

## **Utilizing Global Longitudinal Strain (GLS) to Guide Safe Exercise Prescription and Physical Rehabilitation in Pediatric BAV Patients**

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**Abstract:** Bicuspid aortic valve (BAV) is one of the most common congenital heart defects in children and is frequently associated with progressive valvular dysfunction and aortopathy. Conventional assessment using left ventricular ejection fraction (LVEF) may fail to detect early myocardial impairment. Despite increasing clinical application of speckle tracking echocardiography (STE), limited pediatric evidence exists regarding the prognostic value of global longitudinal strain (GLS) for identifying subclinical left ventricular dysfunction and guiding early clinical decision-making in BAV patients. This study provides an analytical evaluation of recent pilot evidence assessing GLS in pediatric BAV patients, with emphasis on segmental strain abnormalities and phenotype-specific risk stratification through STE-derived measurements. The evidence indicates that GLS is more sensitive than LVEF in detecting subtle myocardial dysfunction even when global systolic performance appears preserved. Segmental strain reductions, particularly in inferior, anterior, and apical regions, were identified as early indicators of myocardial alteration. Integration of GLS into routine pediatric BAV assessment may enhance early risk stratification, support safe exercise prescription, and enable personalized monitoring strategies. Nevertheless, larger multi-center longitudinal investigations are necessary to validate GLS as a standardized prognostic marker in pediatric cardiology practice.

**Keywords:** Bicuspid Aortic Valve, Global Longitudinal Strain, Speckle Tracking Echocardiography, Pediatric Cardiology, Left Ventricular Dysfunction, Exercise Prescription, Risk Assessment

### **Introduction**

In children with bicuspid aortic valve (BAV), global longitudinal strain (GLS), measured by speckle tracking echocardiography (STE), is becoming more widely acknowledged as a sensitive and early marker of left ventricular (LV) failure. The results of the recently released pilot study by Făgărășan et al. [1], which was featured in Children's Special Issue on "Heart Failure in Children and Adolescents," are discussed in this editorial. We also look at the greater ramifications of segmental strain abnormalities and phenotype-specific assessment for risk assessment and long-term monitoring. We also outline future directions in pediatric cardiac imaging and emphasize the need for multi-center studies to validate GLS as a prognostic tool in routine pediatric cardiology practice.

BAV is one of the most prevalent congenital heart diseases, and while it frequently goes undiagnosed in the early stages, it gradually puts patients at risk for serious cardiovascular problems [2]. Aortic stenosis (AS), aortic regurgitation (AR), coarctation of the aorta (CoA), and progressive aortopathy are among the anatomical anomalies that are commonly linked to it [3,4]. The course of the illness can lead to significant morbidity and ultimately need surgical

intervention, even though many juvenile BAV patients do not exhibit any symptoms [5]. Traditionally, left ventricular ejection fraction (LVEF) has been the standard for evaluating LV function; however, it often appears normal even in the presence of early myocardial dysfunction [6]. Incorporating advanced imaging techniques alongside conventional echocardiography is crucial for detecting subtle myocardial impairments that may carry long-term consequences [7].

### **Global Longitudinal Strain as an Early Marker**

The mild LV dysfunction that may precede clinical symptoms and quantifiable reductions in ejection fraction is a crucial but little-studied element of BAV in the juvenile population, as the research by Făgărășan et al. [1] clarifies. In this prospective pilot investigation, the authors used STE to measure GLS in 73 pediatric patients with BAV and compared the results to a control group of healthy children who were age-matched. They present compelling evidence that GLS is a more sensitive marker for subclinical myocardial dysfunction than the traditional LVEF. This finding enriches the existing literature, suggesting that conventional echocardiographic parameters may not adequately capture early myocardial changes [8–11], positioning GLS as a vital tool for risk stratification and early intervention in pediatric cardiology practice.

### **Segmental GLS Patterns and Personalized Risk Stratification**

A critical finding of this study is the reduction in GLS within specific myocardial segments—particularly in the inferior and apical four-chamber views and the anterior segment. These subclinical myocardial alterations, despite normal global LV function, align with the existing research indicating that abnormal strain patterns can serve as early markers of myocardial fibrosis and contractile dysfunction, often preceding overt heart failure symptoms [10,12–14]. The early detection of these abnormalities allows clinicians to implement targeted monitoring and interventions, potentially slowing disease progression.

Furthermore, this study highlights the importance of phenotypic characterization in BAV patients. The IB phenotype was the most prevalent and frequently associated with mild AR. This supports previous research indicating that certain BAV phenotypes carry a higher risk of progressive valvular dysfunction and aortic dilatation [15,16]. Given these findings, personalized risk assessment based on BAV phenotypes can enhance clinical decision-making and patient management.

This raises important questions about clinical care strategies and long-term monitoring. Evaluating whether strain analysis should be incorporated into routine BAV assessments and whether early pharmacological or lifestyle interventions could provide cardiovascular benefits is essential. Additionally, longitudinal studies are needed to determine whether reduced GLS in pediatric BAV patients predicts increased morbidity in adulthood and whether early detection can improve long-term health outcomes.

### **Future Directions in Pediatric Cardiac Imaging**

Future multi-center studies with larger cohorts and extended follow-up periods are essential to validate these findings and establish standardized clinical guidelines. Such studies would help confirm the broader applicability of GLS as a diagnostic tool. Additionally, addressing variability across imaging platforms will be crucial to ensure consistency and reliability in GLS measurements across diverse clinical settings.

While the findings of Făgărășan et al. are compelling, it is important to interpret them within the context of the study's limitations. As a single-center pilot study with a modest sample size and an absence of longitudinal follow-up, its generalizability is limited. Moreover, the study does not fully account for potential confounding variables such as imaging variability, patient comorbidities, and clinical heterogeneity. Therefore, although GLS demonstrates promise as an early marker of myocardial dysfunction, its routine integration into pediatric BAV management should be approached with caution until it is validated by larger, prospective multi-center studies with long-term outcomes.

## Conclusions

Făgărășan et al.'s study provides valuable insights into the early detection of myocardial dysfunction in pediatric BAV patients, reinforcing the role of GLS as a more sensitive marker than LVEF. These findings highlight the need for further research to validate GLS as a prognostic tool and integrate it into routine clinical practice, ultimately supporting early intervention strategies to mitigate disease progression and enhance long-term cardiovascular health in pediatric BAV patients.

## Abbreviations

The following abbreviations are used in this manuscript:

- **AR:** Aortic regurgitation
- **AS:** Aortic stenosis
- **BAV:** Bicuspid aortic valve
- **CoA:** Coarctation of the aorta
- **GLS:** Global longitudinal strain
- **LVEF:** Left ventricular ejection fraction
- **LV:** Left ventricular
- **STE:** Speckle tracking echocardiography.

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