Advancing pectus deformity care: evaluation of current treatments, complications and future innovations

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Part III

Cross-cutting perspectives

Chapter 10

Time heals: the impact of waiting times on pediatric patients' decisions to decline pectus surgery

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ABSTRACT

Background

This study investigates the impact of waiting times, due to Covid-19, on patients' decisions to undergo surgery for pectus deformities.

Methods

We conducted a cross-sectional study of patients (>18 years) on the pectus surgery waitlist at the Amsterdam Pectus Centre. Patients were contacted in January 2025. Primary outcome was the proportion of patients still wanting surgery. Secondary outcomes included symptom progression, reasons and predictive factors for withdrawal (Ravitch surgery, age at waitlist entry, male sex, physical and psychosocial symptoms at waitlist entry). Predictive factors were analyzed using multivariable logistic regression.

Results

Of 141 contacted patients, 75.9% (107/141) were included. Age at waitlist entry was 16.0 years (IQR 15.0-17.0). After an average wait of 56.6 months (SD 22.2), only 52.3% (23/44) of pectus excavatum, 30.9% (17/55) of pectus carinatum/arcuatum and 37.5% (3/8) of flaring patients still wanted surgery. Reasons for withdrawal differed: pectus excavatum patients most often cited body acceptance, while pectus carinatum/arcuatum patients most frequently mentioned strength training. Patients who withdrew showed greater reductions in physical (69.6% versus 25.9%, P=.002) and psychosocial symptoms (95.2% versus 53.8%, P=.004) than patients still wanting surgery. Thirteen patients were treated conservatively while awaiting surgery, with a 35.5% success rate. Age (OR=.53, 95% CI=.33-.86, P=.01) and physical symptoms (OR=.37, 95% CI=.15-.94, P=.04) at waitlist entry were predictors of withdrawal from surgery.

Conclusions

After prolonged waiting, 59.8% of all patients withdrew from surgery, primarily due to body acceptance and physical development. Psychological counseling and strength training should be integrated into pectus care, particularly for young, asymptomatic patients.

INTRODUCTION

Pectus deformities, including pectus excavatum (PE) and pectus carinatum (PC), can impact patients' mental and physical well-being. PC is primarily associated with psychological distress, a disturbed body image, and reduced quality of life (QoL).[1] Unlike PE, no direct link between PC and physical impairment has been established.[2] In contrast, PE has been increasingly linked to cardiopulmonary dysfunction, with recent studies demonstrating improved cardiopulmonary outcomes following surgical correction.[3-5]

Most research in pectus deformities has focused on adults with PE, even though presentation differs by age. Adults usually present with symptomatic PE, most commonly with reduced exercise tolerance and shortness of breath,[6] whereas pediatric patients seldom report physical symptoms before puberty. After puberty, shortness of breath, exercise intolerance and diminished endurance become common.[7, 8] Some patients, however, develop symptoms only well into adulthood, and others realize their earlier limitations only after postoperative improvement.[5, 7, 9] These age-related differences have fueled ongoing debate regarding the necessity and timing of pectus surgery in pediatric patients.

Recently, this discussion was reignited when we observed that numerous patients, who had been on our waitlist for surgery for several years, partly due to delays caused by COVID-19, and had reached adulthood in the meantime, no longer wished to undergo surgery. This suggests that some patients might benefit from postponing the decision to undergo surgery for their pectus deformity until adulthood, when cognitive maturity and a more stable self-image may lead to more informed and deliberate choices regarding surgery.

In light of these findings, we aim to further investigate the impact of waiting times on pectus patients' decisions to proceed with surgical treatment, as well as explore predictive factors that influence these decisions.

PATIENTS AND METHODS

Patients and study design

We conducted a cross-sectional cohort study of patients (>18 years) who were on the waitlist for either the Nuss procedure, Ravitch surgery or flaring correction at the Amsterdam Pectus Centre. These patients were contacted in January 2025. A Medical Ethics Review Committee (METC) official waiver of ethical approval was granted by the METC of the Amsterdam University Medical Center. Informed consent was obtained from all patients (or their parents).

Treatment protocol

Our treatment protocol is shown in Figure 1. We advise patients to begin chest exercises and engage in sports while awaiting surgery. Some patients, although primarily wanting surgery, also initiate conservative therapy while awaiting surgery to help maintain chest wall flexibility. In case of isolated flaring, patients are offered surgical resection. For patients with PE combined with flaring, flaring resection is offered at the time of Nuss bar removal, as the placement of the Nuss bar often alters the appearance of the flaring. For patients with PC combined with flaring, flaring can be removed during Ravitch surgery or after completing Dynamic Compression System (DCS) bracing treatment, for similar reasons as with PE. After electing to undergo surgery, patients are placed on the waiting list according to a first-come, first-served principle. All patients are evaluated by a surgeon prior to being added to the list. There is no standard follow-up during the waiting period unless specifically agreed upon by the surgeon and patient.

Outcomes

The primary outcome of the study was the proportion of patients still willing to undergo surgery. Secondary outcomes included reasons for withdrawing from surgery, symptom progression over time and the identification of predictive factors for withdrawal from surgery (Nuss procedure or Ravitch procedure) after a waiting period.

Data extraction

Patients were contacted by phone by HB to assess their continued interest in undergoing surgery. All patients were asked the same questions (Appendix A). All other data were extracted from patients' medical records. Patients were considered lost to follow-up if there was no response after three phone calls – made at different times of the day, each one week apart – and no response to email after another three weeks.

To assess the severity of the deformity, four standardized medical photographs (example in Figure 2) were taken from different angles as part of our protocol. Three pediatric surgeons independently reviewed and classified the images as mild, moderate, or severe. If reviewer ratings differed no more than one category (e.g. mild, mild, moderate), the median rating was used. Otherwise, consensus was reached through discussion.

Reasons for surgery were categorized into three groups: physical symptoms, psychosocial symptoms, and cosmetic reasons. Physical symptoms and psychosocial symptoms were patient reported. Physical symptoms were categorized as reduced exercise tolerance, pain (posture dependent pain, sharp pain), shortness of breath, dysphagia, pressure-like chest pain, palpitations, back pain, fainting episodes. Psychosocial symptoms were defined as dissatisfaction with the appearance of the thorax, accompanied by an impact on daily life (e.g., avoiding swimming or social activities). Cosmetic reasons were defined as dissatisfaction with the appearance of the thorax without associated psychosocial symptoms.

Conservative therapy included DCS-bracing or Vacuum Bell (VB) therapy. Practical considerations for withdrawing from surgery include factors like lack of time due to work, study commitments, or personal responsibilities.

Statistical analysis

Data were analyzed using IBM SPSS Statistics 28.0. Descriptive measurements were utilized to characterize the study population. Normality of continuous variables was assessed using the Shapiro-Wilk test. Normally distributed variables are reported as mean ± standard deviation (SD) and non-normally distributed variables are reported as median with interquartile range (IQR). Of the available retrospective data, potential predictive factors for withdrawal from surgery (Nuss or Ravitch) were selected based on clinical experience. Patients with only flaring were excluded from this analysis as the indication for this type of surgery is typically established after previous PE or PC treatment and involves different decision-making factors.

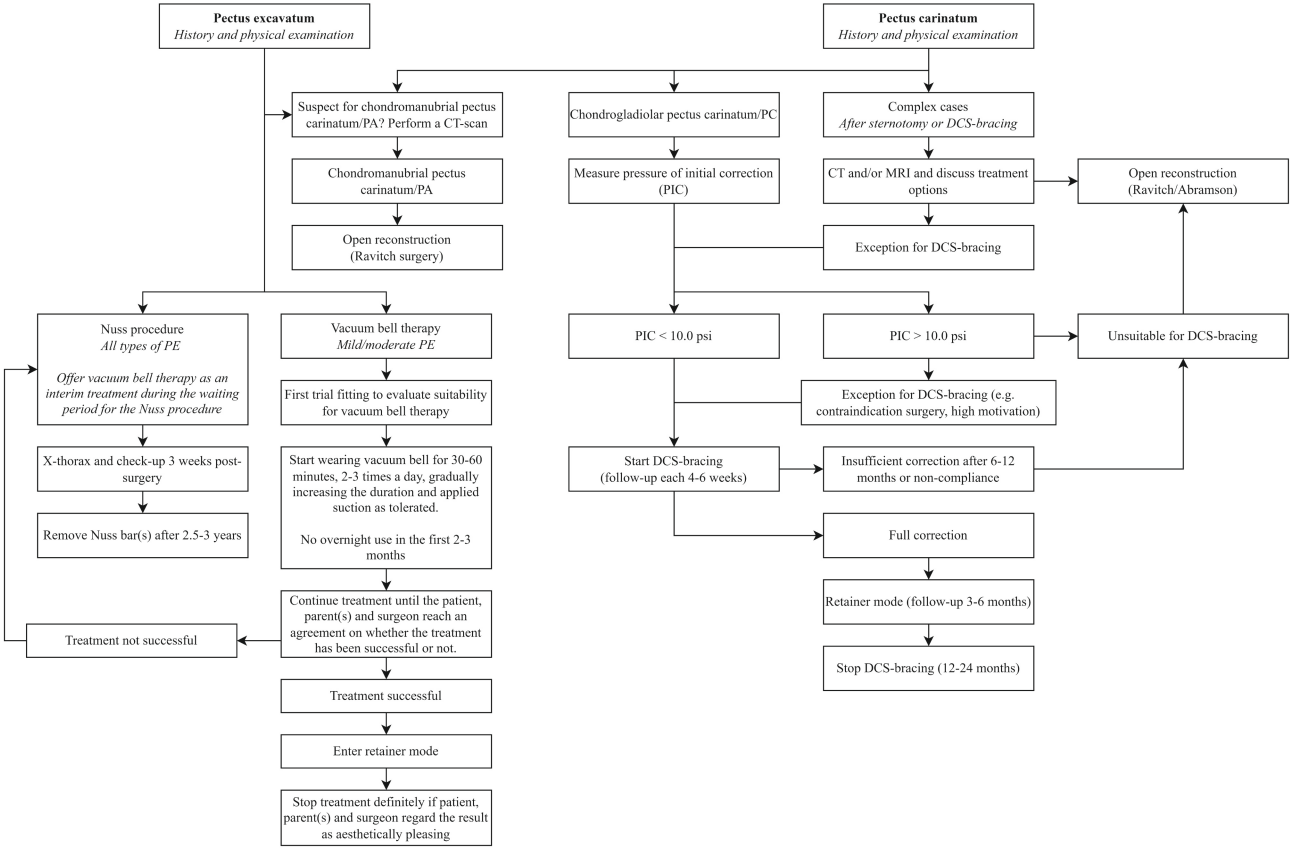

Figure 1 Treatment protocol for pectus excavatum, pectus carinatum and pectus arcuatum (DCS-bracing = Dynamic Compression System Bracing, PA = Pectus Arcuatum, PC = Pectus Carinatum, PE = Pectus Excavatum, PIC = Pressure of Initial Correction)

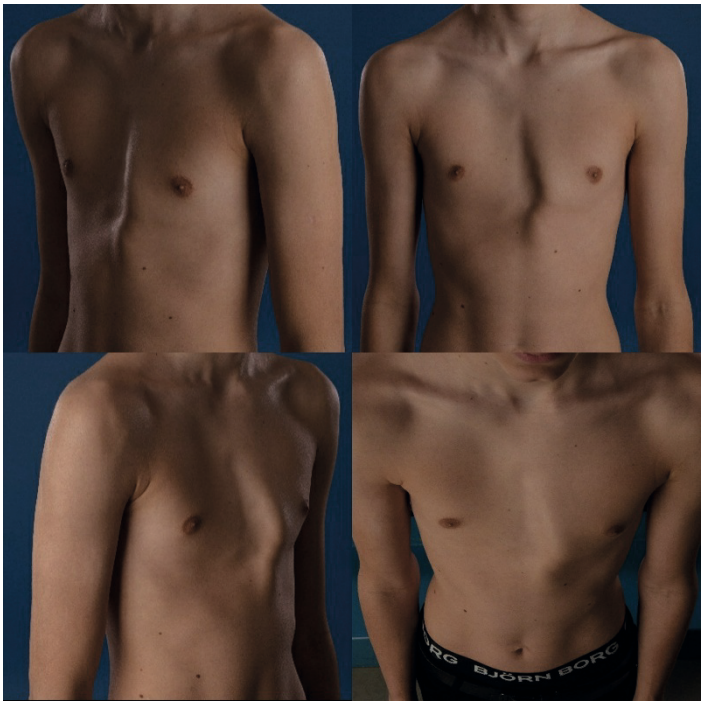

Figure 2 Medical photographs of patient with pectus carinatum

First, univariable logistic regression analysis was performed. Only variables with low collinearity (correlation coefficient between -0.8 and 0.8) were included in the analysis. The input variables included Ravitch surgery, age at waitlist entry, male sex, mild deformity, severe deformity, physical symptoms at waitlist entry and psychosocial symptoms at waitlist entry. Before performing the regression analysis, we examined whether these variables differed significantly between patients listed for Ravitch surgery compared to patients listed for the Nuss procedure, to ensure variable independence. Results were reported in odds ratio (OR) with 95% confidence intervals (95% CI). Nagelkerke's R^2 was calculated to assess the proportion of variation in the outcome explained by the model, with a value >0.15 considered indicative of a meaningful model fit.[10] A receiver-operating characteristic (ROC) curve was created to assess model performance. Area under the curve (AUC) was assessed to quantify the overall discriminative quality of the model. An AUC score of .50–.69 was considered poor, .70–.79 as moderate, and a score of ≥.8 as excellent. Both tests are needed because the ROC curve evaluates the model's discriminative ability, while Nagelkerke's R^2 provides insight into how much of the variability in the outcome is explained by the predictors. A P-value <.05 was considered statistically significant.

RESULTS

As of January 2025, 141 patients (aged >18 years) were on the waitlist for either the Nuss procedure (64/141), Ravitch surgery (67/141) or flaring correction (10/141). Baseline characteristics of the patients can be found in Table 1. Most patients were male (92.2%, 130/141), median age at waitlist entry was 16.0 (15.0-17.0) years and mean waiting time was 56.6±22.2 months (range 11.2-100.0).

Reasons for prolonged waiting time

First, the COVID-19 pandemic significantly increased the surgical backlog. Second, all included patients turned eighteen while waiting. As a pediatric pectus center, we initially could not prioritize adult patients due to staffing shortages, limited operation room availability post-COVID and the elective nature of pectus surgery. Although we offered transfer to other hospitals, most chose to remain on the waiting list until adult pectus surgery resumed.

Severity of deformities, symptoms and motivation for surgery

The severity of the deformity was regarded as mild in 27.4% (32/117), moderate in 63.2% (74/117), and severe in 9.4% (11/117) of patients from for whom medical photographs were available.

Nearly half of patients (45.4%, 64/141) reported physical symptoms at waitlist entry. Among patients with PE, reduced exercise tolerance was most common (29.7%, 19/64), while patients with PC and flaring most frequently reported pain (resp. 25.4%, 17/67 and 30.0%, 3/10). Additionally, psychosocial symptoms were reported by more than a third of patients (35.5%, 50/141).

Despite the prevalence of physical and psychosocial symptoms, a substantial proportion (39.0%) of patients indicated cosmetic concerns as their primary motivation for surgery. The remaining patients reported either physical (33.3%) or psychological (27.6%) symptoms as their main reason for seeking surgical intervention.

In patients with PE, severity of deformity was not significantly associated with the presence of physical complaints overall (P=.16), nor with reduced exercise tolerance specifically (P=.60). Similarly, in patients with PC, no association was observed between severity of deformity and the presence of physical complaints (P=.70).

Percentage of patients still willing to undergo surgery

Of all patients, 9.2% were lost to follow-up (13/141), all other patients were reached by phone. Among them, 6.4% (9/141) had already undergone surgery at another hospital, and 8.5% (12/141) wanted an outpatient consultation with a surgeon before making a decision. Of the remaining patients, 40.2% (43/107) still wanted surgery. This percentage varied across subgroups of patients on the waitlist for the Nuss procedure (52.3%, 23/44), Ravitch surgery (30.9%, 37/55) or flaring resection (37.5%, 3/8) (Figure 3).

Table 1 Baseline characteristics

	Overall (N=141)	**Nuss procedure (n=64/141)**	**Ravitch surgery (n=67/141)**	**Flaring resection (n=10/141)**
Age at waitlist entry (y) [a]	16.0 (15.0-17.0)	16.0 (15.0-17.0)	15.0 (15.0-16.0)	16.0 (14.5-17.0)
Age at evaluation (y) [a]	21.0 (19.0-22.0)	21.0 (19.0-22.8)	20.0 (19.0-22.0)	20.0 (18.8-21.0)
Waiting period (m)	56.6 ± 22.2	58.6 ± 22.8	56.3 ± 21.6	46.1 ± 20.9
Sex [b]				
Male	130 (92.2)	61 (95.3)	62 (92.5)	7 (70.0)
Female	11 (7.8)	3 (4.7)	5 (7.5)	3 (30.0)
Severity of deformity [b] (n=117)				
Mild	32 (22.7)	12 (18.8)	16 (23.9)	4 (50.0)
Moderate	74 (52.5)	37 (57.8)	33 (49.3)	4 (50.0)
Severe	11 (7.8)	4 (6.0)	7 (10.4)	-
Physical symptoms at waitlist entry [b]	64 (45.4)	32 (50.0)	28 (41.8)	4 (40.0)
Type of physical symptoms [b]				
Reduced exercise tolerance	27 (19.1)	19 (29.7)	8 (11.9)	-
Pain	29 (20.6)	9 (14.1)	17 (25.4)	3 (30.0)
Shortness of breath	9 (6.4)	5 (7.8)	4 (6.0)	-
Dysphagia	2 (1.4)	2 (3.1)	-	-
Pressure-like chest pain	6 (4.3)	2 (3.1)	4 (6.0)	-
Palpitations	2 (1.4)	2 (3.1)	-	-
Back pain	2 (1.4)	-	1 (1.5)	1 (10.0)

Table 1 Baseline characteristics *Continued*.

	Overall (N=141)	Nuss procedure (n=64/141)	Ravitch surgery (n=67/141)	Flaring resection (n=10/141)
Fainting episodes	2 (1.4)	1 (1.6)	1 (1.5)	-
Psychosocial symptoms at waitlist entry [b]	50 (35.5)	24 (37.5)	20 (29.9)	6 (60.0)
Main reason for surgery [b]				
Physical symptoms	47 (33.3)	24 (37.5)	21 (31.3)	2 (20.0)
Psychosocial symptoms	39 (27.6)	20 (31.3)	14 (20.9)	5 (50.0)
Cosmetic reasons	55 (39.0)	20 (31.3)	32 (47.8)	3 (30.0)
PIC (PSI, n=34/67)	-	-	7.1 ± 1.8	-
After conservative treatment for PE/ PC [b]	24 (17.0)	6 (9.4)	14 (20.9)	4 (40.0)
Underlying syndrome [b]	4 (2.8)	-	4 (6.0)	-

[a] Continues variables expressed as median (IQR); all remaining continuous variables are expressed as mean ± standard deviation
[b] Data displayed as n (%)
IQR = Interquartile Range, m = months, y = years, n/N = number, PC = Pectus Carinatum, PE = Pectus Excavatum, PIC = Pressure of Initial Correction, PSI = Pounds per Square Inch

Table 2 Reasons for withdrawal from surgery

	Overall (N=64)	Nuss procedure (n=21)	Ravitch surgery (n=38)	Flaring resection (n=5)
Reason for withdrawal [a]				
Acceptance of body	25 (39.1)	11 (52.4)	13 (34.2)	1 (20.0)
Strength training or weight gain	22 (34.4)	1 (4.8)	19 (50.0)	2 (40.0)
Practical considerations	12 (18.8)	6 (28.6)	4 (10.5)	2 (40.0)
Successfully treated with conservative management	5 (7.8)	3 (14.3)	2 (5.3)	-

[a] Data displayed as n (%)
n/N = number

Table 3 Logistic regression for surgery versus no surgery after period on waiting list

Variable	**OR**	**95% CI**	**P-value**
Univariable models [a]			
Ravitch surgery [b]	2.45	1.08-5.57	.03
Age at waitlist entry	.54	.36-.82	.003
Male sex	2.09	.21-20.84	.53
Mild deformity *(n=83)*	2.73	.88-8.41	.08
Severe deformity *(n=83)*	.40	.09-1.80	.23
Physical symptoms at waitlist entry	.31	.13-.72	.006
Psychosocial symptoms at waitlist entry	1.14	.49-2.68	.75
Multivariable model [a]			
Ravitch surgery [b]	1.54	.61-3.90	.36
Age at waitlist entry	.53	.33-.86	.01
Male sex	6.86	.27-174.94	.24
Physical symptoms at waitlist entry	.37	.15-.94	.04
Psychosocial symptoms at waitlist entry	.96	.37-2.5	.94

[a] Analysis in n=99 patients
[b] Reference: Nuss procedure
95% CI = 95% Confidence Interval, n/N = number, OR = Odds Ratio

Reasons for withdrawing from surgery

Patients reported various reasons for withdrawal from surgery (Table 2), most commonly acceptance of their body image (39.1%, 25/107), followed by strength training or weight gain (34.4%, 22/107), practical considerations (18.8%, 12/107), and successful conservative therapy (7.8%, 5/107). Among patients awaiting the Nuss procedure, body acceptance was the primary reason (52.4%, 11/21), followed by practical considerations (28.6%, 6/21). In contrast, patients awaiting Ravitch surgery most frequently cited strength training or weight gain (50.0%, 19/38), with body acceptance ranked second (34.2%, 13/38). Patients awaiting flaring resection reported either strength training or weight gain (40.0%, 2/5) or body acceptance (40.0%, 2/5) as primary reasons for withdrawal from surgery.

Thirteen patients (9.2%) were treated conservatively while awaiting surgery; this was successful in three of eight PE patients (37.5%) and two of five PC patients (40.0%).

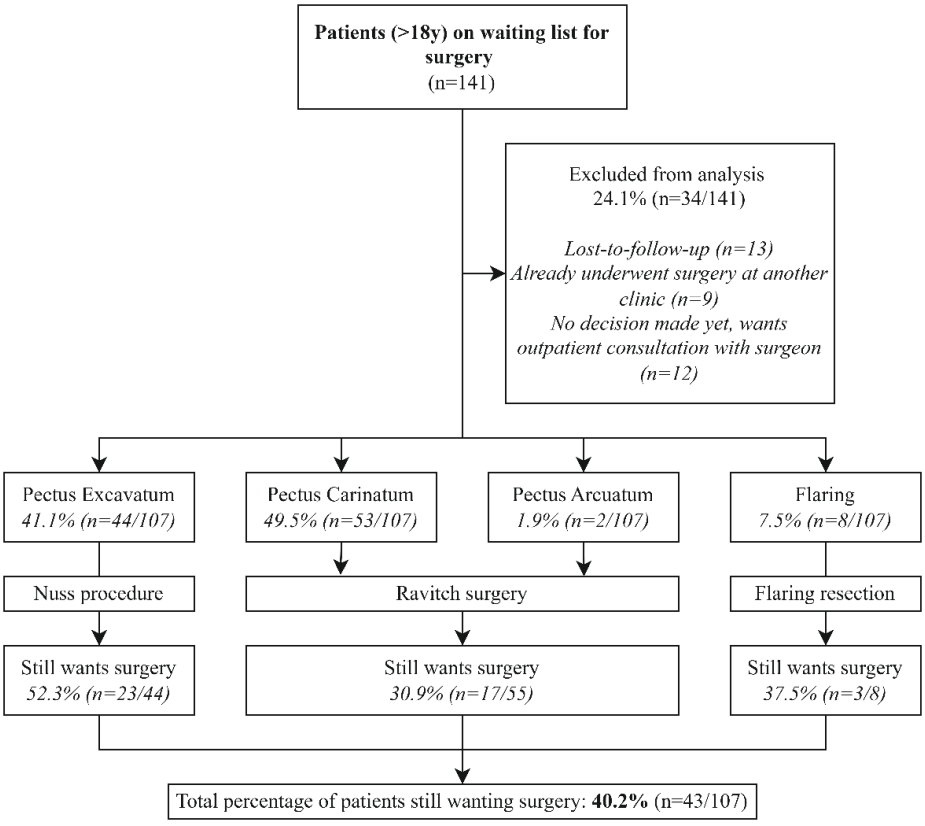

Figure 3 Flowchart of patients included in analysis (n = number, y = year)

Symptom progression over time

The proportion of all patients experiencing physical (from 45.4% to 27.1%) and psychosocial symptoms (from 35.5% to 7.5%) decreased over time (resp. P<.001, P<.001). When comparing patients who withdrew from surgery to those who still wanted surgery, the group withdrawing showed a greater reduction in both physical (69.6% versus 25.9%, P=.002) and psychosocial symptoms (95.2% versus 53.8%, P=.004). Among PE patients, those who withdrew from surgery experienced a larger reduction in physical complaints than those who still wanted surgery (75.0% versus 28.6%, P=.02).

Predictive factors for withdrawal from surgery after a waiting period

Ravitch surgery, age at waitlist entry and physical symptoms at waitlist entry were individually predictive factors of withdrawal from surgery (Table 3). Mild and severe

deformities were included in the univariable model but excluded from the multivariable model due to the proportion of missing values (16/99), which could compromise the integrity and reliability of the model. In the multivariable regression analysis only age at waitlist entry (OR=.53, 95% CI=.33-.86, P=.01) and physical symptoms at waitlist entry (OR=.37, 95% CI=.15-.94, P=.04) remained significant predictors. The final model explained approximately 24% of the variance in outcomes (Nagelkerke's R^2=.24), with an AUC of .74, indicating a clinical meaningful model with a moderate level of discriminative performance (Appendix B).

DISCUSSION

After an average waiting period of nearly five years, only 40.2% of the patients initially listed for any type of pectus surgery still wished to undergo the procedure. Patients withdrew from surgery mainly due to body acceptance or strength training/weight gain, while practical considerations and successful conservative therapy were mentioned less frequently. Reasons varied by deformity type; PE patients primarily cited body acceptance, while strength training or weight gain was the main reason among PC and flaring patients. Conservative treatment offered a moderate success rate during the waiting period. Withdrawal was associated with reductions in both physical and psychosocial symptoms. Younger age and absence of physical symptoms at waitlist entry were predictors of withdrawal from surgery.

Withdrawal from surgery because of body acceptance

Our results show that two-thirds of all patients initially viewed their pectus deformity as a major concern due to cosmetic or psychosocial distress. However, many reconsidered undergoing surgery as they matured and gained greater body acceptance. Moreover, we showed that psychosocial symptoms significantly decreased over time, particularly among patients who withdrew from surgery. Although surgery has been shown to improve self-esteem and body image,[11, 12] our findings suggest that time may also play a crucial role in shifting patients' perspectives regarding body image, self-esteem and the need for surgery.

During adolescence, self-image is still developing, often intensifying body concerns and increasing dissatisfaction with appearance.[13] As cognitive maturity progresses, individuals typically achieve a more stable self-perception, which is reflected by our findings. This process seems to extend into adulthood.[14] In contrast, some authors suggest that body image is largely shaped during a critical period before mid-adolescence, meaning that not all individuals will experience improvement in body image as they mature.[15]

The question is whether surgery should be part of the first treatment options for pediatric pectus patients without clear physical complaints or severe deformity. While pectus deformities may be the cause of lower self-esteem,[16] our findings suggest that surgery is not the only way to address this issue. Rather than focusing solely on chest wall correction, improving self-esteem through targeted psychological support could be an equally effective and less invasive alternative, potentially reducing the need for surgery in mild cases.

However, while this approach may be well suited for patients with PC, it does not necessarily apply to those with PE, since the absence of symptoms does not rule out physical impairment in these patients. Seemingly asymptomatic patients can harbor silent cardiopulmonary limits such as lower stroke volume, reduced VO_2 max and right-ventricular compression, that become evident only on objective testing or after surgical correction.[5] Objective assessment of cardiopulmonary function is essential to determine whether these patients would benefit from surgery.

Withdrawal from surgery because of strength training or weight gain

In addition to psychosocial support, PC patients could also benefit from advice on physical conditioning and muscle development. Similar to our earlier research,[17] this study shows that increasing muscle mass, either through natural growth or training, can effectively conceal PC. Moreover, since most patients are very lean,[18] gaining weight could also be beneficial in masking the deformity.

The necessity of Ravitch surgery should therefore be carefully reconsidered, given that eighty percent of patients initially listed for Ravitch surgery withdrew, due to body acceptance, strength training or weight gain, and concerns about potential surgical risks. Ravitch surgery may be more appropriately reserved for severe cases that are unsuitable for DCS-bracing.

Role of conservative treatment while awaiting surgery

While conservative treatment with the DCS-brace is already standard for most PC patients, the Nuss procedure remains the primary treatment for PE, except for flexible, mild PE. Our previous research demonstrated that VB therapy could be beneficial for patients awaiting surgery,[19] and this study further supports this potential, with 37.5% (3/8) of patients being successfully treated. Although this finding is based on a small subgroup, we believe that VB therapy, combined with psychosocial support, should play a greater role in the treatment of PE if surgery is delayed.

The drawbacks of postponing surgery

Prolonged waiting periods also present practical challenges. Nearly twenty percent of patients who withdrew from surgery cited practical considerations as their reason, indicating that they still desired surgery but could no longer accommodate it in their lives due to competing obligations. This raises concerns about missed treatment opportunities, particularly for those who may have benefitted from surgery but were unable to undergo the procedure due to time constraints rather than a change in perception. For these patients, earlier intervention might have prevented a situation in which surgery is no longer feasible due to life circumstances.

Moreover, with increasing age, progressive ossification leads to greater chest wall rigidity, often requiring additional implants or stabilization techniques to achieve adequate correction in patients with PE. Older age has also been associated with a higher risk of complications.[20] While delaying surgery may help some patients avoid it altogether, it can increase technical complexity and risk for those who eventually undergo the procedure.

Predictive factors for withdrawal from surgery

Age at waitlist entry and the presence of physical symptoms were negative predictive factors for withdrawing from surgery, meaning that the probability of withdrawal decreased as patients were older at waitlist entry and if they had symptoms at that time. In other words, a young, asymptomatic patient on the waitlist has a high chance of changing his/her mind about surgery as they grows older. This finding reinforces the earlier remark that younger patients are still developing their self-image and cognitive maturity, which can shift the perception of their deformity over time. As they grow older, they not only achieve a more stable self-perception but also undergo physical changes, such as the development of muscle mass, which may help conceal the deformity. This natural progression may explain why younger, asymptomatic patients are more likely to withdraw from surgery over time, highlighting the role of psychological adaptation and physical development in decision-making. For the young patient without significant physical symptoms, delaying surgery in favor of psychological and physical support may be a more appropriate initial approach.

The final model demonstrated a moderate ability to distinguish between patients who withdrew from surgery and those who did not. Approximately one-quarter of the variance in withdrawal decisions was explained by the included predictors, making it a meaningful model by current standards. While this leaves room for unmeasured factors, the model proves to be clinically meaningful and is useful in guiding patients through the decision-making process.

Limitations

This study was conducted at a single specialized pectus center, which may limit the generalizability of our findings to other institutions with different treatment protocols or patient populations. However, as a high-volume center with extensive experience in treating pectus deformities, our findings still provide valuable insights into treatment approach.

As a retrospective cohort study, data collection relied on medical records and patient-reported outcomes obtained through telephone interviews, introducing the potential for bias and missing data. We aimed to minimize bias by standardizing the interview process. Due to missing medical photographs, the variables mild and severe deformities could not be included in the multivariable model.

Additionally, surgical indication for PE is typically based on clinical history, visual assessment, and the surgeon's experience. While this long-standing approach is well established in our clinic, it may lack specificity and reproducibility. By contrast, we do use objective measures, such as pressure of initial correction, in patients with PC to support treatment decisions.

Although we observed a marked decline in reported symptoms, particularly among patients who withdrew from surgery, this trend should be interpreted cautiously in patients with PE. Earlier work shows that seemingly asymptomatic PE patients only recognize their cardiopulmonary limitation after experiencing postoperative improvement; thus, absence of self-reported complaints does not guarantee the absence of physiologic impairment.[5] Identifying such patients requires objective assessments, such as cardiopulmonary function testing.

Our findings suggest that psychological support may be an effective alternative to surgery, particularly for younger patients. However, we do not have a clear recommendation on the optimal age on which surgery should be performed. Our study does not define a specific age threshold for when psychological support, combined with conservative treatment, may be sufficient or when surgery becomes the preferred option. We still need to evaluate the implementation of these recommendations in our clinic and plan to report on the outcomes in the future.

We did not evaluate the role of parental expectations and concerns in the decision-making process. Parents play a key role in either reinforcing or alleviating concerns about the pectus deformity in young patients. However, as these patients reach adulthood, they must make the decision independently, which might have influenced

their decision. Although we did not explicitly ask patients about this, we observed that a significant number of adult patients still consulted their parents, suggesting that parental influence may extend beyond childhood.

Conclusions

After an average waiting period of nearly five years, only 40.2% of patients initially listed for surgery still wished to proceed to surgery. Notably, while cosmetic and psychosocial concerns are the main reasons for seeking surgery, improvements in these same areas, through body acceptance or strength training/weight gain, are also the most common reasons for withdrawal. This highlights the importance of integrating psychological counseling into the standard treatment for all pediatric pectus patients, especially the young and asymptomatic patients. This can potentially reduce the need for surgery. Additionally, patients with PC should be encouraged to engage in structured strength training.

For patients with PE, however, caution is warranted: while they may appear asymptomatic, the absence of reported symptoms does not necessarily exclude underlying cardiopulmonary impairment. Furthermore, delaying surgery in PE may increase technical complexity and risk of complications.

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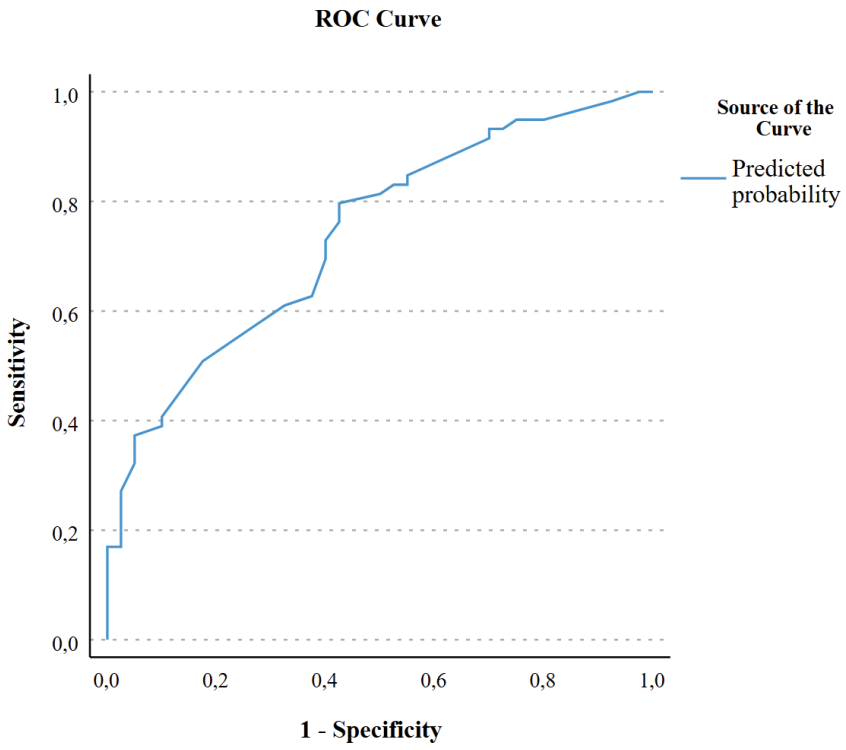
APPENDIX A

Questions
Q1 *What was your initial reason for wanting surgery?*
Q2 *Do you still want to undergo surgery?*
Q3 *If you are no longer interested, what is the main reason for your decision?*
Q4 *Did you experience any physical complaints at the time of your initial assessment?*
Q4.1 *If yes, what complaints did you experience?*
Q4.2 *Do you still experience these physical complaints?*
Q5 *Did you experience any psychological complaints at the time of your initial assessment?*
Q6.1 *If yes, what complaints did you experience?*
Q6.2 *Do you still experience these psychological complaints?*

APPENDIX B


ROC Curve
Sensitivity
1 - Specificity
0,0
0,2
0,4
0,6
0,8
1,0
Source of the Curve
Predicted probability