

# Wake-up test during major spinal surgery under Remifentanil balanced anaesthesia

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**Abstract.** – Damage to spinal cord and subsequent neurological deficit is a recognised complication of major spinal surgery.

It may be produced by a number of causes, not last excessive stretching when surgical instrumentation is positioned; it is easy to understand that early intraoperative warning of potential damage is highly desirable.

Wake-up test is a simple, safe and reliable method of recognition of such a complication, allowing rapid neurological recovery by reduction of spinal distraction.

Remifentanil belongs to a new pharmacokinetic class of opioids (EMO: Esterase Metabolised Opioid) undergoing rapid biotransformation to minimally active metabolites, showing a short and predictable duration of action with no effect of accumulation.

Authors describe a first 10 patient series subjected to wake-up-test during spinal surgery under remifentanil balanced anaesthesia. The protocol the authors set up allowed a very rapid intraoperative neurological examination (in average less than 5 min), without pain and/or disagreement for the patient and no complication related to the test was observed. Authors conclude that the use of Remifentanil for intraoperative awakening during major spinal surgery seems to be a safe, reliable and practical method to detect very quickly any potential neurological damage during the operation.

*Key Words:*

Surgery, Spinal monitoring, Intraoperative opioids, Remifentanil.

## Introduction

Damage to spinal cord and subsequent neurological deficit is a recognised complication of major spinal surgery. It may be produced by occlusion or spasm of the artery of

Adamkiewicz, haemodilution, or excessive stretching of the spinal cord when surgical instrumentation is positioned.

Symptoms vary from transient postoperative sensory changes to paraplegia, Brown-Sequard syndrome and various degrees of motor-sensory impairment.

Early warning of potential damage is highly desirable and two main methods are currently used, alone or in combination: intraoperative electrophysiological monitoring and wake-up test, first described by Vauzelle et al. in 1973<sup>1</sup>.

Electrophysiological monitoring techniques are more sophisticated: however, artifacts may be a problem in the operating room, and false positive or negative cases can occur; not last, monitoring requires expensive equipments and specially trained technicians to be performed. Last but not least, equipment is not always available.

The wake-up test must be performed by a skilled anaesthesiologist, but it does not require any special apparatus. Many Authors used it routinely in patients undergoing surgery involving distraction and/or instrumentation of the spine and various techniques have been proposed<sup>2</sup>.

Remifentanil is a mu-opioid receptor agonist representing a new pharmacokinetic class of opioids named Esterase Metabolised Opioid (EMO)<sup>3</sup>. Remifentanil undergoes rapid biotransformation to minimally active metabolites, showing a short and predictable duration of action with no accumulation of effect, even when a relative overdose of the drug (i.e. long lasting operations on the spine) occurs.

An anaesthetic agent allowing more rapid assessment of the patient could be beneficial when the wake-up test is required. We

used Remifentanyl in a first series of 10 patients undergoing posterior spinal surgery (see Table I for demographic data and Table II for surgery) setting up the following protocol.

## Materials and Methods

### Study design

Patients scheduled for surgery are told some days before that they would be awakened during the operation to check voluntary motor function of the lower limbs.

They are reassured that they will feel no pain at all, will quickly go asleep again, and will not remember the procedure.

The explanation is a part of preoperative assessment of the patient, permits to obtain the consent to the procedure, and makes her/him cooperating. Crawford et al. used hypnosis as an adjunct to anaesthetic management<sup>4</sup>, but in our experience a complete explanation of the technique stressing the importance of checking motor function intraoperatively makes the patient very cooperative. The day of the operation she/he is premedicated with diazepam ( $0.1 \text{ mg} \times \text{kg}^{-1}$  p.o.) and atropine sulfate ( $0.01 \text{ mg} \times \text{kg}^{-1}$  i.m.).

Anaesthesia is induced by a loading dose of Remifentanyl ( $1 \text{ mg} \times \text{kg}^{-1}$  i.v. over 30 sec), followed by a continuous infusion ( $0.5 \text{ mg} \times \text{kg}^{-1} \times \text{min}^{-1}$ ). Vecuronium bromide ( $0.1 \text{ mg} \times \text{kg}^{-1}$ ) is used for tracheal intubation and the patient is ventilated with  $\text{O}_2/\text{N}_2\text{O}$  ( $\text{FiO}_2 = 0.5$ ) and MAC 0.5 Sevoflurane. For maintenance of anaesthesia the remifentanyl infusion rate is reduced by 50%, 5 min after intubation and titrated to maintain stable haemodynamics and an appropriate level of anaesthesia during surgery.

30 minutes before the execution of the test recovery from neuromuscular block is checked by transcutaneous train-of-four stimulation of ulnar nerve at the wrist.

Table I.

Demographic data of patients	
Gender (M/F)	4/6
Age (years) $\pm$ SD	20.5 $\pm$ 6.17
Weight (kg) $\pm$ SD	38.41 $\pm$ 15.83

Table II. Surgery.

Cause	Number
Idiopathic scoliosis	8
Neurofibromatosis	1
Marfan's syndrome	1
Operation mean time (min $\pm$ SD)	445 $\pm$ 85

Then awakening is accomplished by withdrawing sevoflurane 20 minutes before the test. 5 minutes later  $\text{N}_2\text{O}$  is turned off and 100% oxygen is administered while Remifentanyl infusion continues through the wake-up period at the analgesic rate of  $0.1 \text{ mg} \times \text{kg}^{-1} \times \text{min}^{-1}$ .

The patient is then called by her/his first name, asked to move the hands, and, after a positive response asked to move both feet.

Spontaneous breathing during the test is not allowed; the surgical wound is sealed with wet paks, to avoid air embolism through open venous sinuses if deep inspiration of the patient occurs<sup>5</sup>; firm but gentle pressure is applied to the spine until the test has been completed. Throughout the test the patient is continuously reassured.

Once adequacy of spinal function has been checked, the patient is reanaesthetized with thiopentone ( $2 \text{ mg} \times \text{kg}^{-1}$ ) and diazepam ( $0.1 \text{ mg} \times \text{kg}^{-1}$ ) i.v. for its amnesic effect. Remifentanyl infusion starts again following the procedure described in the first part of this section, sevoflurane and  $\text{N}_2\text{O}$  are given again. Supplemental doses of muscle relaxant may be given and mechanical ventilation is continued until the end of surgery.

## Results

Following the protocol intraoperative neurologic examination was done in 4 to 6 minutes (in average  $4.8 \pm 1.5$  min.) after the reduction of remifentanyl anaesthetic rate infusion to analgesic. Minor changes in haemodynamics during the test were observed: heart rate increased in average 16.6% and blood pressure 13.3%. See Table III for details.

We did not observe any complication related to the test. Only 2 patients out of 10 re-

Table III. Haemodynamic changes during the wake up test.

	Before	During	After
M.A.P. (mmHg $\pm$ SD)	80.41 $\pm$ 5.77	91.07 $\pm$ 4.07	81.12 $\pm$ 7.33
HR (bpm $\pm$ SD)	59.14 $\pm$ 7.19	68.98 $\pm$ 9.03	58.78 $\pm$ 8.01

membered the procedure, but did not regard it as painful or more generally as disagreeable.

### Discussion

Paraplegia is one of the most feared complications of spinal surgery. In a series of over 30000 patients compiled by the Scoliosis Research Society the incidence of partial or complete paraplegia was 0.6%<sup>6</sup>.

The wake-up-test, also known as Stagnara's test<sup>1</sup> is an easy way to detect voluntary motor function of the lower limbs. Complications of the technique are very few<sup>7</sup> and we have no knowledge of false-negative wake-up results. Only Diaz and Lockhart<sup>8</sup> reported a case involving a patient with presumed idiopathic scoliosis who had a negative wake-up test and developed a flaccid quadriplegia over the next 12 hours from a previously undiagnosed syrinx that had been extended by the scoliosis correction.

Intraoperative awakening test can be used alone or in combination with electrophysiological monitoring, being a very useful adjunct when the latter shows deteriorate responses, or to confirm positive electrophysiological data.

Contraindications to the test are mental retardation, psychological problems or preexisting neurological impairment. Also language could be a problem in this era of globalization, being foreign patients sometimes unable to understand instructions by the operating team. It is obvious that in major spinal surgery time is crucial to detect as early as possible medullary damage, since absent or unpaired function on testing may recover over a few minutes if distraction will be released.

An anaesthetic agent as Remifentanil, allowing a more rapid assessment of the pa-

tient seems to be beneficial in major spinal surgery. Using manufacturer's recommended dosages, Remifentanil allowed, in our preliminary report, a rapid neurologic evaluation without sacrificing the haemodynamic stability of traditional high-dose opioid techniques.

The extremely rapid clearance from blood and tissue by non specific esterases results in short and predictable duration of effect<sup>9</sup>, while its closest competitor, alfentanil, depends on a small volume of distribution for rapid termination of its effect, but still possesses the potential to accumulate, after long infusions, because of its relatively long terminal elimination half-life.

We often noted, as Vinik and Kissin did<sup>10</sup>, the development of tolerance during long lasting operations as those included in this report. For this reason infusion rate has been constantly titrated and eventually increased to maintain a stable level of anaesthesia.

Interestingly, tolerance did not seem to affect analgesic recommended infusion rate of Remifentanil during the execution of wake-up test.

The use of a combined monitoring, intraoperative awakening and electrophysiological techniques would be optimal; Stagnara's test alone, however, performed with an anaesthetic technique allowing a rapid recovery to a level of consciousness, is a reliable and practical method to detect as soon as possible neurological problems during major spinal surgery.

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