



MODERN SURGICAL APPROACHES IN THE MANAGEMENT OF CONGENITAL CHEST WALL DEFORMITIES.

*Mamajonov Umidjon Shokirovich. (PhD) doctor of philosophy in Medical
Sciences Andijan State Medical Institute.*

Abstract

Congenital chest wall deformities, including pectus excavatum and pectus carinatum, represent common thoracic anomalies in pediatric populations. These conditions can lead to functional impairments, psychological distress, and aesthetic concerns. The aim of this study was to evaluate modern surgical approaches for correcting congenital chest wall deformities, assess their effectiveness, and analyze postoperative outcomes. This research was conducted at the Andijan State Medical Institute, involving pediatric patients with various chest wall malformations. The results demonstrate that minimally invasive techniques, such as the Nuss procedure, combined with patient-specific treatment planning, significantly improve functional and cosmetic outcomes, reduce postoperative complications, and enhance patient satisfaction.

Keywords: congenital chest wall deformities, pectus excavatum, pectus carinatum, pediatric surgery, minimally invasive surgery, nuss procedure, surgical outcomes, thoracic malformations.

Introduction

Congenital chest wall deformities constitute a broad spectrum of structural anomalies of the thoracic cage, present from birth or early childhood. The most common types are pectus excavatum (PE), in which the sternum and adjacent costal



cartilages deviate posteriorly resulting in a sunken (funnel-shaped) anterior chest wall, and pectus carinatum (PC), characterized by a protruding sternum and rib-cage cartilage. (1)

Although some mild cases remain largely asymptomatic, many patients—especially with moderate-to-severe deformities—experience not only aesthetic and psychosocial burdens but also functional impairments. In PE, for instance, the depressed sternum may compress or displace intrathoracic structures, leading to aberrations in cardiac geometry, compression of heart chambers (notably the right ventricle), and restriction of pulmonary expansion. (2)

Clinical studies have documented that patients with chest wall deformities often exhibit reduced lung volumes, restrictive ventilatory patterns, and impaired exercise tolerance. (1) In addition to compromised cardiopulmonary function, many affected individuals suffer from poor body image, social anxiety, and reduced quality of life, particularly during adolescence—a critical period for psychosocial development. (3)

Over the past several decades, surgical interventions aimed at correcting congenital chest wall deformities have significantly evolved. Historically, open techniques — involving cartilage resection, sternal osteotomy, and large incisions — were standard. (4) However, with advances in thoracic and pediatric surgery, minimally invasive procedures have emerged as safer and more effective alternatives. Among these, the Nuss procedure — a retrosternal metal-bar insertion technique — has gained wide acceptance for correcting PE owing to less surgical trauma, reduced recovery time, and favorable cosmetic results. (5)

Contemporary literature also discusses the use of modified techniques, hybrid approaches, and individualized treatment planning — considering factors such as patient's age, chest wall rigidity, deformity severity, and previous thoracic surgeries — to optimize outcomes. (6)

Given these developments, a systematic evaluation of modern surgical approaches for congenital chest wall deformities is timely and necessary. The



primary objectives of the present study are to assess the efficacy and safety of minimally invasive and open surgical techniques in pediatric patients, to analyze the improvements in cardiopulmonary function and aesthetic/cosmetic outcomes, and to propose guidelines for optimal patient selection and surgical timing based on deformity characteristics.

Materials and methods. The study was conducted at the Andijan State Medical Institute and included a total of 45 pediatric patients diagnosed with congenital chest wall deformities. The patient cohort comprised children aged 6 to 16 years, representing a broad spectrum of developmental stages. Both male and female patients were included to ensure representative data on congenital chest wall anomalies across sexes. All participants were selected based on strict inclusion criteria: confirmed diagnosis of either pectus excavatum or pectus carinatum, absence of severe comorbidities that would contraindicate surgery, and informed consent obtained from parents or legal guardians. (1)

A comprehensive preoperative assessment was performed for each patient. This included a detailed physical examination to evaluate the type and severity of the deformity, assessment of thoracic symmetry, and measurement of chest wall indices. Imaging studies such as chest radiography and computed tomography (CT) scans were used to quantify the depth or protrusion of the sternum, assess rib cartilage involvement, and detect any concurrent thoracic anomalies. Pulmonary function tests were conducted to evaluate lung volumes, forced vital capacity, and other respiratory parameters that could influence surgical planning. Additionally, a psychological evaluation assessed the impact of chest wall deformity on self-esteem, social interactions, and overall quality of life. These preoperative assessments allowed for a personalized surgical plan tailored to each patient's anatomical and functional needs. (2,3)

Surgical interventions were selected based on the type of deformity, its severity, patient age, chest wall rigidity, and any prior thoracic surgeries. Among the



cohort, 30 patients underwent minimally invasive procedures, specifically the Nuss technique, which involves retrosternal placement of a curved metal bar to elevate or depress the sternum to its correct anatomical position. This method was chosen for patients with moderate deformities and sufficient chest wall flexibility. The remaining 15 patients underwent traditional open repair procedures, such as the Ravitch technique, which involves cartilage resection and sternal osteotomy, typically reserved for severe or rigid deformities. (4,5)

Postoperative outcomes were evaluated using a combination of functional assessments, including pulmonary function tests and exercise tolerance evaluations, aesthetic evaluation based on pre- and postoperative photographic documentation, and patient satisfaction surveys completed by patients and their parents. Follow-up assessments were conducted at regular intervals—1 month, 3 months, 6 months, and 12 months post-surgery—to monitor recovery, detect any complications, and assess long-term results. Minor complications, such as transient pain, seroma formation, or bar displacement in minimally invasive cases, were recorded and managed according to standard pediatric surgical protocols. (6,7)

This methodology ensured a systematic, objective, and reproducible evaluation of modern surgical approaches for congenital chest wall deformities in pediatric patients. By integrating anatomical, functional, and psychosocial parameters, the study aimed to provide a comprehensive assessment of both surgical efficacy and patient-centered outcomes.

Results. In this study, a total of 45 pediatric patients with congenital chest wall deformities were analyzed, of whom 30 patients (66.7%) underwent the Nuss minimally invasive procedure and 15 patients (33.3%) underwent traditional open repair (Ravitch technique). Among the 30 Nuss procedure patients, 28 patients (93.3%) achieved excellent or very good postoperative aesthetic outcomes based on both photographic documentation and patient/parent satisfaction surveys. Two



patients (6.7%) reported moderate aesthetic satisfaction, primarily due to minor asymmetry in the chest wall.

Pulmonary function tests (PFTs) revealed notable improvements in the Nuss group. Mean forced vital capacity (FVC) increased from 1.78 ± 0.32 L preoperatively to 2.14 ± 0.36 L postoperatively ($p < 0.01$), while forced expiratory volume in 1 second (FEV1) improved from 1.52 ± 0.28 L to 1.85 ± 0.30 L. Exercise tolerance, assessed via a standardized 6-minute walk test, showed a mean increase of 22%, with the average distance rising from 420 ± 35 m preoperatively to 512 ± 42 m at 12-month follow-up.

Patients in the open repair group also showed positive postoperative outcomes. Among the 15 patients, 12 (80%) achieved excellent or very good aesthetic correction, while 3 (20%) reported moderate satisfaction. Pulmonary function in this group improved moderately, with mean FVC increasing from 1.75 ± 0.30 L to 1.98 ± 0.34 L and FEV1 from 1.50 ± 0.25 L to 1.72 ± 0.28 L. However, the average hospital stay for the open repair group was 6.2 ± 1.1 days, compared to 3.1 ± 0.6 days in the Nuss group, indicating longer recovery periods. Postoperative pain scores, measured using a visual analogue scale (VAS), were also higher in the open repair group (5.8 ± 1.2) than in the Nuss group (3.2 ± 0.9) during the first week after surgery.

No major intraoperative complications were observed in either group. Minor complications occurred in 4 patients (8.9%): two cases of bar displacement in the Nuss group (6.7%) and two instances of transient pneumothorax (one in each group). All minor complications were successfully managed with conservative measures or minor interventions, and no long-term sequelae were reported.

Overall, the Nuss minimally invasive procedure demonstrated higher efficiency in terms of aesthetic correction, shorter hospitalization, lower postoperative pain, and better functional recovery compared to traditional open repair. These findings



suggest that minimally invasive approaches can provide significant clinical and psychosocial benefits for pediatric patients with congenital chest wall deformities.

Discussion

The study confirms that modern minimally invasive surgical techniques are effective for correcting congenital chest wall deformities, offering superior cosmetic results, reduced operative trauma, and faster recovery compared to traditional open procedures. Patient selection and individualized treatment planning remain critical to optimize outcomes. Early intervention is recommended in pediatric populations to prevent functional impairments and psychosocial distress. The findings align with international studies highlighting the advantages of minimally invasive approaches, including the Nuss procedure, in pediatric thoracic surgery.

Conclusion

Modern surgical approaches, particularly minimally invasive techniques, provide effective correction of congenital chest wall deformities in children. These methods improve both functional and cosmetic outcomes while minimizing postoperative complications. Individualized treatment planning and multidisciplinary care are essential to ensure optimal long-term results and patient satisfaction.

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