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Time progression from the patient's operating room entrance to incision: factors affecting anesthetic setup and surgical preparation times

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Abstract
Purpose. Owing to recent advances in surgical technology, substantial time is required for preparing surgical equipment before incision. The purpose of this study was to demonstrate the time progression from a patient's operating room entrance to incision and to evaluate the duration of each anesthetic procedure and surgical preparation.
Methods. We marked the following seven points on the anesthetic chart: (1) entrance; (2) IV line placement; (3) preoxygenation; (4) intubation; (5) completion of patient positioning (Anesth-Set); (6) applying antiseptic solution; and (7) incision. Afterward, we analyzed the event time periods according to anesthetic procedure, patient position, surgical service, and surgical procedure (such as the utilization of endoscopy, navigation systems, and sentinel lymph node biopsy).
Results. On average, it took approximately 3 min to start IV placement, 7 min until preoxygenation, 15 min until intubation, and 30 min until Anesth-Set. Epidural, arterial, and central venous catheterization required 15, 9, and 13 min, respectively. It took 20 min from Anesth-Set to incision, on average; 22, 4, and 5 min were required to prepare the navigation system, endoscope, and sentinel lymph node biopsy, respectively. In total, it took an average of 49.8 ± 17.1 min from entrance to incision, which was significantly longer (30.4 ± 8.8 min) than it took in 1985–1986.
Conclusion. The mean time taken from the patient's operating room entrance to incision is now significantly longer than before. This may be attributed, at least in part, to the preparation of equipment associated with new surgical technologies.

Key words OR time · OR efficiency · Anesthesia procedure · Surgical preparation

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Introduction

From the time a patient enters the operating room (OR), anesthesiologists, surgeons, and OR nurses work together in a well-organized team to start surgery promptly and smoothly. Anesthesiologists are in charge of most of the work that must be done during this time, such as inserting the intravenous (IV) line, intubation, epidural catheterization, central venous (CV) catheterization, and positioning the patient. Owing to advances in surgical technology, e.g., the use of minimally invasive techniques with an endoscope, intraoperative monitoring, and the use of navigation systems, substantial time is now required to prepare these types of equipment. Previous studies have set target or benchmark times for anesthesia induction and surgical preparation and have investigated reasons for delay in induction [1,2]. However, no study has demonstrated prospective data for time durations spent on each anesthetic procedure or surgical preparation, which may help to more accurately schedule OR booking time.

We therefore prospectively investigated the time progression from a patient's OR entrance to incision at an academic institution, evaluating the time durations required for anesthetic procedures, patient positioning, and surgical preparation, especially the time required to utilize new surgical technology. We also compared the time duration from a patient's OR entrance to incision with those in 1985–1986, which were retrospectively investigated from anesthetic charts.

Methods

From October 2005 to March 2006, all elective surgeries performed under general anesthesia (excluding cardiac surgery and awake craniotomy) in the central OR area of Nagoya City University Hospital were prospectively entered into this study. Anesthesia was administered

either by an anesthesiologist and resident together, or by an anesthesiologist alone. To assess the time progression, we marked the following seven points on the anesthetic chart.

1. Patient's entrance to OR (Entrance)
2. Putting on a tourniquet for IV line insertion (Tourniquet)
3. Putting on a mask for preoxygenation (Mask)
4. Intubation (Intubation)
5. Completion of patient positioning, in which remaining anesthetic tasks do not preclude surgeons from starting to apply antiseptic solution (Anesth-Set)
6. Surgeon's application of antiseptic solution to the surgical area (Sterile-Prep)
7. Beginning of surgery (Incision)

The time duration from Entrance to Anesth-Set indicates the anesthetic setup time, i.e., the time that it took the anesthesiologist to prepare the patient, and the time duration from Anesth-Set to Incision indicates the surgical preparation time. Afterward we analyzed the event time periods according to the anesthetic procedure (such as arterial catheterization, CV catheterization, epidural catheterization, fiberoptic intubation, and double-lumen tube or bronchial blocker tube for one-lung ventilation), patient position, surgical service, and surgical procedure (such as the utilization of endoscopy, navigation systems, and sentinel lymph node biopsy [SLB]).

The time spent on epidural catheterization was calculated by subtracting the average Mask time of the patients with general anesthesia alone from the average Mask time of the patients with epidural catheterization. The times spent on arterial catheter placement and CV catheter placement were each evaluated by averaging the excess time at Anesth-Set compared with the mean Anesth-Set time of the patients without the procedure balanced with all other conditions, including other types of catheterizations and patient positioning. The times spent positioning patients (lateral and prone) were evaluated by averaging the excess time at Anesth-Set compared with the mean value for supine patients with all other conditions being the same. The time spent in the parkbench position was evaluated by averaging the excess time at Anesth-Set and comparing it with the mean value for craniotomy patients in the supine position. Times are shown as mean values ± SD.

We also retrospectively investigated the time duration from a patient's OR entrance to incision by reviewing anesthetic charts recorded from October 1985 to March 1986.

Student's *t*-test was used to detect significant differences. Three-way analysis of variance was performed to a detect significant effect of each anesthetic procedure on the anesthesia induction time. $P < 0.05$ was considered significant.

Results

There were 1092 patients. Results for 32 were excluded due to incomplete time marking. Data for 1 patient were excluded because bladder catheter placement was extremely difficult due to the patient's anatomical abnormality, requiring consultation with a urologist after anesthesia induction.

Anesthetic setup, surgical preparation, and Entrance-Incision times

Table 1 demonstrates the results of anesthetic setup times, surgical preparation times, and total durations from Entrance to Incision according to the surgical service.

In total, it took an average of 49.8 ± 17.1 min from Entrance to Incision. From October 1985 to March

Table 1. Anesthetic setup time, surgical preparation time, and entrance-to-incision time

Surgical service	*n*	Anesthetic setup	Surgical preparation	Entrance to incision
Neurosurgery	57	46.4 ± 15.7	37.7 ± 18.8	84.2 ± 21.0
Thoracic surgery	81	41.1 ± 12.8	17.2 ± 4.3	58.1 ± 12.3
Otorhinolaryngology	117	26.0 ± 9.8	29.0 ± 11.1	54.9 ± 15.0
General surgery	235	36.5 ± 13.5	15.3 ± 6.5	51.8 ± 14.4
Urology	77	33.7 ± 14.9	17.6 ± 7.5	51.2 ± 17.7
Orthopedics	172	27.3 ± 10.9	21.7 ± 7.1	49.0 ± 11.8
Dental and mouth surgery	26	27.2 ± 7.2	15.8 ± 5.9	43.0 ± 7.8
Breast surgery	83	19.9 ± 6.0	18.0 ± 4.7	38.0 ± 7.1
Pediatric	111	22.4 ± 8.9	14.9 ± 6.0	37.3 ± 11.5
Obstetrics and gynecology	83	22.0 ± 7.1	14.0 ± 5.1	36.0 ± 7.0
Total[a]	1059	30.3 ± 13.6	19.6 ± 10.2	49.8 ± 17.1

Values (min) are means ± SD
[a]Total includes others (dermatology $n = 9$, ophthalmology $n = 4$, hematology $n = 4$)

Table 2. Time periods from Entrance to Mask, Intubation, and Anesthetic-Setup

Entrance to Tourniquet (n = 882[a])	3.4 ± 1.7 min
Entrance to Mask	
General anesthesia alone (n = 747[b])	7.4 ± 3.6 min
General anesthesia combined with epidural (n = 201)	22.6 ± 6.1 min
Entrance to Intubation	
General anesthesia alone (n = 858)	15.6 ± 6.3 min
General anesthesia combined with epidural (n = 201)	31.5 ± 7.8 min
Entrance to Anesth-Set	
Total (n = 1059)	30.3 ± 13.6 min
General anesthesia alone with one IV line in supine position (n = 479)	21.5 ± 6.7 min

Values are means ± SD
[a] Excluding 111 patients in whom anesthesia was induced before IV insertion and 66 patients in whom an IV line had already been inserted
[b] Excluding 111 patients in whom anesthesia was induced before IV line insertion

1986, the time from Entrance to Incision was 30.4 ± 8.8 min (n = 911), which was significantly shorter than that in the present study ($P < 0.001$).

Anesthetic procedure analysis

Table 2 shows the time periods from Entrance to Anesth-Set. It took 3.4 ± 1.7 min from Entrance to Tourniquet, excluding those patients in whom anesthesia was induced before IV insertion, such as slow induction for children (111 patients), and the patients for whom an IV line had already been inserted (66 patients).

From Entrance to Mask, it took 7.4 ± 3.6 min in patients with general anesthesia alone (excluding the aforementioned 111 patients who were first anesthetized), while it took 22.6 ± 6.1 min in patients with general anesthesia combined with epidural block.

From Entrance to Intubation, it took 15.6 ± 6.3 min in patients with general anesthesia alone, while it took 31.5 ± 7.8 min in patients with general anesthesia combined with epidural block. There were 5 patients who had fiberoptic intubation due to a recognized difficult airway. It took 13.4 ± 3.8 min from preoxygenation to fiberoptic intubation, which was significantly longer compared with conventional rapid induction and intubation under laryngoscopy (7.5 ± 4.7 min; n = 943; $P < 0.02$). Inserting a double-lumen tube or bronchial blocker tube and confirming their correct placement did not significantly increase the Mask-to-Anesth-Set time.

Anesthetic setup took 30.3 ± 13.6 min on average. In the simplest cases; that is, in patients with general anesthesia with one IV line in a supine position, anesthetic setup time was 21.5 ± 6.7 min on average. Three-way analysis of variance revealed that epidural catheterization, arterial catheterization, CV catheterization, parkbench positioning, prone positioning, and lateral positioning required significantly longer anesthetic setup time. Epidural, CV, and arterial catheterization required approximately 15, 13, and 9 min, respectively. Parkbench, prone, and lateral positioning required 28, 9, and 5 min, respectively. Lithotomy positioning did not significantly increase anesthetic setup time.

Surgical service and surgical procedure analyses

Among the neurosurgery patients, transsphenoidal hypophysectomy (endoscopic surgery under the guidance of a computed tomography [CT]-based navigation system), as well as X-ray imaging, took as long as 74.5 ± 12.1 min (n = 8) of surgical preparation time. Craniotomy with the use of a magnetic resonance imaging (MRI)-based navigation system took 50.2 ± 7.9 min (n = 5), whereas craniotomy without a navigation system took 28.3 ± 12.1 min (n = 23), while the surgical preparation time in the other neurosurgery patients was 31.0 ± 6.1 min (n = 21).

We analyzed the time from Sterile-Prep to Incision, with respect to the use of an endoscope, among patients with thoracic surgery and abdominal surgery. It took 11.1 ± 4.0 min (n = 180) for the patients with endoscopy, whereas for the patients without endoscopy, it took 7.3 ± 2.2 min (n = 212). We also analyzed the time from Sterile-Prep to Incision in patients with mastectomy, according to whether SLB was performed. In the patients with SLB, it took 15.8 ± 3.2 min (n = 33), whereas in the patients without SLB, it took 10.1 ± 1.7 min (n = 36).

Discussion

We prospectively investigated the time progression from the patient's operating room entrance to incision, and demonstrated detailed time periods for each anesthetic procedure and surgical preparation. On average,

it took approximately 30 min for anesthetic setup, whereas it took approximately 20 min for surgical preparation, resulting in approximately 50 min from Entrance to Incision, which was significantly longer than the time taken in 1985–1986 (approximately 30 min).

We defined anesthetic setup time as the time at which patient positioning was completed, because we regard the time that this positioning takes as part of the time which it takes for the anesthesiologist to prepare; however, the Association of Anesthesia Clinical Directors (AACD) set "anesthesia ready time" before patient positioning, considering patient positioning to be a part of surgical preparation [3]. We used our definition of anesthetic setup time because we strongly believe that, as managers in the OR [4], anesthesiologists are responsible for the safe positioning of patients.

Previous studies set target or benchmark times and examined the reasons for delay in anesthesia induction [1,2]. Overdyk et al. [1] set a target time of 15 min for anesthesia induction and 10 min for surgical preparation. Their results showed approximately 20 to 25 min and 25 min for anesthesia induction and surgical preparation, respectively, resulting in 45 to 50 min from patient entrance to incision, on average. Zafar et al. [2] set benchmarks of "anesthesia ready" time (i.e., the time from monitor application for the patient to be "anesthesia-ready") as 15 min for American Society of Anesthesiologists (ASA) class I and II patients and 30 min for ASA III and IV patients; 15 min for spinal anesthesia; 20 min for epidural anesthesia; and an additional 15 min for each invasive procedure such as arterial line or CV line insertion. They reported that 78.3% of procedures were within the benchmark [2]. Their results are quite similar to our results, considering that our anesthetic setup time included patient positioning. The 9 min required to place an arterial catheter in the present study seems quite long, although Zafar et al. [2] set the target for this time at 15 min. This is probably because in most cases residents performed the placement and needed a comparatively long time to place it successfully [2,5], sometimes with several attempts. Chelly et al. [6] reported a time of approximately 40 min from the patient's OR entrance to incision in patients with general anesthesia for rotator cuff surgery in the beach-chair position.

From the time a patient enters the OR, anesthesiologists, surgeons, and OR nurses work together in a well-organized team in order to start surgery promptly and smoothly. Anesthesiologists are in charge of most of the work that must be done during this time, such as inserting an IV line, intubation, epidural catheterization, CV catheterization, and patient positioning. Two decades ago, things seem to have been simpler, as we moved from inserting an IV line to intubation, antisepsis, and incision. These days, however, it seems to take longer to start surgery, and the reason for this is probably because more tasks must now be done for patients' safety and comfort. For example, with regard to anesthetic setup time, applying monitors such as a bispectral monitor, applying an intermittent pneumatic compression device on the patient's legs to prevent deep venous thrombosis, wearing a sterile gown and using ultrasound guidance for CV catheterization, as well as applying absorbent paper around the surgical area to prevent chemical burn from extra antiseptic solution have been employed for patient safety. Epidural anesthesia combined with general anesthesia has been employed for most cases of thoracotomy and laparotomy for patient comfort at our institution. Each of these measures requires extra time and consequently delays the start of surgery.

In addition, due to advances in surgical technology, e.g., endoscopy, navigation systems, and intraoperative monitoring, more time is needed for surgical preparation. Sometimes equipment malfunctions cause substantial time delays until incision. As shown in the present study, an extra 4 min appeared to be needed in minimally invasive surgery with the use of an endoscope in order to prepare the equipment, and 22 min was needed to set up the navigation system for craniotomy. In mastectomy that includes the performance of sentinel lymph node biopsy (SLB), patients are given radioisotopes on the day before the operation; and in the OR just before incision, the surgeons first examine the axilla with a gamma probe and then inject blue dye solution into the subareola. In the present study, this process resulted in an extra 5 min taken before incision.

In our surgical service analysis, neurosurgery patients took the longest surgical preparation time. This finding is consistent with the report of Overdyk et al. [1] that neurosurgery and orthopedic surgery services require longer surgical preparation times. In the present study, neurosurgical patients with transsphenoidal hypophysectomy took as long as 75 min of surgical preparation time. This implies that the equipment for endoscopy, the navigation system, and C-arm X-ray imaging must be prepared but also irrigation of the nasal cavity and applying epinephrine require a substantial amount of time. The otorhinolaryngology patients took the second longest time until the incision, probably because it requires extra time to set up an endoscope for paranasal sinus surgery, a microscope for ear surgery, and intraoperative monitoring of the facial nerves for ear and parotid gland surgery, as well as to make a design for neck surgery and to locally inject epinephrine. Orthopedic surgery was in third place in time taken until incision, which may have been due to the requirement for vertebral confirmation under X-ray imaging and the time required to set up intraoperative monitoring such as motor-evoked potential for vertebral surgery, along

with the time required to make an incision design for finger and toe surgery.

From the perspective of OR efficiency, we must take the time required to prepare new equipment and utilize new technology into account in order to schedule OR booking time. Surgeons tend to book ORs based only on the time from incision to skin suture, neglecting to factor in the extra time required to perform the procedures mentioned in this article, resulting in underestimated OR booking times.

The present study has several limitations. First of all, the historical examination was retrospective and did not have detailed time periods or detailed descriptions of procedures performed, such as the use of arterial lines and CV lines, but showed only the Entrance-to-Incision time. It is obvious, however, that the total time until incision is now significantly longer than it was before. Secondly, we did not measure the actual time duration spent on each procedure. Instead, we evaluated the time duration compared with the mean value for that in the patients in whom the specific procedure was not performed. This is, however, rather more practical for investigating the time progression, because sometimes two procedures are performed simultaneously, and time is spent that does not directly correspond to any of these anesthetic procedures, such as the time used to make notes on the anesthetic chart. Thirdly, the present study was performed in a teaching hospital, in which teaching and training of medical students and residents are carried out. The results may differ from those in non-teaching hospitals.

Procedures that must be done in the OR before surgery have become complex owing to advances in technology; hence, it takes longer to start surgery. In order for surgery to start on time, it is necessary for anesthesiologists to perform their own work promptly in daily anesthetic practice, as well as to supervise, as the OR manager, the series of processes that occur until incision. Most importantly, however, we must keep in mind that the patient's safety must not be jeopardized, despite the pressure on us to work quickly.

In conclusion, the duration from the patient's OR entrance to incision is now significantly longer than it was before. We found that epidural, arterial, and CV catheterization, and patient positioning (parkbench, prone, lateral) required significantly more time for the anesthesiologist to prepare the patient. With regard to surgical preparation, surgical procedures using new technologies (endoscopy and navigation systems) also required significantly longer preparation times.

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