Intraoperative wake-up test in a deaf-mute adolescent undergoing scoliosis surgery

Yi-Chun Chen, Chien-Kun Ting, Mei-Yung Tsou, Kwok-Hon Chan, Ya-Chun Chu*

Department of Anesthesiology, Taipei Veterans General Hospital and National Yang-Ming University, Taipei, Taiwan, R.O.C.

ABSTRACT

We present our experience in intraoperative wake-up test in a deaf-mute feminine teenager who underwent spine surgery for correction of lordoscoliosis. Inadequate comprehension of the preoperative instructions, together with higher threshold of arousal in deaf-mutism may possibly contribute to lingering of the test. The report implicated direct, painful stimulation of the tested limbs, rather than indirect cues, such as flap on the dorsum of hands would be required for performance of wake-up test in the deaf-mute patients.

1. Introduction

To date, wake-up test (WPT) is still used for checking the spinal cord integrity during spinal surgery in our hospital. The WPT consists of gradually decreasing the anesthetic depth during or immediately after completion of spinal procedures,1,2 asking patients to squeeze the anesthesiologist’s hands and to move their feet upon verbal command, and by so doing the crude motor function is then evaluated. Here we describe a deaf-mute feminine teenager who was subjected to WPT during surgical correction of spinal scoliosis. WPT and somatosensory evoked potentials (SSEP) were applied to guard against intraoperative deterioration of neurological function. Verbal command was replaced by tactile stimulation of the hands during the test. However the test lingered for an hour, as the patient did not respond as originally planned until we slapped her in the soles of her feet. Inadequate recognition of the test, indirect tactile stimulation, together with higher threshold of arousal possibly resulted in the delay of her response to external stimuli during the WPT.

2. Case description

A 15-year-old female was admitted for the correction of a long rightward thoracic lordoscoliosis of 65° Cobb angle. Past history showed congenital deafness without the use of hearing aid ever. Education and communication relied on sign language and she was mentally normal. Physical examination revealed no neurological deficits. The surgeon requested intraoperative WPT for the detection of neurological impairment during the correction. The contents of preoperative anesthetic assessments included explanation of the procedure and potential risks of the test, which were conveyed to her in sign language by her father who acted as our interpreter. As the patient was totally deaf, verbal command relative to moving her hands or legs intraoperatively was replaced by tactile stimulation by flapping the back of her hands. Flapping the back of the right hand signified the request to move the right leg, while flapping the back of the left hand meant to move the left knee. Mimic scenes of the procedures (“FLAP-HAND- MOVE- LEG”) were practiced beforehand under the instructions of the patient’s father and the anesthesiologist.

Before anesthesia, the disposable Quatro Bis-Sensor (Aspect Medical Systems, Newton, MA) was applied to the forehead of the patient and connected to a BIS XP platform (Aspect Medical Systems, Newton, MA) monitor. General anesthesia was induced with 5 mg/kg propofol, 2 μg/kg fentanyl, and 0.15 mg/kg cisatracurium intravenously. After endotracheal intubation, anesthesia...
was maintained with desflurane (3.0–4.0 vol%) in oxygen, and continuous infusion of fentanyl at 1 μg/kg/hr. Cisatracurium was given under the guidance of train-of-four monitor to maintain surgical relaxation. End-tidal CO₂ was maintained between 35 and 40 mmHg. Body temperature was kept between 35.5 and 37.0 °C. Nitroglycerin infusion was given to induce controlled hypotension with the mean arterial pressure being kept between 65–70 mmHg. We entrusted the continuous SSEP to the neurophysiologist. Then the patient was placed in the prone position on the Wilson Plus™ Radiolucent Wilson Frame (OSI, CA, USA) for operation.

Upon the time for WPT at the surgeon’s request, the infusion of desflurane was cut and the infusion of fentanyl was discontinued. Fresh air was flushed to the breathing circuit for gradual washout of the inhalational anesthetic, and the lungs were manually ventilated. Following resumption of spontaneous ventilation, the patient was flapped at the dorsum of the hands every 30 s and the responding movement of the feet was closely watched and felt. Although the end-tidal concentration of desflurane gradually approached zero and the BIS level rose to about 90, no responses were noted. Mean on arterial pressure rose from the pre-test level of around 70 mmHg to 90 mmHg. Later on when the BIS returned to baseline level, the patient could gradually respond by fisting her hands or gripping the hand of the anesthesiologist tightly but was unable to move her legs a bit. Fortunately SSEP data were being registered throughout the course of surgical correction, and the surgeon requested completion of the test to rule out possible neurological deficit. After the test lingering about for almost one hour, the anesthesiologist in charge reluctantly asked the surgeons to drape the surgical wound and uncover the feet and then we gave direct slaps in the soles of the feet. Immediately, the patient dorsiflexed her knees upon the stimulation. After the surgeon was assured of unmolested neurological functions, anesthesia was re-induced with propofol and cisatracurium and desflurane was reintroduced to maintain anesthesia. The surgery was completed uneventfully.

Neurological examinations performed after the surgery were normal. There was no intraoperative recall of pain or of distress during the period of WPT. The patient’s recovery was also smooth and she was discharged home on postoperative day 7.

3. Discussion

Because there is paucity of discourse and discussion in literature focusing on anesthetic management of deaf-mute patients, the anesthesiologists are unable to communicate directly with these patients in sign language since they are not trained in this regard. Deafness may associate with anomalies of acknowledging the anesthetic significance and so, it makes history taking extraordinarily difficult. Thus intraoperative WPT for the deaf-mute is a taxing sweat for the anesthesiologists due to indirect personal communication.

Empirically, during the intraoperative WPT, the hearers appear to be cooperative (obey the command, like lifting up the head, or not lifting too much), oriented (can tell right from left, and hand from foot), and are presumably conscious. From the exhaled concentration of desflurane, the BIS value, and the eventual response that she fisted or tightly gripped the anesthesiologist’s hand in response to flaps, we believed she was conscious and ready for the test. But she failed to move her lower legs. This raised the suspicion of potential neurological damage despite normal SSEP recording. Eventually she moved her lower legs upon direct slapping in the soles of her feet. We speculated that she was awake but missed the “FLAP-HAND- MOVE- LEG” cue during that time period. Why couldn’t she recall and fail to retrieve the cue from memory? The failure may be impelled by the higher sensory threshold in deaf-muteness. Normally we can verbally demand a lightly anesthetized patient to initiate a movement cortically, but this is not the case if we choose tactile stimulation as a cue to make a patient move during light anesthesia. During induction of and emergence from anesthesia, hearing is the last sense to lose and the first sense to come back. Comparatively, recovery of cortical response to tactile stimulation is slower than that to the auditory stimulation. Deaf people have been assumed to rely more heavily on visuospatial codes, but however the visual pathway is most sensitive to the effect of anesthesia, and it is also difficult to use visual stimulation during anesthesia when the patient is in the prone position. Tactile stimulation was chosen as an alternative, nevertheless, cerebral processing of somatosensory input may be suppressed even by very low concentration of the anesthetics. Hence in our patient the cortically initiated movement did not materialize as we expected. According to the previous studies, BIS level at the time of moving during the WPT somewhat widely, ranging between 70 and 90. Our patient couldn’t move her hands until the BIS level was above 90 and moved her legs only at BIS level approaching to the baseline when the painful stimulation was directly applied to the soles. We speculate the arousal threshold of the deaf patients is higher than the patients with normal hearing due to the loss of auditory perception. Responses to tactile or painful stimuli were only detected at a higher BIS level than to verbal command. Polly et al. have previously applied tetanic electrical stimulation to the soles of the feet in very young children for intraoperative WPT. Thus in our case we had to change the intensity and location of stimulation to overcome the thalamocortical suppression by anesthetics. This alternative implicated that strong intensity of stimulation to the tested limb, rather than indirect cue was required for the deaf-mute to perfect the intraoperative WPT.

Proper communication with the deaf-mute patient before operation contributes much to fulfillment of WPT. As the test did not proceed as expected, we had some doubt if our patient fully understood the points of the test. As deaf people have their particular way of organizing information, different kinds of information or strategy presumably have different strengths for memory codes. There have been studies demonstrating that the symbols (in sign language) made with similar handshapes tend to disrupt memory performance and debilitate recall in deaf individuals. Another finding is the sign language takes more memory capacity than the spoken language. Comparatively people with normal hearing can fit more information into their limited-capacity articulatory loops than can deaf people. Taken together, difference in the way of language-memory interaction may contribute to inadequate recognition and subsequent memory formation. Therefore, the ability to communicate with the deaf-mute does not guarantee the ability to interpret or instruct. Practical improvements for effective preoperative communication include incorporation of certified sign language interpreters and the use of short video. A video illustrating the procedure (best with an interpreter presenting to answer any questions the patient may have on the spot) is helpful to communication with deaf patients.

Recall should be one of our concerns. It was reported that the probability for response to verbal command increased along with the potential for explicit recall when the BIS value lay between 60 and 70; and while the BIS value was more than 70, the probability of free recall significantly increased in healthy volunteers. It was also reported that during the WPT, the incidence of explicit recall was estimated to be 17% with a mean BIS level of 75.6 at the start of WPT and 92.9 at the time of purposeful movement. Comparable data in the deaf-mute patients are lacking. Our patient experienced a BIS level higher than those ever reported but without the development of recall.
Further investigations are required to elucidate the difference between the deaf patients and the patients with unmoledest hearing.

Prior to the mid-1970s, the only method for detecting spinal cord injury during corrective scoliosis surgery was the Stagnara wake-up test.\textsuperscript{15} Given the limitations of WPT, intraoperative neurophysiologic monitoring of SSEPs becomes commonplace in some spine centers after publication of the paper by Nash et al. three decades ago.\textsuperscript{16} However, there has been heightened concern and debate about the adequacy of monitoring the SSEPs alone, especially in patients with difficult and extensive deformities.\textsuperscript{17,18,19} The studies on the use of transcranial electric motor evoked potentials (MEPs) suggested the advantage of direct monitoring the spinal cord motor tracts by recording MEPs in addition to monitoring SSEPs.\textsuperscript{20} However, some spine centers have been reluctant to incorporate transcranial electric MEPs to their intraoperative neurophysiologic monitoring regimen despite the obvious benefits of MEPs over SSEPs. The reason is that neurophysiologists of MEPs require more advanced academic knowledge and sophisticated clinical skills than what are necessary due to it’s greater sensitivity to hypovolemia, hypotension, anemia, and anesthetics.\textsuperscript{21} Thus, the choice of the most proper intraoperative neural monitor for surgery of the spinal cord is usually the compromise among the surgeon, the anesthesiologist, and the neurophysiologist after communication. To date, some surgeons specializing in scoliosis still prefer WPT as their final judgment on neural functions in difficult cases. particularly when the signals of MEPs and/or SSEPs are ambiguous. In our preoperative evaluation, we usually contemplate that the object of the WPT is mental-competent, cooperative deaf-mute patient. However, we failed to evoke a voluntary motor response in all extremities by the cues agreed upon beforehand even the patient was actually awakened. We emphasize the neuropsychologic difference of the deaf under the effect of anesthetics and stress. If the deaf patient receives scoliosis surgery without a valid MEP or SSEP monitoring available, the WPT should be performed with some modifications.

In summary, this report implicates that application of strong stimuli directly to the tested feet is justifiable because cerebral function can still be blunt in the light plane of anesthesia. Preoperative communication through a certified sign language interpreter as a middleman together with video introduction of the WPT can effectively help improve the deaf-mutes’ comprehension and memory formation for this surgical intervention. Further investigations are necessary for understanding the difference of anesthetic significance in the deaf-mute patients.

References