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CLINICAL REPORT

Monitored anesthesia care with dexmedetomidine of a patient with severe pulmonary arterial hypertension for inguinal hernioplasty

Hiromi Shinohara · Kiichi Hirota · Masami Sato · Masahiro Kakuyama · Kazuhiro Fukuda

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Abstract The presence of severe pulmonary arterial hypertension (PAH) is a significant risk factor of major perioperative cardiovascular complications in patients undergoing even non-cardiac surgery under anesthetic management. The most important aspect of perioperative care of PAH patients is to avoid pulmonary hypertensive crisis, which can be induced by alveolar hypoxia, hypoxemia, hypercarbia, metabolic acidosis, airway manipulations, and activation of the sympathetic nervous system by noxious stimuli. We report a case of successful monitored anesthesia care supplemented by dexmedetomidine for inguinal hernioplasty of a patient with severe PAH secondary to congenital heart disease.

Keywords Pulmonary arterial hypertension · Monitored anesthesia care · Dexmedetomidine

Introduction

Perioperative patient management, including anesthetic care, for patients with severe pulmonary arterial hypertension (PAH) is among the most challenging of critical care [1–3]. The anesthetic management of patients with PAH leads to a number of difficult problems, especially when regional anesthesia with central neuraxial blockade techniques is considered to be contraindicated. We report successful ilioinguinal/iliohypogastric block-assisted monitored anesthesia care (MAC) supplemented by dexmedetomidine for inguinal hernioplasty of a patient with severe PAH secondary to congenital heart disease.

H. Shinohara · K. Hirota (✉) · M. Sato · M. Kakuyama · K. Fukuda
Department of Anesthesia, Kyoto University Hospital, 54 Shogoin-Kawaracho, Sakyo-Ku, Kyoto 606-8507, Japan
e-mail: hif1@mac.com

K. Hirota
Day Surgery Unit, Kyoto University Hospital, Kyoto, Japan

Case report

A 21-year-old male (weight 38 kg; height 150 cm) was scheduled to undergo hernioplasty for right inguinal hernia with recurrent local swelling and pain. At the age of 1 month, he was diagnosed with atrial septal defect (ASD), ventricular septal defect (VSD), and persistent left superior vena cava. VSD closed spontaneously at the age of 1 year and 4 months. He was diagnosed with pulmonary hypertension at the age of 5 years. The latest heart catheterization (2 months before the hernioplasty) revealed severe PAH at rest under administration of 9 ng/kg/min prostaglandin I_2 (PGI_2) by way of superior vena cava and 250 mg bosentan per day (Table 1). Cardiac function assessed by cardioechography showed ASD and slight tricuspid regurgitation. SpO_2 was 90% under 2 L/min oxygen therapy at rest. Dyspnea was functional class IV [4]. Six-minute walk distance was about 500 m under oxygen therapy. He was prescribed 2 L/min oxygen therapy at night. His current medication consisted of spironolactone, furosemide, allopurinol, and bosentan per os and continuous infusion of PGI_2 [5, 6]. He was medicated with neither anticoagulant nor antiplatelet drug.

At the preoperative consultation, the patient was considered as ASA III [7]. Because of the high risk of general anesthesia and regional anesthesia with central neuraxial blocks from the points of view of circulation stability and anticoagulated state due to PGI_2 administration, MAC with ultrasound-guided ilioinguinal/iliohypogastric block was

Table 1 Heart catheterization data

RA[a]	LA[a]	RV[a]	mPA[a]	aAo[a]	CI (L/min/m^2)	Qp/Qs	Rp/Rs
8/6 (5)	10/7 (5)	94/7	95/43 (63)	84/56 (67)	1.88	1.53	0.62

Heart catheterization result (2 months before the hernioplasty) is demonstrated

RA right atrium, *LA* left atrium, *RV* right ventricular, *mPA* main pulmonary artery, *aAo* ascending aorta, *CI* cardiac index, *Qp* pulmonary blood flow, *Qs* systemic blood flow, *Rp* pulmonary vascular resistance, *Rs* systemic vascular resistance

[a] Values are in sys/dia (mean) mmHg

discussed and approved by the patient. The patient also approved off-label use of dexmedetomidine for anesthesia. On the day of surgery, he was admitted to our day surgery unit on foot with continuous administration of 9 ng/kg/min PGI_2 and premedication with spironolactone, furosemide, allopurinol, and bosentan. In the operation room, the patient was positioned supine. SpO_2 was 90%. PaO_2 and $PaCO_2$ were 62 and 26.6 mmHg, respectively, with 3 L/min oxygen therapy through facemask in supine position. Expiratory air was sampled from nostrils to measure $EtCO_2$ and respiratory rate. An ultrasound-guided ilioinguinal/iliohypogastric block was performed after intravenous injection of 2 mg midazolam. 20 mL 0.5% ropivacaine was administered under real-time ultrasound imaging to detect both the position of the needle tip and the spread of the local anesthetic. Airway devices, including oral and nasal airways, laryngeal mask airway, or cuffed oropharyngeal airway, were not used. MAC was then induced with intravenous administration of 0.4 μg/kg/h dexmedetomidine. After 15 min, the systemic blood pressure was 100/55 mmHg and the BIS number dropped from 95 to around 60. HR and respiratory rate were stable around 60 bpm and 18 times/min, respectively. Dose of dexmedetomidine was titrated between 0.2 and 0.3 μg/kg/h to give a BIS value around 65, or between levels 3 and 4 of the Ramsay sedation score (RSS) [8]. Blood gas analysis after completion of sedation revealed $PaO_2 = 60$ Hg and $PaCO_2 = 30.0$ mmHg. The hernioplasty with mesh plug was performed supplemented with intermittent local infiltration of 0.5% ropivacaine (total 32 mL) by surgeons. During the 71 min-operation, 4 mg ephedrine was injected once to treat systemic hypotension (75/40 mmHg). After the episode, the BP remained in the 85–95 mmHg systolic range for the remainder of the anesthesia. Oxygen saturation was around 90% throughout the anesthesia. Estimated blood loss was little and a total of 400 mL of crystalloid fluid was infused during 125 min anesthesia. After the operation, administration of dexmedetomidine was discontinued and the patient was transferred to the post anesthesia care unit (PACU). After 20 min, he emerged from MAC (RSS: level 2). He did not complain of dyspnea or wound pain at more than 20 mm of visual analogue scale (VAS) during the PACU. He did not request any pain killers in the ward. The patient was discharged on post operation day 1 with continuous infusion of PGI_2 without any circulatory crisis.

Discussion

A primary objective of anesthetic management in patients with PAH is to minimize increases in pulmonary vascular resistance and to maintain systemic vascular resistance [1, 3]. Abrupt increases in pulmonary vascular resistance may induce acute right ventricular failure or oxygen desaturation followed by reduced cardiac output in patients with intracardiac shunting. Pulmonary vascular resistance rapidly increases in response to a variety of stimuli, including alveolar hypoxia, hypoxemia, hypercarbia, metabolic acidosis, and activation of the sympathetic nervous system by noxious stimuli [1, 2, 7]. Hypoxemia and alveolar hypoxia are independent and additive pulmonary vasoconstrictors. General anesthesia also may cause significant hemodynamic instability in response to laryngoscopy, intubation, surgical incision, and the anesthetics themselves. Tracheal intubation has been reported to induce pulmonary hypertensive crisis and death in patients with severe PAH, especially at the time of induction of anesthesia. Positive-pressure ventilation may inhibit systemic venous return and can increase right ventricular afterload by closing of small pulmonary arteries [1, 3, 9].

Regional anesthesia also may be an acceptable alternative to general anesthesia for patients undergoing peripheral procedures such as inguinal hernioplasty. However, central neuraxial blocks may produce unacceptable decreases in systemic vascular resistance in patients with unrestrictive intracardiac shunts, and this action could exacerbate right to left shunting. In addition, those are contraindicated for the anticoagulated patients. Because of administration of PGI_2, which has a potent antiplatelet effect, anesthesia adopting central neuraxial blocks was avoided in this case.

Peripheral nerve blocks improve post-discharge analgesia and reduce opioid-related side effects, thereby facilitating the fast-track recovery process. The combination of local anesthesia and/or peripheral nerve blocks with intravenous sedative and analgesic drugs is commonly referred to as MAC and has become popular in the ambulatory setting [10]. Compared with general endotracheal and central neuraxial anesthetic techniques, MAC-based techniques can facilitate recovery in the ambulatory setting for superficial surgical procedures. The local and peripheral nerve blockage anesthetic technique that provides adequate analgesia is also recommended to minimize the risk of side effects and complications.

It is reported that a reduced level of sedation and greater respiratory depression, which should be avoided in patients with PAH, were noted with the potent opioid remifentanil. As an alternative we used the α_2-agonist dexmedetomidine. Dexmedetomidine reduces central sympathetic outflow and has been shown to induce anxiolysis and sedation [11]. Dexmedetomidine significantly reduced anxiety levels and the requirements for supplemental analgesic medications when given before intravenous regional anesthesia with minimal respiratory depression. Although the direct effect of dexmedetomidine is largely unknown, dexmedetomidine prevents collapse of pulmonary circulation elicited by various kinds of surgical stress [12–14]. Accordingly, in this case, significant respiratory depression, which resulted in reduced respiratory rate and accumulation of CO_2 compared with the baseline was not observed [15]. To overcome the disadvantage of slower onset of dexmedetomidine-induced sedation, midazolam was used to facilitate sedation in this case [15, 16]. Although it has been reported that slower recovery from dexmedetomidine-induced sedation and the occurrence of bradycardia have limited its use for MAC in the ambulatory setting, the patient emerged promptly after discontinuation of dexmedetomidine. Titration of dexmedetomidine according to BIS number and RSS might contribute to prompt emergence [16–19].

In summary, we present a case of successful ilioinguinal/iliohypogastric block-assisted MAC supplemented by dexmedetomidine for inguinal hernioplasty of the patient with severe PAH secondary to congenital heart disease. Dexmedetomidine is an effective baseline sedative for patients undergoing MAC providing less opioid requirements and less respiratory depression. Conditioned preoperative care, improved anesthesia, and surgical care enabled a medically stable ASA physical status III patient to undergo an operation by overnight stay-based surgery.

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