

УДК 616.712-007.24-053.2-089(048.8)  
DOI: <https://doi.org/10.17816/PTORS112043>

Научный обзор



# Хирургическое лечение детей с асимметричной воронкообразной деформацией грудной клетки (обзор литературы)

Б.Х. Долгиев, Д.В. Рыжиков, С.В. Виссарионов

Национальный медицинский исследовательский центр детской травматологии и ортопедии им. Г.И. Турнера, Санкт-Петербург, Россия

**Обоснование.** Хирургическое лечение детей с воронкообразной деформацией грудной клетки является актуальной и до конца не решенной проблемой, несмотря на существование множества способов хирургической коррекции. Известные на данный момент методики не лишены недостатков и не позволяют решать все существующие задачи, особенно в отношении асимметричных форм воронкообразных деформаций грудной клетки.

**Цель** — проанализировать публикации, содержащие информацию о методиках хирургического лечения детей с воронкообразной деформацией грудной клетки.

**Материалы и методы.** В статье представлены результаты поиска литературы, посвященной методам хирургической коррекции воронкообразной деформации грудной клетки. Поиск данных проводили в базах научной литературы PubMed, Google Scholar, eLibrary по ключевым словам. Были выбраны 63 иностранных и отечественных источника за период с 1609 по 2022 г., из которых 29 за последние 10 лет.

**Результаты.** Среди множества методик коррекции деформации грудной клетки торакопластика по D. Nuss стала «золотым стандартом» лечения воронкообразных деформаций грудной клетки. Однако на данный момент не существует универсального варианта оперативного вмешательства, позволяющего достигать всех целей лечения. Используемые в современной хирургии способы коррекции воронкообразной деформации грудной клетки представляют собой преимущественно этапные модификации более ранних методов лечения.

**Заключение.** Недостатки современных торакопластик определяют необходимость поиска новых методик и совершенствования старых, а также формирования стандарта, удовлетворяющего хирургов и пациентов.

**Ключевые слова:** асимметричная, воронкообразная деформация грудной клетки; торакопластика; дети.

## Как цитировать:

Долгиев Б.Х., Рыжиков Д.В., Виссарионов С.В. Хирургическое лечение детей с асимметричной воронкообразной деформацией грудной клетки (обзор литературы) // Ортопедия, травматология и восстановительная хирургия детского возраста. 2022. Т. 10. № 4. С. 471–479. DOI: <https://doi.org/10.17816/PTORS112043>

DOI: <https://doi.org/10.17816/PTORS112043>

Review

# Surgical treatment of children with asymmetric pectus excavatum: Literature review

Bahauddin H. Dolgiev, Dmitriy V. Ryzhikov, Sergei V. Vissarionov

H. Turner National Medical Research Center for Children's Orthopaedics and Trauma Surgery, Saint Petersburg, Russia

**BACKGROUND:** The surgical treatment of children with pectus excavatum is regarded as an urgent problem still demanding solution despite the multitudes of surgical correction methods available nowadays. The currently available well-known techniques cannot be considered perfect because they are not proper enough for solving all the tasks, not to mention the problem of asymmetric forms of pectus excavatum treatment.

**AIM:** To analyze publications containing information on the methods of surgical treatment used for children with pectus excavatum.

**MATERIALS AND METHODS:** The study presents the results of literature review on the methods of surgical correction of pectus excavatum. Information was retrieved in PubMed, Google Scholar, and eLibrary scientific databases using keywords. Consequently, 63 foreign and domestic scientific sources over the period from 1609 to 2022 were identified. Among them, 29 publications refer to the latest decade.

**RESULTS:** Given the variety of methods used for chest deformity correction, thoracoplasty by D. Nuss has become the "gold standard" for the treatment of pectus excavatum. However, according to the search results, it is impossible to name one universal method of surgical intervention that could solve all the urgent problems at present. Modern surgery methods used for pectus excavatum correction can be considered only as modifications of treatment methods having been used before.

**CONCLUSIONS:** The shortcomings of modern thoracoplasty determine the necessity to keep searching for new techniques and improve those available at present. Besides, the standard suitable for both surgeons and patients should be elaborated.

**Keywords:** asymmetric, pectus excavatum; thoracoplasty; children.

**To cite this article:**

Dolgiev BH, Ryzhikov DV, Vissarionov SV. Surgical treatment of children with asymmetric pectus excavatum: Literature review. *Pediatric Traumatology, Orthopaedics and Reconstructive Surgery*. 2022;10(4):471–479. DOI: <https://doi.org/10.17816/PTORS112043>

DOI: <https://doi.org/10.17816/PTORS112043>

科学审查

## 儿童不对称漏斗状胸部畸形的手术治疗(文献综述)

Bahauddin H. Dolgiev, Dmitriy V. Ryzhikov, Sergei V. Vissarionov

H. Turner National Medical Research Center for Children's Orthopaedics and Trauma Surgery, Saint Petersburg, Russia

**论证。**尽管已有许多手术矫正方法,但儿童漏斗胸畸形的手术治疗是一个紧迫且尚未完全解决的问题。目前已知的技术并非没有缺点,也不能解决所有现有问题,尤其是不对称形式的漏斗胸畸形。

**目的。**本研究旨在分析包含漏斗状胸部畸形儿童手术治疗技术信息的出版物。

**材料与方法。**文章介绍了有关漏斗状胸部畸形手术矫正方法的文献检索结果。数据通过关键词在PubMed、Google Scholar和eLibrary数据库中进行检索。选取了1609年至2022年期间的63篇国内外文献,其中29篇为近10年的文献。

**结果。**在众多胸部畸形矫正技术中,D. Nuss的胸廓成形术已成为治疗漏斗状胸部畸形的“黄金标准”。然而,目前还没有一种通用的外科干预方法可以实现所有的治疗目标。现代手术中使用的漏斗胸畸形矫正方法主要是对早期治疗方法的阶段性修改。

**结论。**现代胸廓成形术的缺陷决定了需要寻找新的技术和改进旧的技术,并形成令外科医生和患者满意的标准。

**关键词:** 不对称、漏斗状胸部畸形; 胸廓成形术; 儿童。

### 引用本文:

Dolgiev BH, Ryzhikov DV, Vissarionov SV. 儿童不对称漏斗状胸部畸形的手术治疗(文献综述). *Pediatric Traumatology, Orthopaedics and Reconstructive Surgery*. 2022;10(4):471–479. DOI: <https://doi.org/10.17816/PTORS112043>

收到: 01.11.2022

接受: 13.12.2022

发布日期: 23.12.2022

## 论证

*Pectus excavatum* (漏斗胸) 是一种畸形, 表现为胸骨西化和肋软骨畸形。1594年, Bauhinius首次对其进行了描述[1]。这种畸形可能在出生时就存在, 也可能在青春期发育。约三分之一的病例在婴儿期就有记录, 其余病例在青春期前的儿童期就已发现[2-4]。在青春期发育期, 三分之一的病例胸廓畸形会变得更加明显, 而三分之二的患者胸廓弧度不会进一步发展[5, 6]。

在胸廓畸形总数中, 漏斗胸占90%以上, 其余8%的观察结果为龙骨状畸形 (“鸡胸”, “鸽子胸”、*pectus carinatum*), 范围分别为3:1到13:1[7-10]。漏斗状胸部畸形在人群中的发病率从0.06%到2.3%不等[11, 12], 病理患病率从0.2%到1.3%不等。在儿童中, 每400-1000名健康人中就有一名漏斗胸患者。据报道, 漏斗胸在男孩中的发病率是女孩的3-5倍[13-17]。约60%的患者胸部对称, 其余40%的患者胸部不对称[18]。根据一份报告, 遗传因素在该病症的发生中起着主导作用。证据是患者存在并发畸形, 以及亲属中存在类似的变化[19]。37-40%的病例证实了该病症的遗传性。其他作者并未发现直接的遗传联系[20-22]。该病的发病机制尚不完全清楚[23]。

目的是分析包含漏斗状胸部畸形儿童手术治疗技术信息的出版物。

## 材料和方法

本文介绍了有关漏斗胸手术矫正方法的文献检索结果。以“不对称漏斗状胸部畸形”和“胸廓成形术”为关键词, 在PubMed、Google Scholar和eLibrary数据库中进行了检索。共找到了从1609年到2022年的63篇国内外资料, 其中29篇是最近10年的资料。纳入标准: 有全文来源、随机对照和非对照试验以及系统综述的信息和方法学论文。包含相似信息的重复论文将被排除在外, 如果发现此类论文, 则选择时间上较新的版本。

## 结果与讨论

20世纪初, 迈耶 (Meyer) 于1911年提出[24], 并大量引入了漏斗胸矫正手术技术。随后,

多位学者采用了新的手术技术并对旧技术进行了改进: 1912年, Klapp; 1925年, Zahradnicek; 1931年, Sauerbruch; 1939年, Oshsner和DeBakey; 1948年, Brodtkin; 1949年, Ravitch [25-30]。

Ravitch提出了一种手术干预方法, 包括畸形区肋软骨软骨下切除术和胸骨截骨术。管引入了新的手术方法来矫正胸部畸形, 但上述方法一直是世界范围内手术治疗漏斗胸的标准[31]。

G.A. Bairov的手术方法是切断并降低肩胛突, 横向切开胸骨, 在畸形顶端软骨下切除肋软骨, 然后牵引活动的胸骨, 但由于在儿童生长发育期间畸形复发, 该方法被证明是无效的[32]。

由Judet和Jung[33]首创的基于胸骨180°前后旋转的外科技术, 因其创伤大、效率低, 被列入目前无关紧要的外科矫正方法之列。

迄今为止, D. Nuss的胸廓成形术已成为“黄金标准”, 是最常见、最有效的胸廓成形术, 同时考虑到了以下改良方法[34, 35]。它的基础是通过胸骨后放置钛板改变弹性肋软骨的形状, 这使得前胸壁几乎完全瞬间矫正成为可能[36]。

近年来, D. Nuss技术经历了许多变化和修改[37-39]。胸廓成形术从两侧入路进行。根据胸廓畸形的形状制作的弧形弯曲钢板穿过预制的胸骨后管道并旋转180°, 随后将末端部分固定在肋骨上。钢板插入过程中缺乏可视化控制, 导致并发症风险很高——损伤心脏和心包、肺、大血管、膈肌、内脏以及心律失常, 这一点已被文献数据证实[40-42]。不过, 微创胸廓成形术出现并发症的可能性也取决于操作者[43, 44]。使用视频辅助胸腔镜时, 出现上述问题的概率会降低, 尤其是在严重畸形的情况下[45, 46]。

2007年, M.R. Harrison提出了一种基于磁场力的治疗漏斗胸的替代方法。通过手术将两块磁铁分别置于矫形器的后方和前方, 由于产生的磁场推力, 可以将前胸壁移至前方, 从而矫正畸形。这种方法目前正处于人体临床研究阶段[47, 48]。

对于I级的漏斗肌, 一般不会出现心呼吸综合征, 因此单纯的美学问题就会凸显出来, 在没

有胸腔整形指征的情况下,可以采用手术整容的方法[49, 50]。前胸壁后退的矫正方法是用硅胶假体填充,假体放置在前胸和筋膜下,通常使用脐入路,以获得最美观的效果[51, 52]。

随着时间的推移, D. Nuss原始技术及其改良技术的缺点逐渐显现出来: 胸部畸形复发、曲率可能过度矫正、前胸壁存在残余畸形以及钢板移位。与此同时, 虽然畸形复发的的问题已通过增加植入物固定时间得到了很大程度的解决, 而且由于固定方法和设计的发展, 移位的风险也有所降低, 但另外两个问题还没有完全解决。

值得注意的是, 尽管使用D. Nuss方法治疗漏斗胸疗效显著, 并发症发生率低且创伤小, 但矫正不对称漏斗胸会导致残余不对称的形成, 通常表现为僵硬畸形。这种美学问题会引起外科医生和患者对手术治疗效果的不满, 并产生额外矫正的需求[53]。当无法令人满意地矫正严重不对称的漏斗胸时, 有人提出了一种手术策略, 包括术中从孤立的微创干预过渡到与根治性胸廓成形术相结合[18]。

在某些病例中, 使用D. Nuss技术会导致前胸壁形成继发性畸形[54]。据该技术的作者称, 10年的工作结果显示, 8%的结果不令人满意[32]。使用D. Nuss方法时, 效果不满意的频率达到21%[55]。

自从D. Nuss手术问世以来, 为了提高疗效和安全性, 人们提出了许多适合病理过程形态的胸廓矫正方法, 其中包括H. Park博士提出的非对称漏斗胸。该技术的主要原理是与胸廓畸形轮廓相反的非对称钢板形状[56, 57]。回顾性数据分析显示, 该技术在治疗不对称漏斗胸方面取得了一些成功, 但仍无法实现所有既定目标, 因此需要进一步研究[56, 57]。上述研究提出了一种新技术, 强调导引器的进出部位, 即从不对称的上部到对侧下部, 这也是手术简单和最终

美观的原因。这种技术并不复杂, 但很实用, 可同时对胸廓突出部分施压, 并抬高凹陷的对侧, 在放置导引器后对钢板进行塑形, 以提高准确性[58]。

值得一提的还有“三明治技术”的畸形矫正手术, 该技术也是由H. Park提出的, 其中涉及至少使用两块钢板: 一块在后胸, 另一块在前胸(根据Abramson的观点), 以确保钢板之间的相互挤压和随后的固定[59]。尽管有上述技术的优点, 但通过软组织厚层进行钢板的体外传导会增加各种并发症的风险, 更不用说由于僵硬变形中支点不足而导致该钢板对前胸壁的压力不足。在不对称畸形和遗传综合征中, 钢板移位的风险分别增加了4倍和3倍, 这就决定了需要寻找一种更彻底、更稳定的固定方式[60]。为了预防大多数并发症, 包括病理复发、残留或继发畸形的形成, 有必要寻找和开发更易接受的微创漏斗胸矫正方法[61-63]。

## 结论

严重的漏斗胸可通过手术重建胸骨后间隙来治疗。微创方法在这方面处于领先地位, 在现代化和使用方面前景广阔。

尽管在所述主题方面取得了重大进展并正在进行研究, 但这一方向目前仍具有重要意义和相关性, 特别是对于刚性非对称漏斗胸而言。目前还没有一种通用技术既能满足外科医生和患者的需求, 又能避免影响最终治疗效果的缺点。

## 补充信息

**资金来源。**这项工作没有资金支持或赞助。

**利益冲突。**作者声明, 本文的发表不存在明显和潜在的利益冲突。

**作者的贡献。**B. H. Dolgiev, 收集文献资料, 撰写文章; D. V. Ryzhikov, 研究论文构思, 编辑文章正文; S. V. Vissarionov, 研究设计, 编辑文章正文。

所有作者都为研究和文章撰写做出了重要贡献, 并在发表前阅读和批准了最终版本。

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## ОБ АВТОРАХ

**\* Багауддин Хавашевич Долгиев,**

врач — травматолог-ортопед;  
адрес: Россия, 196603, Санкт-Петербург, Пушкин,  
ул. Парковая, д. 64–68;  
ORCID: <https://orcid.org/0000-0003-2184-5304>;  
e-mail: dr-b@bk.ru

**Дмитрий Владимирович Рыжиков,** канд. мед. наук;

ORCID: <https://orcid.org/0000-0002-7824-7412>;  
eLibrary SPIN: 7983-4270;  
e-mail: dryjnikov@yahoo.com

**Сергей Валентинович Виссарионов,** д-р мед. наук,

профессор, чл.-корр. РАН;  
ORCID: <https://orcid.org/0000-0003-4235-5048>;  
ResearcherID: P-8596-2015;  
Scopus Author ID: 6504128319;  
eLibrary SPIN: 7125-4930;  
e-mail: vissarionovs@gmail.com

## AUTHOR INFORMATION

**\* Bahauddin H. Dolgiev,** MD,

Orthopedic and Trauma Surgeon;  
address: 64-68 Parkovaya str., Pushkin, Saint Petersburg,  
196603, Russia;  
ORCID: <https://orcid.org/0000-0003-2184-5304>;  
e-mail: dr-b@bk.ru

**Dmitriy V. Ryzhikov,** MD, PhD, Cand. Sci. (Med.); ORCID:

<https://orcid.org/0000-0002-7824-7412>;  
eLibrary SPIN: 7983-4270;  
e-mail: dryjnikov@yahoo.com

**Sergei V. Vissarionov,** MD, PhD, Dr. Sci. (Med.),

Professor, Corresponding Member of RAS;  
ORCID: <https://orcid.org/0000-0003-4235-5048>;  
ResearcherID: P-8596-2015;  
Scopus Author ID: 6504128319;  
eLibrary SPIN: 7125-4930;  
e-mail: vissarionovs@gmail.com

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\* Автор, ответственный за переписку / Corresponding author