Predictors of prolonged time of operation using general anesthesia in a teaching hospital

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Abstract

Aim: To investigate predictors of prolonged time of operation using general anesthesia in a teaching hospital.

Methods: From 2012 to 2013, a total of 11,942 operations were performed in the Fukuoka University Hospital. After exclusion of operations without general anesthesia, and those with planned operative time <60 minutes or actual operative time <30 minutes, a total of 10,623 operations were included in the present analysis. Predictors of prolonged operative time (defined as >30% prolongation of planned operative time) were assessed using logistic regression, hierarchical, mixed models with adjustment for random operator effect.

Results: Mean age of participants was 52.1 years and 51.1% were female. Types of performed operations were cranial (5.5%), thoracic (7.2%), abdominal (9.9%), thoracoscopic (3.9%), laparoscopic (6.5%), endoscopic (1.1%), endovascular (2.0%), eye (8.0%), orthopedic (22.9%), skin (6.1%), obstetric (3.2%), gynecologic (7.0%), male genital (1.2%), ear, nose and throat (6.8%), breast (1.6%) and others (7.1%). There were 1649 cases (13.8%) with prolonged operative time. In multivariable analysis, significant predictors of prolonged operative time were female gender (odds ratio [OR] 1.19, 95% confidence interval [95% CI] 1.01 to 1.30), obesity defined as body mass index $\geq$25 kg/m^2 (OR 1.19, 95% CI 1.05 to 1.36), history of heart disease (OR 1.38, 95% CI 1.14 to 1.67), laparoscopic surgery (OR 1.79 vs abdominal surgery, 95% CI 1.34 to 2.38), endoscopic surgery (OR 2.50 vs abdominal surgery, 95% CI 1.24 to 5.07), eye surgery (OR 2.31 vs abdominal surgery, 95% CI 1.43 to 3.72) and intraoperative bleeding $\geq$200 mL (OR 2.95, 95% CI 2.51 to 3.46).

Conclusions: Female gender, obesity, history of heart disease, several types of operation and increased intraoperative bleeding were associated with prolonged operative time.

Key words: prolonged operative time, general anesthesia, predictors, observational study

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Introduction

Prolonged operative time has been shown to associated with adverse events such as fever, anorexia and infection after operation.[1),2)] It may also increase working hours of medical staff and result in worse financial situation at hospitals.

Effective management of operation room require a strategy based on knowledge of predictors for prolonged operative time.

A number of observational studies have suggested skill of surgeon, characteristics of patients and size of hospital as possible predictors of prolonged operative time.[3)-6)] However, current evidence is mainly derived from Western populations, and it is unclear to what extent these findings apply to Japanese populations.

The aim of the present analysis was to investigate predictors of prolonged operative time for various types of surgeries using large-scale database from a teaching hospital in Japan.

Materials and Methods

Study design and participants

This is a cross-sectional study of patients who received operations in the Fukuoka University Hospital. From Jan 2012 to Dec 2013, a total of 11,942 operations were performed in the hospital. After exclusion of operations without general anesthesia (n=508), and those with planned operative time <60 minutes (n=427) or actual operative time <30 minutes (n=384), a total of 10,623 operations were included in the present analysis. This study was approved by the Medical Ethics Review Board of the Fukuoka University (No 15-130).

Predictors

We collected information on gender, age, body mass index (BMI), types of performed surgeries (cranial, thoracic, abdominal, thoracoscopic, laparoscopic, endoscopic, endovascular, eye, orthopedic, skin, obstetric, gynecologic, male genital, ear nose and throat, breast or others; emergency (operation which was not scheduled but was required to be conducted as soon as possible) or elective), and intraoperative bleeding volume from hospital electronic medical record database including operation records. Histories of diabetes, hypertension, and heart disease were estimated from medical histories, medications and insurance names of disease of the hospital electronic medical record database.

Outcomes

The outcome was >30% prolongation of the scheduled operative time, which was decided by a surgeon on an application form of each operation.

Statistical analysis

Predictors of prolonged operative time were assessed using logistic regression, hierarchical, mixed models with adjustment for random operator effect. Effects of predictors were shown as odds ratio (OR) with 95% confidence intervals (95% CI). SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) was used for the statistical analysis and $P < 0.05$ was considered statistically significant.

Results

Mean age of participants was 52.1 years and 51.1% were female.

Types of performed operations were cranial (5.5%), thoracic (7.2%), abdominal (9.9%), thoracoscopic (3.9%), laparoscopic (6.5%), endoscopic (1.1%), endovascular (2.0%), eye (8.0%), orthopedic (22.9%), skin (6.1%), obstetric (3.2%), gynecologic (7.0%), male genital (1.2%), ear, nose and throat (6.8%), breast (1.6%) and others (7.1%). (Table1)

Scheduled and observed operative time according to type of surgery was shown in Table2. Average of observed operative time was longer than that of scheduled operative time for thoracic surgery, laparoscopic surgery and endoscopic surgery. (Table2)　With regard to emergency surgery, average of observed operative time was longer than that of scheduled operative time for laparoscopic surgery and gynecologic surgery.

There were 1649 cases (13.8%) with prolonged operative time. In crude analysis, significant predictors of prolonged operative time were female gender (odds ratio [OR] 1.19, 95% confidence interval [95% CI] 1.06 to 1.35), obesity defined as BMI $\geq$25 kg/m^2 (OR 1.23, 95% CI 1.08 to 1.40), history of heart disease (OR 1.38, 95% CI 1.15 to 1.64), and intraoperative bleeding $\geq$200 mL (OR 2.60, 95% CI 2.24 to 3.01). Thoracoscopic surgery (OR 0.47, 95% CI 0.30 to 0.74), endovascular surgery (OR 0.42, 95% CI 0.23 to 0.78) and obstetric surgery (OR 0.41, 95% CI 0.23 to 0.74) were associated with lower risks of prolonged operative time, while laparoscopic surgery (OR 1.31, 95% CI 1.00 to 1.71), endoscopic surgery (OR 1.85, 95% CI 0.96 to 3.53) and eye surgery (OR 1.55, 95% CI 0.99 to 2.42) were marginally associated with higher risks of prolongation. (Table3)

In multivariable analysis, female gender (OR 1.14, 95% CI 1.01 to 1.30), obesity (OR 1.19, 95% CI 1.05 to 1.36), history of heart disease (OR 1.38, 95% CI 1.14 to 1.67), laparoscopic surgery (OR 1.79, 95% CI 1.34 to 2.38), endoscopic surgery (OR 2.50, 95% CI 1.24 to 5.07), eye surgery (OR 2.31, 95% CI 1.43 to 3.72) and intraoperative bleeding ≥200 mL (OR 2.95, 95% CI 2.51 to 3.46) remained statistically significant. Endovascular surgery (OR 0.50, 95% CI 0.26 to 0.97) and obstetric surgery (OR 0.24, 95% CI 0.13 to 0.47) were also significantly associated with lower risks of prolongation. (Table3)

Discussion

In the present analysis using large-scale database from a teaching hospital in Japan, female gender, obesity, history of heart disease, several types of operation (Thoracoscopic, endoscopic and eye surgery) and increased intraoperative bleeding were significantly associated with prolonged operative time.

Obese patients have been shown to have increased risks of prolonged operative time in orthopedic or laparoscopic surgery.[7)-12)] We confirmed the findings of the previous studies and demonstrated that obesity was clearly associated with prolonged operative time for various types of surgeries in the large-scale observational study of Japanese. Strategies to reduce body weight before operation (e.g. pre-operative weight reduction program) may be useful in reducing the risks of prolongation.

In the present analysis, we investigated the effects of diabetes, hypertension and heart disease on prolonged operative time, but did not collect information on histories

of diseases in lung, kidney or liver, or smoking habits, which is a limitation to this study. As a result, history of heart disease was associated with increased risks of prolongation of planned operative time. There has been very few studies which investigated the association between history of heart disease and prolonged operative time, but an observational study of 17,412 operations (mean patient age 55.8 years) conducted from 1993 to 2005 in a hospital in Netherland reported that history of heart failure nor coronary artery disease was not associated with increased risks of prolongation. [9] The controversial findings may be attributable to differences in hospital setting and characteristics of patients (e.g. ethnicity and age) .

A number of studies investigated effects of gender on prolonged operative time. Some studies reported higher risks of prolongation among female patient[5),13)] while some others reported opposite findings.[14),15)] In the present analysis, female gender was associated with increased risks of prolongation. The controversial findings may be attributable to differences in study design or characteristics of participants, surgeons and hospitals.

There has been limited evidence regarding the type of surgery and prolonged operative time. An observational study reported that ratios of actual vs planned operative time was larger in neurosurgery, eye surgery, ear, nose and throat surgery than general surgery.[17)] However, sample size of the study (160 patients) was somewhat small and findings of laparoscopic and endoscopic surgery were not reported. In the present analysis of 11,942 operations confirmed that eye surgery was associated with higher risks of prolonged operative time than abdominal surgery. In contrast, cranial and ear, nose and throat surgery was not associated with

prolonged operative time. Future large studies are required to establish the influence of surgery type on prolongation of planned operative time.

In the present analysis, increased intraoperative bleeding was a very strong risk factor of prolonged operative time. These findings are comparable with those from previous studies which reported clear associations between intraoperative bleeding and prolongation of surgeries.[10),16)] In order to reduce the risks of prolonged operative time, it would be important to minimize intraoperative bleeding.

To our knowledge, this is one of the largest studies which investigated predictors of prolonged operative time for various types of surgeries among Japanese. A limitation involves possible selection bias due to single center study. Another limitation is lack of information on detailed reasons of the prolongation. A third limitation is that setting of this study was a teaching hospital. Because operative time in teaching hospitals have been shown to be longer than that in non-teaching hospitals[18)], our findings may not be applicable to general hospitals. A fourth limitation is that there might have been variation in scheduled operative time because there was not standardized procedures to decide the scheduled operative time for each type of surgery.

In conclusion, female gender, obesity, history of heart disease, several types of operation and increased intraoperative bleeding were associated with prolonged operative time in a large-scale observational study in a teaching hospital in Japan. High-risk strategies focusing on these predictors (pre-operation weight reduction,

reduction in intraoperative bleeding, recognition of high-risk patients beforehand) would help effective management of operation room in hospital.

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Table1: Characteristics and clinical features of participants

	Participants (n=10623)
Female	5424(51.1%)
Age (years)	52.1±23.5
Body mass index (kg/m^2)	22.4±4.4
Diabetes	1397(13.2%)
Hypertension	2552(24.0%)
Heart disease	1086(10.2%)
Type of surgery	
Cranial surgery	581(5.5%)
Thoracic surgery	762(7.2%)
Abdominal surgery	1048(9.9%)
Thoracoscopic surgery	411(3.9%)
Laparoscopic surgery	692(6.5%)
Endoscopic surgery	119(1.1%)
Endovascular surgery	217(2.0%)
Eye surgery	847(8.0%)
Orthopedic surgery	2434(22.9%)
Skin surgery	653(6.1%)
Obstetric surgery	335(3.2%)
Gynecologic surgery	739(7.0%)
Male genital surgery	129(1.2%)
Ear, nose and throat surgery	727(6.8%)
Breast surgery	171(1.6%)
Other surgery	758(7.1%)
Emergency surgery	1916(18.0%)
Intraoperative bleeding (mL)	203.3±546.7

Values are mean ± SD for continuous variables and N (%) for categorical variables. Emergency surgery was defined as operation which was not scheduled but was required to be conducted as soon as possible.

Table2: Scheduled and observed operative time according to type of surgery

	Scheduled operative time (min)	Observed operative time (min)	Difference (min)
Any surgery	172.1±127.8	162.4±138.1	-9.7±73.1
Elective (n=8707)	176.5±132.9	167.5±144.2	-9.0±74.4
Emergency (n=1916)	151.8±99.2	139.4±102.6	-12.4±67.2
Cranial surgery	248.3±146.1	223.2±147.8	-25.1±84.5
Elective (n=308)	284.7±154.3	258.1±154.0	-26.5±92.9
Emergency (n=273)	207.2±124.4	183.7±129.8	-23.6±73.9
Thoracic surgery	313.0±137.5	313.2±172.9	0.2±112.9
Elective (n=578)	323.7±128.9	335.2±173.2	11.4±113.5
Emergency (n=184)	279.4±157.2	244.1±152.9	-35.3±103.4
Abdominal surgery	225.5±181.5	214.0±191.0	-11.5±96.6
Elective (n=744)	259.6±202.9	244.1±215.1	-15.5±106.7
Emergency (n=304)	142.3±55.9	140.5±69.9	-1.8±64.6
Thoracoscopic surgery	161.8±65.6	144.3±88.0	-17.5±67.5
Elective (n=284)	189.2±58.1	165.2±86.8	-24.0±66.9
Emergency (n=127)	100.4±30.1	97.5±71.1	-2.9±66.8
Laparoscopic surgery	196.3±102.5	202.3±113.7	6.0±69.3
Elective (n=588)	209.5±104.3	213.9±116.0	4.5±71.6
Emergency (n=104)	121.7±43.5	136.5±70.1	14.8±53.6
Endoscopic surgery	169.4±56.5	177.6±88.7	8.2±76.3
Elective (n=113)	167.0±51.9	175.7±88.7	8.7±77.9
Emergency (n=6)	215.0±111.3	212.3±89.0	-2.7±38.6
Endovascular surgery	200.3±81.7	141.4±75.6	-58.9±78.0
Elective (n=154)	211.4±75.6	147.6±72.4	-63.7±74.9
Emergency (n=63)	173.3±89.9	126.3±81.6	-47.1±84.8
Eye surgery	88.5±30.3	85.2±44.0	-3.3±36.3
Elective (n=634)	83.4±27.4	79.8±41.5	-3.6±36.4
Emergency (n=213)	103.5±33.5	101.2±47.4	-2.3±36.1
Orthopedic surgery	112.5±52.8	109.2±60.2	-3.3±46.5
Elective (n=2273)	111.1±51.1	108.4±59.4	-2.8±46.1
Emergency (n=161)	131.5±69.8	120.9±69.6	-10.6±50.9
Skin surgery	199.4±204.2	192.6±223.1	-6.8±106.2
Elective (n=587)	206.2±212.7	198.9±230.7	-7.3±109.0
Emergency (n=66)	139.1±77.8	136.9±126.8	-2.2±76.9
Obstetric surgery	97.9±38.8	81.8±24.6	-16.1±42.3
Elective (n=117)	98.2±41.1	92.9±27.0	-5.3±39.3
Emergency (n=218)	97.8±37.6	75.9±21.0	-21.9±42.9
Gynecologic surgery	148.1±73.2	142.2±93.4	-5.9±57.1
Elective (n=675)	149.6±74.4	142.9±94.9	-6.7±56.1
Emergency (n=64)	132.7±57.8	134.9±77.1	2.2±67.1
Male genital surgery	160.9±102.1	131.7±80.7	-29.2±58.2
Elective (n=120)	164.3±104.7	134.9±81.7	-29.4±60.0
Emergency (n=9)	116.7±38.1	89.7±51.6	-27.0±23.6
Ear, nose and throat surgery	176.3±110.2	152.6±110.6	-23.7±67.5
Elective (n=703)	177.0±111.1	153.5±111.5	-23.5±68.0
Emergency (n=24)	156.3±75.6	126.9±74.3	-29.4±51.6
Breast surgery	202.8±144.0	171.1±153.6	-31.7±54.2
Elective (n=170)	203.1±144.4	171.5±153.9	-31.6±54.3
Emergency (n=1)	150.0	110.0	-40.0
Other surgery	181.9±107.7	169.1±128.5	-12.8±69.5
Elective (n=659)	186.8±110.6	172.8±130.6	-13.9±70.2
Emergency (n=99)	149.7±78.7	144.2±111.3	-5.5±64.4

Values are mean ± SD.

Table 3: Predictors of prolonged operative time among 10623 participants

	N (%)		Crude analysis		Multivariable analysis	
	1st listed	2nd listed	Odds ratio (95% CI)	P value	Odds ratio (95% CI)	P value
Female vs male	753 (13.9%)	896 (17.2%)	1.19 (1.06 – 1.35)	0.003	1.14 (1.01 – 1.30)	0.035
Age ≥65 vs <65years	631 (15.6%)	1018 (15.5%)	1.02 (0.90 - 1.15)	0.778	0.94 (0.82 - 1.07)	0.333
Body mass index ≥25 vs <25 kg/m^2	436 (17.1%)	1154 (14.9%)	1.23 (1.08 - 1.40)	0.001	1.19 (1.05 - 1.36)	0.008
Diabetes vs no diabetes	230 (16.5%)	1419 (15.4%)	1.09 (0.93 - 1.28)	0.288	0.99 (0.83 - 1.18)	0.917
Hypertension vs no hypertension	402 (15.8%)	1247 (15.5%)	1.05 (0.92 - 1.20)	0.454	0.98 (0.84 - 1.13)	0.749
Heart disease vs no heart disease	199 (18.3%)	1450 (15.2%)	1.38 (1.15 - 1.64)	<0.001	1.38 (1.14 - 1.67)	0.001
Type of surgery						
Cranial vs abdominal surgery	57 (9.8%)	193 (18.4%)	0.66 (0.42 - 1.04)	0.075	0.74 (0.46 - 1.19)	0.216
Thoracic vs abdominal surgery	116 (15.2%)	193 (18.4%)	0.85 (0.59 - 1.22)	0.380	0.62 (0.41 - 0.92)	0.018
Thoracoscopic vs abdominal surgery	48 (11.7%)	193 (18.4%)	0.47 (0.30 - 0.74)	0.001	0.63 (0.39 - 1.03)	0.066
Laparoscopic vs abdominal surgery	152 (22.0%)	193 (18.4%)	1.31 (1.00 - 1.71)	0.051	1.79 (1.34 - 2.38)	<0.001
Endoscopic vs abdominal surgery	34 (28.6%)	193 (18.4%)	1.85 (0.96 - 3.53)	0.065	2.50 (1.24 - 5.07)	0.011
Endovascular vs abdominal surgery	16 (7.4%)	193 (18.4%)	0.42 (0.23 - 0.78)	0.006	0.50 (0.26 - 0.97)	0.039
Eye vs abdominal surgery	152 (17.9%)	193 (18.4%)	1.55 (0.99 - 2.42)	0.054	2.31 (1.43 - 3.72)	<0.001
Orthopedic vs abdominal surgery	394 (16.2%)	193 (18.4%)	0.75 (0.54 - 1.05)	0.091	0.98 (0.69 - 1.40)	0.923
Skin vs abdominal surgery	119 (18.2%)	193 (18.4%)	0.95 (0.67 - 1.35)	0.770	1.13 (0.77 - 1.65)	0.532
Obstetric vs abdominal surgery	27 (8.1%)	193 (18.4%)	0.41 (0.23 - 0.74)	0.003	0.24 (0.13 - 0.47)	<0.001
Gynecologic vs abdominal surgery	110 (14.9%)	193 (18.4%)	0.71 (0.46 - 1.11)	0.138	0.64 (0.39 - 1.05)	0.076
Male genital vs abdominal surgery	16 (12.4%)	193 (18.4%)	0.84 (0.46 - 1.55)	0.581	1.02 (0.53 - 1.98)	0.944
Ear, nose and throat vs abdominal surgery	84 (11.6%)	193 (18.4%)	0.54 (0.37 - 0.79)	0.002	0.77 (0.51 - 1.16)	0.211
Breast vs abdominal surgery	9 (5.3%)	193 (18.4%)	0.35 (0.14 - 0.89)	0.027	0.55 (0.21 - 1.44)	0.224
Other vs abdominal surgery	122 (16.1%)	193 (18.4%)	0.89 (0.65 - 1.23)	0.493	1.22 (0.87 - 1.71)	0.260
Emergency vs elective surgery	296 (15.4%)	1353 (15.5%)	1.00 (0.86 - 1.17)	0.988	1.06 (0.90 - 1.25)	0.503
Intraoperative bleeding ≥200 vs <200 mL	476 (22.0%)	1166 (13.8%)	2.60 (2.24 - 3.01)	<0.001	2.95 (2.51 - 3.46)	<0.001

95% CI indicates 95% confidence interval.

1st listed indicates female for gender, ≥65 years for age, body mass index ≥25 kg/m^2 for obesity, diabetes, hypertension, heart disease, each type of surgery, emergency surgery and ≥200mL for intraoperative bleeding, and 2nd listed indicates male for gender, <65 years for age, body mass index <25 for obesity, no diabetes, no hypertension, no heart disease, abdominal surgery, elective surgery and <200 mL for intraoperative bleeding.