



Correlation of Preoperative State Anxiety and Pain Six Weeks After Surgical Correction of Pectus Excavatum

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Abstract

Background: Pain is a major concern in the early postoperative phase after correction of pectus excavatum. Most studies only focus on pain management in the first days after surgery and describe methods to alleviate the pain immediately postoperatively. The severity of postoperative pain may be influenced by anxiety. So far, few studies have looked into the relationship between anxiety and postoperative pain after pectus excavatum correction.

Objectives: This study aimed to investigate the correlation between preoperative anxiety and late postoperative pain scores.

Methods: This was a prospective cohort study. Anxiety was assessed with the State and Trait Anxiety Inventory questionnaire. Visual analogue scale (VAS) for pain scores assessed the pain at rest and activity. Anxiety was measured before surgery and pain scores six weeks after surgery. A hierarchical linear regression analysis was performed to investigate the correlation between baseline anxiety and pain measurements six weeks after surgery.

Results: In this study, 136 patients were included. State anxiety was not associated with postoperative pain (mean of pain on activity and in rest), only with pain on activity after six weeks. Age and sex were not effect modifiers in any of the models. Relevant confounding factors, although not significant, consisted of trait, sex, minor complications, epidural duration, major complications, and the number of stabilizer plates. The explained variance of state anxiety on VAS for pain scores was minimum after 6 weeks.

Conclusions: Preoperative anxiety does not appear to influence postoperative pain after PE correction.

Keywords: Thoracic Surgery, Chest Wall, Fear, Postoperative Management, Pediatric, Anesthesia

1. Background

The most important anterior chest wall deformity is the pectus excavatum (PE). It predominantly affects males. The prevalence of PE is about 1 in 400 (1). The most important complaints are cosmetic and shortness of breath during exercise. The Nuss surgical procedure has been reported to give good cosmetic results (2). In addition, studies reporting physical improvement after correction are increasing in number (3).

Although pain is an important problem after any kind of surgery, thoracic surgery may be very painful (4). In surgical correction of PE with a Nuss-bar, the indentation of the sternum is corrected with implanting a steel bar underneath the sternum and the required new position of the sternum is immediately achieved. When the procedure

is explained to patients, the surgeon often refers to braces for crooked teeth; however, the remodeling of the teeth often takes years, whereas in PE correction the remodeling is done in seconds and the pain is accordingly less.

In the literature, most studies only focus on pain management in the first days after surgery (5). In these studies, pain was a significant problem for many patients, possibly impacting on satisfaction with the results (6). It may thus be worthwhile to influence pain and pain sensation in these patients in order to improve the satisfaction with the results of surgery.

It is known that the level of experienced pain is influenced by a number of factors such as depression, stress, anxiety, pain catastrophizing, and insomnia (7, 8). Patients are informed about the severe postoperative pain that may occur and this may induce anxiety. However, few studies

have looked into the relationship between baseline anxiety and postoperative pain in PE patients, so far.

2. Objectives

This study assesses the relationship between anxiety and pain in patients with a planned surgical PE correction. We hypothesized that a high level of preoperative anxiety would lead to a higher level of reported postoperative pain 6 weeks after PE surgery.

3. Methods

3.1. Study Design

The participants were recruited from three academic hospitals and one large general hospital in the Netherlands from January 2013 to January 2017. The patients having 12 years of age and older scheduled for surgical correction of a PE were included in this study. The exclusion criteria were poor proficiency in the Dutch language and prior chest wall surgery. In the current study, the participants were asked to complete questionnaires before surgery (T1) and 6 weeks (T2) after surgery. Questionnaires used were a demographic questionnaire, the State and Trait Anxiety Inventory (STAI) questionnaire to assess anxiety and visual analogue scale (VAS) for pain scores to measure pain experienced. The demographic questionnaire asked about age, sex, social habits, school and/or work, family history, and sports activities.

The Dutch-validated short version of the STAI was used. Items were scored on a four-point Likert scale and subsequently, these scores were added up. Scores of the STAI can vary between 6 and 24 with a higher score, indicating more anxiety. The resulting score can either be used as a total score or dichotomized in high or not-high, with cut-off scores derived from the manual. The short versions have good reliability and validity (9). Pain at rest and activity postoperatively was measured with a VAS score of 100 mm, with anchors at 100 mm (worst pain imaginable), and 0 mm (no pain at all) (10).

In addition to the questionnaires, the medical records of the participants were checked in terms of surgery, type of procedure, type of pain medication, used and duration of pain medication taken both in hospital and after discharge. Furthermore, postoperative morbidity was registered. This was defined as surgical complications occurring within 6 weeks after the operation. These complications were divided into major and minor complications. Major complications were comprised of early recurrence of the pectus within 6 weeks, wound infection,

hematoma for which re-do surgery was required, pneumonia and bar dislocation. Minor complications comprised of urinary catheter infections, pneumothorax, and seroma. These data were obtained from the database in which the surgical complications are consistently registered. Since all these preoperative factors may influence the relation between the level of preoperative anxiety and pain at 6 weeks measurement, they were considered possible confounders. Age and sex were also deemed possible effect modifiers.

3.2. Statistical Procedure

The focus of this study was on the relationship between preoperative anxiety (STAI-state (T1)) and postoperative pain (VAS pain (T2)) after 6 weeks, both continuous variables. A hierarchical linear regression analysis was performed. The mean VAS score was calculated from the VAS score in rest and the VAS score during activity for any individual patient. Categorical variables were presented as numbers (percentage); continuous variables with a normal distribution were described with mean \pm standard deviation. Two-tailed P value less than 0.05 was considered statistically significant.

3.3. Analysis Plan

In this study, IBM SPSS Statistics 23 was used for all statistical analyses. First of all, the data were checked for erroneous values and missing data. Respondents with relevant missing data were not encountered in this study group. Hierarchical regression analyses were used to answer the hypotheses. In model 1, the “crude” effect of state anxiety (X) on the primary outcome variable and mean VAS for pain scores after 6 weeks were evaluated. In model 2A, the possible influence of the effect modifiers sex and age were investigated accompanied by interaction terms. The preoperative confounders (type of pain medication, duration of pain medication) and of confounders such as STAI Trait and the number of stabilizer plates used, number of bars used, major or minor complications on the relationship between X and mean VAS for pain scores after 6 weeks (Y) were assessed in model 2B.

Model 3 included repeated analyses in a patient group without postoperative complications. Model 4 consisted of two submodels 4A and 4B. It was a repeated analysis with VAS for pain score at rest and activity after 6 weeks as dependent variables, respectively. Relevant confounding was defined as a 10% change in regression coefficient (B). Effect modification was defined as a significant P value ($P < 0.05$) of the regression coefficient of the interaction term.

3.4. Sample Size Calculation

The size of the study population was based on a conservative estimate for the effect of state anxiety on postoperative pain scores after 6 weeks. Previous studies have shown a very high percentage of patients with high levels of direct operative pain. In the literature, a difference of 14 mm in mean VAS score is considered the minimal clinically important difference (MCID) (11).

Based on the above, sample size calculation was performed using G*Power 3.1 (12). The effect size of 0.15 with a Power of 0.8, significance level of 0.05, and number of predictions 10, a total sample size of 118 was calculated. With an expected 5% drop-out rate, at least 127 participants had to be included.

4. Results

One hundred thirty-six patients participated in the multicenter cohort study. There were 121 male and 15 female participants. The median age was 16 years (range 12 - 22 years). Fifteen patients received more than one Nuss bar during operation. The number of placed Nuss bars depends on the preoperative correction of the PE. If residual PE exists after the first bar placement, a second bar is placed behind the sternum and fixed onto the chest wall (ribs). Stabilizer plates were used to prevent rotation of the bar by blocking rotation through support on the ribs. One hundred and seven patients had one stabilizer plate implanted, 29 had two stabilizer plates. Twenty-six patients suffered one or more complication was 26 (19%). Major complications were seen in 9 persons (7%). Baseline characteristics and results are shown in Table 1.

4.1. Relationship of State Anxiety and VAS Score After 6 Weeks (The Models)

In model 1, the crude analysis showed no significant relationship between state anxiety and mean VAS for pain scores 6 weeks postoperative ($B = 0.08$, 95% $BI = -0.02 - 0.17$, P value = 0.11). The direct analysis reported an R square (R^2) of 0.02. This showed that a very small part (2 percent) of the variance in the mean VAS for pain scores contributed to state anxiety.

In model 2, we explored the possible effect modification caused by sex and age by adding them to the regression model. The interaction term of state anxiety-sex and the interaction term state anxiety-age showed a P value of 0.65 and 0.44, respectively, which means that neither sex nor age as an interaction term had a significant influence on the relationship between state anxiety and mean VAS for

Table 1. Patients Clinical Characteristics and Preoperative Results^a

Variables	Values
Age, y	16 (12 - 22)
Males	121 (89)
Preoperative questionnaires	
STAI state	11.2 ± 3.3
STAI trait	16.3 ± 4.9
Preoperative	
Nuss bar one versus two implants	121 (89)
Stabilizer plate one versus two implants	107 (79)
Postoperative	
Major complications	9 (6.6)
Minor complications	17 (12.5)
Total complications	26 (19.1)
Epidural use/duration (in days)	3.5 ± 1.3
Oral pain medication (in hospital in days)	5.9 ± 1.7
Pain scores at 6 weeks postoperative	
Mean VAS for pain score	24 ± 19
VAS for pain scores at rest	18 ± 19
VAS for pain scores at activity	29 ± 21

^aValues are expressed as No. (%) or mean ± SD or median (range).

pain scores at 6 weeks. The model 2A adjusted for both (demographic factors) sex and age showed a P value of 0.28. The adjusted model 2B with confounders (Table 2) did not lead to significant results. More the regression coefficient turned negative more effect of state anxiety on mean VAS for pain scores after 6 weeks ($B = -0.02$, 95% $BI = -0.10 - 0.14$, P value = 0.76). The R square was 0.10 that indicated a little more than 10% of variance in mean VAS for pain scores after 6 weeks was explained by combined factors in the adjusted model 2.

In model 3, we explored the group of patients who did not suffer a complication. This group of patients should, in theory, have a smaller physical impact on their bodies and therefore, less inflammation and less pain. The same hierarchical regression analyses as in model 2 were performed. The relationship between state anxiety and VAS for pain scores after 6 weeks was not significant in patients without complications. The R square was 0.03 that showed there was little explained variance in this crude analysis. Both interaction terms for sex or age were not significant. The definitive model 3 was adjusted for proven confounders of sex and epidural and neither was significant (P value = 0.17).

Table 2. Analyses of the Models

	B	95% BI	P Value
Model 1 crude	0.08	-0.02 - 0.17	0.11
Model 2A: Adjusted for demographic factors (sex and age)	0.05	-0.04 - 0.15	0.28
Model 2B: Adjusted for trait anxiety, sex, minor complications, epidural duration, major complications, and number stabilizer plates	-0.02	-0.146 - 0.10	0.76
Model 3 crude	0.09	-0.01 - 0.197	0.07
Model 3: Adjusted for sex and epidural duration	0.07	-0.03 - 0.17	0.17
Model 4A crude	0.03	-0.06 - 0.13	0.51
Model 4A: Adjusted for sex, trait anxiety, minor complications, and epidural duration	0.07	-0.19 - 0.04	0.22
Model 4B crude	0.13	0.02 - 0.23	0.02
Model 4B: Adjusted for trait anxiety, sex, and minor complications	0.04	-0.10 - 0.17	0.56

For analysis of the components of the mean VAS for pain scores after 6 weeks, a separate regression analysis was performed on dependent variable VAS for pain scores after 6 weeks at rest state (model 4A) and VAS for pain scores after 6 weeks at activity state (model 4B).

The relationship between state anxiety and VAS for pain scores after 6 weeks at rest was not significant (P value = 0.51). Testing the interaction terms showed no significant difference. Adjusted model 4A for confounders did not show a significant difference (P value = 0.22).

In model 4B, the relationship between preoperative state anxiety and dependent variable VAS for pain scores after 6 weeks at activity gave a P value of 0.024, which made it significant (B = 0.13, 95% BI = 0.02 - 0.23). This (crude) model did not show a more than explained variance of the VAS for pain scores at activity of 3.8%. The interaction terms and the adjusted model with confounders were not significant.

The results of the analyses of the “crude” and adjusted models are summarized in [Table 2](#).

5. Discussion

In the current study, the relationship between state anxiety measured preoperatively and VAS for pain scores 6 weeks postoperatively was assessed. This relationship was not significant for the mean VAS for pain scores and VAS for pain scores at rest and the “crude” analysis influence of state anxiety on the variance in mean VAS for pain scores after 6 weeks was 2.9% maximum. Evaluation of potential confounders showed there was no significant confounding effect in terms of total score trait anxiety, sex,

minor complications, duration epidural, major complications and the number of stabilizer plates in model 2. Despite the significant finding of the crude analysis of the dependent variable VAS for pain scores at activity, the reported average VAS for pain scores after 6 weeks was below 3 in all three groups (activity, rest, mean). Only 9.6% of the patient group reported taking oral pain medication after 6 weeks. Furthermore, the explained variance was just 3.8%.

In other diagnoses, the relationship between anxiety and pain has been studied as well ([13-20](#)). These studies report different results. Explained variance in pain scores postoperatively varied between 10% and 22% ([15](#)). However, other studies showed a definite relationship in a univariate analysis, but adding measurements such as the STAI did not change the relationship ([16](#)). Furthermore, anxiety was a strong predictor of pain medication used both in-hospital as after discharge ([14, 17](#)).

One important difference between the current study and the aforementioned studies is the age of the patients. Different effects on anxiety depend on age and pain ([18](#)). In this study, the patients were predominantly adolescents whereas in the other studies only adults are included. It is possible that factors other than anxiety influence pain experience in adolescents. Some evidence suggests that female patients are less capable of coping with pain as well as a gender difference exists towards anxiety ([19](#)). However, the literature on this subject is scarce. What is known is that adolescents may be more inclined to pain catastrophizing ([20](#)) and thus experience more pain without being reflected in scores on state anxiety. Patients receive extended information about the procedure and the resulting postoperative pain. This may either lead to catastrophizing with resulting higher pain experience ([8](#)) or may lead to better handling of the pain due to better preparation ([7](#)). Although this last phenomenon is specifically studied in with patients cancer and patients with chronic pain, pain education may efficiently have the same effect in other patient groups.

Another important factor is that the pain is scored 6 weeks after the surgical procedure. After discharge from the hospital patients receive a booklet with daily restrictions for the first 6 weeks. These restrictions include no sports activities, no lifting heavy objects, and sleeping in the supine position. It may be that once patients are allowed to mobilize, the relationship between state anxiety and pain completely changes. It is known that anxiety may lead to more self-imposed restrictions in daily activities ([21](#)).

5.1. Limitations

One of the limitations of the current study was the study population derived from different hospitals. Although the surgical procedure and preoperative policies were similar for the whole group, the amount of inflicted damage to tissue during surgery and dynamic pain management might affect pain outcome scores. Furthermore, pain was measured only after 6 weeks postoperative and therefore, changes in pain level over time in the first postoperative weeks were not taken into consideration.

5.2. Conclusions

There is no significant relationship between anxiety measured with STAI state preoperative and mean VAS for pain scores or VAS for pain scores at rest after 6 weeks. However, there is a significant relationship between state anxiety preoperative and VAS for pain scores at activity 6 weeks postoperatively in surgically corrected pectus excavatum.

Footnotes

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