



Modifications to the Nuss procedure for pectus excavatum repair: A 20-year review



David M. Notrica^{a,b,c,*}

^a Department of Surgery, Phoenix Children's Hospital, 1919 East Thomas Road, Phoenix, AZ 85016, United States

^b Mayo Clinic College of Medicine, United States

^c University of Arizona College of Medicine Phoenix, United States

Background

In May of 1997, Dr. Donald Nuss presented a radically new technique for repairing pectus excavatum at the American Pediatric Surgery Association (APSA)¹. Prior to the APSA presentation, the standard technique for repair was an open operation involving resection of either all, or sections of the costal cartilage attaching to the sternum.^{2,3} This was followed by a sternal osteotomy with or without a sternal strut.⁴ Other techniques included flipping the deformed sternum.⁵ The procedure described by Dr Nuss eliminated resection of the cartilage and need for a sternal osteotomy. His technique was revolutionary in multiple ways. The most important, was that for the first time, pediatric surgeons followed basic orthopedic principles for repairing a bony and cartilaginous anomaly. This included an internal splinting into normal anatomic alignment, respect for the growth centers, and stabilization of the repair. The prior technique violated these principles with some patients developing nonunion, pseudoarthrosis, floating sternum, loss of correction over time, lung herniation, acquired thoracic dystrophy, or chronic pain.^{6–8} Additionally, the new technique could be done in less time and with less blood loss.

Nuss' minimally invasive technique for the correction of pectus excavatum was initially described after a ten-year experience. While new techniques are often described shortly after their development, this technique had already undergone 10 years of evolution prior to publication and became one of the most frequently cited articles published in that journal. Pediatric surgeons around the globe rapidly adopted the technique, and a major international group (the Chest Wall International Group, CWIG) formed to share advice and experience with chest wall repair.

As adoption continued, widespread use of the technique led to the publication of complications.^{9–26} While the initial published experience included over 42 patients from a single center, the procedure has now been done more than 50,000 times.²³ This increase in operative repairs has increased experience, resulted in wider adoption, but has also led to modifications.²³

Modifications have been driven by multiple factors, but complications were clearly a driving force for change.²⁶ Cardiac perforation was reported by several centers throughout the world and bar flipping requiring reoperation was a troublesome complication in every significant series.^{9,10,14,19,27} Other modifications focused on using the procedure on different patient populations or for different problems or improving the cosmesis. A few modifications have focused on pain control.

Using Pubmed, Medline, Scopus, and MESH a search was created using the terms “Minimally invasive repair of pectus excavatum” or “Nuss Procedure” and “modification” or “technique.” Additionally, every publication with the first two key words were screened for modifications. Numerous discrete modifications were identified. These were further analyzed by type of modification to understand areas that have undergone the most significant changes and the problems the modifications were attempting to address.

Types of modifications

Modifications to the surgical technique have been numerous. These modifications can be grouped into 7 general categories: (1) Modifications to patient selection or indications (2) modification to patient positioning and incisions (3) modification of bar passage (4) modifications to shape, size or number of bars (5) Modifications to bar fixation and (6) modifications for intercostal stripping (7) modification for operative planning or simulation.

Patient selection

Increasing age in children

The most significant change has been the age of patients for pectus repair. In the original paper published by Nuss et al., the median age at surgery was 5 years (Fig. 1). No one over age 15 years was even included in the original publication and the maximum age for possible repair was unknown. By 2008, Nuss was recommending the procedure be done while the chest was still pliable, but at an age where the bars would still be in place during their adolescent growth spurt (but allowed that younger children could be done if significant cardiac and/or pulmonary compression).²⁸ Current trends have shown a markedly increase in age at

* Correspondence to: Department of Surgery, Phoenix Children's Hospital, 1919 East Thomas Road, Phoenix, AZ 85016, United States.

E-mail address: dnotrica@phoenixchildrens.com

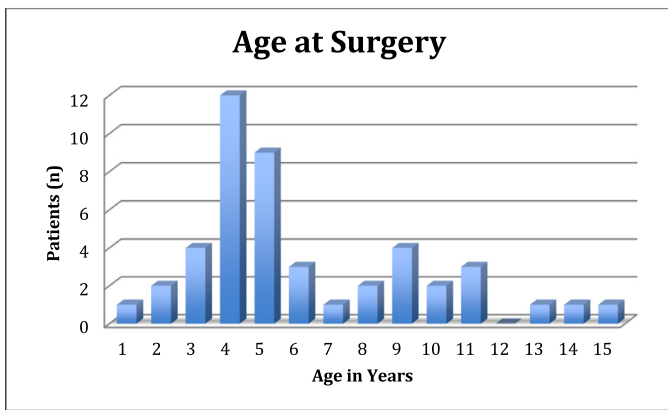


Fig. 1. Nuss' original publication shows a median age of 5 years. This histogram details the age at surgery in years. (Redrawn from Nuss D, Kelly RE, Jr., Croitoru DP, Katz ME. A 10-year review of a minimally invasive technique for the correction of pectus excavatum. *J Pediatr Surg.* 1998;33(4):545-552.) reproduced with permission.

repair.²⁹ Papandria et al. found by 2009 the mean age at operation was over 14 years and even the youngest 25th percentile had increased to 13 years of age (Fig. 2). Much of the change in age at repair was driven by diverse factors. Most insurance companies would only authorize repair for patients with symptoms, and many symptoms did not develop until the teenage years. Additionally, our understanding of the ability of the chest to remodel even in adulthood increased significantly (Nuss). Reports of acquired thoracic dystrophy in young children undergoing the older near-total cartilage resection type of repair of pectus also drove the age of referral higher.^{6,30} By contrast, centers outside the United States are reporting excellent results in repair of younger patients, advocating for repair after 3 years of age.³¹

Broader applications

The patients selected for surgery have changed significantly. Surgery for recurrent pectus excavatum after open repair has been reported in several large series.^{32–37} Many of these involve hybrid procedures, but successful repair with a less modified Nuss procedure has also yielded good results.^{33,34,36,38–40} Situations where thoracic hernias are present, cases of floating sternum, cases of complete non-union or pseudoarthrosis have also

demonstrated some limits where the Nuss procedure may not be appropriate.^{8,40,41}

Adults and seniors

Shortly after the description of the Nuss procedure, the procedure was applied to older patients.⁴² Several large series have described good results in adult patients, including middle-aged patients.^{43,44} Additionally, seniors (including patients as old as 72 years) have been reported with successful results.⁴⁵

Women and modifications for breast concerns

Pectus excavatum is markedly more common in men, but women and girls with symptomatic pectus excavatum have undergone the Nuss procedure.⁴⁶ Modifications for women have included moving the incision to the inframammary crease, and avoiding specific aspects associated with cosmetic disturbances of the breast.⁴⁷ Additionally, several papers have addressed prior breast augmentation in women, which does not appear to be a limitation.^{48,49} Simultaneous chest repair and breast augmentation have been done.⁴⁹ Modifications have included use of biomesh to separate the bar from the implant, removal of existing implants prior to Nuss repair, and staged repair.⁴⁸

Concurrent lung surgeries

Some patients with pectus excavatum need concurrent thoracic surgery. The Nuss procedure has been combined with other surgeries such as blebectomy and thoracoscopic lung resection.^{50,51} Post-operative pain and limitations of pulmonary toilet, however, may have contributed to a persistent air leak after lung resection in one report and combined surgeries may not be ideal for all patients.⁵⁰

Concurrent cardiac surgery

The risk of cardiac injury for Nuss after prior cardiac surgery has been reported as 7% in this high-risk population.⁵² By contrast, Wang et al., Sacco et al., and Park et al. reported good results for concurrent Nuss procedure with cardiac surgery, which may justify doing the operations at the same surgery.^{53–55} In the combination cases, placement of the bar is done at the conclusion of the cardiac

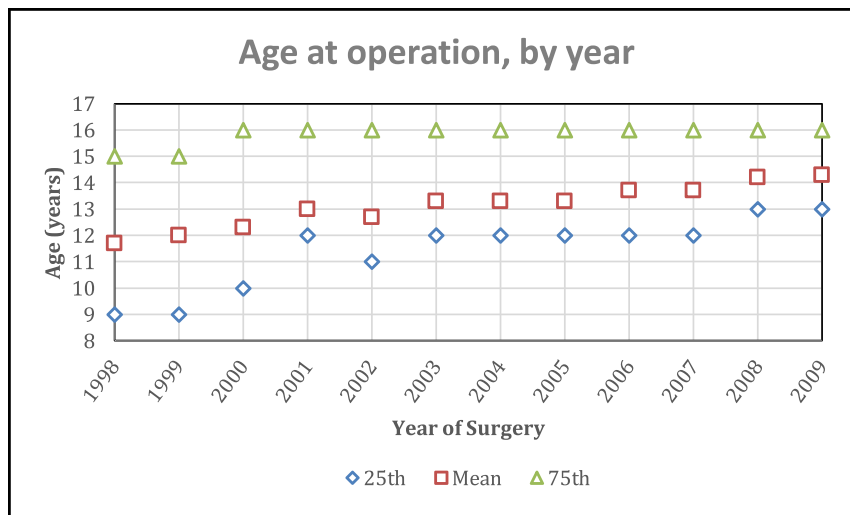


Fig. 2. Changes in the age of operation using the Nuss procedure over time, Mean and 25th/75th percentiles. (Modified from Papandria D, Arlikar J, Sacco Casamassima MG, et al. Increasing age at time of pectus excavatum repair in children: emerging consensus? *J Pediatr Surg* 2013;48:191-6.) reproduced with permission.

Download English Version:

<https://daneshyari.com/en/article/8813779>

Download Persian Version:

<https://daneshyari.com/article/8813779>

[Daneshyari.com](https://daneshyari.com)