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ABSTRACT:

Background: Aortic stenosis is pathological condition in which aortic valve which is present between left ventricle and aorta becomes narrowed. Patients with aortic stenosis had high mortality rate due to left ventricular dysfunction which leads to improper blood supply to the body and associated coronary artery disease. Echocardiography is the modality to evaluate cardiac disease. Patients refer on further modalities for confirmation of disease or preoperative evaluation. **Objective:** To investigate feasibility of computed tomography coronary angiography in diagnosing left ventricle dysfunction in patients with aortic stenosis. **Methodology:** This cross-sectional descriptive study conducted at Punjab Institute of Cardiology, Lahore. Sample size of our research was 40. **Results:** The participants ranged in age from 17 to 73 years (72.5%male), with the majority of the patients were of the age between 21 to 40 years. 12.5% of those aged over 65 while 87.5% were between 17 to 64 years affected with aortic stenosis. 9(22.5%) patients had congenital bicuspid aortic valve causing aortic stenosis while 31(77.5%) had trileaflet aortic valve which acquire aortic stenosis. 13(32.5%) patients out of 40 had LVEF < 50% out of which 6(46.2%) patients had dilated LV with moderate LV systolic dysfunction and 7(53.8) patients had dilated LV with severe LV systolic dysfunction were diagnosed on CTCA. **Conclusion:** CTCA is more feasible for early and accurate diagnosis of left ventricular dysfunction in aortic stenosis patients. CTCA can improve the diagnostic potential and treatment plans for patients with aortic stenosis and associated left ventricular dysfunction.

Key words: Computed tomography coronary angiography (CTCA), Left ventricle (LV), Aortic Stenosis (AS), Ejection Fraction (EF)

1. INTRODUCTION

Aortic stenosis occurs when the aortic valve narrows and blood cannot flow normally. Progressive valve narrowing and the ensuing left ventricular remodeling response are two hallmarks of aortic stenosis.[1] The most prevalent kind of valvular heart disease is aortic stenosis. Aortic sclerosis, a modest form of fibrocalcific leaflet alterations, is the first stage of aortic valve disease and is linked to a 50% higher risk of unfavorable cardiovascular events even in the presence of normal leaflet opening. Aortic sclerosis frequently advances to more severe leaflet calcification; the

disease's final stage is marked by blockage of left ventricular outflow, which makes it unable to raise cardiac output sufficiently during exertion. If LV outflow blockage is not relieved once even minor symptoms appear, heart failure and death result.[2] Once primarily caused by rheumatic fever, the most common pathogenesis today is an active inflammatory process with some features that are similar to atherosclerosis.[3] The lesion of AS begins with leaflet thickening and sclerosis with progression to hemodynamically significant narrowing, usually said to be present when the aortic valve area is less than 2 cm^2.[4] Degenerative illness is the most prevalent cause of AS, although AS can also be brought on by endocarditis, systemic inflammatory illness, congenital valve abnormalities, and numerous other conditions. Bicuspid aortic valve is thought common congenital valve defect causing Aortic stenosis, and the prevalence of bicuspid aortic valve is about 0.5–1% in children.[5]

In an unselected older population, HTN, diabetes, and dyslipidemia all independently and dose responsely correlated with incident AS; taken together, they accounted for almost one-third of the risk of severe AS.[6] Both bicuspid and tricuspid aortic valves may acquire calcific aortic stenosis as a result of abnormal aortic function.[7] Development of significant aortic stenosis tends to occur earlier in persons with congenital bicuspid aortic valves as well as in people who have problems with the metabolism of calcium, including renal failure.[8] Calcific aortic stenosis is the most prevalent heart valve disorder in developed countries. After systemic arterial hypertension and coronary artery disease, aortic stenosis is the third most common cardiovascular disease in developed nations, with a frequency of 1.7% in people over 65 and 0.4% in the general population.[9] Many patients with a normal trileaflet aortic valve experience calcification; however, 60% of Aortic Valve Replacements in patients under the age of 70 and 40% in those over 70 have bileaflet architecture.[10] Aortic valve stenosis affects 3% of persons older than 65 years and is the significant cardiac valve disease in developed countries. The patient is asymptomatic for many years and relatively safe in this latent period. The prognosis deteriorates and the death rate rises sharply at the onset of symptoms.[11] An estimated 4.2 to 5.6 million adults in the United States have some form of clinically important valve disease.[12] Asia is the largest continent in the world and consists of markedly heterogeneous ethnicities. With documented prevalence rates of 1.86 in China, 4.54 in India, and 1.3 in Bangladesh per 1,000 people, rheumatic aortic stenosis is most prevalent in Asia.[13] The main method for diagnosing aortic stenosis is transthoracic echocardiography.[14] Reduced ejection fraction is associated with an increased risk of perioperative mortality; however, patients without surgery have a poor prognosis and valve replacement improves long term outcomes. Ejection fraction reductions are directly related to afterload increases and will reverse after valve replacement.[15]

Computed tomography angiography is established for the assessment of severe aortic stenosis considered for transcatheter aortic valve replacement.[16] Therapeutic management of Aortic Stenosis is essentially determined by the severity of the stenosis, the patients symptomatic status and the status of LV systolic function.[17] There is currently no effective medical treatment available to slow the course of aortic stenosis or to enhance prognosis.[18] Surgical aortic valve replacement has been the gold standard treatment for decades. However, transcatheter aortic valve replacement has emerged as an attractive, less invasive option for appropriately selected patients.[19] Patients with severe Aortic Stenosis who are at high surgical risk can be effectively treated with transcatheter aortic valve replacement. These patients are frequently old and affected by multiple cardiovascular comorbidities, such as

hypertension, coronary artery disease, peripheral vascular disease, and diabetes mellitus. Computed Tomography angiography can be used to assess peripheral vascular access sites and coronary artery anatomy.[20]

It is strongly advised to perform a coronary angiography for determining transcatheter aortic valve replacement eligibility.[21] Among asymptomatic patients with very severe aortic stenosis, early surgical aortic valve replacement led to a considerably decreased risk of death from cardiovascular causes during the follow-up period compared with conservative therapy.[22] The aim of this study is to assess left ventricle dysfunction using computed tomography coronary angiography in aortic stenosis patients. After this study, we will seek to provide valuable insights into the potential role of CT as an adjunct or alternative imaging modality to echocardiography, thereby enhancing the diagnostic capabilities and management strategies for patients with aortic stenosis and associated left ventricle dysfunction.

2. MATERIAL AND METHODS

A cross-sectional descriptive study was performed by using non-probability convenient sampling technique in Punjab Institute of Cardiology, Lahore, Pakistan. In this study Patients diagnosed with Aortic Stenosis on echocardiography were included. Patients with severe renal impairment contraindicating the use of contrast agent, Uncooperative patients and patients who declined to give consent were excluded. Study was performed on CT machine model Toshiba Alexion of 640 slices 5^{th} generation. A complete analysis of the cross-sectional radiological examination of 40 patients was carried out for assessment of aortic stenosis on computed tomography coronary angiography. The data collected included age, gender, risk factors and computed tomography coronary angiography parameters. Data was evaluated and analyze with statistical package for social sciences (SPSS) 25 and Microsoft excel of 2016. For continuous variables, the mean and standard deviation (SD) were computed.

3. RESULTS

Participants in the study ranged in age from 17 to 73 (of which 72.5% were male), with majority of patients being between 21 and 40 years old. 12.5% of those aged over 65 while 87.5% were between 17 to 64 years affected with aortic stenosis. 9(22.5%) patients had congenital bicuspid aortic valve causing aortic stenosis while 31(77.5%) had Trileaflet aortic valve which acquire aortic stenosis. 13(32.5%) patients out of 40 had LVEF < 50% out of which 6(46.2%) patients had dilated LV with moderate LV systolic dysfunction and 7(53.8) patients had dilated LV with severe LV systolic dysfunction were diagnosed on CTCA.

4. DISCUSSION

The most prevalent valvular heart disease that results in death is aortic stenosis. In order to evaluate the validity and viability of computed tomography-derived fractional flow reserve in patients with severe aortic stenosis, Michail et al. 2021 carried out a prospective study. Patients received invasive FFR and CTCA according to normal protocol. To evaluate CT-FFR independently, CTCA pictures were evaluated. 39 patients (92.3%) out of 42 had interpretable CTCA, which allowed for the estimation of CT-FFR. 76.2±6.7 years was the mean age (71.8% male). With 76.7% diagnostic accuracy, the corresponding values for sensitivity, specificity, positive predictive value, and negative predictive value were 73.9%, 78.4%, 68.0%, and 82.9%, respectively. According to available data, CT-FFR's

diagnostic accuracy may make it possible for it to be used in clinical settings and lay the groundwork for further studies.[23]

In 2017, a retrospective study led by Lennart van et al. aimed to ascertain the clinical outcome of individuals who had both simultaneous moderate AS and LV systolic dysfunction. The study included 305 patients, with a mean age of 73 ± 11 years and 75% of them being male.[24] In our study total 40 patients were studied with age ranging between 17 to 73 years (72.5%male), most patients were of the age between 21 to 40 years. An ejection fraction determined from CTCA can be used to assess LV dysfunction in patients with aortic stenosis. In conclusion, CTCA has improved the visualization of the aortic valve and left ventricle anatomy and pathology. A trustworthy and thorough explanation revealed by a CTCA scan serves as a pre-operative road map.

According to a 2014 study by Czarny MJ et al. 2% of people 65 years of age or older have valvular aortic stenosis, a degenerative illness.[25] According to a Qais et al. 2023 study, aortic stenosis which affects 5% of adults over 65 is the most frequent valvular heart disease, with a 1-3% incidence of severe stenosis. Congenital or acquired aortic stenosis is both possible.[11] 9(22.5%) patients had congenital bicuspid aortic valve causing aortic stenosis while 31(77.5%) had trileaflet aortic valve which acquire aortic stenosis.

A 2019 study by JS Dahl et al. found that one unfavorable effect of severe aortic stenosis's pressure overload is left ventricular systolic failure. An LVEF cut point of less than 50% has been applied in the case of the asymptomatic patient.[26] Retrospective research by JS Dahl et al. in 2015 involved asymptomatic individuals with severe aortic stenosis; guidelines suggest that LVEF of less than 50% be used as the cutoff point for aortic valve replacement referrals because it is linked to death.[27] In our study 13(32.5%) patients out of 40 had LVEF < 50% out of which 6(46.2%) patients had dilated LV with moderate LV systolic dysfunction and 7(53.8) patients had dilated LV with severe LV systolic dysfunction. When treating severe Aortic stenosis, early and accurate detection of LV dysfunction aids in the best possible time of intervention.

5. CONCLUSION

CTCA is more feasible for early and accurate diagnosis of left ventricular dysfunction in aortic stenosis patients. CTCA can improve the diagnostic potential and treatment plans for patients with aortic stenosis and concomitant left ventricular dysfunction.

REFERENCES

1. Bing R, Cavalcante JL, Everett RJ, Clavel MA, Newby DE, Dweck MR. Imaging and impact of myocardial fibrosis in aortic stenosis. JACC: Cardiovascular Imaging. 2019 Feb;12(2):283-96.
2. Rashedi N, Otto CM. Aortic stenosis: changing disease concepts. Journal of cardiovascular ultrasound. 2015 Jun;23(2):59.
3. Carabello BA. Introduction to aortic stenosis. Circulation research. 2013 Jul 5;113(2):179-85.
4. Thaden JJ, Nkomo VT, Enriquez-Sarano M. The global burden of aortic stenosis. Progress in cardiovascular diseases. 2014 May 1;56(6):565-71.
5. Akahori H, Tsujino T, Masuyama T, Ishihara M. Mechanisms of aortic stenosis. Journal of cardiology. 2018 Mar 1;71(3):215-20.

6. Yan AT, Koh M, Chan KK, Guo H, Alter DA, Austin PC, Tu JV, Wijeysundera HC, Ko DT. Association between cardiovascular risk factors and aortic stenosis: the CANHEART aortic stenosis study. Journal of the American College of Cardiology. 2017 Mar 28;69(12):1523-32.
7. Boudoulas KD, Triposkiadis F, Boudoulas H. The aortic stenosis complex. Cardiology. 2018 Oct 16;140(3):194-8.
8. Grimard BH, Safford RE, Burns EL. Aortic stenosis: diagnosis and treatment. American family physician. 2016 Mar 1;93(5):371-8.
9. Lindman BR, Clavel MA, Mathieu P, Iung B, Lancellotti P, Otto CM, Pibarot P. Calcific aortic stenosis. Nature reviews Disease primers. 2016 Mar 3;2(1):1-28.
10. Rashedi N, Otto CM. Aortic stenosis: changing disease concepts. Journal of cardiovascular ultrasound. 2015 Jun 1;23(2):59-69
11. Qais Z, Qais K, Dhillon S. Aortic Stenosis (AS). InClinical and Surgical Aspects of Congenital Heart Diseases: Text and Study Guide 2023 Jan 21 (pp. 105-112). Cham: Springer International Publishing.
12. Kanwar A, Thaden JJ, Nkomo VT. Management of patients with aortic valve stenosis. InMayo Clinic Proceedings 2018 Apr 1 (Vol. 93, No. 4, pp. 488-508). Elsevier.
13. Tay EL, Ngiam JN, Kong WK, Poh KK. Management of severe aortic stenosis: the Singapore and Asian perspective. Singapore medical journal. 2018 Sep;59(9):452.
14. Boskovski MT, Gleason TG. Current therapeutic options in aortic stenosis. Circulation research. 2021 Apr 30;128(9):1398-417.
15. Everett RJ, Clavel MA, Pibarot P, Dweck MR. Timing of intervention in aortic stenosis: a review of current and future strategies. Heart. 2018 Dec 1;104(24):2067-76.
16. Rossi A, De Cecco CN, Kennon SR, Zou L, Meinel FG, Toscano W, Segreto S, Achenbach S, Hausleiter J, Schoepf UJ, Pugliese F. CT angiography to evaluate coronary artery disease and revascularization requirement before trans-catheter aortic valve replacement. Journal of cardiovascular computed tomography. 2017 Sep 1;11(5):338-46.
17. Clavel MA, Magne J, Pibarot P. Low-gradient aortic stenosis. European heart journal. 2016 Sep 7;37(34):2645-57.
18. Marquis-Gravel G, Redfors B, Leon MB, Genereux P. Medical treatment of aortic stenosis. Circulation. 2016 Nov 29;134(22):1766-84.
19. Joseph J, Naqvi SY, Giri J, Goldberg S. Aortic stenosis: pathophysiology, diagnosis, and therapy. The American journal of medicine. 2017 Mar 1;130(3):253-63.
20. Chieffo A, Giustino G, Spagnolo P, Panoulas VF, Montorfano M, Latib A, Figini F, Agricola E, Gerli C, Franco A, Giglio M. Routine screening of coronary artery disease with computed tomographic coronary angiography in place of invasive coronary angiography in patients undergoing transcatheter aortic valve replacement. Circulation: Cardiovascular Interventions. 2015 Jul;8(7):e002025.
21. Paradis JM, Fried J, Nazif T, Kirtane A, Harjai K, Khalique O, Grubb K, George I, Hahn R, Williams M, Leon MB. Aortic stenosis and coronary artery disease: what do we know? What don't we know? A

comprehensive review of the literature with proposed treatment algorithms. European heart journal. 2014 Aug 14;35(31):2069-82.

22. Kang DH, Park SJ, Lee SA, Lee S, Kim DH, Kim HK, Yun SC, Hong GR, Song JM, Chung CH, Song JK. Early surgery or conservative care for asymptomatic aortic stenosis. New England Journal of Medicine. 2020 Jan 9;382(2):111-9.
23. Michail M, Ihdayhid AR, Comella A, Thakur U, Cameron JD, McCormick LM, Gooley RP, Nicholls SJ, Mathur A, Hughes AD, Ko BS. Feasibility and validity of computed Tomography-Derived fractional flow reserve in patients with severe aortic stenosis: the CAST-FFR study. Circulation: Cardiovascular Interventions. 2021 Jan;14(1):e009586.
24. van Gils L, Clavel MA, Vollema EM, Hahn RT, Spitzer E, Delgado V, Nazif T, De Jaegere PP, Geleijnse ML, Ben-Yehuda O, Bax JJ. Prognostic implications of moderate aortic stenosis in patients with left ventricular systolic dysfunction. Journal of the American College of Cardiology. 2017 May 16;69(19):2383-92.
25. Czarny MJ, Resar JR. Diagnosis and management of valvular aortic stenosis. Clinical Medicine Insights: Cardiology. 2014 Jan;8:CMC-S15716.
26. Dahl JS, Magne J, Pellikka PA, Donal E, Marwick TH. Assessment of subclinical left ventricular dysfunction in aortic stenosis. JACC: Cardiovascular Imaging. 2019 Jan;12(1):163-71.
27. Dahl JS, Eleid MF, Michelena HI, Scott CG, Suri RM, Schaff HV, Pellikka PA. Effect of left ventricular ejection fraction on postoperative outcome in patients with severe aortic stenosis undergoing aortic valve replacement. Circulation: Cardiovascular Imaging. 2015 Apr;8(4):e002917.

LIST OF TABLES:

Table 1: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Hypertension	40	0	1	.28	.452
Diabetes	40	0	1	.10	.304
Obesity	40	0	1	.08	.267
hyperlipidemia	40	0	1	.10	.304
FH	40	0	1	.10	.304
Smoke	40	0	1	.15	.362
Valid N (list wise)	40				

Table 2: Aortic Valve * LV Cross tabulation

Count

		LV				
		Good LV Function	Fair LV Function	Moderate LV Dysfunction	Severe LV Dysfunction	Total
Aortic Valve	Thickened Calcified Bicuspid	3	1	2	0	6
	Thickened Calcified Trileaflet	9	6	5	2	22
	Thickened Aortic Root	5	1	0	3	9
	Heavily Calcified Bileaflet	1	0	0	2	3
Total		18	8	7	7	40