BJA Open

BJA Open, 7 (C): 100147 (2023)

doi: 10.1016/j.bjao.2023.100147
Original Research Article

ORIGINAL RESEARCH ARTICLE

A prospective observational study of recall of discomfort on tracheal extubation after general anaesthesia

Hiroshi Shinoura*, Yuuri Ooshima and Hiroshi Sato

Department of Anesthesia, Tokyo Metropolitan Cancer and Infectious Diseases Center, Komagome Hospital, Tokyo, Japan

*Corresponding author. E-mail: hiroshi_shinoura@tmhp.jp

Abstract

Background: Tracheal extubation is a critical stage in the management of general anaesthesia during which serious complications may occur. Immediately before extubation, patients often exhibit signs that suggest that they are awake and experiencing discomfort. There is concern that patients may retain such memories of the extubation process. However, previous studies have not examined patient recall of extubation in detail. We therefore investigated the frequency of recall of discomfort during extubation, as well as first orientation to place, and other recollections upon emerging from general anaesthesia.

Methods: In a prospective observational study, 818 patients were interviewed during routine post-anaesthesia rounds on the day after general anaesthesia. The primary outcome was the proportion of patients recalling discomfort during extubation. The secondary outcome was the location of orientation to place upon emerging from general anaesthesia.

Results: Recall of discomfort during extubation was uncommon, at 1.1% (n=9; 95% confidence interval [CI]: 0.5–2.1%). Only 3.1% of patients recalled the extubation process at all (n=25; 95% CI: 2.0–4.5%). The first orientation to place was most commonly in transit to a ward, in 41% of cases (n=337; 95% CI: 38–45%).

Conclusions: Recall of discomfort during extubation appears to be rare, and the great majority of patients may not retain any memory of the extubation process. This information may be used to reassure patients and guide extubation practices for anaesthetists.

Clinical trial registration: UMIN Clinical Trials Registry (UMIN000046136).

Keywords: discomfort during extubation; emergence from anaesthesia; general anaesthesia; memory of extubation; preoperative examination; recall of extubation; tracheal extubation

Tracheal intubation and extubation are important stages in the management of general anaesthesia and carry the risk of serious complications.[1] Many previous studies have examined difficult intubation, and various guidelines provide recommendations for performing the procedure safely.[2,3] However, only one guideline specifically deals with the difficulties encountered in extubation.[4] Therefore, in our hospital, tracheal extubation is usually performed on the basis of the anaesthetist's experience and clinical judgement.

In our experience, at the time of extubation, patients are able to shake hands with the physician, open their mouth, and take deep breaths with prompting. They also often buck or move about violently as though in pain, raising concerns that they are experiencing discomfort during extubation. If we rigorously evaluate eye opening, purposeful movement, and adequate spontaneous ventilation, patients sometimes buck and move about even more violently. Anaesthetists may thus feel compelled to extubate immediately to relieve a patient's discomfort, even if the patient has not been adequately evaluated and optimised for extubation.

However, even if a patient appears to be in discomfort, it is difficult to know how they actually feel. If patients are extubated too quickly out of concern for patient discomfort without adequate evaluation, there is a risk of apnoea,

Received: 11 January 2023; **Accepted:** 24 May 2023

aspiration, and laryngospasm after extubation. These can put the patient at serious risk. Therefore, some degree of discomfort during extubation is considered acceptable from the perspective of patient safety.

Only three studies that reported the frequency of recall of extubation as an endpoint were identified,[5–7] and we are not aware of any studies that have examined the frequency of recall of discomfort during extubation. Consequently, it is unclear whether such events are serious enough to merit concern.

Therefore, we investigated the frequency of recall of discomfort on extubation and patients' first recollections on emerging from general anaesthesia. A low frequency of recall would suggest that extubation need not be rushed and may be performed on the basis of clinical judgement, despite apparent patient discomfort. Using this information, when obtaining preoperative informed consent, one could also provide the patient with more accurate information regarding extubation.

Methods

The present study was conducted from 1 December 2021 to 31 March 2022 at Tokyo Metropolitan Cancer and Infectious Diseases Center, Komagome Hospital, an 800-bed, secondary care hospital, and was registered with the University Hospital Medical Information Network Clinical Trials Registry (30 November 2021; UMIN000046136). The requirement for written informed consent was waived by the Institutional Review Board because this was a prospective observational study (4 November 2021; No. 2795). An option for opt out was nonetheless provided.

Patients eligible for inclusion were aged 20 yr or older, underwent general anaesthesia with tracheal intubation, and were extubated in the operating theatre. Excluded were emergency surgery cases and patients with ASA physical status 3 and above, difficulty communicating, or no opportunity to be questioned the day after general anaesthesia (e.g. because of discharge). Other factors that might influence extubation, such as difficult intubation, were not considered exclusion criteria, as their influence was not clear-cut.

Anaesthetic induction, maintenance, and emergence and as well as tracheal extubation were performed at the discretion of the anaesthetist in charge. No preoperative sedatives were administered. At induction of anaesthesia, patients were given analgesia (fentanyl, remifentanil or both), an anaesthetic (propofol, thiopental, or midazolam), and a neuromuscular blocking agent (rocuronium). Maintenance of anaesthesia was with inhalational (sevoflurane or desflurane) or i.v. anaesthesia (propofol). Epidural anaesthesia may have been performed in addition to general anaesthesia for abdominal or thoracic surgery.

After extubation, the patients were transferred from the operating table to a bed if there were no problems with respect to their pulse, BP, oxygen saturation, respiratory rate, consciousness, or pain. The patients were then moved to the PACU or ICU. In the PACU, the patients were evaluated again in the same manner and moved to a ward (including the high care unit) if they were stable. As a rule, the anaesthetist in charge evaluated and treated the patients until they left the PACU.

During the post-anaesthesia rounds on postoperative Day 1, the patients were asked if they had any memories regarding extubation and what their first recollection on emerging from general anaesthesia was. All questions were asked by three authors using a standardised questionnaire (Table 1). Answers were given spontaneously without prompting, and if not clear, the answer was recorded as unclear. The outcome assessors were three authors who were not blinded.

The primary outcome was the proportion of patients who recalled discomfort on extubation. The secondary outcome was their recollection of orientation to place: where they first remembered being upon emerging from general anaesthesia. The patients were expected to have difficulty remembering their exact location because, for most of them, their first and only experience of being in the operating theatre was on the day of surgery. In response to our questions in a preliminary survey and in our previous study (not published), many patients distinctly remembered being on the operating table and in the ward. However, some of them were unable to give exact answers as to where they were if their recollection of first orientation to place was between the operating table and the ward. Therefore, the location was categorised as being on the operating table, in a ward, or in transit between them. The time of patient arrival in a ward was defined as the point at which vital signs were first recorded after the patient's arrival.

Sample size was determined using data obtained in the preliminary survey and our previous study (not published). In the preliminary survey, approximately 1% of patients recalled discomfort on extubation, and in our previous study, 0.7% of patients recalled extubation. Therefore, assuming that 1% of patients recall discomfort on extubation, 700 patients were needed to maintain the 95% confidence interval (CI) within 1%. To allow for data loss, the sample size was increased by 20%—840 patients.

Statistical analysis

Descriptive statistics were used to analyse the data. Recall of discomfort during extubation, first orientation to place, and memories after emergence from general anaesthesia are expressed as frequencies and 95% CIs. For patient characteristics and anaesthetic dosage, continuous variables are expressed as medians and inter-quartile range. All statistical analyses were performed using Easy R software (Jichi Medical University, Saitama, Japan).[8]

Results

Of the 911 eligible patients, 818 were included in the analysis (Fig 1). Table 2 shows the patients' characteristics. An inhalational anaesthetic was used to maintain anaesthesia in 93% (n=763) of patients. Midazolam, which is known for its ability to induce amnesia, was used at induction of anaesthesia in only 0.5% (n=4) of patients.

The frequency of recall of discomfort on extubation was 1.1% (n=9; 95% CI: 0.5—2.1%). The frequency of recall of

Table 1 Standardised questionnaire.

Question no.	Questions
1	Where do you first remember awakening from anaesthesia?
2	What was your first memory after awakening from anaesthesia?
3	Do you remember the breathing tube being pulled out after the surgery?
4	Did you experience discomfort when the tube was pulled out?

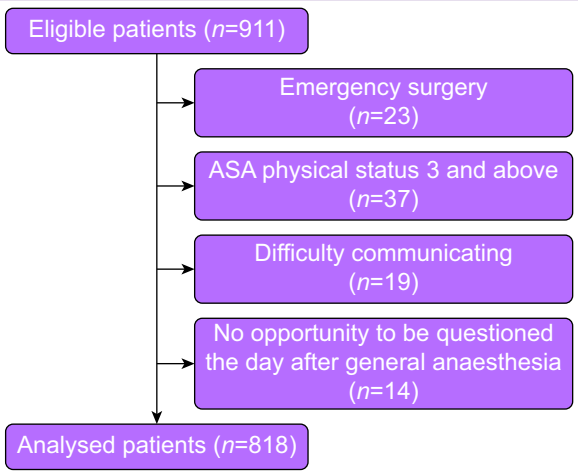

Fig. 1. Flow of patient selection. Excluded were emergency surgery cases, patients with ASA physical status 3 and above, difficulty communicating, or did not have the opportunity to be questioned on the day after general anaesthesia (e.g. discharged).

Table 2 Patients' characteristics. All data are expressed as a number (%). Age, BMI, and anaesthesia time are expressed as the median (IQR). HCU, high care unit; IQR, inter-quartile range.

	Analysed patients (*n*=818)
Sex, *n* (%)	
Male	307 (38)
Female	511 (62)
Age (yr), median (IQR)	64 (51–73)
BMI, median (IQR)	22 (20–25)
ASA physical status, *n* (%)	
1	203 (25)
2	615 (75)
Department, *n* (%)	
Breast surgery	152 (19)
Colorectal surgery	104 (13)
Respiratory surgery	101 (12)
Gynaecology	78 (10)
Orthopaedic	67 (8)
Other departments	315 (39)
Anaesthesia time (min), median (IQR)	192 (136–304)
Epidural anaesthesia, *n* (%)	
Yes	381 (47)
Intubation method, *n* (%)	
Oral intubation	799 (98)
Nasal intubation	19 (2)
Anaesthesia method, *n* (%)	
Inhalation anaesthesia	763 (93)
TIVA	55 (7)
Use of midazolam, *n* (%)	
Yes	4 (0.5)
Use of neuromuscular blocking agent reversal drug, *n* (%)	
Yes	666 (81)
Postoperative ward, *n* (%)	
General ward	391 (48)
HCU	292 (36)
ICU	135 (17)

Table 3 Frequency of recall of extubation and discomfort during extubation.

	Analysed patients (*n*=818)
Recall of extubation, *n* (%); (95% confidence interval)	
Yes	25 (3.1); (2.0–4.5)
Discomfort	9 (1.1); (0.5–2.1)

extubation regardless of discomfort was 3.1% (*n*=25; 95% CI: 2.0–4.5%) (Table 3). Eight of nine patients who recalled discomfort on extubation were female, and three of them had undergone total intravenous anaesthesia. Their anaesthesia time tended to be shorter, and their age tended to be younger than the study population in general (Table 4).

First orientation to place was on the operating table in 17% of cases (*n*=136; 95% CI: 14–19%), in transit between the operating table and ward in 41% (*n*=337; 95% CI: 38–45%), and in a ward in 39% (*n*=317; 95% CI: 35–42%). The median transit time between extubation and the ward was 24 min (95% CI: 24–25 min). Hearing a voice on emergence was the most commonly reported recollection (66% [*n*=536; 95% CI: 62–69%]) (Table 5).

Discussion

The frequency of recall of discomfort on extubation was low, at 1.1% (*n*=9; 95% CI: 0.5–2.1%). At the time of extubation, most patients were able to open their eyes and mouth and take deep breaths with prompting. Many of the patients exhibited severe bucking or similar bodily movements, raising concerns that they might retain memories of discomfort on extubation. However, given their low frequency, such memories were considered to be of negligible importance.

Recall of extubation has been investigated in three previous studies. The first compared remimazolam *vs* propofol for maintenance anaesthesia and reported an overall frequency of recall of extubation of 17% (28 of 163).[5] The second compared extubation performed by residents and anaesthetists and reported an overall frequency of recall of 6.7% (773 of 11 529).[6] The third reported a frequency of recall of 10% (202 of 1993).[7] These frequencies were higher than in the present study (3.1% [*n*=25; 95% CI: 2.0–4.5%]). Factors contributing to the differences are unclear, but we note that the first study had fewer cases per year (163 cases over 5 yr). Factors, such as age, sex, anaesthesia method, and duration of anaesthesia, may be involved, although the aim of the present study was not to examine the factors affecting the frequency of recall of extubation.

When obtaining preoperative informed consent for anaesthesia, an explanation of the extubation process is provided. Patients often ask when they will awaken from anaesthesia, but our replies may vary based on our own experience as anaesthetists. The present study found that patients retain few if any memories of extubation, and that about half of patients' first recollections of emerging from general anaesthesia form during a period within approximately 30 min of extubation.

During extubation, some patients calmly opened their eyes and mouth and breathed on their own without assistance or prompting. Other patients bucked and moved about

Table 4 Characteristics of patients who recalled discomfort during extubation. Propofol, sevoflurane, desflurane, and remifentanil values represent continuous doses given intraoperatively. The fentanyl value represents the total dosage given intraoperatively.

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
Sex	Female	Female	Female	Female	Female	Female	Female	Male	Female
Age (yr)	46	47	71	49	49	43	42	26	39
Height (cm)	164	164	155	156	158	155	146	174	157
Weight (kg)	94	64	43	46	50	75	41	72	44
BMI	35	24	18	19	20	31	19	24	18
ASA physical status	2	1	2	1	2	2	2	1	1
Department	Colorectal surgery	Plastic surgery	Gynaecology	Breast surgery	Breast surgery	Plastic surgery	Colorectal surgery	Liver surgery	Plastic surgery
Anaesthesia time (min)	94	90	61	120	126	132	158	165	111
Anaesthesia type	Inhalation anaesthesia	TIVA	TIVA	Inhalation anaesthesia	Inhalation anaesthesia	Inhalation anaesthesia	Inhalation anaesthesia	Inhalation anaesthesia	TIVA
Midazolam	No	No	No	No	No	No	No	No	No
Neuromuscular blocking agent reversal drug	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Anaesthetic									
Propofol (mg kg^{-1} h^{-1})		7	4						5
Sevoflurane (%)	1.5				1.5				
Desflurane (%)				4		4	4	4	
Remifentanil (μg kg^{-1} min^{-1})	0.15	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2
Fentanyl (μg)	200	200	100	50	250	300	50	300	150

Table 5 First orientation to place and recall after emerging from general anaesthesia. Time spent on the operating table was defined as the time from extubation to the end of anaesthesia, as recorded on the medical chart. Time of patients' arrival at a ward was defined as the time when the vital signs were first assessed in a ward, as recorded on the medical chart. Each time represents the duration from extubation. Wards include the ICU and high care unit. Time is expressed as the median and 95% confidence interval (CI).

	Analysed patients (*n*=818)
First orientation to place, *n* (%); (95% CI)	
On the operating table	136 (17); (14–19)
In transit from the operating table to a ward	337 (41); (38–45)
Ward	317 (39); (35–42)
Unclear	28 (3); (2–5)
Elapsed time (min), median (95% CI)	
Time spent on the operating table after extubation	2 (2–2)
Time from extubation to arrival at ward	24 (24–25)
First recall on emergence, *n* (%); (95% CI)	
Extubation	25 (3); (2–5)
Voice of family	183 (22); (20–25)
Voice of attending physician	53 (6); (5–8)
Other voices	300 (37); (33–40)
Other	159 (19); (17–22)
Unclear	18 (2); (1–4)
No response	80 (10); (8–12)

violently. However, almost all patients had no memory of the extubation process. We were often surprised at the disparity between the impressions we had of the patients' behaviours on emergence and their memories on the following day. Although patients may appear to be awake and oriented upon emergence from anaesthesia, they may not retain memories of this experience. We therefore cannot assume that patients will understand even simple instructions given to them upon emergence and remember to follow them. Given the potential for serious complications to occur between extubation and arrival at the PACU, understanding the effects of anaesthesia during this time with regard to state of consciousness is extremely important and warrants further research.

The present study has several limitations. First, the patients were interviewed only once on the day after the procedure as part of routine post-anaesthesia rounds. A previous study of intraoperative awareness reported that questioning patients at three different times captured intraoperative awareness more accurately.[9] In that study, the patients were interviewed three times: in the PACU, 1–3 days after anaesthesia, and 7–14 days after anaesthesia. Nineteen patients reported intraoperative awareness, and the third interview captured 1.5 times more intraoperative awareness than the second interview, although there was overlap. However, in the present study, the patients were interviewed only once as a matter of convenience. Thus, the frequency of recall of discomfort during extubation may be somewhat lower in the present study. Second, to collect real-world clinical data, the particulars of anaesthesia management and extubation were

not controlled by protocol and were left to the discretion of each anaesthetist. The timing of extubation typically differs amongst individual anaesthetists. Therefore, it may be difficult to generalise the findings of the present study. Third, patients with ASA 3 and above were excluded. Many papers use ASA 3 and above as an exclusion criterion. However, it may not have been necessary to exclude them in the present study. There were 37 patients with ASA 3 and above, but there were no patients with recall of extubation, which would not have affected the results.

In conclusion, the present study investigated the frequency of patient recall of discomfort during extubation and memories, such as first orientation to place on emergence from general anaesthesia. Recall of discomfort during extubation was infrequent, as patients generally did not remember the extubation process at all. Patients may be reassured by this information. We suggest that physicians should not feel compelled to risk premature extubation, even if the patient exhibits behaviours or signs suggestive of discomfort.

Authors' contributions

Study design: all authors
Data collection: all authors
Data analysis: HSh, YO
Writing of first draft: YO
Revision: HSh, HSa

Funding

Tokyo Metropolitan Cancer and Infectious Diseases Center, Komagome Hospital.

Acknowledgements

The authors would like to thank M. Saito (Tokyo Metropolitan Cancer and Infectious Diseases Center, Komagome Hospital, Tokyo, Japan) for his assistance with the statistical analyses, T. Kikuchi (Department of Anesthesiology and Pain Medicine, Juntendo University Nerima Hospital, Tokyo, Japan) for his assistance with critically reviewing the paper, J.R. Valera (Tokyo Metropolitan Cancer and Infectious Diseases Center, Komagome Hospital) for his assistance with editing the paper, and K. Miyasaka (Department of Critical Care and Anesthesia, National Center for Child Health and Development, Tokyo, Japan) for his assistance with critically reviewing and editing the paper.

Declarations of interest

The authors declare that they have no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bjao.2023.100147.

References

1. Cook TM, Woodall N, Frerk C. Major complications of airway management in the UK: results of the fourth national audit project of the royal college of anaesthetists and the difficult airway society. Part 1: anaesthesia. *Br J Anaesth* 2011; **106**: 617–31
2. Frerk C, Mitchell VS, McNarry AF, et al. Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults. *Br J Anaesth* 2015; **115**: 827–48
3. Piepho T, Cavus E, Noppens R, et al. S1 guidelines on airway management: guideline of the German society of Anesthesiology and intensive care medicine. *Anaesthesist* 2015; **64**: 27–40
4. Popat M, Mitchell V, Dravid R, Patel A, Swampillai C, Higgs A. Difficult Airway Society guidelines for the management of tracheal extubation. *Anaesthesia* 2012; **67**: 318–40
5. Sato T, Mimuro S, Kurita T, et al. Recall of extubation after remimazolam anesthesia with flumazenil antagonism during emergence: a retrospective clinical study. *J Anesth* 2022; **36**: 688–92
6. Inoue S, Abe R, Tanaka Y, Kawaguchi M. Anesthesia management by residents does not alter the incidence of recall of tracheal extubation: a teaching hospital-based propensity score analysis. *Braz J Anesthesiol* 2017; **67**: 251–7
7. Takahashi M, Nakahashi K, Karashima Y, Kitaguchi K, Furuya H. The memory of tracheal extubation during emergence from general anesthesia. *Masui* 2001; **50**: 613–8
8. Kanda Y. Investigation of the freely available easy-to-use software 'EZR' for medical statistics. *Bone Marrow Transplant* 2013; **48**: 452–8
9. Sandin RH, Enlund G, Samuelsson P, Lennmarken C. Awareness during anaesthesia: a prospective case study. *Lancet* 2000; **355**: 707–11

Handling Editor: Phil Hopkins