
Brief Reports

Onset of vecuronium neuromuscular blockade at the hand with an arterio-venous shunt

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Purpose: To evaluate the onset of vecuronium neuromuscular blockade in the hand with an arterio-venous shunt for haemodialysis.

Methods: In 15 adult patients receiving haemodialysis for renal failure the onset of vecuronium-induced neuromuscular blockade after 0.08 mg·kg⁻¹ vecuronium iv was measured. Using train-of-four mechanomyographic monitoring, the force of contraction of the adductor pollicis of both hands with and without arterio-venous shunt was measured simultaneously.

Results: The times from the injection to the first depression of twitch response (latent onset) and 95% twitch depression (onset) in the hand with and without arterio-venous shunt were 114.7 ± 33.4 and 218.7 ± 59.9 and 117.3 ± 34.3 and 208.7 ± 60.9 sec respectively. No difference in the onset of vecuronium neuromuscular blockade in the hand an arterio-venous shunt was demonstrated.

Conclusion: The presence of an arteriovenous fistula does not modify the onset on neuromuscular blockade. Either arm can be used to monitor onset of neuromuscular blockade in chronic renal failure patients with an arterio-venous shunt in the hand for haemodialysis.

Objectif : Évaluer au niveau de la main l'installation du bloc neuromusculaire au vécuronium chez des porteurs d'un shunt artérioveineux installé pour l'hémodialyse.

Méthodes : On a mesuré chez 15 adultes hémodyalisés pour insuffisance rénale l'installation du bloc neuromusculaire après l'administration de 0,08 mg·kg⁻¹ iv de vécuronium. Des moniteurs mécanomyographiques ont servi à mesurer le force de contraction de l'adducteur du pouce aux deux mains dont celle du shunt artérioveineux.

Résultats : Les intervalles mesurés entre l'injection et la dépression du premier twicht (latence d'installation) et 95% (installation) avec et sans shunt artérioveineux étaient respectivement de 114,7 ± 33,4 et 218,7 ± 59,9 et 117,3 ± 34,3 et 208,7 ± 60,9 s. L'installation du bloc neuromusculaire au vécuronium ne différait pas du côté shunt.

Conclusion : La présence d'une fistule artérioveineuse ne modifie pas l'installation du bloc neuromusculaire. On peut utiliser indifféremment les deux bras pour le monitoring de l'installation du bloc neuromusculaire chez les insuffisants rénaux chroniques porteur d'un shunt artérioveineux pour hémodialyse.

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THE accurate measurement of onset time is important to estimate the timing of tracheal intubation in clinical practice. The onset time of neuromuscular block by a relaxant is affected by change in regional blood flow.^{1,2} Monitoring neuromuscular block at the hand in the presence of an arterio-venous shunt for haemodialysis may be misleading because an arterio-venous shunt may affect regional blood flow and change drug delivery to the receptor sites in the hand muscles. The purpose of this study was to evaluate the onset of neuromuscular block of vecuronium at the hand with an arterio-venous shunt for haemodialysis in chronic renal failure.

Methods

With approval from our Human Research Committee and informed consent, 10 adult male and five female patients with chronic renal failure scheduled for elective surgery aged 23–64 yr and weighing 43–65 kg with an arterio-venous shunt in the forearm for haemodialysis were studied. All were haemodialyzed one day before surgery. Premedication consisted of 2–2.5 mg midazolam *im* one hour before induction of anaesthesia. None of the patients had neuromuscular diseases or received any medication that might alter neuromuscular transmission. Serum potassium concentration before anaesthesia was $< 4.5 \text{ mEq}\cdot\text{L}^{-1}$ in all patients. Anaesthesia was induced with 2–3 mg midazolam *iv* and maintained with fentanyl and nitrous oxide (50–60%) in oxygen administered by face mask. Ventilation was controlled manually to maintain normocapnia. After stable responses from the both adductor pollicis muscles had been obtained for > five minutes, the patients were given $0.08 \text{ mg}\cdot\text{kg}^{-1}$ vecuronium through an indwelling cannula on the dorsum of a hand without arterio-venous shunt.

Train-of-four responses in both hands were simultaneously recorded every 12 sec by measuring the force of thumb adduction produced in response to supramaximal stimulation of the ulnar nerve at the wrist (Myograph 2000, Biometer, Denmark). The resting tension applied to the thumb was adjusted to 200 g. The degree of neuromuscular block was measured as the decrement in contractile response of the first response (T_1), relative to control. The times from the administration of neuromuscular relaxant to the first depression of T_1 (latent onset time) and to depression of T_1 to 5% of control were measured. The temperature of the skin covering the thenar eminence was also measured (Thermofiner CTM303, Treumo, Japan).

Data were expressed as mean \pm SD and analysed by ANOVA, followed by Student's *t* test. $P < 0.05$ was considered significant.

Results

Complete depression of the first twitch responses after vecuronium was observed in all patients. No difference in skin temperature was demonstrated in the both hands. The times from vecuronium injection to the start of depression of the train-of-four response (latent onset time) and to 95% depression of single twitch height (onset time) were not different in the hands with and without an arterio-venous shunt (Table). Because we wished to minimize circulatory disturbance in the forearm with an arterio-venous shunt by tightly immobilization of the hand in a split for a long time, we are not able to observe the recovery from neuromuscular blockade in more than two of the fifteen patients before the trachea was intubated. In those two cases, no differences in speed of recovery of neuromuscular blockade between the hands were demonstrated.

Discussion

This study demonstrated that an arterio-venous shunt for haemodialysis in the forearm did not affect the onset of vecuronium neuromuscular blockade in the adductor pollicis muscle.

Monitoring of neuromuscular blockade in the adductor pollicis muscles is routine during the administration of muscle relaxants. Neuromuscular relaxants are clinically administered into a vein on the hand. In the present study, vecuronium was injected through an intravenous cannula on the back of hand without arterio-venous shunt. It has been reported that onset of neuromuscular block was similar if the ipsilateral or contralateral hand to the injection site was used for monitoring neuromuscular blockade.³ This indicates that the interval between injection of the drug in a peripheral vein and its arrival at the neuromuscular junction of both adductor pollicis muscles produces no difference in onset time between the two upper limbs monitored in the present study. Goat *et al.*¹ studied the onset time of gallamine in an animal model in which blood flow to the muscle under study was controlled through a roller pump and showed that the onset and depth of paralysis were inversely related to

TABLE I Time to latent onset and to 95% twitch (T_1) depression in the hand with and without an arterio-venous shunt for haemodialysis after intravenous administration of $0.08 \text{ mg}\cdot\text{kg}^{-1}$ vecuronium.

Monitoring side	Time to latent onset (sec)	Time to 95% T_1 depression (sec)
hand without shunt	117.3 \pm 34.3	208.7 \pm 60.9
hand with shunt	114.7 \pm 33.4	218.7 \pm 59.9

regional blood flow of the muscle being monitored. We believe this is the first report in which regional haemodynamic changes affect the onset time of neuromuscular relaxant.

The extent of neuromuscular blockade produced by relaxants is also affected by non-circulatory factors such as receptor affinity, potency, or concentration of the drug at the neuromuscular junction.^{4,5} The speed of drug diffusion from capillary blood to the receptor sites of the muscle being monitored is governed by the concentration-gradient of the relaxant. Feldman *et al*⁶ demonstrated that the onset of action of neuromuscular blocking agents following the administration of same dose of relaxants was much quicker after a single bolus injection than after an infusion, although the intensity of maximum block was similar. Thus, access of neuromuscular blocking agents to the neuromuscular junction can be influenced by a concentration-gradient between the receptor area and plasma.

The circulatory and non-circulatory factors above might produce a change in the delivery, diffusion rate, or concentration-gradient of a neuromuscular blocking agent in the adductor pollicis muscle in patients with an arterio-venous shunt in the forearm. In the present study, no difference in the onset of action of vecuronium between the hands with and without an arterio-venous shunt was demonstrated. All patients including had arterio-venous shunts inserted more than one year before the study. Although we did not measure local capillary blood flow in the forearm with an arterio-venous shunt for haemodialysis, it was assumed that this time interval was enough to grow the collateral vascularization in the forearm with an arterio-venous shunt for haemodialysis. Indeed, no difference in the temperature of skin surface was found between the forearms.

We conclude that the hand with an arterio-venous shunt for haemodialysis may be used for assessing onset of neuromuscular block following a standard dose of vecuronium administered into a peripheral vein in patients with chronic renal failure.

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