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Diagnostic Significance of Z-Score in Echocardiography in Children with Congenital Heart Defects

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Abstract: Congenital heart defects (CHD) are among the most common cardiovascular disorders in children. Continuous growth and somatic variability in pediatric patients limit the diagnostic accuracy of absolute echocardiographic measurements, highlighting the importance of standardized Z-score assessment.

Keywords: congenital heart defects, pediatric cardiology, echocardiography, Z-score, diagnosis.

Introduction

Congenital heart defects (CHD) remain one of the most significant challenges in modern pediatric cardiology, accounting for a substantial proportion of morbidity, disability, and mortality among children. According to epidemiological data, the prevalence of CHD ranges from 8 to 10 per 1,000 live births, with a considerable number of patients requiring long-term follow-up and timely surgical or interventional correction.

Echocardiography is the cornerstone of non-invasive assessment of cardiac anatomy and function in pediatric patients. It provides detailed information on cardiac chambers, valves, and great vessels and plays a decisive role in diagnosis, therapeutic planning, and postoperative monitoring. However, interpretation of absolute echocardiographic measurements in children is complicated by continuous somatic growth and age-related variability of cardiac structures. The use of fixed linear dimensions without appropriate normalization may result in misinterpretation of physiological growth as pathological remodeling or, conversely, underestimation of true structural abnormalities.

To overcome these limitations, the Z-score concept has been introduced into pediatric echocardiography. Z-score represents a standardized statistical measure that reflects the number of standard deviations by which a measured parameter differs from the population mean, adjusted for body surface area (BSA), age, and sex. This approach allows for accurate comparison of cardiac dimensions across different age groups and body sizes.

In recent years, echocardiographic Z-scores have been widely adopted in international guidelines and clinical practice for the assessment of congenital heart defects. They are particularly valuable in evaluating valve annuli, ventricular dimensions, and great vessel diameters, as well as in determining indications for surgical intervention and monitoring postoperative growth

patterns. Nevertheless, the clinical application and interpretation of Z-scores require further systematization, especially in regional pediatric cardiology practice.

The present study aims to analyze the diagnostic significance of echocardiographic Z-score parameters in children with congenital heart defects.

Materials and Methods

This study included pediatric patients diagnosed with various forms of congenital heart defects who were examined in a specialized cardiology center. All children underwent comprehensive transthoracic echocardiographic examination using standard imaging protocols.

Measurements included cardiac chamber dimensions, valvular annuli diameters, and great vessel sizes. Body surface area was calculated using standard formulas. Z-scores were determined based on validated reference datasets adjusted for age, sex, and BSA.

Z-score values between −2 and +2 were considered within normal limits. Values below −2 indicated hypoplasia, whereas values above +2 were interpreted as dilation of the corresponding cardiac structure.

Results

The analysis demonstrated that a significant proportion of children with congenital heart defects exhibited abnormal Z-score values compared to reference ranges. The most pronounced deviations were observed in valvular annuli and great vessel dimensions, particularly in patients with complex or combined cardiac anomalies.

In several cases, Z-score analysis revealed subclinical dilation or hypoplasia that was not clearly identifiable using absolute echocardiographic measurements alone. These findings emphasize the higher sensitivity of Z-score–based assessment in detecting early structural remodeling.

Discussion

The findings of this study confirm the high diagnostic value of echocardiographic Z-scores in the evaluation of children with congenital heart defects. Unlike absolute measurements, Z-scores provide an individualized assessment that accounts for physiological growth and developmental variability, which is especially critical in pediatric populations.

Z-score assessment is particularly important during infancy and early childhood, when cardiac growth is rapid and non-linear. The ability to distinguish between normal developmental changes and pathological remodeling has direct implications for clinical decision-making. In this context, Z-scores serve as an objective tool for identifying patients at risk of progressive dilation or hypoplasia of cardiac structures.

In pediatric cardiac surgery, Z-score values are widely used to determine the timing and type of surgical intervention. For example, significant dilation of the aortic root or hypoplasia of valve annuli, confirmed by elevated or reduced Z-scores, may necessitate early corrective procedures. Moreover, Z-score–based evaluation facilitates standardized communication between pediatric cardiologists and cardiac surgeons.

Postoperative follow-up represents another important application of Z-score analysis. Monitoring the growth of reconstructed cardiac structures relative to somatic growth allows clinicians to assess the long-term effectiveness of surgical correction and to detect secondary complications at an early stage.

Despite its advantages, the use of Z-score requires strict adherence to standardized measurement techniques and the application of appropriate reference datasets. Population-specific variations and methodological inconsistencies may influence Z-score calculations, underscoring the need for continuous validation and adaptation of normative data.

Overall, the integration of Z-score analysis into routine pediatric echocardiography enhances diagnostic accuracy, improves risk stratification, and contributes to personalized management of children with congenital heart defects.

Conclusion

Echocardiographic Z-score analysis represents a highly informative and reliable diagnostic tool in children with congenital heart defects. Its application enables accurate assessment of cardiac structure dimensions, supports early diagnosis of pathological changes, optimizes clinical and surgical decision-making, and improves long-term prognostic evaluation.

References

1. Lopez L., Colan S.D., Frommelt P.C. et al. Recommendations for quantification methods during the performance of a pediatric echocardiogram. *J Am Soc Echocardiogr*. 2017.
2. Pettersen M.D., Du W., Skeens M.E., Humes R.A. Regression equations for calculation of Z-scores of cardiac structures in a large cohort of healthy infants, children, and adolescents. *J Am Soc Echocardiogr*. 2008.
3. Cantinotti M., Assanta N., Murzi B. et al. Echocardiographic nomograms for chamber dimensions and great arteries in children. *Cardiology in the Young*. 2019.
4. Foster B.J., Khoury P.R., Kimball T.R. et al. New reference values for pediatric echocardiographic measurements. *Pediatr Cardiol*. 2021.
5. Sluysmans T., Colan S.D. Structural measurements and normalization in pediatric echocardiography. *J Am Coll Cardiol*. 2005.
6. Dallaire F., Slorach C. Normalization of echocardiographic measurements in children. *Heart*. 2016.
7. Cohen M.S. Echocardiography in congenital heart disease. *Prog Pediatr Cardiol*. 2018.
8. Baumgartner H. et al. Imaging in congenital heart disease. *Eur Heart J*. 2020.