

Anesthetic Management and Role of Dexmedetomidine During Intraoperative Wake Up Test in Juvenile Idiopathic Scoliosis Correction Surgery: A Case Report

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Abstract: Although neurophysiologic monitoring has been continuously developing, a wake-up test is still regarded as gold standard to detect intraoperative motor dysfunction for scoliosis correction surgery. When the wake-up test is being performed, a calm and co-operative patient is truly required. Anesthesia for the wake-up test is one of the greatest challenges for anesthesiologists. One of the anesthesia for the test includes dexmedetomidine. Dexmedetomidine has sedative, analgesic and sympatholytic properties, suitable for the wake-up test procedures. This report aims to demonstrate results of dexmedetomidine to detect the intraoperative motor dysfunction for the scoliosis correction surgery during the performed wake up test. This patient was 11 years old. She was diagnosed juvenile idiopathic scoliosis with the Cobb's angle 55 degrees. She was scheduled for posterior fusion scoliosis correction with the intraoperative wake-up test. After the surgeon team requested the wake-up test, desflurane was discontinued, but dexmedetomidine was continued with the infusion. The test took only eight minutes before the patient's awakening with satisfying condition. The girl was perfectly co-operative without any postoperative recalls. During the wake-up test, dexmedetomidine was suggested as a kind of pertinent anesthetic considerations. Its properties were of analgesic, sedative, sympatholytic, and neuro-protective properties.

Keywords: Dexmedetomidine, Scoliosis, Wake-Up, Idiopathic

1. Introduction

Idiopathic scoliosis, most common type of spine deformity, refers to an unknown-cause abnormal lateral curve of spine that mostly affects children and adolescents [1]. Severe degrees of scoliosis can affect respiratory and cardiovascular functions. The incidence rates of idiopathic scoliosis among 11-13-year-old Thai children, were at 4.46% (1-2% in North America), which was more predominant among female than male children [2]. The deformity generally requires surgical correction in case the Cobb's angle is wider than 40 degrees [3]. The purpose of the correction is to prevent further reduction of the respiratory reserve [1]. However, the surgical correction probably results in motor dysfunction by rod compression or spinal cord ischemia. Therefore, an intraoperative motor function

examination, formally named as "The Stagnara wake up test" or simply called the wake-up test, has been applied since 1973 to detect complications as early as possible for immediate effective results of treatment [4]. The wake-up test has been the gold standard for scoliosis correction surgery [5] although there are several novel neurophysiologic monitoring techniques, including SSEP or MEP which can be intraoperatively applied to monitor sensory functions and motor functions simultaneously and continuously.

While the wake-up test is being performed, the patient is required to follow commands, ranging from hand gripping to leg rising. Both calmness and co-operation are necessarily needed to prevent any unintentional movements, causing both falling and accidental injury. Consequently, we administered dexmedetomidine, α_2 -adrenoreceptor agonist, during the test due to its pharmacologic properties [6-7],

compatible with the required prevention.

2. Case Report

Three years ago, an 11-year-old girl was diagnosed juvenile idiopathic scoliosis. She was looked after with braces and physical therapy, but her spine had its progressive lateral curve. Therefore, she was scheduled for the surgical correction, posterior T₄-L₁ vertebra spine fusion, and the wake-up test was also requested to detect any motor dysfunction after the rod screwing.

She had proper weight (40 kg) and height (152 cm) of her age. Except scoliosis, her other medical conditions were healthy. She could perform daily activities without dyspnea. She had no history of emergency admission, resulted from pulmonary and cardiac conditions. After her physical examination, her left shoulder was higher than the right one. Scapular asymmetry was found during Adam's forward bend test. Laboratory investigation revealed no polycythemia. Figure 1 displayed her spinal scoliosis, of which the Cobb's angle was 55 degrees, with its normal cardiac size and pulmonary vasculature was demonstrated via the chest radiography. However, a preoperative pulmonary function test had not been evaluated. This patient was accepted for the surgery under an ASA physical status II. The consent form was then obtained from her. One day before the surgery, she was informed and practiced to follow commands during the wake-up test again to confirm her actual comprehension.

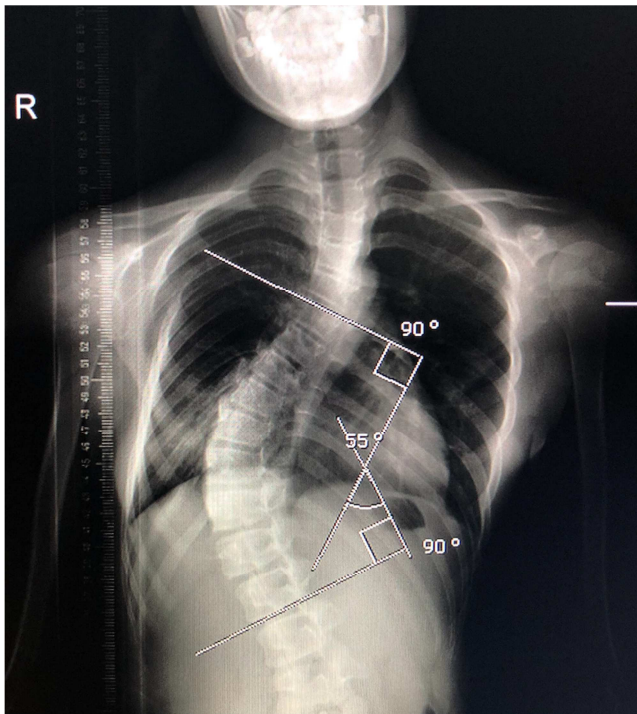


Figure 1. Chest Radiography with the Cobb's Angle Measurement of the Case.

On the day of the surgery, the patient was connected to routine standard monitoring and one invasive arterial line.

Moreover, she was monitored by depth of anesthesia with bispectral index (BIS) monitoring, which revealed 97% of BIS before induction. An analysis of arterial blood gas revealed that there was neither hypoxia nor hypercarbia with normal acid-base balance (pH 7.3, PaO₂ 249 (P/F ratio 500), PaCO₂ 40, HCO₃ 20.2, BE -6). After uneventful anesthetic inductions and intubations, the patient body was changed to prone position with her arm tucking. Then, the procedures started to be performed. The patient was stable with nearly baseline hemodynamics. Ventilation was controlled by EtCO₂ between 35 and 40 mmHg, together with oxygen saturation from 98 to 100%. Depth of anesthesia was maintained with 0.8 -1.0 MAC of desflurane in air, being titrated to keep BIS at 40-60% and maintain 0.4 mcg/kg/hr of dexmedetomidine infusion continuously. 0.5-1.0 mcg/kg of fentanyl was intermittently administered to control her intraoperative pain.

After the spinal rod instruments were placed, an orthopedic surgeon asked for the wake-up test. Not only desflurane was found to be discontinued, but atracurium also reversed its muscular blockage effects due to neostigmine and glycopyrrolate. We had been waiting until BIS monitoring showed the number up to 80%, and the TOF ratio rose to 0.7. However, 0.4 mcg/kg/hr of dexmedetomidine was continued infusion. The duration took eight minutes for a proper condition of the patient to wake her up. We asked her to grip her hands to evaluate of consciousness levels and then asked her to move her feet. She could do both two commands without any unfavored situations such as extreme movement which was likely to cause falling or accidental extubation.

The patient was administered by 1 mcg/kg of Propofol and 0.5 mcg/kg of Atracurium after the test. The results appeared satisfying. Furthermore, a level of anesthesia had been maintained exactly the same as the level before the wake-up test until the operation was successfully done. The total duration spent 5.5 hours with 2,000 ml of Acetar, 1,000 ml of HES, and a unit of packed red cells (250ml), which were replaced for 1,000-ml blood loss. Once, she was immediately extubated in the operating theater. At postoperative, there showed a refusal of intraoperative recall, 1 hour and 1 day respectively. Without any complications, four days later after the surgery, she was finally discharged from the hospital.

3. Discussion

Idiopathic scoliosis is one of the most common of spinal deformity (70% of all causes). It has been divided into three categories, depending on ranges of ages and coincidences with periods of rapid growth spurts – infantile (<3year of age), juvenile (3-10 year of age), and adolescent (>10 year of age) [8]. This patient was diagnosed juvenile idiopathic scoliosis due to its onset at eight years old. In general, degrees of spinal curvature potentially affect both respiratory and cardiovascular systems (Table 1) [3]. Most cases can be managed by conservative treatment. Simply, 0.2-0.5% of cases, which the Cobb's angle is wider than 40 degree,

require surgical intervention [9].

Table 1. Correlation of Angle of Curve and Symptoms in Patient with Scoliosis.

Angle of Curvature	Significance
<10	Normal
>25	Echocardiography Evidence of Increased Pulmonary Artery Pressure
>40	Surgical Intervention
>65	Restrictive Lung Disease
>100	Symptomatic Lung Disease, Dyspnea on Exertion
>120	Alveolar Hypoventilation

The fundamental requirement of surgical treatment is posterior spinal fusion with or without instruments. A preoperative evaluation and a preparation put an emphasis on displaying degrees of spinal curvature and indicating respiratory symptoms. Laboratory investigations, based on findings from the history and the physical examination in table 2 [1], are required.

Table 2. Preoperative Investigations for Scoliosis Surgery.

Routine Investigations	Additional Investigations
Plain Chest Radiography	ECG and Echocardiography
Pulmonary Function Test	(Non-Idiopathic Scoliosis)
Blood Test	Arterial Blood Gases (in case
Full Blood Count	Spirometry not Possible)
Coagulation Screen BUN and	
Electrolytes Calcium and Phosphate	
Blood Cross Match	

Pulmonary Function Test (PFT) should be routinely performed with all patients to detect a restrictive lung defect [1]. On the other hand, this case had no preoperative PFT, reported by the surgeons. The surgeon team revealed she had no respiratory symptoms, and her other conditions were reported healthy. Therefore, we ensured the patient's safe conditions by the arterial blood gas analysis which showed not only the patient had neither hypoxia nor hypercarbia, but acid base was also within its normal range.

The patient's spinal motor function was discovered after the instrument placing during the wake up test. However, it is of cautions for some patients who have contraindication for the test, including mental retardation, psychological problems or preexisting neurological impairment. Obviously, most of juvenile idiopathic scoliosis patients, similar to this patient, are children under ten years old. It is considerably necessary to evaluate each child about his/her maturity before making a decision to perform the test with a particular child.

The wake-up test needs patient's co-operations to follow commands during the test in order to prevent serious complications such as accidental tracheal extubation, falling from a surgical table, air embolism or rod dislocation [3]. There are many anesthetic regimens which are designed and provided for the wake-up test to achieve satisfying outcome. During the wake-up test, anesthetic goals are ranging from co-operative patients, adequate pain controlling and prevention of recall to fast waking up. The fast waking up is highly required in order to detect spinal cord's injury as early as possible, and then to solve certain concerning problems rapidly.

A proper anesthetic selection is a challenging issue among anesthesiologists. In this case, we chose anesthetics from literature reviews. There is an anesthetic-maintaining comparison between total intravenous anesthesia (TIVA) and inhalation anesthesia. Grottke O, et al. (2004) found that desflurane, a very low blood-gas coefficient anesthetic agent, had a significant shorter duration of awakening among the inhalation group than the propofol TIVA group did (6.2 mins vs 17 mins, respectively [10]. Therefore, it is recommended to provide desflurane to promote shortening awakening time.

Dexmedetomidine, a selective α_2 -agonist agent, has several characteristics suitable for the wake-up test such as analgesic and sedative effects without any respiratory suppression [11]. Bagatini A, et al. (2004) reported a case in which 0.4 mg/kg/hr of dexmedetomidine was administrated. Not only awakening time had not been prolonged, but it could be able to reduce patients' sympathetic response. The patient in the study quietly woke up without recall [7]. Furthermore, Ibraheim OA. (2013) conducted a study, of which the results revealed that dexmedetomidine-received patients had a shorter awakening time during the test than those who received fentanyl. Interestingly, there were 20% of patients in the fentanyl group who had recall, but those who received dexmedetomidine had no recall [12].

Dexmedetomidine contains another additional benefit which significantly helps reduce intraoperative blood loss due to blood pressure and heart rate reducing [13]. Therefore, dexmedetomidine should be considered as an adjuvant agent for the wake-up test [7]. Similar to previous studies, we chose to infuse dexmedetomidine during the test. This patient woke up within 8 minutes after discontinuing desflurane without any unsatisfying events.

Furthermore, there was some evidence of dexmedetomidine's neuroprotective effects in animal studies. The studies revealed that dexmedetomidine with several mechanisms could protect spinal cord injury from cord compression and ischemic reperfusion. 1. dexmedetomidine could lower interleukin-2 and a tumor necrosis factor (TNF- α), an inflammatory mediator, which potentially induced secondary spinal cord injury [14]. 2. dexmedetomidine promoted anti-inflammation genes, but suppressed a pro-inflammation gene expression [15]. 3. dexmedetomidine could reduce the neuropathic pain of rats' spinal cord injury by inhibiting a spinal purinergic receptor (P2X7R) gene which plays an important role in the neuropathic pain [16]. Consequently, these benefits were considered suitable for spinal surgery, especially scoliosis correction surgery. During the scoliosis correction by some instruments, the spinal cord might be compressed. In addition, the correction might probably result in losing certain amount of blood supply due to the stretching of the spinal arteries.

Preoperative pulmonary function tests are useful for evaluating a respiratory-reserved status. Among anesthesiologists, the test helps us decide to perform a postoperative extubation instantly. According to prior reviews, patients with mild to moderate scoliosis (Cobb's angle 55 degrees) have 87.5% of FVC and 87% of FEV₁,

indicating normal lung functions in a high ratio [17]. In addition, a retrospective case of a control study revealed preoperative arterial hypoxia in relation to postoperative complications [18]. Even if the patient of this case had no preoperative pulmonary function tests, after the surgery, we decided to extubate the patient immediately because the patient had no symptoms, no preoperative hypoxia and the Cobb's angle of her scoliosis was at its moderate level.

4. Conclusion

Anesthetic management for idiopathic scoliosis correct surgery with an intraoperative wake-up test is challenging for anesthesiologists. Using techniques and using anesthetic should be carefully selected for each particular patient. In this case, dexmedetomidine was recommended a kind of pertinent anesthetic considerations for wake-up tests owing to its analgesic, sedative, sympatholytic and neuro-protective properties. It revealed neither an unexpectedly intraoperative awakening nor a prolongation of post-anesthetic recovery time.

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