CAS 2023 Annual Meeting

Resident's Oral Competition Abstracts

Contents

Comparison of Different Vasopressors on Spinal Cord Blood Flow

AUTHORS

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INTRODUCTION

Acute spinal cord injuries (SCI) can have long-lasting impact on a patient's physical and psychological wellbeing and have significant personal and societal costs. Therefore, the initial management of acute SCI remains critical in neurological outcomes. The current guidelines recommend increasing spinal cord perfusion pressure (SCPP) in acute phase of SCI as measured by elevated mean arterial pressure (MAP). Yet, it is not clear whether MAP is a good surrogate for spinal cord perfusion as multiple factors such as intrathecal and epidural pressures, vessel reactivity, and autoregulation can confound the overall SCPP. Therefore, this study investigated the effects of commonly used vasopressors on spinal cord perfusion as it relates to MAP in a rodent animal model. We hypothesize that MAP will have a direct correlation to SCP, and that there is no difference between various vasopressors in augmenting SCP.

METHODS

This study was approved by the Animal Policy and Welfare Committee at our institution. Under isoflurane anesthesia, nine male Sprague-Dawley rats were surgically instrumented with arterial and intravenous lines for blood pressure measurement and intravenous delivery of phenylephrine (PE), vasopressin (VP), norepinephrine (NE) and epinephrine (EP), respectively. Given the size limitations of the artery of Adamkiewicz in this rodent model, a transonic flow probe was situated around a directly adjacent lumbar spinal artery, since collateral circulation of the spinal cord often arises from these arteries.[1] The flow probe was able to detect changes in blood flow through the artery over time. Rats were subjected to the following treatments: PE 5-10 mcg/kg/min for 30 minutes, VP 0.002-0.004u/min for 30 minutes, NE 0.3-0.6 mcg/kg/min for 30 minutes, and EPI 0.2-0.4 mcg/kg/min for 30 minutes. Spinal cord blood flow following vasopressor infusion was analyzed as a percentage of the baseline blood flow prior to the start of infusion. Data are presented as mean±SEM, with statistical significance denoted at $p<0.05$.

RESULTS

Data were analyzed via one-way ANOVA. The baseline MAP was 108.4±9.3 mmHg; following treatment with vasopressors, the MAP was 121.1±10.9 mmHg (PE), 125.1±8.3 mmHg (VP), 132.7±10.6 mmHg (NE) and 108.4±8.1 mmHg (EPI). The heart rates were 295.4±12.3 (baseline), 297.0±12.4 (PE), 295.1±12.2 (VP), 313.8±13.3 (NE), and 321.9±10.6 (EPI). The percentage of spinal cord blood flow change from baseline was 102.1± 9.6%

(PE), 87.34±12.8% (VP), 100.1±18.9% (NE), and 279.4±51.7% (EPI) (overall p<0.0001; post-hoc p<0.0001 for EPI). The change in spinal cord blood flow normalized to the change in MAP were as follows: 0.92±0.08 (PE), 0.79±0.13 (VP), 0.90±0.22 (NE), and 3.1±0.69 (EPI) (overall p<0.0001; post hoc p=0.0003 for EPI).

DISCUSSION

To our knowledge, this is the first study to directly measure spinal cord perfusion in response to infusion of various vasopressors. The current guideline for treatment of acute SCI is to elevate MAP >85mmHg for up to 7 days, but the literature supporting these recommendations are weak. The results of this study challenges the dogma that increase in MAP directly corresponds to increase in SCP. Moreover, epinephrine may be the best vasopressor to maintain SCP. Future studies to determine if this correlates to improved blood flow in SCI (rodent SCI model) and improved outcomes following SCI (clinical study) are warranted.

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Decreasing Environmental Impact and Costs of Using Inhalational Anesthetics by Replacing Chemical Absorbers with an Innovative Carbon Dioxide Membrane Filter System: Preliminary Results from a Prospective, Randomized, Clinical Trial

AUTHORS

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INTRODUCTION

Memsorb™ is a device that uses a semipermeable polymeric membrane to remove carbon dioxide (CO_2) from anesthesia circuits. CO_2 flows down a concentration gradient into the hollow lumen of the fibers and is continuously flushed out of the circuit by an air/oxygen gas mixture. This device can effectively eliminate CO_2 using the GE Datex-Ohmeda Aisys CS2 anesthetic machine in-vitro[1]; its use in a clinical setting has not been established. This prospective randomized clinical trial was designed to (1) examine the efficacy of the Memsorb™ system at CO_2 elimination in-vivo and (2) determine anesthetic gas usage when using the device with GE Datex-Ohmeda Aisys CS2 anesthetic machines.

METHODS

This study protocol was reviewed and approved by the local research ethics board. 87 patients were enrolled in this prospective randomized controlled trial since 2021. Inclusion criteria were patients with age >18, ASA I – III, undergoing elective surgical procedures. Exclusion criteria included severe respiratory disease, raised intracranial pressure, use of anesthetic agents other than sevoflurane, use of fresh gas flow (FGF) less than 2 L/min, laparoscopic surgery, or self-reported pregnancy. The primary outcome measure was effectiveness of Memsorb™ compared to traditional carbon dioxide absorbers at eliminating CO_2 during the maintenance phase of anesthesia, measured as end-tidal CO_2 ($ETCO_2$) and inspired CO_2 ($FiCO_2$). The secondary outcome was the amount of inhaled anesthetic used during the maintenance phase of anesthesia. A two-tailed Mann-Whitney U-test was performed to assess for statistical significance using GraphPad Prism software. Data are presented as median (25% percentile – 75% percentile; minimum, maximum).

RESULTS

72 patients met the inclusion criteria and were included in the analysis. The groups were similar with respect to age, sex, body mass index, or comorbidities. $ETCO_2$ was measured to be 39.2 (36.7 – 40.8; 33.5, 48) mmHg in the control group compared to 38.7 (36.5 – 41.5; 32.6, 55) mmHg in the Memsorb™ group. $FiCO_2$ was higher in the Memsorb™ group at 4 (3 – 5; 0.8, 8) mmHg compared to 1 (0.7 – 1.1; 0, 3) mmHg in the control group ($P<0.0001$). Minute volume (MV) ventilation was 5.7 (4.7 – 6.6; 3, 8.4) L/min in the control group

compared to 5.9 (5.1 – 7.0; 3.5, 9.4) L/min in the Memsorb™ group. More sevoflurane inhalational agent was used in the Memsorb™ group at 0.34 (0.27 – 0.43; 0.13, 0.71) ml/min compared to 0.27 (0.21 – 0.33; 0.15, 0.53) ml/min in the control group (P=0.0097).

DISCUSSION

Our study shows that this device can be successfully used with the GE Datex-Ohmeda Aisys CS2 anesthetic machines in a clinical setting. Despite higher $FiCO_2$ levels, no MV changes were required to maintain equivalent $ETCO_2$. We observed higher sevoflurane usage with this device, similar to a recently published study[2] but contrasting with findings published by the developers of this device[3]. This observation may be related to flushing air/oxygen mixture used to reduce the $FiCO_2$. Further studies are underway examining the impact of increased $FiCO_2$ on $PaCO_2$, as well as the effectiveness of the device in laparoscopic surgery and low-FGF anesthesia.

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Invasive Hemodynamic Monitoring During Anesthesia: Is There a Better Way?

AUTHORS

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INTRODUCTION

Patients undergoing complex surgery require strict blood pressure monitoring to minimize hemodynamic fluctuations as these have been linked to increased post-operative mortality, morbidity, delirium, and stroke[1]. The current gold standard for blood pressure monitoring is the placement of an intraarterial catheter. While this technique provides continuous blood pressure readings, the insertion of this monitor is painful, time consuming, and carries a risk of infection, bleeding, nerve, and arterial injury[1]. An alternative device called ClearSight by Edwards LifeSciences allows for beat-to-beat blood pressure monitoring using a non-invasive finger microcuff. A previous study comparing the accuracy of the ClearSight and arterial line systems in cardiac surgery patients used a handful of time points per patient for their analysis[2]. In this study, we sought to compare continuous blood pressure measurements collected by ClearSight and arterial line systems in elective cardiac surgery patients for the duration of their surgery.

METHODS

Ethics approval was obtained from the Biomedical Research Ethics Board. In this prospective observational study, we recruited 30 patients scheduled for elective cardiac surgery. We compared systolic (SBP), diastolic (DBP), and mean arterial blood pressure (MAP) measured by the ClearSight system (ABP) versus the arterial radial line (ART). We simultaneously recorded ABP and ART measurements every 20 seconds from induction to incision closure, except during cardiopulmonary bypass. The accuracy of the ClearSight system was determined based on the accepted threshold (±5 mmHg, standard deviation of <8 mmHg) recommended by the Association for the Advancement of Medical Instrumentation[3]. For SBP, DBP, and MAP, we used one-sample t-tests to assess for the difference between ABP and ART, and ordinary least-squares linear regression to test for proportional bias. Due to the large sample size, we considered effect size (Cohen's d and r) to interpret results. Bland-Altman[4] plots were created with limits of agreement (LOA), where confidence intervals were adjusted for multiple observations per individual[5]. Data was further analyzed with percentage error (PE), agreement tolerability index (ATI), and interchangeability. Lastly, a paired samples t-test was used to compare time to placement of ABP and ART.

RESULTS

Our analysis included 17,502 SBP, 17,899 DBP, and 17,957 MAP data points. Fixed bias was present in differences between ART and ABP with SBP (mean difference=8.66, $p<0.001$, Cohen's d=0.705) and DBP (mean difference=-2.03, $p<0.001$, Cohen's d=-0.236), but was not present in MAP (mean difference=-0.29, $p<0.001$, Cohen's d=-0.032). Proportional bias was significant in SBP (B=0.043, $p<0.001$, r=0.056, r-squared=0.003), DBP (B=-0.107, $p<0.001$, r=0.124, r-squared=0.015), and MAP (B=-0.043, $p<0.001$, r=0.211, r-squared=0.045), but had a small influence on the data. Though LOA intersected with 0, distance from the mean was >5 mmHg for SBP, DBP, and MAP. PE for SBP, DBP, and MAP were lower than the PE cutoff calculated from the ART data. ATI for SBP, DBP, and MAP were all <1, indicating acceptable agreement. Average interchangeability rates show SDP 37.52%, DBP 50.23%, and MAP 49.65%. It was significantly faster to place the ABP (1.69.5±0.57 min) in comparison to ART (5.64±4.15 min; $p<0.001$).

DISCUSSION

Based on the data, ABP is not an acceptable replacement for ART when considering the clinically acceptable mean difference in blood pressure of 5 mmHg. However, according to statistical standards, there is evidence to suggest ABP may be interchangeable with ART. This, combined with the ease of placement and setup of the ClearSight microcuff (in comparison to the intraarterial catheter), allows for quicker onset of surgery and may benefit emergent patients where time is critical.

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Risk Factors for Postoperative Neurologic Symptoms Following Arthroscopic Shoulder Surgery with Interscalene Block: An Exploratory Secondary Analysis of Pooled Randomized Controlled Trial data

AUTHORS

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INTRODUCTION

Regional anesthesia is recommended for outpatient arthroscopic shoulder surgery to improve postoperative analgesia.[1] Interscalene brachial plexus block (ISB) provides analgesia comparable to other techniques,[1] and is most reliable for surgical anesthesia.

Postoperative neurologic symptoms (PONS) in the operative arm are feared complications of both regional anesthesia and arthroscopic shoulder surgery.[2,3] While most cases of PONS resolve, a few will last longer than 6 months, suggesting a permanent nerve injury.[2] Potential predictors of PONS have been proposed in narrative knowledge syntheses,[2,3] despite clinical studies empirically investigating PONS risk factors being uncommon. Large case series have rarely examined predictors beyond block technique and composition. This knowledge gap hinders research into PONS prevention and prognostication.

The objective of this study was to identify patient, surgical and anesthetic related PONS risk factors. We hypothesized that type of surgery, surgical position, and the use of perineural adjuvants would increase the risk of PONS.

METHODS

With institutional research ethics board approval, this secondary analysis pooled near identical data sets from two randomized controlled trials conducted on arthroscopic shoulder surgery patients at least 18 years of age at a single ambulatory surgical centre. The trials' primary outcome was the analgesic duration of ISB with 30cc of 0.5% bupivacaine and either perineural or intravenous dexamethasone or dexmedetomidine as adjuvants. Excluded from the trials were those with a relative or absolute contraindication to ISB or the adjuvants, or conditions like diabetes mellitus or daily opioid use that could significantly modify the analgesic duration of the ISB.

Patient characteristics and details of anesthetic and surgical care were collected by chart review or postoperative telephone interview for both trials. PONS was a secondary outcome assessed by telephone follow-up at 14 days and 6 months postoperatively. PONS was defined as one or more of numbness, weakness, or tingling in the surgical limb, regardless of severity or assumed etiology.

Maximum likelihood logistic regression was performed to assess for associations between independent variables and PONS at 14 days or 6 months using R version 4.0.5. Firth penalized likelihood logistic regression was applied selectively for independent variables with unstable estimation problems from low variability.

RESULTS

After excluding one patient who withdrew from follow up, PONS prevalence was 83 in 477 patients at 14 days. By 6 months, 73 of 83 cases (88.0%) had resolved, leaving 10 patients with persistent PONS (2.1%). In univariate analyses, only postoperative day one quality of recovery-15 questionnaire score (QoR-15)[4] was significantly associated with 14-day PONS. Higher QoR-15 total (odds ratio (OR) 0.97 (95% confidence interval (95%CI) 0.96 to 0.99), $p < 0.01$) and emotional domain (OR 0.90 95% CI 0.85 to 0.96, $p < 0.001$) scores, suggesting better recovery, were associated with lower PONS risk. The emotional domain specifically assesses comfort, control, anxiety and depression. Report of all three PONS symptoms at 14 days, versus other 14-day symptom combinations, was associated with persistent PONS at 6 months (OR 11.5 95% CI 2.2 to 61.8, $p < 0.01$) (Figure 1). Multivariable analyses were precluded by the limited number of significant univariate associations.

DISCUSSION

Previously proposed PONS risk factors like a history of smoking or hypertension,[2] lateral surgical position,[3] and paresthesia during block performance[2] were not replicated in this study. The observed association with quality of recovery and emotional state should be considered exploratory, though associations between preoperative mental health and postoperative functional outcomes have been observed in arthroplasty populations.[5] The constellation of weakness, numbness and tingling at 14 days may portend a worse prognosis for 6-month PONS than other symptomatology but requires additional validation. Larger studies with standardized PONS outcome reporting are needed for better PONS prediction and prevention.

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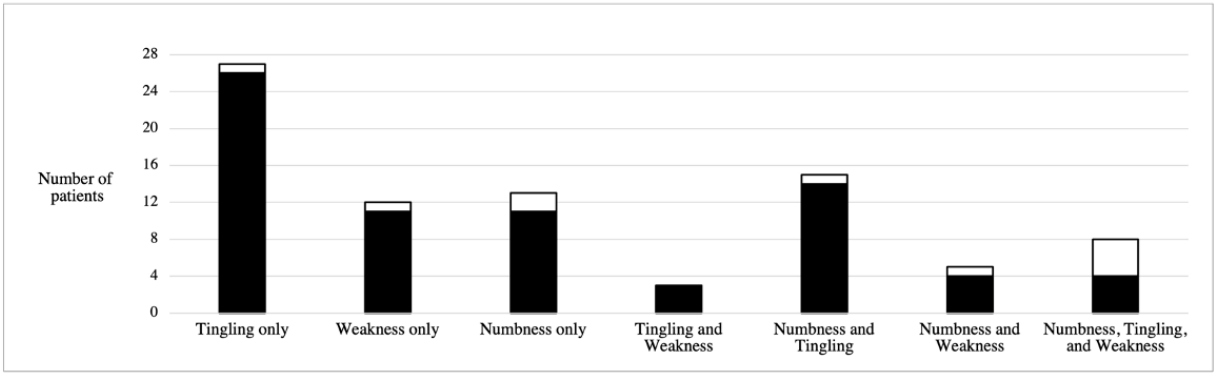

Figure 1: Resolution (shaded) or persistence (unshaded) of postoperative neurologic symptoms at 6 months, by type of postoperative neurologic symptoms at postoperative day 14

Strain Echocardiographic Parameters and Clinical Outcomes Associated with Significant Atrioventricular Regurgitation in an Adult Fontan Cohort

AUTHORS

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INTRODUCTION

As Fontan patients continue to experience longer life expectancy, the general anesthesiologist will inevitably contribute to the care of adult Fontan patients undergoing non-cardiac surgery. Significant atrioventricular valve regurgitation (AVVR) is common in adult Fontan patients and its hemodynamic and clinical significance must be evaluated in the perioperative setting. Strain echocardiography is now commonly reported in pre-operative echocardiograms. This technology of two-dimensional speckle-tracking echocardiography permits evaluation of subclinical myocardial dysfunction and offers technical benefits over traditional echocardiographic parameters. We aimed to evaluate the association of AVVR with echocardiographic parameters and adverse outcomes.

METHODS

Fontan adult patients (≥18 years) with lateral tunnel or extracardiac connection actively followed at our institution were retrospectively reviewed. Patients with AVVR on most recent transthoracic echocardiogram (≥grade 2 as per American Society of Echocardiography guidelines) were matched with Fontan controls. All routine echocardiographic parameters, including global longitudinal strain (GLS), were measured. The composite outcome of Fontan failure included Fontan conversion, protein losing enteropathy, plastic bronchitis, and New York Heart Association Class III/IV.

RESULTS

Sixteen patients (14%, mean age 28.4 ± 7.0 years) with predominantly moderate AVVR (81%) were identified. The mean duration of AVVR was 8.1 ± 5.8 months. There was no significant reduction in ejection fraction (EF) (51.2% ± 11.7% vs. 54.7% ± 10.9%, $P = 0.39$) or GLS (−16.0% ± 5.2% vs. −16.0% ± 3.5%, $P = 0.98$) associated with AVVR. Larger atrial volumes and longer deceleration time (DT) were observed in the AVVR group. Patients with AVVR and a worse GLS (≥−16%) had higher E velocity, DT, and medial E/E' ratio. The incidence of Fontan failure did not differ from controls (38% vs. 25%, $P = 0.45$). Patients with worse GLS (≥−16%) demonstrated a marked trend toward a higher incidence of Fontan failure (67% vs. 20%, $P = 0.09$).

DISCUSSION

In Fontan adults, a short duration of AVVR did not influence EF or GLS but was associated with larger atrial volumes and those with worse GLS demonstrated some differences in diastolic parameters. These findings may inform the perioperative care of adult Fontan patients. Larger multicenter studies throughout its disease course are warranted.

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Symptoms of Anxiety and Depression After Major Elective Non-Cardiac Surgery: A Secondary Analysis of the Measurements of Exercise Tolerance Before Surgery (METS) Multicenter Prospective Cohort Study

AUTHORS

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INTRODUCTION

Patients report that psychological well-being is an integral component of their recovery process following surgery.[1] Surgery is meant to be therapeutic, but it can also be emotionally burdensome, leading some patients to experience new onset or worsening psychological distress afterwards. Whether related to patient- or procedure-specific factors, anxiety and depression after surgery are known to be associated with other adverse outcomes and complications.[2,3] To better align perioperative care and psychosocial supports with patients' needs, better characterization of anxiety and depression after surgery is needed. Findings from previous studies have limited generalizability as most were single-center studies conducted in homogenous samples of patients undergoing a single procedure.[4] No studies have yet described changes in anxiety or depression in a large prospective cohort undergoing a broad case mix of surgeries.

METHODS

We conducted a secondary analysis of Measurement of Exercise Tolerance before Surgery (METS), an international cohort study which evaluated measures of cardiopulmonary fitness before major elective non-cardiac surgery in adults.[5] This sub-study received local REB approval. The primary outcome in this study was the anxiety/depression item on the EQ-5D-3L, which asked respondents to describe their status as "none", "moderate", or "severe" at baseline before surgery, then at 30 days and 1 year after surgery.

The first study objective was to characterize the trajectory of anxiety/depression symptoms after surgery. A cumulative link model was fitted, with the 3-level (ordinal) anxiety/depression rating as the outcome and a random intercept for each participant. Time was modeled continuously after verifying non-linearity assumptions. Age, sex, procedure type, and an interaction between time and sex were included in the model as covariates.

The second objective was to identify patient- and procedure-specific risk factors for the

composite endpoint of severe or worsened anxiety/depression after surgery. A multivariable logistic regression model was fitted and included age, sex, smoking, cancer-related surgery, procedure type, and anesthetic technique as potential predictors.

Missing data was handled using Multivariate Imputation by Chained Equations. Statistical significance was defined as a two-tailed $p<0.05$.

RESULTS

The analytic cohort included 1,546 patients (median age 65 years [IQR 57–72]; 40.7% female) undergoing a broad range of orthopedic, abdomino-pelvic, thoracic, peripheral vascular, and plastic procedures. Moderate-to-severe anxiety/depression was reported by 32.6% of participants at baseline, 27.3% at 30 days, and 26.2% at 1 year after surgery (Figure 1). In trajectory analyses, older patients were less likely to have greater symptoms (aOR 0.64, 95% CI: 0.57–0.73). Females had greater symptoms compared to men (aOR 1.69, 95% CI: 1.33–2.16); however, their symptoms were more likely to improve over time (aOR 1.19, 95% CI: 1.02–1.39). Of the patients who survived to 1-year follow-up, 326 (21.7%) experienced the composite outcome of severe or worsened anxiety/depression after surgery. In multivariable regression modelling, increasing age was associated with lower odds of the composite endpoint (aOR 0.98 per year, 95% CI: 0.97–1.00).

DISCUSSION

One-third of patients reported moderate-to-severe anxiety/depression before major elective non-cardiac surgery. Female and younger patients were more likely to experience worse symptoms at any given time. Unlike males, females reported a downward trend in symptoms over time. Younger adults were more likely to experience worsened or severe anxiety/depression. To better understand the epidemiology and factors associated with psychological distress after surgery, future studies should use more comprehensive measurement tools at frequent time intervals. New knowledge about adverse psychologic outcomes in surgical patients can facilitate earlier identification of at-risk individuals and inform the development of timely, targeted psychosocial interventions.

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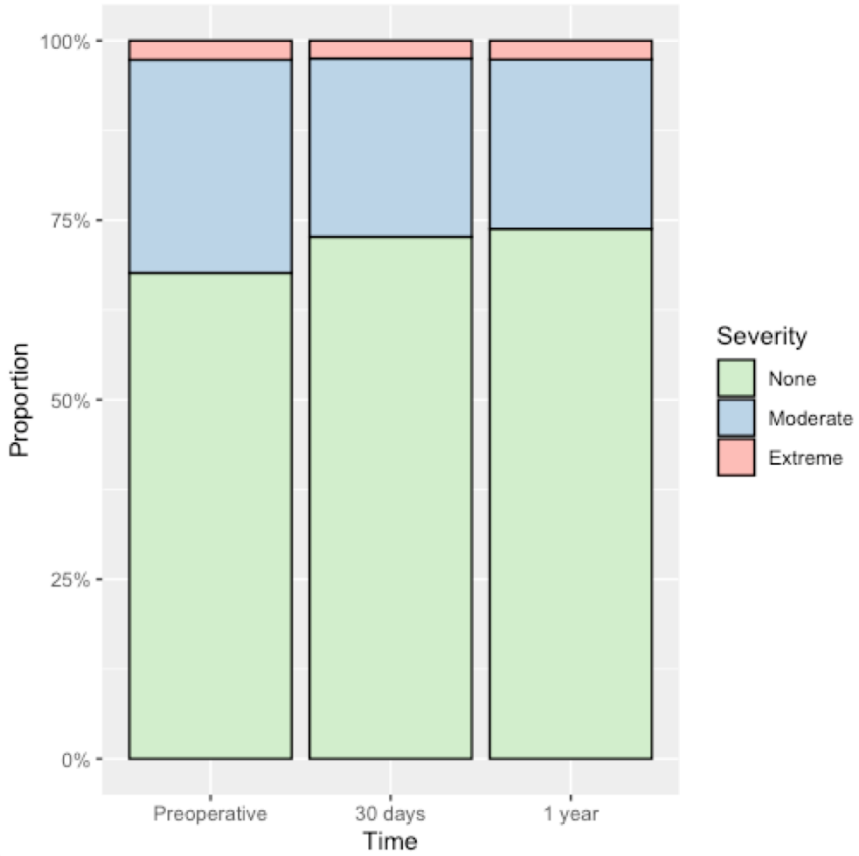

Figure 1. Stacked bar plot of participants' responses to the EQ-5D-3L item about their level of anxiety/depression at each timepoint during the study.