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Application of a Narcotrend-assisted monitor for depth of anesthesia on microwave coagulation for the patients with liver cancer during total intravenous anesthesia with propofol and fentanyl

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[Abstract] Background and Objective: Computed tomography (CT)-guided microwave coagulation is a minimally invasive surgery for patients with liver cancer. Total intravenous anesthesia with propofol and fentanyl is commonly used. The depth of anesthesia during microwave coagulation for liver cancer is still monitored by clinical signs. There are few subjective and effective indicators. This study explored the application of Narcotrend-assisted ‘depth of anesthesia’ monitoring on microwave coagulation for patients with liver cancer during total intravenous anesthesia with propofol and fentanyl. **Methods:** A total of 40 patients with liver cancer who underwent CT-guided microwave coagulation were randomly assigned to receive Narcotrend index monitoring or standard clinical monitoring for depth of anesthesia with 20 patients in each group. All patients received total intravenous anesthesia with propofol and fentanyl. The depth of anesthesia for the patients in the Narcotrend group was measured according to a Narcotrend index, which was maintained between D2 and E0. The depth of anesthesia for those in the standard clinical practice group was measured according to heart rate, mean arterial pressure, and patient movement. Changes of hemodynamics, the duration of the emergence from anesthesia, and the recovery of orientation were recorded. The doses of propofol and fentanyl, postoperative visual analogue scores (VAS), and the incidence of postoperative nausea and vomiting were also recorded. **Results:** There was no significant alteration in heart rate or mean arterial pressure between the two groups. Compared with other anesthetic stages, both heart rate and mean arterial pressure decreased during the induction of the anesthesia in the two groups ($P < 0.05$). The doses of propofol were higher in the standard clinical practice group than in the Narcotrend group [(460 ± 30) mg vs. (380 ± 35) mg, $P < 0.01$]. The duration of emergence and orientation were longer in the standard clinical practice group than in the Narcotrend group [(9.5 ± 2.9) min vs. (4.9 ± 2.2) min, $P < 0.01$; (12.2 ± 3.5) min vs. (6.6 ± 3.2) min, $P < 0.01$, respectively]. There was no difference in the dosage of fentanyl, VAS, or the incidence of postoperative nausea or vomiting between the two groups ($P > 0.05$). **Conclusion:** For patients with liver cancer, monitoring the depth of anesthesia with Narcotrend on microwave coagulation can contribute to lower dosage of propofol and shorten duration of recovery during total intravenous anesthesia with propofol and fentanyl.

Key words: Narcotrend, microwave coagulation, liver cancer, propofol, fentanyl, total intravenous anesthesia

Microwave coagulation is thought to be the most effective minimally invasive modality for the treatment of liver cancer.¹ During the procedure, spontaneous breathing is maintained and patients awaken soon after the operation. Total intravenous

anesthesia with propofol and fentanyl is a commonly used method and the depth of anesthesia is judged primarily by clinical manifestations rather than objective indices. Narcotrend (NT) (Narcotrend, Monitor Technik, Bad Bramstedt, Germany) is a novel device for monitoring the depth of anesthesia that has been widely used in European countries.^{2,3} Numerous studies demonstrate that NT can effectively reflect changes in the depth of anesthesia during intubated general anesthesia, thereby guiding the appropriate use of narcotics.^{4,6} Currently, investigations on the use of NT in clinical surgery is rare. Therefore, the present study investigated the role of NT in the monitoring of the depth of anesthesia induced by intravenous propofol-fentanyl in clinical settings.

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Data and methods

General data

A total of 40 patients with liver cancer who were scheduled to undergo microwave coagulation under the guidance of computed tomography (CT) were admitted to the Interventional Department of the Sun Yat-sen University Cancer Center from January 2009 to March 2009. To assess the fitness of our patients, we used the American Society of Anesthesiologists (ASA) guidelines and found that all patients were grades II to III, and those with neurologic or psychiatric problems, hearing defects, and alcohol or drug dependence were excluded. These 40 patients were randomly assigned into NT group (aged 25–69 years; mean 44 years) or standard clinical group (aged 20–70 years; mean 41 years), with 20 patients in each. The mean body weight of the NT and clinical groups were (60 ± 8) kg and (60 ± 7) kg, respectively. In the respective NT and clinical groups, 3 and 4 patients had coexisting hypertension. The duration of anesthesia in the NT and clinical groups were (91 ± 30) min and (88 ± 31) min, respectively. There was no significant difference between the two groups in terms of age, body weight, hypertension, or the duration of anesthesia ($P > 0.05$).

Procedures of anesthesia and monitoring

An intravenous infusion of compound sodium lactate [$10 \text{ mL}/(\text{kg} \cdot \text{h})$] was initiated after the patient was transferred to the CT room. An electrocardiogram (ECG), pulse oxygen saturation (SpO_2), and mean arterial pressure were monitored with a multifunctional monitor (Goldway UT4000). Oxygen was delivered through a facial mask. Anesthesia was induced with an infusion of propofol [$3 \text{ mg}/(\text{kg} \cdot \text{h})$] and fentanyl ($2 \mu\text{g}/\text{kg}$) in micro-pumps within 10 min. The anesthesia maintenance was performed by 4–8 $\text{mg}/(\text{kg} \cdot \text{h})$ of propofol. Local anesthesia with lidocaine at the puncture site was performed by the surgeon, then CT-guided microwave coagulation for liver cancer was performed. The patient maintained spontaneous breathing during operation.

The monitoring indices for the clinical group included heart rate (50–100 bpm), blood pressure ($\pm 20\%$ baseline blood pressure), and body movement. When the heart rate exceeded 100 bpm, blood pressure increased by more than 20% of the baseline level, or body movement occurred, fentanyl ($1 \mu\text{g}/\text{kg}$) was added, the infusion rate of propofol was increased, and urapidil (10–15 mg) and metoprolol (1 mg) were added, as necessary. If the heart rate dropped below 50 bpm, atropine (0.2–0.5 mg) was given. If the blood pressure dropped by more than 20% of the baseline level, Ephedrine (5–10 mg) was added. The anesthesia was lightened 10 min before the end of the operation.

In the NT group, the forehead of the patient was cleaned and three special poles (Blue sensor, Medicotest Olstykke, Denmark) were attached that were connected to the NT device. Skin resistance was ensured to be under 6 k Ω and between the poles was ensured to be under 3.5 k Ω . NT values were kept between D2–E0 during the operation by adjusting the pump.² Urapidil (10–15 mg) was infused when blood pressure increased by more than 20% of the baseline level, fentanyl ($1 \mu\text{g}/\text{kg}$) was infused

when the heart rate exceeded 100 bpm, and metoprolol (1 mg) was added as necessary. Fentanyl ($1 \mu\text{g}/\text{kg}$) was given when body movement occurred; atropine (0.2–0.5 mg) was given when the heart rate dropped below 50 bpm; ephedrine (5–10 mg) was added when blood pressure dropped by more than 20% of the baseline level. At 10 min before the end of the operation, the fentanyl infusion rate was adjusted to target NT values between D0–D1.

Observational indices

ECG, heart rate, mean arterial pressure, and NT scores were continuously monitored. Arousal time (the time from the drug cessation to the time when the patient can open eyes on command) and the time for the recovery of orientation (the time from when patient can open eyes on command to the restoration of orientation) were recorded, as well as the doses of propofol and fentanyl, postoperative VAS scores, and the incidence of nausea and vomiting. The intraoperative awareness of the patients was inquired within 24 h after the operation.

Statistical analysis

SPSS version 16.0 was used. Quantitative data were expressed as mean \pm SD and categorical data were expressed as numbers. Quantitative data were analyzed with a χ^2 test and categorical data were analyzed with an independent t test or an analysis of variance. Data were recognized as significant when $P < 0.05$.

Results

Comparisons of propofol doses, arousal time, and time for orientation recovery between both groups

As compared with the clinical group, propofol doses, arousal time, and the time for orientation recovery of the NT group were significantly less ($P < 0.05$), while the difference between doses of fentanyl was not statistically significant ($P > 0.05$) (Table 1).

Table 1 Comparison of the duration of anesthesia emergence and orientation recovery, doses of propofol and fentanyl, and postoperative visual analogue scores (VAS) between the Narcotend group and the clinical practice group

Item	Clinical practice group	Narcotrend group	<i>P</i>
Duration of emergence (min)	9.5 \pm 2.9	4.9 \pm 2.2 ^a	<0.01
Duration of orientation recovery (min)	12.2 \pm 3.5	6.6 \pm 3.2 ^a	<0.01
Dose of propofol (mg)	460 \pm 30	380 \pm 35 ^a	<0.01
Dose of fentanyl (mg)	0.13 \pm 0.03	0.15 \pm 0.03	0.68
VAS	0.46 \pm 0.52	0.54 \pm 0.69	0.23

All values are expressed as mean \pm SD of 20 patients in the relevant groups. Compared with the clinical practice group, $P < 0.01$.

Comparisons of heart rate and blood pressure between both groups

As compared with the clinical group, there was no difference

in heart rate or blood pressure between the two groups at the corresponding time ($P > 0.05$). The heart rate and blood pressure of both groups dropped after the induction of anesthesia, which was significantly different from those at other time points ($P < 0.05$, Figures 1 and 2).

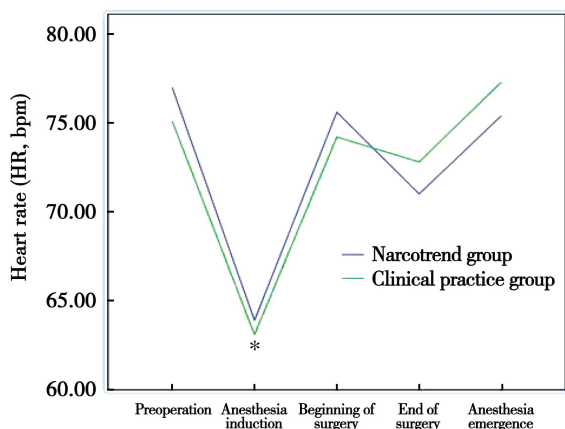


Figure 1 Changes in heart rate during different anesthetic stages in two groups of patients with liver cancer

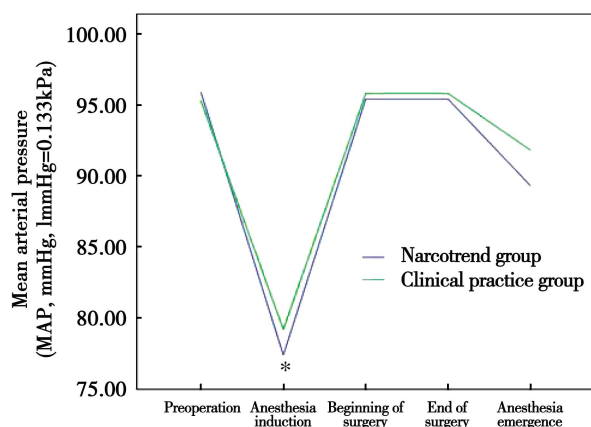


Figure 2 Changes in mean arterial pressure during different anesthetic stages in two groups of patients with liver cancer

Comparisons of the use of vasoactive agents

The uses of Ephedrine, atropine, metoprolol, and urapidil were not statistically different ($P > 0.05$).

Comparisons of the incidence of nausea and vomiting after surgery between both groups

No nausea or vomiting was reported after surgery for any patients, and no intraoperative awareness was reported by patients when followed up 24 h postoperatively.

Discussion

Microwave coagulation for liver cancer is conducted in a CT room, making it an operation that occurs outside the operating

room. Anesthesia facilities are simple in CT rooms and monitoring the perioperative depth of anesthesia is conducive to the reduction of anesthetic complications, such as upper airway obstruction by the tongue root, which is attributable to an overdose of anesthesia. Kreuer *et al.*⁷ found that when bispectral index (BIS) measurements were between 65–40 (indicating general anesthesia), 52.6% of NT was maintained at stage D and 41.1% was at stage E. No intraoperative awareness was reported during 1–3 d of postoperative follow-up.¹¹ The present study monitored the depth of anesthesia induced by intravenous propofol and fentanyl with NT. The NT was maintained at D2–E1 during surgery. The results showed that the hemodynamics of the NT group were stable and no intraoperative awareness was reported during follow-up, indicating good predictability of the depth of anesthesia.

In the clinical group, the depth of anesthesia was primarily evaluated by clinical indices, including heart rate, blood pressure, and body movement. Vasoactive agents were used to target the appropriate NT range for patients in the NT group. The results showed that there was no difference in the use of vasoactive agents between the two groups, while the use of propofol in the NT group was reduced, indicating that heart rate and blood pressure were insufficient in evaluating the depth of anesthesia, which might lead to drug overdose. Monitoring total intravenous anesthesia with propofol and fentanyl with NT can reduce drug dose, which is consistent with investigations from other countries.^{6,8}

Schmidt *et al.*⁹ proposed that NT could distinguish phases of induction, maintenance, and arousal during anesthesia with propofol/remifentanyl. Other studies show that NT monitoring can shorten anesthesia arousal time,^{10,11} while some other studies drew conflicting conclusions.⁶ In the present study, arousal time and the time for the recovery of orientation were shortened in the NT group, which might be attributed to the doses of propofol.

Remifentanyl-propofol is the most commonly used drug combination for total intravenous anesthesia. But anesthesia with remifentanyl may increase the risk of respiratory suppression and the occurrence of postoperative hyperalgesia. In the present study, VAS scores were low after the induction of anesthesia with total intravenous propofol and fentanyl, indicating the feasibility of total intravenous anesthesia with propofol and fentanyl in CT-guided microwave ablation for patients with liver cancer. The VAS scores were not significantly different during the waking phase between the two groups, which might be attributed to the insignificant differences of the fentanyl doses.

In conclusion, monitoring the depth of anesthesia with NT for microwave coagulation of liver cancer during total intravenous anesthesia with propofol and fentanyl can reduce the dose of propofol and shorten anesthesia recovery time.

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