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Reversing the Effects of a Peripheral Nerve Block with Normal Saline: A Randomised Controlled Trial

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Abstract

Objective: The objective of the present study was to determine whether or not the effects of peripheral nerve block can be reversed by flushing normal saline down a peripheral nerve block catheter following the completion of arteriovenous (AV) fistula surgery.

Methods: In the present study, 38 patients undergoing AV fistula surgery were recruited, and a brachial plexus block with a peripheral nerve catheter was established. Following surgery, the patients were randomised to either the control group or the washout group, where 10 mL of normal saline was flushed down the peripheral nerve catheter at 15-minute intervals for 1 h while the patients were in the postoperative recovery room. An observer blinded to the patient group allocation assessed motor and sensory functions in all patients at 15-minute intervals for 1 h, and pain scores were recorded.

Results: There was no difference in time to resolution of motor or sensory block in the two groups. The median changes in the motor score were 1.5 out of 10 for the control group and 2 for the washout group (p=0.95). The median changes in the sensory score were 3 out of 10 for the control group and 1 for the washout group (p=0.14). There were no differences in pain scores over the study period in either group (p=0.44).

Conclusion: We were unable to show any useful improvement in block resolution with normal saline washout of supraclavicular or infraclavicular brachial plexus blocks following AV fistula surgery.

Keywords: Arteriovenous fistula, conduction anaesthesia, nerve blockade

Introduction

Peripheral nerve blockade has a number of potential benefits to the patient with respect to pain relief and avoidance of general anaesthesia. However, there are times when blockade of the target nerve or inadvertent blockade of the surrounding nerves is not well tolerated by the patient. The classic example of this is inadvertent blockade of the phrenic nerve while undertaking a brachial plexus block.

There is reasonably robust evidence in the literature supporting the reversal of epidural anaesthesia and analgesia with either normal saline or Ringer's lactate solution lavage to 'washout' the neural blockade achieved with local anaesthesia (1-4). There are several case reports of this being applied to an interscalene brachial plexus block to reverse the effects of a phrenic nerve blockade (5-9).

The aim of the present study was to test whether there is any shortening of the duration of motor and sensory blockade with an intermittent bolus of normal saline down a peripheral nerve catheter following brachial plexus blockade for arteriovenous (AV) fistula formation.

Arteriovenous fistula surgery was selected for the present study for a number of reasons: it is traditionally a day stay surgery, and therefore improved recovery post-regional blockade may provide some additional safety/functional

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improvement to the patient, and because it is not traditionally painful, rapid regression of the block would not be detrimental to the patient's postoperative analgesic management.

Methods

The study was approved by the Health and Disability National Ethics Committee (approval no.: 14/NTB/45). The clinical trial was registered with the Australian and New Zealand Clinical trials network (reference no.: ACTRN12618000129280).

A sample size was calculated on a 50% increase in speed of resolution of the block being a clinically significant change in the time taken for the block to wear off. With this change in block resolution, 12 patients would have been needed in each group to show a statistically significant difference between the groups. To account for drop outs and missing data, the aim was to recruit 20 patients in each group.

Patients scheduled for an AV fistula under branchial plexus block between November 2014 and January 2016 were approached to participate in the trial. A total of 38 patients agreed to participate in this period, signed informed consent documents and were randomised to the trial. Randomisation was via concealed envelope to either the control group or the treatment (washout) group. Overall, 20 were randomised to the control group, and 18 were randomised to the washout group.

It was expected that the approach to the brachial plexus would be either an infraclavicular or a supraclavicular block. One patient from the washout group after randomisation received an axillary brachial plexus block and was subsequently excluded from the analysis. The CONSORT diagram shows the number of patients eligible in the period. The majority of patients were excluded due to the unavailability of research staff to undertake the study. There was no restriction on being in the study multiple times for different surgical encounters; one patient was recruited to be in the study twice and was allocated to different groups on each occasion.

The approach to the brachial plexus was left to the discretion of the attending anaesthetist. All patients had a catheter over needle technique (Pajunk Tsui e.catheter, Pajunk Medical Systems, Karl-Hall-Strasse 178187, Geisingen, Germany) for placement of the brachial plexus block via either a supra- or an infraclavicular approach. Local anaesthetic dose was at the discretion of the anaesthetist.

Assessment started when the patient reached the recovery area. The patient's motor function at the wrist and the elbow and sensory functions in the nerves of the arm were assessed at 0, 15, 30, 45 and 60 min. Flexion and extension in the wrist and elbow were assessed on the modified Bromage motor score (0=no movement, 1=flicker of movement, 2=movement possible when gravity is excluded, 3=movement is possible against gravity, but not if any further resistance is added, 4=movement is possible against gravity and some resistance and 5=normal motor strength). Sensory response to temperature (with an ice pack) and light touch (finger stroke) were assessed in the ulnar, median, radial, musculocutaneous and median antebrachial nerve distribution of the forearm and graded in a binary fashion (present or absent). Pain scores were also recorded at each motor and sensory assessment.

The assessments were conducted by three observers blinded to the patient group allocation, two consultant anaesthetists and a trained research nurse. The recovery nurse looking after the patient was not blinded to the group allocation and in the washout group administered normal saline via the peripheral nerve catheter.

In the control group, the peripheral nerve catheter was left in situ until the patients were discharged from the recovery room at 60 min. In the washout group, the patient had 10 ml of normal saline flushed down the peripheral nerve catheter by the attending recovery nurse at four time points, each 5 min before the assessment was to occur (i.e. 10 min, 25 min, 40 min and 55 min after the admission to the recovery room).

For each patient, a change over time was calculated for each category. For motor, a change over time was a score out of 10 (a combined score out of 5 for elbow and wrist). For sensory assessment, the score was out of 5 for each of light touch and temperature, and a combined score out of 10 for both variables was also calculated. The pain score yielded a score out of 10 at each time point.

Statistical analysis

The Kolmogorov-Smirnov test was used to test the normality of data, and none of the data was normally distributed. Therefore, the Mann-Whitney U test for non-normal data was used to compare the two groups.

Results

Overall, 37 patients had data available for analysis, with 20 in the control group and 17 in the washout group. Patient demographics are summarised in Table 1.

There was no difference in time to resolution of the block in any of the characteristics measured, as shown in Table 2. The analysis in Table 2 shows the difference in the motor and sensory scores over the entire period, i.e. the difference between time 0 and 60 min. Figures 1-3 show the mean change at each testing interval over 60 min.

Table 1. Patient demographics

	Washout	Control	p
Male gender	13/17	16/20	0.71
Mean weight (kg)	101 (SD 22.3)	98 (SD 22.4)	0.72
Mean age (years)	55 (SD 13.5)	59 (SD 10.8)	0.39
BMI	33.6 (SD 8.3)	32.9 (SD 7)	0.78

BMI: body mass index

Table 2. Resolution of block characteristics

	Washout	Control	p
Change in motor score (median and IQR)	2 (0-5)	1.5 (0-5)	0.95
Change in light touch score	0 (0-1)	1 (0-2)	0.21
Change in temperature sensation score	1 (0-1)	1 (0-3)	0.19
Combined sensory change	1 (0-2)	3 (0-6)	0.14
Change in pain score	0 (0)	0 (0)	0.44

IQR: interquartile range

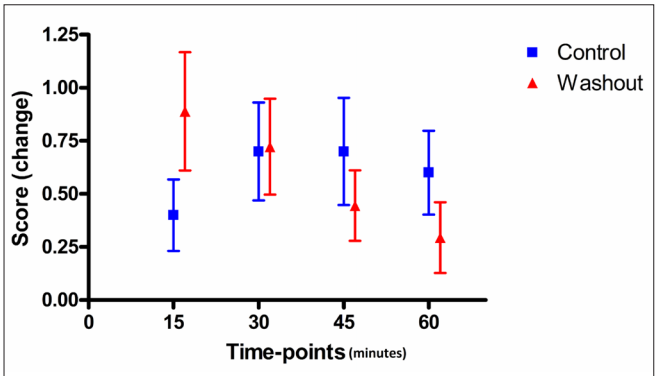

Figure 1. Average change in motor score at each time point in the control and washout groups

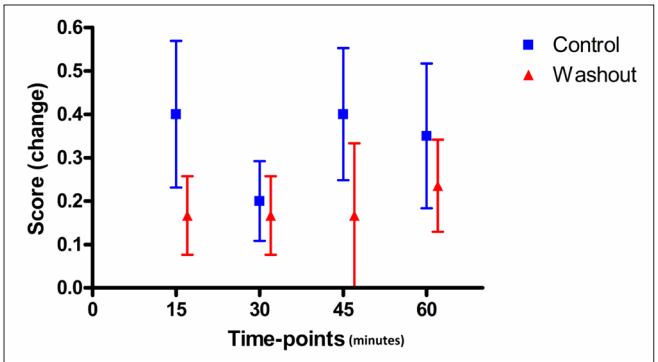

Figure 2. Average change in temperature sensation score at each time point in the control and washout groups

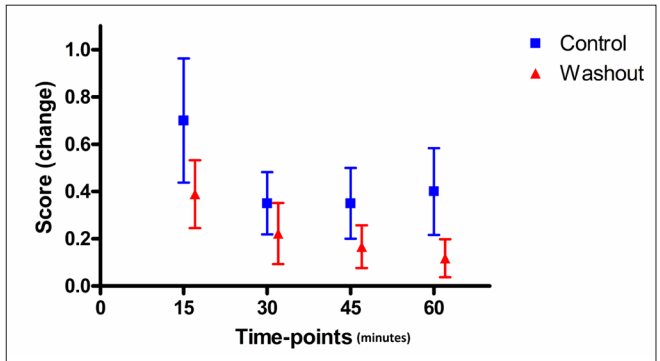

Figure 3. Average change in light touch sensation score at each time point in the control and washout groups

One patient in the control group converted to GA due to patient distress and prolonged surgical time (total surgical time 216 min). This patient also received additional local anaesthesia through the peripheral nerve catheter and had a discernible block in the recovery room.

Six patients in each group received either a second dose of local anaesthesia down the catheter or some skin infiltration by the surgeon to supplement the block. All but one of these patients had discernible block in the recovery room, indicating at least partial block success.

Four patients had minimal levels of block when reaching the recovery room (scoring 8 or 9 out of 10 for either power or sensation). They were evenly distributed between the groups with two in each group. Three out of these four patients successfully had their surgery without further supplemental of the block, indicating either very rapid regression of the block or relative sparing of the motor and light touch sensory functions with significant blockade of the nociceptive stimuli.

Discussion

The main finding of the present study is that there is no major difference in the resolution of a peripheral nerve blockade when an intermittent bolus of normal saline is given down a peripheral nerve catheter following the end of surgery.

There have been a series of case reports (1, 4) and at least three randomised controlled trials (2, 3, 10) that suggest reversal of the effects of either spinal or epidural anaesthesia or reduced offset time when normal saline or ringers lactate is used to 'wash off' the local anaesthetic. The exact mechanism of this reversal of the effects of local anaesthesia has not been elucidated. It may be related to diluting the local anaesthetic, changing the pH thereby affecting the ionisation of the local anaesthetic, providing an increased gradient for its exit from the nerve or related to the increased concentration of sodium in the vicinity of the nerve.

There is some suggestion via case report that this may also be possible in peripheral nerve blockade; there are several case reports of phrenic nerve function improving soon after a bolus of normal saline to 'wash off' the local anaesthetic (5-9). However, in the present study, we were unable to show improved resolution of either motor or sensory function with intermittent normal saline boluses.

The present study was powered to show a 50% reduction in time to resolution of the block. Obviously, this is a large difference and significantly reduces the numbers of patients that are required in the sample if a large difference is expected. A large difference was preferred to produce a clinically meaningful result. In our institution, all of these patients are discharged from hospital after 2 h, so a large and rapid decrease in the block duration may have some clinically important safety features in this group of patients. A small change in duration of the block would not be clinically useful. Therefore, while we cannot rule some alteration in block duration with this sample size, we can confidently say that there is no clinically useful alteration in motor or sensory function with the washout protocol.

One of the explanations for not being able to see a difference between the groups would be if the block had already recovered as soon as the patient reached the recovery room. This only happened in four patients, and these patients were evenly distributed between the groups and therefore should have had no effect on the results.

There are a number of reasons why peripheral nerves appear to react differently to the 'wash off' technique than nerves in the epidural space or nerves in the cerebrospinal fluid. There are structural differences in the nerves, and there are differences in blood flow between the epidural space and the supraclavicular and infraclavicular areas. Both of these factors could affect the concentration of the local anaesthetic in the nerve and the concentration gradient for exit of the local anaesthetic from the nerve. Additionally, the effect on the phrenic nerve could be different to the effects on sensory and motor functions at the brachial plexus. The phrenic nerve is a small calibre nerve, and the diaphragm is different to other muscles. It is relatively resistant even to neuromuscular blockade and may be small changes in phrenic nerve function translate to large and clinically relevant changes in diaphragmatic function.

Alternatively, the timing of the wash off may influence the ability to reverse the effects of the local anaesthetics. The previous case reports have been soon after the institution of the nerve block, when the patients unexpectedly experienced respiratory distress. In our study, the wash off occurred at the end of the case, at the very least an hour after the institution of the block. At this stage, there may be no benefit of a direct dilutional effect, or altering concentration gradients many only have a subtle effect on washout of local anaesthetic from the nerve.

Conclusion

We were unable to show a clinically meaningful reduction in time to resolution of the block with intermittent normal saline lavage down a peripheral nerve catheter in patients who have AV fistula surgery.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Health and Disability National Ethics Committee (Approval no.: 14/NTB/45).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – K.B., B.T.; Design – K.B., B.T.; Data Collection and/or Processing – C.S., J.T.; Analysis and/or Interpretation – K.B.; Writing Manuscript – K.B., C.S.; Other – K.B., C.S., J.T., B.T.

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Conflict of Interest: The authors have no conflicts of interest to declare.

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