream may have decreased in incidence with improvements in anesthetic care (in a similar way to awareness).[1,2,33] Although rare, this type of dream probably still has a higher incidence than awareness[3] and may be prevented by clinical vigilance and depth-of-anesthesia monitoring.[9] However, in this study, BIS monitoring did not prevent the occurrence of near-miss awareness dreams.

The second type of dream may occur when patients

are recovering from drug-induced hypnosis and may have entered physiologic sleep.[11] Evidence supporting "sleep" dreams during recovery from our study includes the following: (1) Patients who dreamt during anesthesia were similar with respect to age and health to patients who recall dreaming a lot during sleep. (2) Dreamers often reported that they were dreaming just before they "woke up." (3) Dreams were short, simple, and not very strange, resembling dreams of sleep onset.[29] They were not hallucinations occurring during consciousness, like some drug-induced states.[34] (4) Dreaming during maintenance seems unlikely as deep levels of anesthesia were present without differential clinical signs of inadequate anesthesia in dreamers and nondreamers.

Predictors of Dreaming

Patients who reported dreaming were younger and healthier and dreamed more often at home than patients who did not report dreaming. Our result is supported by sleep studies reporting that older, sicker patients experience difficulty falling asleep and recall fewer dreams,[35,36] and by previous studies of dreaming during anesthesia.[3,9,31] However, home dream recall frequency has not been reported to influence dreaming during anesthesia in previous studies.[13,16,18,19] If our hypothesis about recovery dreams being dreams of sleep is correct, patients who remember dreams at home should also remember their dreams after anesthesia.

Women often report more dreams after anesthesia than men.[9,20,31] A possible explanation is the propensity to higher dream recall after sleep in women[25] and the fact that women emerge from anesthesia faster than men[37,38] and hence are able to communicate their dreams sooner, before they are forgotten. However, in our study, men who emerged more quickly from anesthesia than women were more likely to report dreaming, whereas the opposite was true for men who emerged more slowly. This result is difficult to explain.

Propofol maintenance was a predictor of dreaming even after multivariate adjustment. Propofol maintenance was associated with higher incidences of dreaming in previous studies when compared with enflurane,[18,19] isoflurane,[13,16] or isoflurane, sevoflurane, or desflurane.[9] A possible explanation for such findings is that patients receiving propofol maintenance emerged more rapidly from anesthesia than patients receiving isoflurane or enflurane.[19] However, our current and previous studies have supported an increased incidence of dreaming in the propofol group even when compared with desflurane.[9] Differences in the pharmacologic actions of propofol and the volatile agents in this respect require further study. Regional anesthesia was associated with increased odds of dreaming in this study, but this result should be interpreted with caution because the numbers were small. This result awaits confirmation by a larger study.

In our study, patients who opened their eyes on command sooner were more likely to report dreaming. However, whereas times between completion of wound closure and eye opening were shorter in dreamers, times between completion of wound closure and the first interview were similar (and therefore our calculated BIS gradients were similar). In addition, dreamers had higher BIS values at the first interview. Dreaming patients therefore spent a longer time in a lightly unconscious or perhaps sleep state[11] between opening their eyes and being interviewed, during which time they might have dreamed. The exact physiologic state of these patients is speculative because their raw electroencephalograms have not been inspected for drug-induced or physiologic sleep features and BIS monitoring cannot accurately differentiate between sleep and anesthesia.[39]

Potential Weaknesses of This Study

Dreaming is a subjective experience, both for the dreamer and for the dream interpreter. It was difficult for the interpreter to determine whether dreaming truly represented near-miss awareness, especially if the patient believed that he or she was dreaming. Similarly, it was difficult for the interpreter to determine when dreaming occurred, even if the patient was sure that dreaming occurred during or after anesthesia. In addition, we may have modified the incidence, content, or form of dreams by informing patients about dreaming during the consent process.

We chose to use BIS as measure of anesthetic depth in this study because (1) BIS monitoring is widely available in our centers, (2) BIS monitoring is validated as a reasonable measure of the depth of hypnosis,[22] and (3) we used BIS monitoring in our previous study on dreaming and wanted to explore the issue further.[9] However, BIS monitoring may not have captured changes in the electroencephalogram that may be associated with dreaming, in particular sleep-like features during recovery. As mentioned above, collection of raw electroencephalographic data would be necessary for this purpose.

Although a BIS range of 40–60 was recommended, the median BIS during maintenance was 37 (interquartile range, 32–41). This deep level of anesthesia provided us with a narrow range of anesthetic depths with which to make predictions and may have minimized the number of near-miss awareness reports. We were also not able to identify whether higher median BIS values predicted a faster recovery, as reported previously.[38] Finally, because of the numerous multivariate analyses, an inflated type I error cannot be excluded. However, only significant univariate predictors of clinical significance were highlighted or included in multivariate models.

In conclusion, dreaming during anesthesia is a common side effect of anesthesia that is harmless, pleasant, and unrelated to the depth of anesthesia in the majority of cases. The similarities between most anesthetic

dreams and the dreams of sleep onset suggest that anesthetic dreaming occurs during recovery when patients are in a lightly sedated or physiologic sleep state. Our results are therefore reassuring to patients and their carers, who occasionally may equate dreaming with inadequate anesthesia.

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