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REVIEW ARTICLE

Scoping Review of the Correlation between Infantile Chest Wall Surgery and Scoliosis Risk

Michael Ginzburg PsyD, LMFT, CO[1*]; Rachel White CPO[2]

[1]Senior Orthotist/Prosthetist at UC Davis Health PM&R. Certified by the American Board of Certification in Orthotics, Prosthetics and Pedorthics; Licensed Clinical Psychologist by the California Board of Psychology; Licensed Marriage and Family Therapist by the California Board of Behavioral Sciences, and a member of the European Society of Medicine, American Board of Sexology, and the International Society on Scoliosis Orthopaedic and Rehabilitation Treatment.

[2]Senior Orthotist/Prosthetist at UC Davis Health PM&R. Certified by the American Board of Certification in Orthotics, Prosthetics and Pedorthics, and is an active member of the American Academy of Orthotics and Prosthetics and of the International Society on Scoliosis Orthopaedic and Rehabilitation Treatment.

[*]mginzburgco004912@yahoo.com

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ABSTRACT

The relationship between the chest wall surgeries performed in infancy and the risk on scoliosis onset is poorly understood and controversial. A series of investigations, including systematic literature review and retrospective analysis, was performed and revealed a prevalence of scoliosis in the post-surgical population that exceeds that seen in the general population by a significant amount. Further, the 1:1 M:F ratio seen in the post-surgical does not correspond to the ratio seen in the adolescent idiopathic scoliosis diagnosis, while the prevalence of the left-sided thoracic curves and the progression of the scoliotic curves to surgical magnitudes are also diverging from the AIS norms. The population that has experienced chest wall surgery in infancy has been shown to exhibit conditions that impact scoliosis risk and treatment compliance. The classification of the post-surgical curves as syndromic scoliosis is advised. The patient population that has experienced infantile chest wall surgery is recommended to be screened for scoliosis more frequently and at a younger age as compared to their peers. Unique benefits of supplementing conservative scoliosis care with behavioral health/psychotherapeutic interventions is discussed below.

Introduction

The relationship between infantile chest wall surgeries and the risk of scoliosis onset has been poorly understood and controversial. Professional opinions on this subject have ranged from ascribing the surgeries performed as a cause of the scoliosis that responds to treatment differently from known scoliosis subtypes to no relationship exists between these conditions. Scoliosis is a condition that is known to have progressive qualities with life-long sequelae and is a common cause of spinal fusion surgeries with early detection and patient-specific interventions shown to ameliorate some of these risks (Barton et al., 2017; Grossman et al., 2018; Hresko et al., 2018). A series of investigations to clarify the relationship between these diagnoses has been conducted with secondary goals to identify optimal detection and treatment options for this poorly understood patient population and will be presented here as a sequential scoping review.

Definition of Terms

Chest wall surgery: For the purpose of this study, chest wall surgery refers specifically to thoracotomies and sternotomies.

Scoliosis: 3-dimensional spinal deformation that exceeds 10 degrees of Cobb angle (Dubousset, 2017). The most frequently described clinical subtypes are: idiopathic, neuromuscular, degenerative, congenital, non-structural, and syndromic.

Infantile: The surgeries targeted for study were performed between birth and 1 year of age.

Theoretical Orientation

This inquiry was conducted from the Biopsychosocial Theory orientation.

Methods

Our investigation began with an attempt at a meta-analysis by Ginzburg, White & Taylor, 2022 of the existing body of knowledge. A review of PubMed digital library was conducted using the search terms: scoliosis, thoracotomy, sternotomy, congenital heart disease, and CHD. The identified publications were reviewed, in their entirety, for confounding variables such as co-occurrence of neuromuscular disorders. A total of 13 studies were identified for inclusion, spanning publication dates 1993-2020. The data revealed was too heterogeneous to meta-analyze with different surgical, rehabilitation techniques and scoliosis detection strategies employed. A statistically significant majority of the studies included reported a positive correlation between the surgeries performed and the scoliosis risk. Numerous authors/researchers attributed post-surgical scarring and adhesions as the causal pathomechanism of the scoliosis seen.

The inquiry continued with a structured literature review by White & Ginzburg, 2023 following the PRISMA protocol guidelines. Scopus digital database was included in the review. Total of 30 retrospective cohort studies spanning publication dates 1975-2023 and representative of populations of 5 continents were included. The aggregation of the publications included 5722 patients who underwent either a sternotomy, thoracotomy, or both, with 1093, 19%, developing scoliosis. This significantly outpaced the reported 1-4% rate of idiopathic scoliosis in the general population (Kuznia et al., 2020). Only 3 of the 30 studies reported scoliosis prevalence in the post-surgical patient population that remained on par with the prevalence of scoliosis in the general population. Clinically relevant information, such as curve direction, sex ratio, and propensity of the curve progression, remained unclear and under-reported. Further, the population studied in the most recent publications remained skeletally immature at the time of inclusion and at continuing risk of scoliosis onset, suggesting that the actual prevalence of scoliosis in the post-surgical patient population is higher than that which was seen.

The investigation was followed up by Ginzburg & White 2024 with a retrospective analysis of the cases at our university hospital. SlicerDicer tool of

Citrix EHR was utilized to identify 316 cases of chest wall surgeries to address coarctation of aorta, tetralogy of fallot, transposition of the great arteries, truncus arteriosus, pulmonary arterial atresia, esophageal atresia, total anomalous pulmonary venous return, congenital heart defect, and tracheoesophageal fistula between 1999 and 2023. The diagnoses were chosen for the emergent nature of the surgical correction, supporting the infantile surgical intervention that was subsequently confirmed. Within the studied cohort 8.5% of the population developed scoliosis, again outpacing the 1-4% general population prevalence by a statistically significant amount. This consideration was also amplified by the considerations that some of the individuals with the more recent surgical dates remained skeletally immature and at continued risk of onset and that all clinical subtypes of scoliosis combined to 0.18% of the cases seen at our institution. Further divergence from the idiopathic scoliosis was seen with the sex ratio of 1:1 F:M seen in the post-surgical group as compared to 4:1 and up to 10:1 reported for the idiopathic scoliosis in the general population (Barton & Weinstein, 2017). Similarly, the direction of the thoracic curves was 1:1 Rt:Lt, again diverging from the predominantly right-sided curves seen in the idiopathic scoliosis (Barton & Weinstein, 2017).

Excited by the potential for a new scoliosis categorization IRB approval to gain access to confidential medical records was sought and secured. Each available chart was reviewed in detail by Ginzburg& White, 2025, for diagnoses and considerations that impact scoliosis risk, and influence orthotic care for scoliosis patients.

Results

Medical records were available for review in 27 out of 28 cases.

From the 27 cases reviewed, 24 cases were multi-disciplinary and multi-center, 2 of them multi-state, and 1 international, with the available record best described as incomplete.

From the 27 cases reviewed, 6 individuals were described as "critically ill" with one child passing away before skeletal maturity.

All 28 cases were initially diagnosed as Idiopathic Scoliosis, with 1 case being re-diagnosed as neuromuscular scoliosis following continued diagnostic work-up.

From 22 of the individuals have reached skeletal maturity 5 of the involved patients required surgical correction of the scoliosis, greatly outpacing the surgical population described by idiopathic scoliosis diagnosis (Barton & Weinstein, 2017).

Orthopedic diagnoses that impact scoliosis risks, such as leg length discrepancy, pelvic obliquity, and accessory ribs were seen in 7 of the cases

Neurodevelopmental and/or psychiatric diagnoses, chromosomal abnormalities that impact both risk of scoliosis onset and are relevant to scoliosis treatment, were seen in 14 cases. These were inclusive of Trisomy 21, Autism Spectrum Disorder, Cerebral Palsy, DiGeorge Syndrome, Turner X syndrome, learning disabilities, mood disorders, ADHD, and trauma/stress-related diagnoses.

Discussion

A meta-analysis of this patient population has been complicated by the heterogeneity of scoliosis detection methods, diverging surgical techniques used in different countries, and in the context of the rate of progress in Rehabilitation Science seen over the course of the last 25 years – different historical periods. A cause-and-effect relationship between the surgeries performed and scoliosis risk could not be well identified in the existing body of literature. An anonymous retrospective analysis revealed a prevalence of scoliosis in the post-surgical population that significantly exceeds the natural prevalence of scoliosis in the general population (Barton & Weinstein, 2017). A detailed review of the involved cases revealed sex ratio not seen in the Idiopathic Scoliosis diagnosis, progression of the scoliotic curves to surgical magnitude that exceeds the prevalence seen in the Idiopathic

Scoliosis diagnosis, curve direction/laterality that is uncommon in Idiopathic Scoliosis.

The diagnoses studied were chosen as those that call for an infantile surgical correction and resulted in a cohort with numerous physiological and behavioral co-morbidities. The co-occurring conditions also impact the risk of scoliosis onset and carry negative implications for conservative scoliosis treatment non-compliance, which may in part explain the disproportionate surgical risks as compared to the general population. Further, the multidisciplinary, high-complexity needs of this patient population have contributed to multi-center, multi-regional care that was documented in unconnected Electronic Health Records of competing networks and institutions.

Our institution is a regional, academic, Level 1 trauma center: the individuals receiving our emergent or higher-order care routinely return to their communities for preventative or routine procedures. It is therefore likely that the true prevalence of scoliosis in the post-surgical population is higher than the retrospective analysis demonstrated, with those individuals lost to follow-up after the surgeries were performed. The reclassification of the post-surgical curves to a theorized post-surgical subtype and away from the syndromic one remains plausible, but is not statistically supported at this time.

Conclusions

A positive correlation between infantile chest wall surgeries and scoliosis risk in childhood and/or adolescence is confirmed.

The scoliotic curves in this population do not follow reported patterns of curve dexterity, sex ratio, and amenability for conservative treatment as compared to idiopathic scoliosis.

The population studied was shown to have multidisciplinary needs and a greater engagement with the healthcare system as compared to the adolescent idiopathic scoliosis population.

The co-occurrence of other diagnoses in this target population severely complicates the identification of the pathomechanism of scoliosis onset.

The scoliotic curves in this patient population are best described as syndromic.
This patient population can greatly benefit from the combination of Behavioral Health interventions with their medical care.

Treatment Considerations

Greater scoliosis screening frequency starting from a childhood age is strongly recommended after infantile chest wall surgeries.

A combination of Behavioral Health strategies and interventions such as journaling, group/peer support, normalization- doll braces, Higgy Bears; and outpatient psychotherapy with conservative scoliosis treatment is adamantly encouraged.

Greater frequency of follow up during orthotic/ conservative scoliosis management treatment is advised.

Future Research Advocacy

Gaps of knowledge regarding the impact of chest wall surgeries in infancy on the risk of scoliosis onset and/or progression remain. Please join us in conducting multi-center retrospective analysis of a greater volume of cases. Both Pediatric Cardiology and Pediatric Orthopedics perspectives would be welcome and invaluable. The role of physiotherapeutic scoliosis-specific exercise interventions in mitigating the scoliosis onset risk for the post-surgical population is not currently known.

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