Editorial

Raising the bar in the management of pectus excavatum

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Over the past years, various diagnostic protocols and (non-) surgical treatment options for pectus excavatum have been proposed, though general consensus on the most optimal approach is lacking (1). In a recent study, "*The management of pectus excavatum in pediatric patients: a narrative review*", published in *Translational Pediatrics*, Scalise and Demehri [2023] attempt to bridge the gap of the current lack of consensus on pectus excavatum care by providing a balanced review of the available literature. In their comprehensive review, they also commented on the latest developments and challenges in the field, providing valuable insights into the care of pectus excavatum (2).

Patient-tailored approach

Pectus excavatum is a deformity that is known for its diverse presentation in terms of anatomical appearance, physical symptoms, and psychosocial effects. Objective measures and cardiopulmonary outcome measures often do not correlate with experienced symptoms. A patient-tailored approach that considers each patient's specific needs based on their physical exam, imaging, and personal preferences is therefore warranted. To be able to provide such an approach, one should be familiar with all the available imaging modalities [i.e., computed tomography (CT), X-thorax, magnetic resonance imaging (MRI), conventional photography, 3D imaging, and echocardiography] and treatment options [i.e., surgical repair (Nuss or Ravitch procedure) or conservative treatment (vacuum bell)] as described in the comprehensive review by Scalise and Demehri (2).

One might wonder whether all patients with pectus deformities are currently receiving an optimal patient-tailored approach since pectus excavatum care is such a niche within different medical disciplines. Therefore, treatment in specialized high-volume chest wall centers might be beneficial. As part of a true patient-tailored approach, these centers could offer a multidisciplinary approach involving specialists (e.g., pediatricians, cardiologists, pulmonologists), besides the treating surgeon, dedicated to pectus excavatum care.

Latest developments

Scalise and Demehri also discuss the latest developments in the field (2). Of all the innovations described, we want to further emphasize the importance of three of the most recent ones, namely 3D optical surface imaging, sternal

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elevation, and intercostal nerve cryoablation.

3D optical surface imaging

With 3D optical surface imaging, a non-radiation-based imaging tool, accurate assessment and monitoring of the deformity can be safely achieved (3). Besides deriving severity indexes like the 3D image-derived external Haller index (4) as mentioned by Scalise and Demehri (2), 3D optical surface imaging can also be used for automatic quantification of multiple morphologic features encompassing pectus depth, width, length, volume, position, steepness, flaring, asymmetry and mean cross-sectional area (3,5,6). These morphologic features provide more detailed information on the morphology of the deformity when compared to severity indexes. Furthermore, cardiac compression prediction models based on this imaging modality have been developed (7). Our group also recently developed aesthetic outcome prediction models to enhance information provision and expectation management among patients (8).

Sternal elevation

Since the first description of the Nuss procedure by Nuss in 1998, several modifications have been made to further optimize the procedure in terms of safety (9). This includes sternal elevation, which enables a safer mediastinal passage during minimal invasive repair of pectus excavatum (MIRPE) reducing the risk of cardiac and/or pericardial lesions. Application of sternal elevation increases the retrosternal space during the surgical procedure which facilitates thoracoscopic exposure and reduces the risk of scraping the anterior chest wall where the internal mammary arteries are located. It also may prevent intercostal muscle stripping by reducing rotational forces during flipping of the correctional bar. Though sternal elevation can be applied by various means, the crane technique is the most widely employed. Scalise and Demehri (2) report that different types of retractors are used in the crane technique, as described in the review by Haecker *et al.* (10), but they all operate on the same principle of mechanically lifting the sternum. The former studies did not objectively determine the effectiveness of the crane technique. A recent study reported that the external pectus excavatum depth facilitated by the crane technique can be reduced by 78% (11). We recommend sternal elevation by the crane technique during MIRPE in patients with severe deformities, and especially in those with increased chest wall rigidity, or a history of cardiac surgery.

Intercostal nerve cryoablation

Postoperative pain is currently the limiting factor for early discharge after MIRPE. Intercostal nerve cryoablation has recently been introduced to optimize postoperative pain management for patients who undergo MIRPE. Whilst most recent studies on cryoablation are retrospective in nature and have small sample sizes, it is a promising technique for postoperative analgesia (12,13). Scalise and Demehri (2) also discussed the reduced length of hospital stay as demonstrated in the meta-analysis by Daemen *et al.* (12) and reduced opioid requirements as reported in the randomized clinical trial by Graves *et al.* (13). Future research should focus on recovery and the patient's quality of life related to the application of this novel postoperative pain management strategy for MIRPE.

Patient satisfaction, long-term outcomes, and socioeconomic impact

Scalise and Demehri briefly touch upon patient satisfaction with each intervention and compliance with the non-surgical approach (2). Little is known about the different treatments' long-term functional, cosmetic, and psychological outcomes. It is imperative to evaluate the long-term effectiveness and safety of all different treatment options, as well as their impact on patient well-being and quality of life. Given the complex nature of the condition and the potential for late complications, such as recurrence, knowledge about which patient benefits most from which treatment leads to further optimization of the patient-tailored approach. Additionally, there are still treatment-specific questions that remain unanswered, for example, the optimal age for bar implantation and removal. In this respect, the difference between European and Asian practices is remarkable.

Scalise and Demehri also discuss the effect of surgical repair on cardiopulmonary function in the context of pectus excavatum (2). Literature on this topic remains ambiguous and further prospective randomized-controlled research should be conducted to provide more insights into the physiologic impact of the deformity and its repair. This also touches on the discussion of which patients should seek correction of the deformity. Some argue that surgical correction should only be available for symptomatic patients. However, this is practically not feasible as no

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definition for a symptomatic pectus excavatum has been established and as previously mentioned, objective indexes do not correlate with experienced symptoms. Moreover, a recent study underscores the interobserver variation in diagnosis of pectus excavatum between experts (14).

Furthermore, both the lack of long-term outcomes and the controversies regarding the reversibility of cardiopulmonary function hurdle an accurate estimation of the socioeconomic impact of the deformity. This is also reflected by health insurance differences between countries. The National Health Service (NHS) England, for example, states that there is not sufficient evidence to justify routine commissioning of surgical repair of the deformity (15). Only patients with a severe deformity and evidence of cardiopulmonary compression on imaging may be considered for surgery by the NHS England, and as a result, most patients will need to fund their own surgery. NHS England based their policy on a review of the available literature which they divided into two subsections. With respect to the impact of surgery on cardiorespiratory and functional outcomes, they refer to the ambiguity, statistical heterogeneity, and low-evidence study designs of the conducted studies. Regarding the effectiveness of surgical repair on psychological, social, and behavioral outcomes they also point out the weaknesses in the study designs in the found evidence. The available studies are not well-controlled, making it difficult to establish which effect is attributable to surgery and which to other covariates. Moreover, limited information is provided on the clinical significance of the found statistically significant results. Though patients narratively report an improved quality of life, in the absence of minimal important difference cut-off values for the disease-specific psychometric questionnaires, it is challenging to objectively estimate what effect surgery might have on a patient's life.

Conclusions

Reviews, such as the commented one, undoubtedly aid in the dissemination of knowledge among healthcare professionals. Despite developments in monitoring and treatment options, there are still notable gaps in our understanding of the long-term outcomes of pectus excavatum. It is important to note that there is still a need for new evidence in the field of pectus excavatum. In particular, studies that provide more robust evidence on the effectiveness and functional outcome of surgical repair are warranted. Such studies would help to establish more standardized diagnostic and treatment protocols, which would greatly benefit patients with pectus excavatum. Hence, continued research in this area is crucial to ensure that pectus excavatum patients are receiving the best possible care.

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