Submitted March 2015, accepted July 2015

CLINICAL IMAGE

Electrical burns caused by a train-of-four monitor

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Keywords - **burn, train-of-four, TOF**

Abstract

A 56-year-old Caucasian female was admitted to our ICU because of acute respiratory failure due to severe pneumococcal pneumonia. She was intubated and mechanically ventilated. Due to progressive respiratory deterioration culminating in arterial hypoxaemia and hypercapnia, the patient was turned into the prone position to improve oxygenation. The patient was sedated to a Richmond agitation and sedation score of -4. Neuromuscular blocking agents (NMBAs) were started within two hours of the diagnosis of acute respiratory distress syndrome (ARDS), as this treatment may improve mortality and decrease the duration of mechanical ventilation and complications related to barotraumas in ARDS patients when started early and continued for 48 hours.[1]

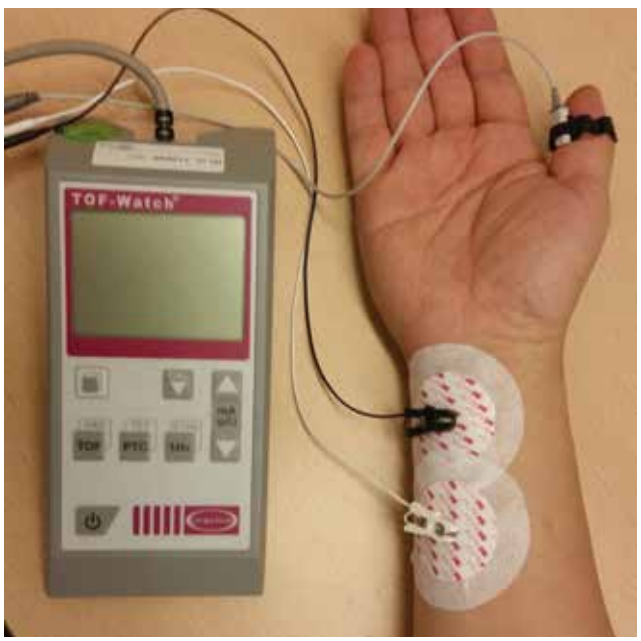

Figure 1. A TOF-watch

To assess the depth of neuromuscular blockade and ensure proper medication dosing, a train-of-four (TOF) monitor was used. The model is TOF-Watch®. The electrodes are attached to the skin on the internal surface of the wrist, along the course of the ulnar nerve. The contact area of the stimulating electrodes is 7 mm *(figure 1)*. The nerve is stimulated by four successive stimuli delivered at 2 Hz with a current of 50 mA. With increasing degrees of block, the twitches in the TOF progressively fade starting with the fourth and eventually disappear one by one. The ratio of the height of the fourth response to the first has been defined as the TOF ratio. The optimum level of neuromuscular blockade is reached when 80-90% of receptors are blocked; this corresponds with 1 or 2 twitches on TOF testing. When using continuous infusion of NMBAs, TOF monitoring is recommended for neuromuscular monitoring. A baseline measurement is started and thereafter performed every 15 minutes until adequate depth of muscle relaxation has been achieved, after which the measurement is performed every four hours.

Figure 2. Second-degree burns on the wrist caused by peripheral stimulation of the ulnar nerve

In our patient TOF monitoring was used. However, 40 hours after the start of NMBAs, second-degree burns were observed on the wrist with superficial skin necrosis *(figure 2)*. The TOF monitor was immediately removed and neuromuscular blockade was discontinued. The patient had been ventilated in the prone position for 38 hours and had been turned into a supine position two hours before discontinuation of NMBAs. Electrical burns of the skin caused by a peripheral nerve stimulator has been reported previously in one publication.[2] However, in the past 40 years no additional cases have been reported even though various operating manuals of TOF monitors warn for electrical burns in case of high-current intensity or tetanic stimulation. The burns on the wrist of our patient seemed to be caused by the repetitive electrical pulses sent by the TOF monitor. Pressure sores seemed unlikely as the patient had been treated in prone position in an air fluidised bed with arms alongside the chest and abdomen with palms facing upwards. An allergic reaction was also unlikely as the same electrodes were used for heart rhythm monitoring. The reported current level was 50 mA and measurement was performed every four hours at a frequency of 2 Hz according to the protocol. The causes of the electrical burns in our patient may be monitor malfunctioning with uncontrolled current intensity or a too rapid firing frequency. Another possible cause is high skin resistance due to dry skin or the presence of preliminary scar tissue at the contact area of the electrodes. As defined by Joule's law, the higher the skin resistance the more heat is released in the skin which causes skin injury. However, the TOF monitor's alarm for high skin resistance did not go off and no malfunctioning of the monitor was found on re-examination of the device. The wound was cleaned and the skin was viable, so no surgical exploration was needed. The burns were treated with sulfadiazine cream. The patient's skin healed completely within 12 weeks.

TOF monitoring is frequently used in the ICU to assess the depth of neuromuscular blockade. Electrical burns are a rare, but serious complication. We therefore advise to regularly check the site of the TOF monitor for burns and the TOF monitor itself for malfunctioning by assessing the electrical pulse interval and the current intensity. Immediate discontinuation of TOF monitoring is advised.

Disclosure

All authors declare no conflict of interest. No funding or financial support was received.

References

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