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ORIGINAL ARTICLE

# Adverse effects of anesthesia in interventional radiology

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PURPOSE
The aim of the study was to evaluate adverse events related to the use of anesthesia and anesthetic procedures associated with interventional radiology.

MATERIALS AND METHODS
We retrospectively evaluated 124 interventional radiological procedures performed with anesthesia within a one-year period. Patients were separated into four groups according to the duration of procedure, the type of procedure performed, anesthetic agents used, and complications associated with anesthesia.

RESULTS
Of the 124 patients, 59 had neurovascular procedures, 10 underwent implantation of a tracheal stent, and 19 had painful procedures. Fifteen of 36 pediatric patients had diagnostic angiography, and 21 had interventional procedures. Two patients in the neurovascular intervention group had cerebral hemorrhage and cerebral infarctions, and anaphylactic reaction developed in one patient, who underwent percutaneous hepatic hydatic cyst drainage.

CONCLUSION
Interventional radiological procedures seem to be safe from an anesthesiologist's point of view. However, morbidity and mortality in this patient population can be reduced when the potential complications associated with interventional radiology are well understood by the anesthesia team.

*Key words:* • *anesthesia* • *radiology, interventional*

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Interventional radiology, which is a common treatment in Turkey, is increasingly performed with the administration of anesthesia. Escalating number of these procedures, as well as the variety in types and degrees of difficulty of interventional radiological practice, has brought about this occurence. Because the association of interventional radiology with anesthesia is relatively new, interventional radiology with anesthesia may involve unknowns for radiologists. Additionally, as interventional procedures occur outside the surgical environment, which is unusual for anesthesiologists, it may present unknowns for them as well. As yet, worldwide standardization has not been established for interventional radiological procedures (1). Therefore, we retrospectively evaluated our interventional radiological procedures performed with anesthesia and revised its adverse events within a one-year period.

## Materials and methods

We evaluated 124 interventional radiological procedures performed with sedation or anesthesia during the previous year. Patients were separated into four groups according to the duration of the procedures, the type of procedure performed, anesthetic agents used, and complications associated with anesthesia.

All the patients who underwent interventional radiological procedures associated with anesthesia were examined by anesthesiologists at least one day before the intervention and all necessary procedures or consultations were performed. Interventional radiological procedures performed with anesthesia were explained to the patients or their relatives. According to the nature of the intervention and patient's age, food was withheld for 6-8 hours the night before the intervention was performed. Intravenous cannulation was performed on all patients and blood pressure, heart rate, and peripheral oxygen saturation were noninvasively monitored. Anesthesia was administered with a Siemens Servo 710 (Siemens, Germany) equipment to the patients undergoing general anesthesia.

## Results

One-hundred and twenty-four patients who underwent interventional radiological procedures with anesthesia during the one-year period were evaluated. This represents 8% of all the patients who underwent diagnostic and interventional procedures in our radiology department during this time. Excluding diagnostic procedures anesthesia was used during the same time period in 18% of all patients undergoing interventional radiological procedures. Of the 124 patients, 59 underwent neurovascular procedures (i. e., intracranial aneurysm or arteriovenous malformation [AVM] embolization), 10 patients had implantation of a tracheal stent (5 had tumors, 3 of which were benign and 2 had nar-

rowing of the airway due to tracheomalacia), 21 were pediatric cases who underwent interventional procedures such as percutaneous drainage of liver hydatid cyst, soft tissue hemangioma, or renal cysts. Fifteen were pediatric patients undergoing diagnostic angiography, and 19 were adults undergoing painful procedures such as percutaneous biliary drainage.

Demographic data and intervention periods are shown in Table 1. In all patients receiving neurovascular interventions, or tracheal stent implantations, and in all pediatric patients, based on the level of difficulty of intervention, or the preference of anesthesiologist, orotracheal intubation or intratracheal general anesthesia was used. Diagnostic angiography team administered general anesthesia by mask or sedation-analgesia using midazolam, fentanyl, or ketamine. Sedation-analgesia with midazolam and fentanyl was used to ensure the cooperation of patients undergoing painful procedures.

Anesthetic agents used in interventional radiological procedures in our study are shown on Table 2. Adverse events were as follows: One of the two patients in the neurovascular intervention group had intracranial hemorrhage while the other one had coil protrusion and cerebral infarctions. Anaphylactic reaction developed in one patient who underwent percutaneous hepatic hydatid cyst drainage. No other complications were experienced by the other patients.

## Discussion

Although the frequency of interventional radiological procedures performed with anesthesia is increasing, there are no reports, to the best of our knowledge, in the literature concerning stardardization of such procedures (1). Additionally, there is only a small database about these procedures in Turkish publications. Mc Dermott et al. have reported that anesthesiologists observed only 10% of all patients who underwent interventional radiological procedures during the last 10 years (2). Of these patients, 68% had food withheld before the intervention, 60% gave written consent, 49% of patients were monitored during the intervention, supplemental oxygen was not administered to 16-28% of patients, although sedation-analgesic was. At least one exitus was reported in 28% of all radiology departments in England during the same 10-year period (2). In spite of the anathesiologist-monitored procedure ratio of 10% cited by Mc Dermott et al., 18% of all patients had interventional radilogocial procedures in association with an anesthesia team. Because of a lack of standardization or consensus about interventional radiological procedures performed with anesthesia, there may be undervalued points and negligence regarding these procedures.

As with surgical interventions, radiological intervention patients must be examined by both anesthesiologists and radiologists before the intervention is performed. Additionally, patients must be given information about the intervention and anesthesia technique to be used, and written consent must be obtained. Mc Dermott et al. emphasized these issues in their report, as a written consent was obtained from only 60% of their patients (2). Mueller et al. have reported that if patients were given information before the intervention, they felt more comfortable during the procedure and their pain scores were lower in comparison to patients who were not informed and did not give written consent (3). They also reported that patients who had undergone interventional radiological procedures were more relaxed and their pain scores were lower than patients who had never received interventional radiological procedures (3).

In our department, all the patients undergoing interventional radiological procedures were given information about the procedures and had given written consent. All of our department's patients undergoing anesthesia were examined by both a radiologist and an anesthesiologist. Moreover, laboratory examinations and additional consultations from departments such as cardiology were performed to provide optimum results.

All patients undergoing anesthesia or sedation had food withheld according to their ages at least 6-8 hours before the intervention. All of them were monitored during the intervention and additional oxygen support was supplied. It is interesting that only 18% of all patients undergoing interventional radiological procedures had the support of an anesthesia team. There was no mortality in patients undergoing interventional radiological procedures performed with anesthesia during the year we reviewed.

Haslam et al. (4) have reported that the most frequently used anesthetic drugs used during interventional radiological procedures in the USA was midazolam (92%), morphine (42%),

**Table 1.** Demographic data of the cases and the intervention periods

| Intervention | Number | Gender (and *n*) | Age (years) | Period of intervention (minutes) |
|---|---|---|---|---|
| Neurovascular | 59 | 39 M 20 F | 45.14 ± 22.75 | 123.6 ± 41.66 |
| Tracheal stent | 10 | 9 M 1 F | 52.31 ± 19.72 | 35.26 ± 13.52 |
| Pediatric | 21 | 15 M 6 F | 5.14 ± 3.22 | 23.46 ± 17.66 |
| Diagnostic | 15 | 7 M 8 F | 5.21 ± 2.55 | 26.42 ± 11.17 |
| Painful intervention | 19 | 8 M 11 F | 48.13 ± 18.67 | 29.51 ± 9.66 |

**Table 2.** The anesthetic media which were administered in our cases

| Number of cases | Fentanyl | Sevoflurane | Thiopental | Propofol | Midazolam | Ketamine |
|---|---|---|---|---|---|---|
| Neurovascular (n=59) | 59 | 59 | 55 | 4 | 0 | 0 |
| Tracheal stent (n=10) | 10 | 10 | 4 | 6 | 0 | 0 |
| Pediatric (n=21) | 10 | 16 | 0 | 0 | 4 | 4 |
| Diagnostic (n=15) | 13 | 11 | 0 | 0 | 10 | 8 |
| Painful intervention (n=19) | 19 | 0 | 0 | 0 | 16 | 0 |
| Total (n= 124) | 89% (111/124) | 77% (96/124) | 47% (59/124) | 8% (10/124) | 24% (30/124) | 9.6% (12/124) |

and diazepam (33%). They reported a European frequency of midazolam (58%), diazepam (45%), fentanyl (33%), and morphine (20%). We prefer intratracheal general anesthesia in neurovascular interventions and tracheal stent implantations for pediatric patients. There are some publications reporting a preference of sedation-analgesia in the same group of patients. Anesthetic drugs used during intervential radiological procedures in our department (including intratracheal general anesthesia) are shown in Table 2. According to American and European written reports, the difference in choice of our anesthetic media may be related to the experience of our radiology and anesthesia departments, the necessity of avoiding patient motion during the intervention, and personal preference of the physicians. We administer fentanyl intravenously (2 µg/kg) and generally combine it with 0.003-0.1 mg/kg of midazolam or 1-2 mg/kg propofol in our clinical practice. We administer thiopental and sevoflurane in the standard doses used in general anesthesia.

Because of our radiology department's sensitivity and to prevent time loss while awaiting anesthesiologists, alternative procedures were considered. Mason et al. discussed this situation in their report and according to a common protocol between radiology and anesthesiology departments in Boston Children's Hospital, they formed a sedation-analgesia protocol for doctors and nurses to follow in radiology departments (5). They were using glycopyrrolate, ketamine and midazolam in varying combinations in this protocol. Although this protocol is effective and safe, they emphasize the necessity of the anesthesia team to be ready for the potential risk of respiratory arrest or other complications. Unlike Mason et al., we use ketamine in repeated infusion (5). Because glycopyrrolate is not available in Turkey, we use 0.01 mg/kg atropine in our routine practice. Similar to this, we administer 0.5-1 mg/kg ketamine intravenously and 0.03-0.1 mg/kg midazolam. The drug doses that we use in our practice are shown in Table 3.

As there are great differences between endovascular and surgical treatments of the same pathology, there are also various anesthetics used. For example, in surgical treatment of a liver hydatid cyst, general anesthesia is required, but in percutaneous treatment, sedation-analgesia is sufficient. Furthermore, these procedures carry some risks and during or after the treatment some complications may occur. Whether performing neurovascular or the other interventional procedures, nearly all radiologists know the complications and their treatments and, therefore, they may manipulate the anesthesiologists if it is necessary. These adverse events may be prevented by the establishment of a permanent anesthesia team in radiology departments. Watkinson et al. have reported that forming a permanent anesthesia team in radiology departments may reduce the rate of morbidity (6). Jones et al. also emphasized this possiblility and they suggested that in interventional radiology departments, working with an experienced neuroanesthesia team is preferable (7).

Treatments that require a lengthy period of time in the operation room and also require a lot of intravascular interventions (e. g., blood, different anesthetic drugs, vascular tonus changers) are performed in our interventional radiology department with anesthesia and without any complications. But, for example, awakening period of AVM embolization is very critical, and because unnecessary straining and a sudden increase of blood pressure may cause intracranial hemorrhage, performing interventions with a permanent and experienced anesthesia team may prevent these adverse events.

In interventional radiology, complications related to the technique itself are treated by interventional radiological methods as well. After these procedures, clinical complications may occur, whether or not anesthesia was used. Talke has reviewed the intracranial aneurysms and reported the ratio of complications as 25.4% and 9.7%, respectively, and the ratio of mortality as 3.5% for the surgery team, and 0.5% for the endovascular team (8). Lusseveld et al. have researched the ruptured basilar aneurysm and have reported a long-term mortality of 30% for the surgery team and 11% for the endovascular team (9). Purdy et al. reported the ratio of complications as 11%, which they claim is due to multifactorial causes like patient selection and using anticoagulant or opioid-like drugs during the intervention (10).

Looking at our patients' complications, one patient undergoing neurovascular intervention had hemorrhage and the other had infarction. The patients were transferred to the intensive care unit and were discharged from hospital without any further complications. Anaphylactic reaction developed in one patient who underwent an intervention because of liver hydatid cyst. Hydatid cyst interventional treatments may cause fatal anaphylactic reactions if the content of cyst flows into the vascular circulatory system. Today, percutaneous treatment of liver hydatid cysts is the most safe and effective method in patients for whom the procedure is deemed appropriate (11). In our patient, urticaria, which started from the forehead and spread to the face and body, was observed a short time after the needle was inserted into the cavity of the cyst. Subsequently, unease, respiratory problems, bradycardia, hypotension, and cardiovascular collapse developed. Following this acute reaction, we performed orotracheal intubation and immediately administered 0.5 mg of IV adrenaline. Although the cardiogram was being monitored, cyanosis had developed and pulselessness continued. External cardiac compression was performed and a second dose of adrenaline was administered 5 minutes after the first dose. Cardiovascular collapse was reversed after approximately 10 minutes. The patient was then transferred to the reanimation clinic and was discharged one day later, fully conscious and lucid.

**Table 3.** Doses of anesthetic media that are used in our practice

| Procedure | Fentanyl | Thiopental | Propofol | Midazolam | Ketamine |
|---|---|---|---|---|---|
| IV | 1-2 µg/kg | 5-7 mg/kg | 1-3 mg/kg | 0.03-0.1 mg/kg | 0.5-1 mg/kg |
| IM | — | — | — | 0.08 mg/kg | 3-10 mg/kg |
| PO | — | — | — | 0.5-0.75 mg/kg | 5-6 mg/kg |

IV: intravenous, IM: intramuscular, PO: per oral

Missant and Velde have reported that anesthesia procedures performed outside of the operation room may increase morbidity and complications due to the difficulty of reaching the patient during an emergency, working in a small area, insufficient monitorization, and lack of cooperation between the working teams (12). Martin and Lennox also have reported that adequate monitorization may reduce the complications associated with interventional radiological procedures (13).

In conclusion, the type of anesthesic administration employed in interventional radiological procedures is determined by the physical conditions of the operation room together with the experience of the radiology-anesthesia team. When anesthetizing these patients, proper monitorization must be utilized and conditions for possible urgent intervention and intensive care observed because of the probability of complications such as hemorrhage, vascular occlusion, or anaphlactic reactions. Moreover, performing interventional radiology with a permanent anesthesia team in the radiology department may prove to be invaluable.

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