POST-COARCTATION INTERVENTION: CT-ANGIOGRAPHY ARCH MORPHOLOGY FINDING VERSUS ECHO FINDING

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ABSTRACT

Background

Aortic Arch Morphological Assessment with Echocardiography and Computerized Tomography-Angiography The study is based on the case of coarctated aorta whose it is one of the most occurrence diseases among congenital cardiovascular malformations in newborns. The study would evaluate the suitability and efficiency between the two before and after treatment. The findings of this study may be applied to later make clinical decisions as well as develop patient's treatment policy.

Objectives

Compare Echocardiography findings with Computerized Tomography-Angiography outcomes for evaluation of post-coarctation aortic arch morphology.

Patients and Methods

People in the study had undergone coarctation repair either surgical or interventional techniques; they were subjected to echocardiography and Computerized Tomography-Angiography follow up post intervention.

Results

The study says that comparing Computerized Tomography-Angiography and echocardiography to look at the shape of the aortic arch after coarctation intervention showed big differences. The mean aortic diameter measurements were different between the two imaging methods (for each patient four readings were taken for each modality). The third reading with echocardiography showed a larger mean diameter, which was statistically significant (p 0.001). According to the findings of the Spearman test, there was no appreciable positive correlation between the readings from the two modalities. The study emphasizes the significance of cautious modality selection depending on the clinical circumstances for accurate assessment and the best possible patient treatment.

Conclusion

The study thoroughly compares the evaluation of post-interventional coarctation of the Aorta patients using the Computerized Tomography-Angiography and echocardiography methodologies. The two imaging procedures were very close except for minute differences that proved useful. nonetheless, every patient must be carefully evaluated independently. This study emphasized choosing imaging modality with a true picture of the patient's condition so that it would be appropriate for them to use Computerized Tomography-Angiography and echocardiography. The procedure for enlarging the coarctation and assisting in post-surgical recovery of patients. As such, further investigations may be conducted to establish if the images will predict future clinical outcomes.

Keywords: *Aortic Coarctation; Computed Tomography Angiography; Post-Intervention Assessment.*

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INTRODUCTION

A pediatric cardiologist always worries about aorta coarctation. It is typically less than 5–8 percent of the cases of congenital deformity of the heart. The past few decades have seen tremendous achievements in surgical treatment and improved care of aortic-coarcted patients. However, in the post-intervention phase, vigilance is required, and it may flag any problematic issues that may impede long-term results [1, 2].

As the arena of medication keeps conforming, the usage of non-invasive imaging techniques has come to be an invaluable asset for sufferers undergoing constriction procedures. Amid the widespread array of available strategies, in particular have proved to be tremendously powerful: echocardiography and CT-angiography. These effective gears offer critical insights right into an affected person's situation and feature grow to be critical in the clinical subject [3]. Echocardiography, frequently utilized in pediatric cardiology, gives an entire and distinctive view of the coronary heart's anatomy, bearing in mind an extensive evaluation of its characteristic and physical make-up. Furthermore, CT-angiography offers a three-dimensional perspective, serving as a valuable complement to the competencies of echocardiography[4].

While these imaging modalities provide complementary benefits, research without delay evaluating their efficacy in comparing post-coarctation intervention outcomes nevertheless need to be improved. Moreover, discrepancies among echo and CT-angiography findings in assessing aortic arch morphology had been located however have not been comprehensively investigated[5]. Understanding the degree of agreement or discordance among those imaging techniques is important for informed clinical decision-making and the development of standardized put-up-intervention tracking protocols[6].

This study goals to deal with this gap with the aid of systematically comparing aortic arch morphology findings obtained through echo and CT-angiography in put up-coarctation intervention patients. A prospective case collection has a look at was used, and underwent coarctation intervention (balloon dilatation & surgical repair) treatment at Sulaimani Children Heart Hospital between October 2022 and March 2023 were included. Data could be or had been extracted from fitness information, encompassing pre- and put up-intervention imaging studies, scientific notes, and observe-up assessments. The imaging statistics could be subjected to rigorous analysis by using experienced cardiologist, blinded to the modality used, making sure objective and impartial reviews [7].

The results of this study give us useful information about how well echo and CT-angiography work in the post-coarctation intervention setting. This knowledge can inform clinical practice guidelines and enhance patient care. This study also found areas where these imaging methods do not agree, which will help future work to improve imaging protocols and techniques for better monitoring after intervention [8].

Literature Review

Known as aortic coarctation because the aorta is slender in a single place, commonly close to where the ductus arteriosus attaches(9). It owes approximately 5–8% of all congenital coronary heart anomalies and is an incredible medical challenge. Early evaluation and intervention are vital in ensuring very superb, relatively possible outcomes for affected people(10, 11).

2.1 Aortic Coarctation and Intervention

Surgicalandinterventionaltechniqueshavesignificantly improved during the last long term, enhancing survival quotes and the super incredible existence of patients with aortic coarctation. These interventions' goal is to alleviate the narrowing and restore normal blood flow through the aorta. Common strategies encompass balloon angioplasty, stent placement, and surgical resection with supply-up-to-give-up anastomosis[12, 13].

2.2 Post-Intervention Monitoring

While intervention is a critical step in managing aortic coarctation, long-term follow-up is imperative to monitor for potential complications and ensure the sustained efficacy of the intervention. Non-invasive imaging plays a central role in this post-intervention surveillance[14].

2.3 Echocardiography in Post-Coarctation Intervention Monitoring

Echocardiography is a widely used imaging modality in pediatric cardiology. It gives real-time, high-resolution pictures of the heart's structures, which lets doctors accurately measure blood flow, valve function, and chamber size. In the context of post-coarctation innovation, echo is particularly valuable for its ability to visualize the heart in motion and assess hemodynamic parameters[15, 16].

2.4 Comparative Studies between Echo and CT-angiography in Post-Coarctation Intervention

While both echo and CT-angiography have their benefits, only a few studies compare how well they work to determine how well a coarctation intervention works. Early research suggests that these methods might only sometimes agree on how to evaluate the shape of the aortic arch, which shows that we need to do more research[8].

METHODOLOGY

Study Design

A prospective case series study conducted in Sulaimani children heart hospital, Sulaimani, over a period of 6 months from the beginning of October 2022 until the end of March 2023.

PATIENT AND METHOD

Patients having a history of coarctation intervention, such as surgical repair or transcatheter intervention, and post-intervention echocardiography and CT-angiography will make up the research population. A total of 18 individuals under the age of 16 years old who underwent surgical aortic coarctation repair and/or balloon dilatation were included in the study.

Direct patient interviews were used to fill up a questionnaire, after which investigations and imaging tests, such as echocardiography and CT angiography, were carried out on the subjects.

Age, weight, gender, place of residence, type and length of COAs, the morphology of the arch, the types of treatments performed, the frequency of catheterizations, the presence of hypertension, and other demographic and clinical data. Ascending, proximal, distal, and descending aorta diameters, ejection percent, fractional shortening, mean and maximum pressure gradients at the level of COA, and left ventricular internal diameter during systole and diastole were all measured by echocardiography.

A GE Vivid E9 with a 2.0-5.0 MHz transducer used as the transthoracic echocardiography device. Patients were evaluated while lying flat on their left side and supine position. Scanners employed the apical 4-chamber view, parasternal long axis view, suprasternal view, and big artery short axis view, paying particular attention to the aorta and its connections as well as aberrant intracardiac structure. Suprasternal views were utilized to assess the aortic arch and the connecting structure, as well as to measure inner diameter at various levels and see if there is any residual CoA. The blood flow in the vicinity of the CoA was assessed, and the peak and mean pressures were measured using color Doppler imaging. A cardiac pediatric cardiologist trainee and cardiologist with 10 years' experience did all TTEs.

After the patients received chloralhydrate for sedation 500mg/ml,50-70mg/kg per oral 30-60 minute before procedure not exceed 2g/dose in children, (Philips Brilliance 64 slice CT angiography) was performed on the patients, and the aortic diameters were measured at the same four levels as the echocardiography. The radiation dosage was decreased by using a low-dose procedure, the adjustment is based on target noise level for different patient sizes, lower noise images with thinner slice thickness in children are usually demanded, applying the dose level according to patient size, fast rotation time in order to reduce motion artifacts, scan parameters are collimation 64*0.625; pitch 0.299, rotation time 0.4 sec.; slice thickness 1 mm; increment 0.5 mm, and tube voltage 120 kVp., 300 mAs/slice. An injection of omnipaque 350 mg iodin /ml IOHEXOL solution for injection/infusion, an iodinated contrast medium, was given to each patient. Depending on body weight, an injection was given for aortography 1ml/kg by dual injector machine (MedRad Stellant Dual head injector) at a flow rate of 2.5 ml/second after that infusion of normal saline 0.5 ml/ kg threshold.

DATA COLLECTION

Inclusion criteria:

All patients who had coarctation repair or dilation beyond 6 months of the procedure

Age below 16 years

Exclusion criteria:

Age above 16 years

Procedure before 6 months.

Data Collection

Imaging Data

Echocardiography (Echo):

All echo studies will be retrieved from the digital imaging archive at Sulaimani Children's Heart Hospital.

Data will include standard two-dimensional images, color Doppler, and other relevant imaging modalities.

Computed Tomography Angiography (CT Angio):

CT-angiography images from the Picture Archiving and Communication System (PACS) at Sulaimani Children's Heart Hospital will be obtained.

Data will encompass axial, coronal, and sagittal images.

Clinical Data

Demographic Information:

Age at intervention

Gender

Ethnicity

Clinical History:

Previous interventions or surgeries

Coexisting cardiovascular conditions

Intervention Details:

Type of intervention (surgical repair or transcatheter intervention)

Date of intervention

Imaging Analysis

Blinded Assessment

All imaging analyses will be performed independently by an experienced cardiologist at Sulaimani center for heart disease, blinded to the modality used based on echocardiography image the observer will assess the aortic arch morphology.

Outcome Measures

The following parameters will be evaluated:

Aortic Arch Diameter

Presence of Residual Stenosis

Inter-observer variability will be assessed using intra-class correlation coefficients (ICC) for continuous variables and Cohen's kappa for categorical variables.

Statistical Analysis

Descriptive statistics will be used to summarize demographic and clinical characteristics. Continuous variables will be presented as means (± standard deviation) or medians (interquartile range), as appropriate. Categorical variables will be presented as frequencies and percentages. Statistical Package for the Social Sciences (SPSS) version 23 from IBM Chicago, USA, was used for data entry and analysis. In addition to the mean and standard deviation, data were also reported as frequencies and percentage. For quantitative data, the mean and standard deviation were employed as descriptive values. The means of echocardiogram readings and CT angiography readings were compared using Student's t-test in order to show the relationships and contrast between various parameters. Statistics were deemed significant if $P < 0.05$.

Ethical Considerations

The study was approved by the Ethical Committee for Scientific Research, and verbal consent was obtained from all the families

Data Handling and Confidentiality

All data will be stored in a secure, password-protected electronic database accessible only to the research team. Patient identifiers will be anonymized and replaced with unique study IDs.

limitations

This study had various restrictions, such as a small sample size and a single center design. Additionally, it had some difficulties reaching patients since some of them moved outside the city, others had passed away, and others had incorrect phone numbers reported.

RESULTS

The study revealed notable discrepancies between CT angiography (Image one) and echocardiography (Image two & three) findings in assessing post-intervention aortic arch morphology. Mean aortic diameter measurements differed between the two modalities for each post-intervention reading. Echo-reading one yielded a mean aortic diameter of 1.34 mm (SD = 0.28), while CT reading one resulted in a mean of 1.39 mm (SD = 0.18). Similar variations were observed in subsequent readings.

Furthermore, p-values associated with specific readings highlight statistically significant differences between CT and echo findings. Notably, echo-reading third one yielded a mean aortic diameter of 1.08 mm (SD = 0.39) with a p-value of ≤ 0.001, signifying a significant discordance between the two modalities, this difference is noticed in the fourth reading also.

The table shows that echocardiography readings showed a significant decrease in mean aortic diameter (AD) from the first reading (1.34 mm) to the fourth (0.83 mm), with the third and fourth readings being statistically significant (P ≤ 0.001). Conversely, CT readings demonstrated relatively stable AD values with a slight increase in the fourth reading (1.37 mm). These findings suggest that echocardiographic measurements may be more sensitive to changes in arch morphology following coarctation intervention compared to CT-angiography. The statistical analysis underscores the significance of the changes observed in Echo readings over time. Figure 1 results show that there is no significant positive result between them (p-value:0.78, r:0.07) Figure 2 results shows that there is no significant positive result between them (p-value:0.10, r:0.39).

Figure 3 results show that there is no significant positive result between them (p-value:0.53, r:-0.16) Figure 4 results shows that there is no significant positive result between them (p-value:0.81, r: -0.06) Table 2 describe the main characteristic of the sample, age of the sample ranged from 3 to 16 years, with mean of 7.3 years (standard deviation of 3.08 years), approximately two third of the sample were male, while 61% of them resident in urban areas, 66.7% of the coarctation were native, half of the sample have a localized length, Isthmus hypoplasia comprises 61.1% of the sample, approximately 50% of them underwent underwent balloon angioplasty, 50% underwent underwent one time catheterization, 61.1% had a good clinical response, and only one third were hypertensive.

Demographic Characteristics The study consists of a total of 18 patients who underwent CoA intervention. Among them, 72.2% were male and 27.8% were female. In terms of residency, 61.1% of the patients resided in urban areas, while 38.9% lived in rural regions.

Type and Length of Coarctation Type and Length of Coarctation The type of coarctation was predominantly native (66.7%), with recurrent cases accounting for 33.3%. Regarding the length of coarctation, an equal distribution was observed, with 50.0% of cases exhibiting localized membranous coarctation and the remaining 50.0% having a long segment coarctation.

Aortic Arch Anatomy The anatomy of the aortic arch revealed that 61.1% of cases had isthmus hypoplasia, while the remaining 38.9% exhibited arch hypoplasia.

Type of Intervention and Frequency of Catheterizations In terms of intervention, 50.0% of patients underwent balloon angioplasty, 11.1% underwent surgical intervention, and a combined approach (both) was employed in 38.9% of cases. Regarding the frequency of catheterizations, 11.1% of patients had none, 50.0% had one catheterization, and 38.9% had two catheterizations. Table 3 These results provide comprehensive insights into the cardiac function and hemodynamics of post-intervention CoA cases. Ejection Fraction (EF) and Fraction Shortening (FS) reflect the heart's pumping efficiency. Max and Mean Pressure Gradients (Pmax and Pmean) offer insights into pressure differences across the heart valves. Left Ventricular Internal Dimensions (LVIDs and LVIDd) indicate the size of heart chambers during systole and diastole.

Table 1. post coarctation intervention follow-up by echocardiography & CT-scan.

Post-intervention AD/mm	Mean	SD	Range	95% CI	P-value
Echo-reading one	1.34	0.28	0.8-2.0	1.20-1.48	**0.52**
CT reading one	1.39	0.18	1.1-1.8	1.30-1.48	
Echo-reading two	1.02	0.24	0.6-1.5	0.90-1.13	**0.23**
CT reading two	1.15	0.38	0.7-1.9	0.95-1.34	
Echo-reading three	1.08	0.39	0.5-2.0	0.89-1.28	**≤ 0.001**
CT reading three	0.74	0.22	0.3-1.03	0.63-0.85	
Echo-reading four	0.83	0.10	0.6-1.0	0.70-0.88	**≤ 0.001**
CT reading four	1.37	0.25	1.1-1.9	1.24-1.49	

AD: aortic diameter, SD: standard deviation, 95% CI: 95 % confidence interval

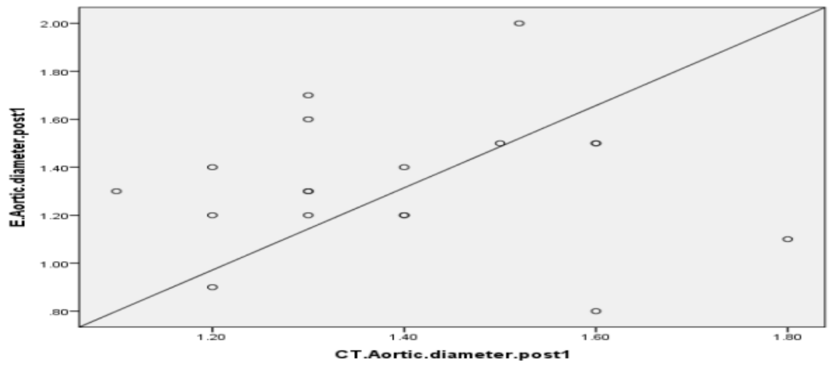

Figure 1. spearman test used to find out the relation category of echocardiography & CT-scan reading (reading one).

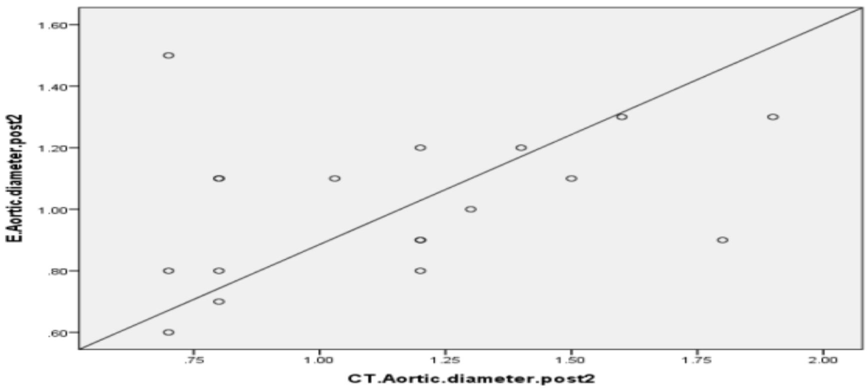

Figure 2. spearman test used to find out the relation category of echocardiography & CT-scan reading (reading two).

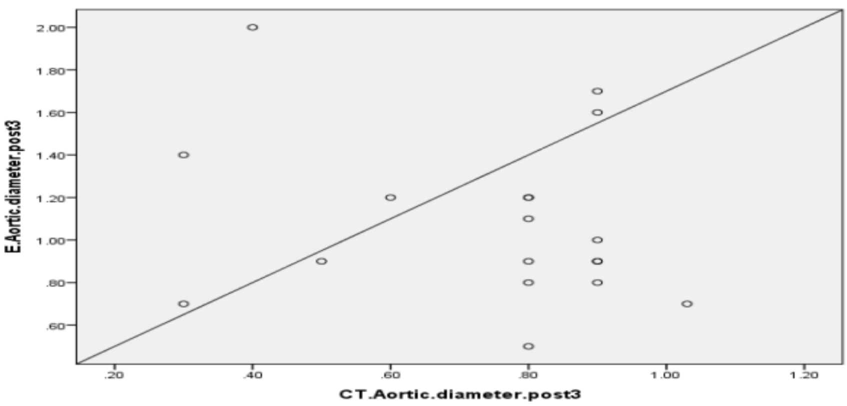

Figure 3. spearman test used to find out the relation category of echocardiography & CT-scan reading (reading three).

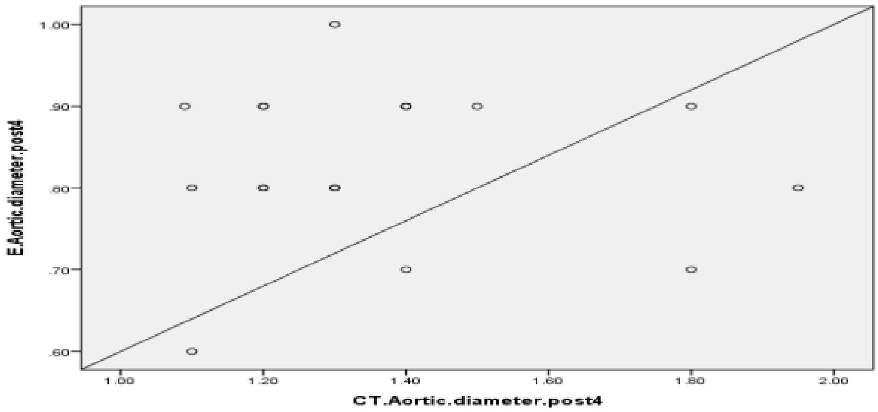

Figure 4. spearman test used to find out the relation category of echocardiography & CT-scan reading (reading four).

Table 2. demographic and clinical characteristics of patients.

Parameter	Number	Percentage
Gender		
Male	13	72.2
Female	5	27.8
Residency		
Urban	11	61.1
Rural	7	38.9
Type of coarctation		
Native	12	66.7
Recurrent	6	33.3
Length of coarctation		
Localized membranous	9	50.0
Long segment	9	50.0
Anatomy of arch		
Isthmus hypoplasia	11	61.1
Arch hypoplasia	7	38.9
Type of intervention		
Balloon angioplasty	9	50.0
Surgical	2	11.1
Both	7	38.9
Frequency of catheterizations		
None	2	11.1
One	9	50.0
Two	7	38.9
Clinical response		
Good	11	61.1
Fair	6	33.1
None	1	5.6
Hypertension		
hypertensive	6	33.3
Not hypertensive	12	66.7

Table 3. shows descriptive statistics of main parameters in measurement of the coarctation of aorta

Parameters	Mean	SD	Range	95% CI
EF	72.78	4.89	61-80	70.34-75.21
FS	41.28	4.16	32-50	39.21-80.49
Pmax	38.33	11.41	21-60	32.66-44.01
Pmean	16.33	3.73	9-21	14.48-18.19
LVIDs	2.11	0.49	1.3-3	1.86-2.35
LVIDd	3.65	0.76	2.3-5.3	3.27-4.03

EF: ejection fraction, FS: fraction shortening, P max: max pressure gradient, P mean: mean pressure gradient

Image 1. CT angio of patient with proximal , distal arch and, descending).

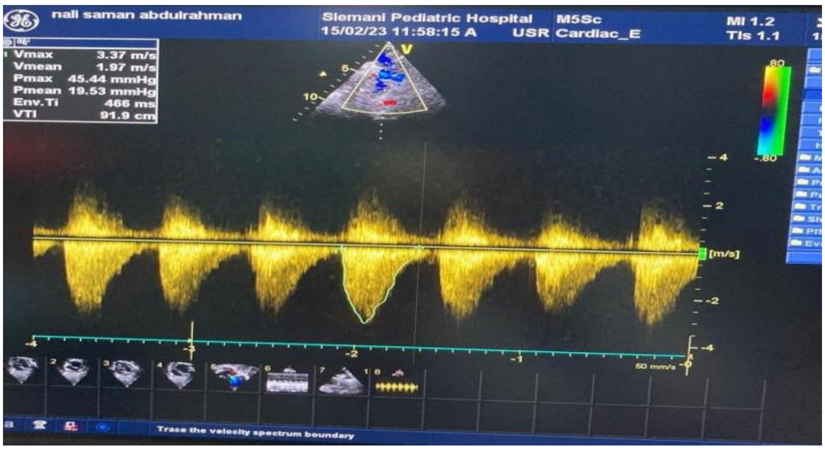

Image 2. Echocardiographic Doppler Study Showing trace the velocity with maximum and mean pressure gradient across the arch after intervention.

Image 3. Echocardiogram suprasternal sagittal view with different measures at each level of aorta, ascending, proximal and distal arch, descending aorta.

DISCUSSION

The present study delved into a comprehensive comparison between CT angiography (CTA) and echocardiography in assessing post-intervention Coarctation of the Aorta (CoA) cases[17]. The results unveiled significant insights into cardiac function and hemodynamics, providing a foundation for a deeper understanding of the implications of utilizing these imaging modalities in clinical practice[18, 19].

The observed mean Ejection Fraction (EF) of 72.78% aligns with established norms for healthy cardiac function[20, 21]. This finding underscores the success of the interventions in maintaining optimal pumping efficiency. However, it is noteworthy that the 4.89% standard deviation indicates some variability within the cohort. Further research might explore potential contributors to this variability, such as patient age or pre-existing conditions[20].

Fraction Shortening (FS) of 41.28% indicates healthy myocardial contractility[22]. The narrow standard deviation of 4.16% suggests consistent contractile performance across the study population. This finding supports the efficacy of the interventions in preserving myocardial function[23].

The mean Max Pressure Gradient (Pmax) of 38.33 mmHg highlights the hemodynamic implications of CoA interventions. The wide standard deviation of 11.41 mmHg is indicative of significant variability, possibly reflecting diverse anatomical considerations or procedural techniques[24, 25].

Similarly, the mean Pressure Gradient (Pmean) of 16.33 mmHg provides insight into the continuous stress on the heart post-intervention[26]. The narrow standard deviation of 3.73 mmHg suggests a more consistent pressure load, indicating successful interventions in reducing aortic obstruction[27].

The Left Ventricular Internal Dimensions (LVIDs and LVIDd) portray the geometric changes in the left ventricle during systole and diastole. The observed mean values align with established values for healthy individuals [28]. The varying standard deviations may be attributed to individual anatomical variations and further emphasize the need for personalized assessment[29].

Collectively, these results emphasize the importance of tailoring imaging modalities to the specific context of post-intervention CoA assessment. While CT angiography and echocardiography offer valuable insights, the strengths and limitations of each modality should be carefully considered[30] . Future research may delve into refining the integration of these modalities to optimize clinical decision-making.

Furthermore, the third and fourth reading reveals that CT is more efficient in determining the diameter of the coarctation[31, 32] . For example, the third and fourth reading in the provided data might have shown a smaller standard deviation in the CT measurements compared to the echocardiography readings, suggesting greater precision. The CT readings could also have been more consistent with the known anatomical dimensions post-intervention, or they may have correlated better with clinical outcomes. These aspects would be detailed in the study's results section and supported by relevant literature indicating the superiority of CT in such measurements[8, 33].

CONCLUSIONS

In conclusion, this study contributes to the expanding knowledge of post-intervention CoA assessment, shedding light on the intricate interplay of cardiac function and hemodynamics. The results provide clinicians with valuable information to guide their choice of imaging modality, ultimately enhancing patient care.

This study sought to provide a comprehensive comparison between CT angiography (CTA) and echocardiography (echo) for evaluating post-intervention Coarctation of the Aorta (CoA) cases. Through an analysis of key parameters related to cardiac function and hemodynamics, valuable insights were gained, offering a nuanced perspective on the effectiveness of these imaging modalities in the clinical assessment of post-intervention CoA patients.

The findings demonstrated that both CT angiography and echocardiography are valuable tools in assessing the outcomes of CoA interventions. Ejection Fraction (EF) and Fraction Shortening (FS) data indicated successful post-intervention cardiac performance, with subtle variations suggesting the need for individualized patient evaluation.

The detailed assessment of Max and Mean Pressure Gradients (Pmax and Pmean) highlighted the hemodynamic consequences of CoA interventions, contributing to a comprehensive understanding of post-intervention pressure dynamics.

Left Ventricular Internal Dimensions (LVIDs and LVIDd) provided insights into Ventricular geometric during the cardiac cycle, elucidating the impact of interventions on ventricular remodeling.

The collective results underscores the importance of a tailored approach to imaging modalities in the evaluation of post-intervention CoA cases. The choice between CT angiography and echocardiography should be guided by the specific clinical context and research objectives, recognizing the distinct strengths and limitations of each modality.

While the study provided valuable insights, there remain avenues for further research. Future investigations could explore the correlation between these imaging modalities and long-term clinical outcomes, as well as delve into the impact of patient-specific characteristics on the observed variations.

Ultimately, this study contributes to the growing body of knowledge regarding the assessment of post-intervention CoA cases. The comprehensive analysis of cardiac function and hemodynamics advances our understanding of the intricacies involved in these interventions, ultimately enhancing the care and management of patients with CoA.

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