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Improvement of Forced Vital Capacity (FVC) after Saline Washout in the Setting of Post Interscalene Catheter Phrenic Nerve Palsy

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Introduction

The interscalene nerve block is a commonly used regional technique for shoulder surgeries and has been shown to improve post-operative pain outcomes. This nerve block is also known to have an incidence of phrenic nerve paralysis given the proximity of the phrenic nerve to the interscalene groove where the local anesthetic is deposited. [1] These effects may serve to be clinically detrimental in patients with pre-existing pulmonary pathology who are unable to tolerate any decrease in their pulmonary function. Our study aims to investigate whether a large volume normal saline washout bolus through a pre-existing interscalene catheter can reverse these effects, and if so in what time span one may expect it to take effect prior to initiating other rescue efforts.

Materials and Methods

Institutional Review Board (IRB) approval and patient consent were obtained for this single institution, randomized, double blinded study. The study was also registered with ClinicalTrials.gov (NCT03677778). Twenty adult patients undergoing elective primary total shoulder arthroplasty or shoulder arthroscopy were enrolled. Exclusion criteria included significant pulmonary disease such as severe COPD and OSA requiring CPAP use, as well as any contraindication to nerve block placement including but not limited to coagulopathy. A baseline pulmonary assessment using a digital spirometer (CMI Health SpiroLink Meter, Alpharetta, GA, USA) that measures expiratory function and provides data on peak expiratory flow (PEF), forced vital capacity (FVC), and FEV1, was taken of all patients prior to block placement. Patients were instructed on how to use the spirometer at this time to increase familiarity for post-operative measurements. All patients then received a standard ultrasound guided interscalene nerve block catheter, placed in the pre-operative bay and bolused with 10 mL 0.5% ropivacaine prior to surgery. All surgeries were completed under a general anesthetic and patients received an additional 10 mL 0.5% ropivacaine upon arrival to the recovery room to control for the variable length of surgical time. Recovery room nurses were notified to not connect patient’s catheters to local anesthetic infusion pumps until completion of study measurements. After 30 minutes from time of post-operative bolus, repeat spirometry measurements were taken. At this time patients were randomized in a 1:1 ratio to either receive a 30 mL normal saline washout or no intervention. Both patients and research personnel

measuring study outcomes were blinded. Repeat measurements were then taken at 5 minutes, 15 minutes, and 30 minutes post-intervention or control time. Subsequently, after the completion of study measurements, patient's nerve catheters were then connected to the local anesthetic infusion pumps per institutional protocol and managed per normal standard of care.

A total of 21 patients were enrolled in the study, 11 treatment, 9 control, and one patient who failed to complete all post-operative measurements and hence withdrawn from the study. The best measurement from the three samples taken at each time point was used to calculate the percent change from baseline, defined as the spirometry measurements taken 30 minutes after the 10 cc 0.5% ropivacaine bolus given in PACU. The average percent change of the treatment group was then compared to the control group at each time point using a t-test and significance defined as p value less than 0.05.

Results/Case Report

There were no significant differences in demographics between the control group and the treatment group when considering age, height, weight, BMI, gender, and presence of lung pathology (Table 1). Although the measured values from pulmonary function testing are dependent on factors such as age and height, the data was calculated as percent change allowing for standardization regardless of such patient factors. We noted statistically significant improved outcomes of FVC at 30 mins after intervention with a p value of 0.02, suggesting a delayed reversal of the phrenic nerve paralysis. There were otherwise no statistically significant changes seen between the saline washout and control patients for the other measurements including PEF or FEV1, at any of the time points (Figure 1).

Discussion

This is the first double blinded randomized study to demonstrate the clinical improvement of FVC at 30 minutes following a 30 ml saline washout. This is in contrast to the randomized clinical trial conducted by Gerber et al that showed no significant difference in phrenic nerve paralysis when observing ultrasonographic diaphragmatic excursion after 10 mL normal saline aliquots. [2] Their study did note, however, that patients receiving saline washouts had less incidence of progression to full hemi-diaphragmatic paralysis. We anticipated that with a larger volume of normal saline, a greater effect of full reversal from phrenic nerve paralysis would be seen.

Our results showing an improvement in FVC after 30 mins correlates most with return of phrenic nerve function as several studies in patients with amyotrophic lateral sclerosis have shown this measurement to be most sensitive to phrenic nerve function. [3] Factors noted during study progression that may have impacted the lack of significant improvement in other values, such as PEF, included the variability in patient alertness and ability to follow instructions within one hour of a general anesthetic. Variation in factors such as the quality of a patient's mouth seal around the spirometer and ability to follow exhalation instructions to ensure standardized measurements were noted.

Literature regarding potential reversal of phrenic nerve paralysis now spans studies looking at the above mentioned effect of normal saline aliquot boluses, the impact of the site of local anesthetic deposition [4], to use of digital pressure to prevent local anesthetic spread [5] with no clinically significant results noted. While our study focused on examining the onset and effectiveness of a saline washout, it did not study the effect beyond a 30 minute time interval. Therefore, although not an immediate solution, use of a saline washout can be used in clinically appropriate scenarios to improve FVC by hastening the return of phrenic nerve function in 30 minutes. In summary, this study illustrated that the onset of clinical improvement from a saline washout may take up to 30 minutes to be effective and therefore

alternative airway and respiratory support must be immediately available and ready to employ.

References

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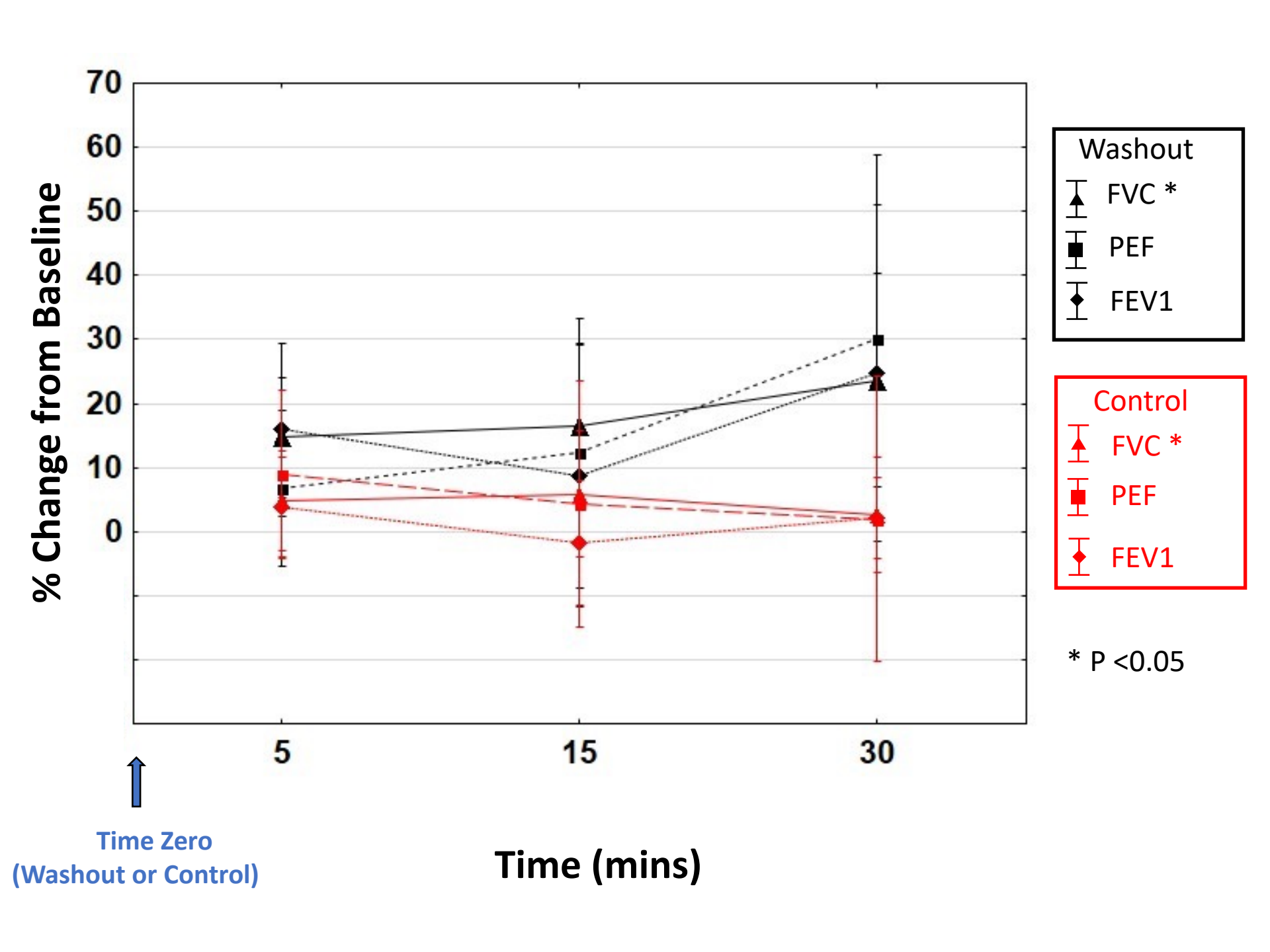
Disclosures

No

Tables / Images

Table 1: Demographic Data

	Treatment Group (n=11)	Control Group (n=9)	p-value
Age, years (SD)	64.9 (12.3)	60.1 (18.5)	0.49
Weight, kg (SD)	94.4 (31.6)	89.1 (20.3)	0.67
Height, cm (SD)	173.6 (13.6)	177.2 (11.2)	0.53
BMI, kg/m^2 (SD)	31 (8.6)	28.2 (4.9)	0.41
Gender, n (%)			
Male	7 (64%)	7 (78%)	1.0
Female	4 (36%)	2 (22%)	
ASA Status, n (%)			
1	1 (9%)	0	1.0
2	5 (45%)	6 (67%)	
3	5 (45%)	3 (33%)	
Lung Pathology, n (%)			
Former Smoker	2 (17%)	3 (33%)	1.0
OSA	3 (25%)	0	


70
60
50
40
30
20
10
0
% Change from Baseline
5
15
30
Time (mins)
Time Zero
(Washout or Control)
Washout
FVC *
PEF
FEV1
Control
FVC *
PEF
FEV1
* P <0.05