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Original Article

Point of Care Ultrasound Echocardiography in COVID Patients – A Single-Center Study

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Abstract

Introduction: POCUS increasingly used for efficient detection of cardiorespiratory complications of COVID-19 Cardiac POCUS may have similar benefits to transthoracic echocardiography while decreasing staff exposure to patients with COVID-19. Cardiac POCUS has utility, with up to 50% of patients with COVID-19 having cardiac abnormalities on echocardiography, leading to management changes in nearly one-third.

Purpose: This study aimed to define abnormalities and TTE analysis in acute COVID-19 infections and to determine their implications in management and prognosis.

Methods: Sick patients in COVID wards of Government Rajaji Hospital, Madurai were subjected to POCUS echocardiography with 2D portable Echo machine with adult transducer 3–5 MHz using 2D, M mode, PW, CW, and CFM with the help of trained cardiac sonology technicians with PPE. The images were supervised by cardiologist by video calls. Study period is from April 2021 to March 2022 during second wave of COVID-19 pandemic.

Results: Out of 17,562 patients of COVID-19, 1552 patients were subjected to POCUS Echocardiography Examination. Out of those, 55.54% were male and 44.46% were female. Five hundred and ninety-six patients were above 60 years. From the 1552 patients, 26.6% showed structurally normal heart. Abnormal findings were classified follows CAD – 15.34%, cardiomyopathy – 5.41%, calcific AS – 2.2%, in acute coronary syndrome – STEMI – 2.4%, RHD – 1.42%, pleural effusion – 0.97%, PAH in 5.54%, and pericardial effusion – 3.87%. According to symptoms, 42.33% had pneumonia, 34.6% – diabetic, 31.19% – hypertensive, and 4.51% had CKD. Possible myocarditis is in 0.13% and pulmonary embolism in 0.13%.

Conclusion: In the pandemic situation, cardiologist can use telemedicine as a tool to diagnose abnormal cardiac conditions making use of portable echo machines with the help of cardiac sonology technicians.

Key words: Cardiac POCUS, COVID-19, Telemedicine, Cardio Sonology Technician, Screening

INTRODUCTION

Point of care ultrasound echocardiography (POCUS) is an aid to help the medical world to diagnose cardiac abnormalities quickly. Good training and dedication are needed for any medical doctor (non-sonologist) to do fast screening in the bed side.[1] Especially in the COVID pandemic situation, all medical doctors are diverted to look after COVID patients and there is shortage of qualified sonologist and cardiologist.[2] Good portable echocardiography enabled ultrasound machine and well-trained cardiac sonology technician is enough to do the screening echocardiography to COVID patients in COVID isolation wards. POCUS Echo is used in ED, Triage, ICU, IMCU, and IRCU. It is a game changer in the management of seriously ill patients. Knowing cardiac status by POCUS Echo is a boon for emergency management.

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Table 1: The total number patients admitted in Madurai Government Rajaji Hospital during the COVID-19 pandemic

	Total in patients	
Sex	**Number of patients**	**Percentage (for 17,562 patients)**
Male	10,339	58.88
Female	6937	39.5
Children	286	1.63
Total	17,562	

Table 2: The month-wise total number of patients who have undergone point of care ultrasound echocardiography

	Number of patients who underwent POCUS echo	
Month	**Number of patients**	**Percentage (for 1552 patients)**
July-21	217	13.99
August-21	219	14.11
September-21	203	13.08
October-21	230	14.82
November-21	143	9.21
December-21	89	5.73
January-22	317	20.43
February-22	134	8.63
Total	1552	

POCUS: Point of care ultrasound echocardiography

Table 3: The gender-wise total number of patients who have undergone point of care ultrasound echocardiography

	Sex	
Sex	**Number of patients**	**Percentage (for 1552 patients)**
Female	690	44.46
Male	862	55.54
Total	1552	

Table 4: The age-wise total number of patients who have undergone point of care ultrasound echocardiography

	Age – group	
Age	**Number of patients**	**In percentage (for 1552 patients)**
<10	12	0.77
11–20	49	3.16
21–30	135	8.7
31–40	174	11.21
41–50	243	15.66
51–60	343	22.10
>60	596	38.40
Total	1552	

Bed side echocardiography screening can be done by them and if in doubt they can contact qualified echo cardiographer/cardiologist using video calling showing the images and videos acquired for sick patients using standard views. Review examination can be ordered if the views are not clear enough to give impression.[3]

Improved portability of the ultrasound machine has enabled cardiac ultrasound imaging to be performed at the bed side offering cardiac status to their clinical scenario. Artificial intelligence (AI) is utilized by many handheld echocardiographic machines. Miniaturized technology is used in such hand held portable cardiac ultrasound system. During COVID-19 pandemic, this POCUS method posed logistical challenges in holistic care of patients, highlighting the need for accurate easily disinfected equipment that could be used at the patient's bed side. Basic software implemented to enhance 2D/M mode/CPM, PW, and CW facilities. AI-based automated LVEF is possible to reduce the time of examination.[4]

In COVID patients, time taken for POCUS examination is 5–10 min[5] and the contact time for entire examination is <20 min. Life-threatening condition such as mechanical complication (ventricular septal rupture, free wall rupture, and papillary muscle rupture) following acute coronary syndrome (ACS), massive pericardial effusion (PE), acute pulmonary embolism, aortic dissection, and myocarditis can be picked up in the bedside and enable them to manage appropriately in the right time. The reliability is good, because the POCUS examinations done by technicians are supervised over telemedicine (video calls) [Figure 1] using Android type of phones at both ends.

By this method, shortage of qualified cardiologist is managed by trained cardio sonology technicians who are mostly younger than 40 years. Further, doctors more than 50 years with comorbidities when compared to young technicians are having more risk to get infected.[6] Advantage is the reproducibility as many times if the patient is hemodynamically stable. We can do review POCUS examination if needed. Detailed echocardiography can be done if the patient's infectivity period is over. Some may need Balloon Valvotomy, Surgical Management or Percutaneous Device Closure. The chance of getting infection is very low, due to reduced time of contact, good immunity system of young technicians, and use of PPE.

MATERIALS AND METHODS

Study Population

The study comprises patients admitted at COVID wards, Government Rajaji Hospital and Madurai Medical College, Madurai with cardiac symptoms such as fever, easy fatigue, chest discomfort, palpitation, and shortness of breath.

Study Period

The study was April 2021–March 2022.

Selected Patients for the Study

Sick patients in ED, critical care unit and SARI wards, those with undue tachycardia and other ECG abnormalities ordered by physician in charge of the wards.

Machine Used for the Study

Mindray – M6 Ultrasound and 2D Echo Machine Portable over cart wheel using adult Echo transducer 3–5 MHz facilitating the following methods: Basic software implemented to enhance 2D/M mode, CPM, CFM, PW, CW, and POCUS echocardiography using standard views.

The cardio sonology technician did POCUS (PLAX, LAX, SAX, A4C, A5C, and sub-coastal views) echocardiography examination. They performed in standard views. Those images and videos were recorded and shown by telemedicine (video calling) to cardiologist [Figure 2]. If any doubt, Echo was repeated or sent to cardiology OP. Reports given in standard format meant for POCUS echocardiogram.

Statistical analyses of the data are conducted using the software IBM SPSS 20.0 version. Statistical inference was derived using Chi-square test.

The cardio sonology technician who did POCUS echocardiography examination takes necessary precautions as follows:

1. PPE level II–III.
2. Social distancing of 1–2 feet.
3. Doffing and donning.
4. Cleaning with spirit after every examination.
5. 7 days of work for 6 h followed by 7 days of quarantine (two technicians alternately can work).
6. Subjecting themselves for RTPCR test after 5 days of work.
7. Sterilization of the utensils and fomites
8. Keep them isolated during duty period and 5 days after duty period until their nasopharyngeal RTPCR swab

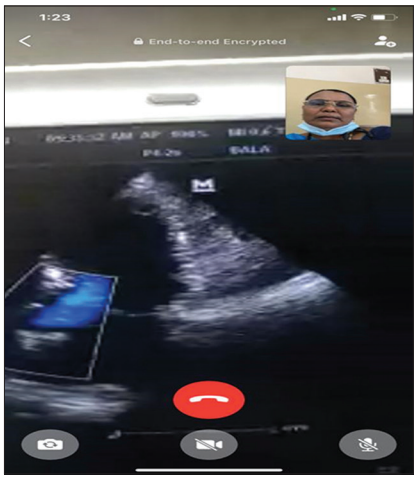

Figure 1: The cardiologist supervising the POCUS examinations over telemedicine (video calls)

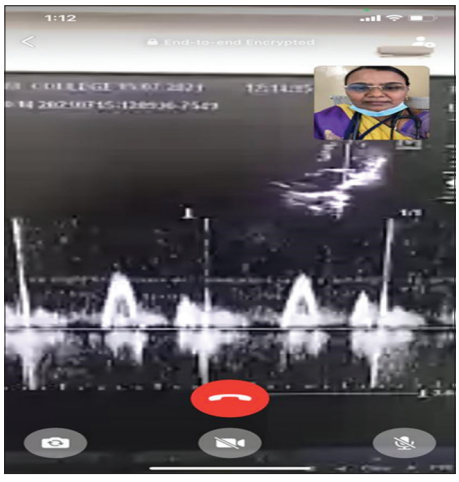

Figure 2: The taken POCUS echocardiography examination has been showed and examined by the cardiologist

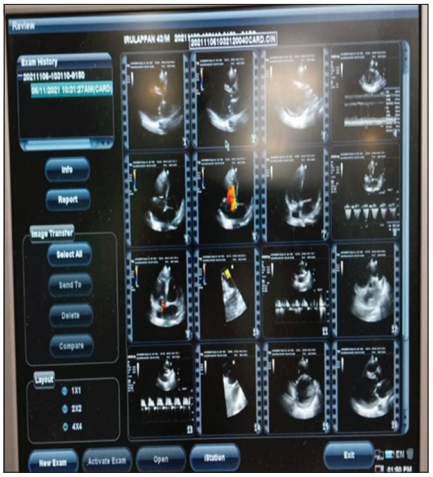

Figure 3: The image of dilated cardiomyopathy view in POCUS echocardiography.

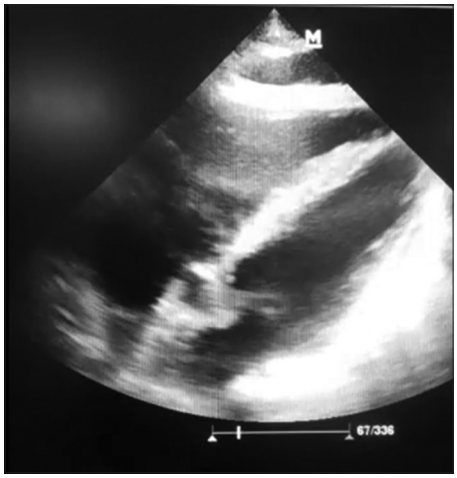

Figure 4: The image of dilation of RA and RV

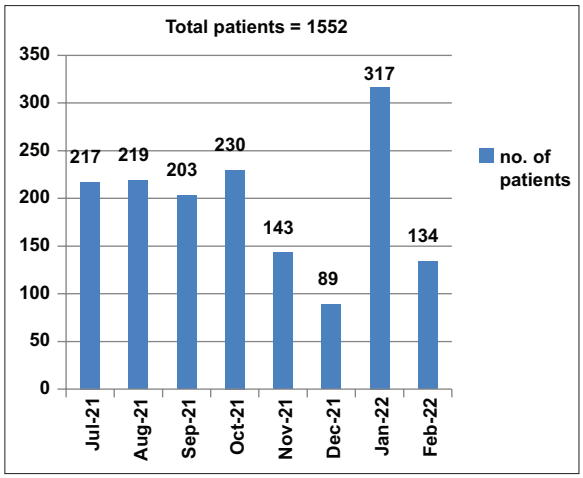

Chart 1: Represents the month-wise total number of patients who have undergone POCUS echo

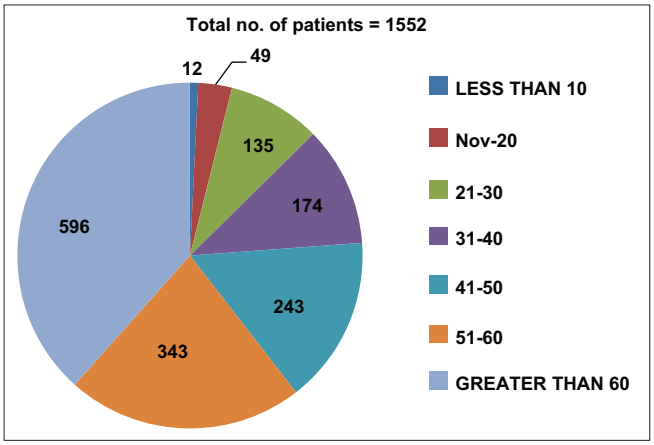

Chart 2: Represents the age-wise total number of patients who have undergone POCUS echo

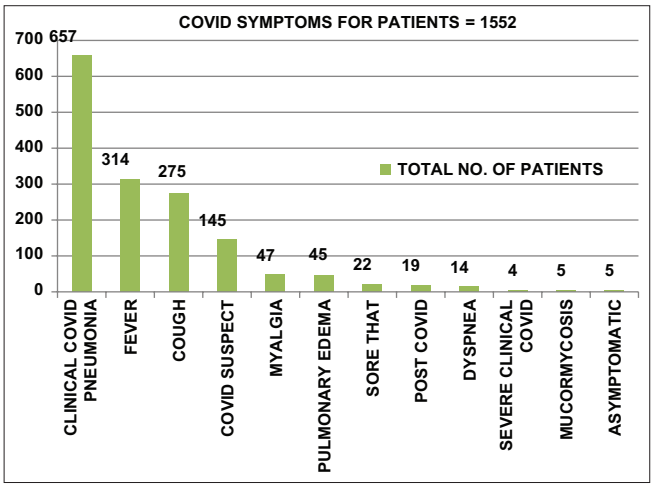

Chart 3: Represents the COVID symptoms for the patients undergone POCUS echo

test results are published.

9. Prophylactic measures such as vaccination and soap bathing.
10. Nutritious food, etc.

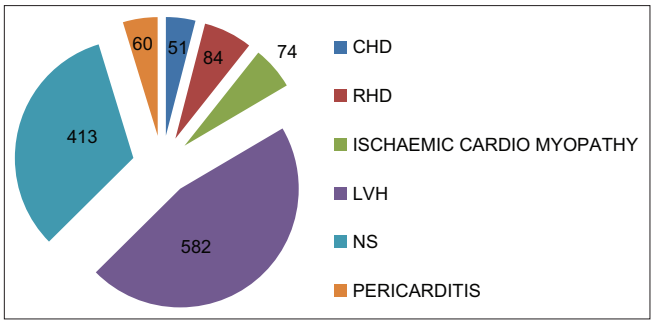

Chart 4: Represents the cardiac conditions of patients who have undergone POCUS echo

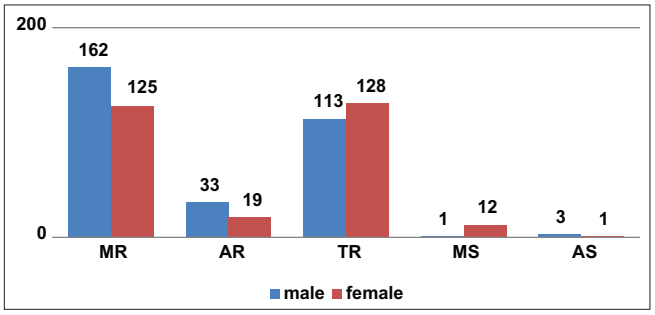

Chart 5: Represents the number of patients with both rheumatic and non-rhematic valvular heart diseases who have undergone POCUS echo

Inclusion Criteria

Patients admitted in COVID wards who were symptomatic and referred cases from ED, ICU, patients with cardiac murmurs, and ECG abnormalities for cardiac evaluation were included in the study.

Exclusion Criteria

Those patients who are not willing to undergo Echo Cardiogram were excluded from the study.

RESULTS AND ANALYSIS

Totally 1552 COVID-19 patients were subjected to POCUS echocardiography evaluation [Tables 1 and 2] and [Chart 1].

Sex and Age Criteria

Eight hundred and fifty-two were male, 674 were female, and 15 were children. Male↔Female ratio is 1.25:1. The highest age group is more than 60 years (596 out of 1552 patients) [Chart 2].

Normal Heart

Four hundred and thirteen (26.65%) – (M-211; F-202) were diagnosed to have structurally normal heart [Tables 3 and 4] and [Chart 4 and Video 1].

Concentric Left Ventricular Hypertrophy (LVH)

Concentric LVH was present in 582 (M-330; F-252) patients (37.5%) among total cases. It constitutes 51.09% among

Table 5: The COVID symptoms for the patients undergone point of care ultrasound echocardiography

	COVID symptoms			
Covid	**Male**	**Female**	**Grand total**	**Percentage (for 1552 patients)**
Clinical COVID pneumonia	359	298	657	42.33
Fever	157	157	314	20.23
Cough	131	144	275	17.72
COVID suspect	82	63	145	9.34
Myalgia	21	26	47	3.03
Pulmonary edema	20	25	45	2.9
Sore throat	11	11	22	1.42
Post covid	10	9	19	1.22
Dyspnea	6	8	14	0.90
Severe clinical covid	1	3	4	0.3
Mucormycosis	2	3	5	0.32
Asymptomatic	3	2	5	0.32
Total	803	749	1552	

those with abnormal Echocardiography. LVH diagnosed using IVS/PW thickness and LV mass [Tables 7 and 8].

Diastolic Dysfunction

Two hundred and seventy-seven patients (17.85%) – (M-171; F-106) had diastolic dysfunction out of 1552 patients. Among them, 266 patients (17.13%) had Grade I, six patients had Grade II, five patients had Grade III, and none had Grade IV diastolic dysfunction.

CAD and ACS

Among abnormal echocardiographic findings, CAD tops the list with 238 (15.34%) – (M-155; F-83) followed by Cardiomyopathy (Ischemic, DCM [Figure 3], HCM and PPCM). ACS accounts to 62 cases (4%) which include STEMI, NSTEMI and Unstable Angina. Stress Cardiomyopathy in one patient (F-1) [Tables 9 and 10] and [Video 2].

Rheumatic and Non-Rheumatic Valvular Heart Diseases: 597 (38.46%) – (M-312; F-285)

Patients had valvular diseases out of 1552 patients. Among them, 287 patients (3.86%) – (M-125; F-162) had Mitral Regurgitation (MR), RHD could be diagnosed in 22 cases (1.41%) – (M-8; F-14), 13 patients (M-1; F-12); had mitral stenosis (MS), five patients (M-0; F-5) had severe MS. (MVOA < 1 m^2), four patients (M-3; F-1) had aortic stenosis (AS), no patients had severe AS, 52 patients (M-33; F-19) had aortic regurgitation (AR), and tricuspid regurgitation (TR) found in 241 patients (M-113; F-128) (all are functional TR) [Table 11 and Chart 5].

Severe Pulmonary Arterial Hypertension

Present in five patients (M-2; F-3). Among them, D-shaped LV due to severe pulmonary arterial hypertension was present in two cases (M-1; F-1). Escalation of oxygen therapy was recommended for those who had moderate-to-severe pulmonary arterial hypertension without pre-existing heart disease. Serial examinations have done

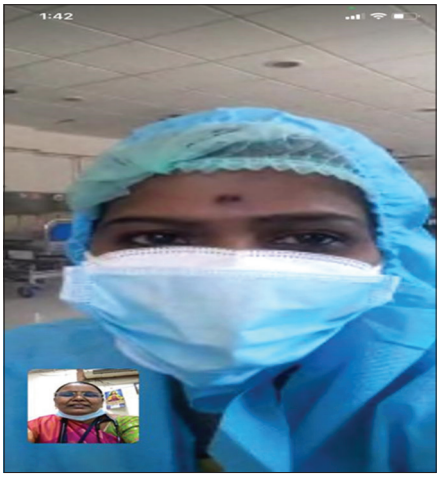

Figure 5: The technically qualified and trained cardiac sonologist in telemedicine under supervision of the cardiologist.

which showed reduction in TRPG. Severe hypoxia patients on ventilator had significant TR. Such patients were kept as high-risk group and intense monitoring recommended [Table 12].[7]

LV Systolic Dysfunction

LVSD was present in 238 patients (15.33%) – (M-155; F-83). Ninety-three patients (6.37%) had ejection fraction of <50% by teicholtz method.[8]

PE: 60 patients (3.86%) – (M-32; F-28) had PE. Among them, two patients had massive PE [Video 3]. One had tamponade and she underwent emergency pericardial tapping under Echo guidance [Figure 6].

Cardiologist did it with full COVID precautions in the IMCU ward under careful monitoring. Thin sheet of PE was seen in 22 cases. Mild PE in 18 cases. [Table 13] Moderate PE was in eight cases. Known hypothyroid cases had PE predominantly.[9]

Figure 6: The image of massive pericardial effusion with cardiac tamponade

Pleural Effusion

Echo free space behind descending thoracic aorta in 15 patients (0.97%) – (M-9; F-6). They had left-sided mild effusion.[10]

Pulmonary Embolism

Since COVID predispose patients to pulmonary embolism due to dehydration and cytokine release mediated endothelial damage and possible abnormal coagulation profile.[11] Unprovoked acute pulmonary embolism could be identified by Echo Cardiograph criteria such as dilated right atrium (RA) and right ventricle (RV) with moderate TR [Figure 4]. Echo Cardiograph (ECG) was abnormal for that case showing $S_1Q_3T_3$ pattern. He was lysed with alteplase. However, the patient succumbed to death due to massive PE and hypoxia due to severe lung involvement. He was a 34-year-old male with WELL's score of 2. He was not on any drugs and there were no comorbid illness. Another patient with sub-massive PE was treated with Heparin Infusion followed by oral anticoagulant. In our center, rivaroxaban was advised 15 mg twice a day for 3 months.

Myocarditis

All breathless patients with tachycardia and heart rate >120 were screened for possible myocarditis.[12] Clinical, ECG, and Echo showing LV systolic dysfunction with dilatation of LV cavity.

Eleven patients had possible Myocarditis. Among them, two had severe LVSD. Both died in COVID wards. They were around 40 years and the lung involvement was around 40% [Table 5]. Hence, we were about to name them as "40–40 COVID syndrome." All were started on Inj.methyl prednisolone – 1 mg body weight twice a day dosage for 3–7 days depending on the response. Cardioprotective drugs were given. Anti-failure drugs were given. Digoxin and beta-blockers were judiciously used. Ivabradine used to control sinus tachycardia. Oxygen therapy escalated to keep SpO_2 > 92%. Endomyocardial biopsy and cardiac MRI could not be done since patients were too sick.

Congenital Heart Diseases (CHD)

Totally, 51 patients had **CHD**s. Among those, mitral valve prolapse (MVP) tops the list followed by atrial septal defect (ASD), patent foramen ovale (PFO), ebstein anomaly, and dextrocardia.

Calcific Aortic Stenosis

Thirty-four patients had calcified aortic stenosis of mild-to-moderate severity. They were advised to have followed up.

Arrhythmias

Nineteen patients (1.2%) – (M-15; F-4) had tachy arrhythmia and atrial fibrillation (AF)[13,14] was the most common tachy arrhythmia. Ventricular tachycardia (VT) was present in one patient (55/F) with DM and HT. She survived. Sinus tachycardia during study was found in 64 cases (4.12%) – (M-37; F-27). Sinus bradycardia was found in nine cases (0.58%) – (M-6; F-3). There were 2 cases of Complete Heart Block (0.1%) [M-2; F-0]. All tachy arrhythmia reverted either by DC cardio version or chemical cardio version, followed up for tachy cardiomyopathy, features of myocarditis.

Invasive Fungal Sinusitis/Mucormycosis

Totally, six cases were diagnosed to have mucormycosis among those 1552 patients who underwent POCUS echocardiography. Many cases were suspected to have fungal sinusitis around 100 cases. There was one case of isolation, one case had pulmonary mucormycosis, and one had orbital mucormycosis. Overall prognosis was bad in those with COVID pneumonia with mucormycosis infection. Diabetic patients were more prone to have mucormycosis infection.[15]

DISCUSSIONS

Symptoms Analysis

Among 1552 cases, who underwent POCUS echocardiography, five cases were asymptomatic. Others were symptomatic.

Fever was the predominant symptom in 314 cases (20.23%), followed by cough – 275 cases (17.72%), suspected COVID – 145 cases (9.02%), myalgia – 47 cases (3.03%), and acute pulmonary edema, which was given the diagnosis in 45 cases (2.9%).[16,17]

Twenty-two cases (1.42%) had sore throat; post-COVID patients were admitted due to persistent dyspnea – 14 cases (1.22%). All the 14 patients were having severe breathlessness during POCUS echo study and most of

Table 6: The co-morbid conditions for the patients who have undergone point of care ultrasound echocardiography

Co-morbid conditions						
Serial number	**Co-morbid conditions**	**Male**	**Female**	**Total**	**In percentage (for 1552 patients)**	***P***
1	DM	309	228	537	34.60	0.484
2	HTN	279	205	484	31.19	0.160
3	CKD	52	18	70	4.51	0.031
4	Anaemia	7	13	20	1.29	0.005
5	Thyroid	1	19	20	1.29	0.472
6	PTB – active	16	3	19	1.22	0.433
7	DKA	3	2	5	0.32	0.922
8	AKI	2	3	5	0.32	0.970
9	Portal HTN/DCLD	5	0	5	0.32	0.007
10	CKD on HD	3	0	3	0.2	0.782
11	Connective tissue disorders (CHD)					
	SLE	0	1	1	0.06	0.495
	RA	0	3	3	0.2	0.470
12	PAOD	1	0	1	0.06	0.742
13	DVT	3	1	4	0.26	0.828
14	PLHA	3	1	4	0.26	0.084
15	RTA	4	0	4	0.26	0.001
16	s/p renal transplant	2	1	3	0.2	0.668
17	Cancer					
	AML	1	1	2	0.19	0.437
	CML	2	0	2	0.19	0.858
	Breast	0	1	1	0.06	0.952
18	Omicron	1	0	1	0.06	0.105
19	Dengue	2	1	3	0.2	0.000
20	Typhoid	1	0	1	0.06	0.952
21	Invasive fungal sinusitis	0	1	1	0.06	0.742
22	Lung diseases					
	COPD	14	14	28	1.8	0.583
	Asthma	15	8	23	1.5	0.305
	TB	6	2	8	0.52	0.914
	ARDS	4	2	6	0.4	0.388
	ILD	1	2	3	0.2	0.737
	Cavitation in mediastinum	1	0	1	0.06	0.952
23	Thrombocytopenia	2	1	3	0.2	0.052
24	DUB	1	0	1	0.06	0.742
25	CNS					
	CVA	20	7	27	1.74	0.518
	Suspected covid altered sensorium for evaluation	1	0	1	0.06	0.742
	CIDP	2	0	2	0.19	0.869
	Systemic sclerosis	0	1	1	0.06	0.742
	Hyponatremia	1	0	1	0.06	0.952
	Metabolic encephalopathy	3	0	3	0.2	0.567
26	ICH on mechanical ventilation	1	0	1	0.06	0.952
27	Psychiatric illness	0	1	1	0.06	0.952
	Grand total	769	540	1309	84.34	

P>0.05 not reject (accept) the null hypothesis and *P*<0.05 reject the alternative hypothesis. DM: Diabetes mellitus, HTN: Hypertension, CKD: Chronic kidney disease, DKA: Diabetic ketoacidosis, AKI: Acute kidney Injury, HD: Haemodialysis, CHD: Congenital heart disease, RA: Right atrium, PAOD: Peripheral arterial occlusive disease, DVT: Deep vein thrombosis, PLHA: People Living With HIV/AIDS, RTA: Road traffic accident, AML: Acute Myeloid Leukaemia, CML: Chronic myelogenous leukaemia, COPD: Chronic obstructive pulmonary disease, TB: Tuberculosis, ARDS: Acute respiratory distress syndrome, CVA: Cerebral vascular accident, SLE: Systemic lupus erythematosus, CIDP: Chronic inflammatory demyelinating polyneuropathy, DCLD: Decompensated chronic liver disease, PTB: Pulmonary tuberculosis, ILD: Interstitial lung disease, DUB: Dysfunctional Uterine Bleeding, CNS: Central Nervous System, ICH: Intracerebral Brain Hemorrhage

them were on ventilator therapy (0.9%), severe COVID infection with poor prognostic markers were there in four cases (0.32%).

Comorbid Conditions

Among 1552 patients who underwent POCUS echocardiography, 537 patients were diabetic irrespective of type of diabetes (34.6%), 484 patients were hypertensive (31.18%), 70 patients has chronic kidney disease (CKD) – (4.5%), three cases were getting regular hemodialysis (HD), 20 patients (1.29%) had severe anemia (Hemoglobin [HB] <8 g/dL), 20 patients had hypothyroidism (1.29%), consistent finding was mild PE in them, and 19 patients (1.22%) had active pulmonary tuberculosis (TB), for them ATT started with the help of thoracic physician [Table 6 and Chart 3].[18,19]

Five patients had diabetic ketoacidosis (DKA) as a complication due to poor control of diabetes mellitus (DM) and use of steroids, one patient (male) had peripheral arterial occlusive disease (PAOD), four patients had deep vein thrombosis (DVT) – (M-3; F-1), 4 patients had people living with HIV/AIDS (PLHA) – (M-3; F-1), status post renal transplant were of 3 patients – (M-2; F-1), acute myeloid leukemia (AML) cases were 2 in number, chronic myelogenous leukemia (CML) cases were 2 in number, CA breast was in 1 case, 27 cases (1.74%) with acute cerebral vascular accident (CVA) were examined, road traffic accident (RTA) – four cases underwent echo, few were taken for emergency surgery, acute kidney injury (AKI) cases were 5 who underwent POCUS echo, 51 cases (3.29%) of chronic obstructive pulmonary disease (COPD) and asthma, and six cases of acute respiratory distress syndrome (ARDS).

Table 7: The number normal and abnormal study of cardiac patients who have undergone point of care ultrasound echocardiography

	Normal			
Cardiac status (Normal / Abnormal)	**Male**	**Female**	**Total**	**Percentage (for 1552 patients)**
Normal study	211	202	413	26.6
Abnormal study	651	488	1139	73.39

Around five cases underwent emergency amputations due to acute limb ischemic gangrene.

COVID Plus Syndromes

Three patients – (M-2; F-1) had dengue, one patient (male) had typhoid,[20,21] and one patient had leptospirosis.

Common echo finding was significant tricuspid regurgitation (TR). The subcostal views were taken in patients who were connected to HFNO, NRM mask, and ventilators.

Temporary Pace Makers *In Situ*

Three cases underwent echo who had lead in RV apex. Subcostal views showed it better. Femoral vein route were used for all the three cases. Among them, one later underwent permanent pacemaker implantation (PPI), other recovered to have around 40 per minute discharged against medical advice (AMA) with oral orciprenaline 10 mg twice a day dosage. We lost follow up of that patient. All the three patients were male.

Pregnancy and COVID Cases

Among 48 women with pregnancy[22] with RTPCR positive (38 cases) and rest with Clinical COVID who underwent POCUS echo had fever as predominant symptom followed by cough and pneumonia. Lung involvement was not more

Table 8: The abnormal cardiac conditions of patients who have undergone point of care ultrasound echocardiography

	Abnormal cardiac conditions by echo				
Serial number	**Abnormal cardiac status by echo**	**Male**	**Female**	**Total**	**Percentage (for 1552 patients)**
1	CAD	155	83	238	15.34
2	Cardio myopathy	58	26	84	5.41
3	Calcified aortic stenosis	14	20	34	2.20
4	ACS				
	STEMI	28	9	37	2.4
	Unstable angina	14	6	20	1.3
	N-STEMI	3	2	5	0.32
5	VHD (organic+functional)	312	285	597	38.47
6	RHD	8	14	22	1.42
7	Pleural effusion	9	6	15	0.97
8	CAD (known case)	6	5	11	0.71
9	Para doxical septal motion	1	1	2	0.13
10	Pulmonary embolism	2	0	2	0.13
11	Corpulmonale	0	1	1	0.06
12	Myocarditis	1	1	2	0.13
13	Pericardial effusion	32	28	60	3.87
14	Possible myocarditis	0	2	2	0.13
15	CHD				
	MVP-AML	14	22	36	2.32
	ASD	2	7	9	0.58
	PFO	2	2	4	0.26
	Ebstein anomaly	1	0	1	0.06
	Dextro cardia	1	0	1	0.06
16	Impending cardiac tamponade	0	1	1	0.06
17	Pulmonary hypertension	45	41	86	5.54
18	Concentric LVH	330	252	582	37.5

CAD: Coronary artery disease, ACS: Acute coronary syndrome, ST-Elevation Myocardial Infarction, NSTEMI: Non-STEMI, CAD: Coronary artery disease, CHD: Coronary heart disease, MVP: Mitral valve prolapse, AML: Acute myeloid Leukaemia, ASD: Atrial septal defect, PFO: Patent foramen ovale, VHD: Valvular heart disease, RHD: Rheumatic heart disease, LVF: Left Ventricular Hypertrophy

than 40%. Three cases only underwent CT chest with precautions preferably in 2nd and 3rd trimester.

Thirty-eight mothers had mild-to-moderate hypoxia, two were diabetic, and two were hypertensive, 28 mothers had normal study, mild global hypokinesia was there in one case, left ventricular systolic dysfunction (LVSD) moderate was there in one case, four mothers had trivial mitral regurgitation (MR), three mothers had mild mitral regurgitation (MR), and one mother had moderate mitral regurgitation (MR)

Table 9: The number of patients with coronary artery disease who have undergone point of care ultrasound echocardiography

CAD				
Coronary artery territory	Male	Female	Total	Percentage (for 1552 patients)
Global/mild global	102	62	164	10.57
LAD territory (AWMI)	28	16	44	2.84
RCA/LCX territory (IWMI)	25	5	30	1.93
Total	155	83	238	15.34

CAD: Coronary artery disease, AWMI: Anterior wall myocardial infarction, LAD: Left Anterior Descending Artery, RCA: Right coronary artery, LCX: Left Circumflex, IWMI: Inferior wall myocardial infarction

Table 10: The number of patients with cardio myopathy who have undergone point of care ultrasound echocardiography

Cardio myopathy				
Type of cardio myopathy	Male	Female	Total	Percentage (for 1552 patients)
Ischaemic cardio myopathy	52	22	74	4.77
DCM	5	3	8	0.52
HCM	1	-	1	0.06
PPCM	-	-	-	-
Takotsubo cardiomyopathy/apical blooning syndrome	-	1	1	0.06
Total	58	26	84	5.41

DCM: Dilated cardiomyopathy, HCM: Hypertrophic cardiomyopathy, PPCM: Peripartum cardiomyopathy

Table 11: The number of patients with both rheumatic and non rhematic valvular heart diseases who have undergone point of care ultrasound echocardiography

ECHO – VHD																
Severity	Male					Female					Total					
	MR	AR	TR	MS	AS	MR	AR	TR	MS	AS	MR	AR	TR	MS	AS	
Trival	51	13	14	0	0	36	5	16	0	0	87	18	30	0	0	
Mild	81	19	81	1	2	59	13	89	4	1	140	32	170	5	3	
Moderate	30	1	15	0	1	29	1	17	3	0	59	2	32	3	1	
Severe	0	0	3	0	0	1	0	6	5	0	1	0	9	5	0	
Total	162	33	113	1	3	125	19	128	12	1	287	52	241	13	4	

MR: Mitral regurgitation, MS: Mitral stenosis, AR: Aortic regurgitation, AS: Aortic stenosis, TR: Tricuspid regurgitation, VHD: Valvular heart disease

Global hypokinesia may be due to hypoxia sequelae or peripartum cardiomyopathy. She is under follow-up. Since her left ventricular ejection fraction (LVEF) was 55%, she was advised to undergo elective lower segment caesarean section (LSCS) at the time of delivery. Team approach was followed.

There was difficulty in getting views by standard parasternal long axis (PLAX), short axis (SAX), Apical 4 Chamber (A4C), and apical 5 chamber (A5C) in critically ill cases and those on ventilators. Modified views were used to demonstrate interested structures (Subxiphoid views).

All screening echo examination gave details about situs, chambers, valves, and left ventricular (LV) function. Tricuspid annular plane systolic excursion (TAPSE) could be seen in A4C view when asked for it. Other modalities such as tissue doppler imaging and contrast imaging were not used for want of technical expertise. Difficult to examination cases were reviewed next day with available views. Detailed echo examinations were asked for in five

Table 12: The number of patients with pulmonary hypertension who have undergone point of care ultrasound echocardiography

Pulmonary hypertension				
Severity	Male	Female	Total	Percentage (for 1552 patients)
Mild	31	35	66	4.25
Moderate	6	5	11	0.71
Severe	2	3	5	0.32
No	2	2	4	0.26
Total	41	45	86	5.54

Table 13: The normal and abnormal functions of the left atrium and left ventricle for patients who have undergone point of care ultrasound echocardiography

LA and LV				
Chamber, Size, Shape and Function	Male	Female	Total	Percentage (for 1552 patients)
LA				
Shape				
Dilated	35	29	64	4.12
LV				
Shape				
"D"-shaped	1	1	2	0.13
Dilated	35	27	62	3.9
Normal	1	0	1	0.06
Function				
Adequate	7	3	10	0.64
Mild	36	23	59	3.8
Moderate	8	5	13	0.84
Severe	4	6	10	3.8
Total	125	94	219	14.11

LV: Left ventricle, LA: Left atrium

patients – (0.32%). They were to attend regular cardiology OP if they need further evaluation.[23] PTCA elsewhere done for 1 ACS[24] case that had anterior wall myocardial infarction (AWMI) lysed at COVID ICU and discharged at request. He was a teacher by occupation holding private insurance coverage. We collected information over phone. Echo showed stunning with EF 47%.

From April 2021 to March 2022, total in patients were in COVID wards 17,562. Among them, 1552 patients (8.84%) only underwent this POCUS echo, mostly on the day of admission in SARI ward and ICU itself. Among 286 Children,[25] only 15 children were screened and all were normal. Four hundred and twenty-six patients succumbed to death during that period out of 17,562 patients (2.43%). Overall mortality rate for male is 1.49% (N-263) and female is 0.93% (N-163). No children died during this period. There was a mean time to scan of 2 days from ICU admission. This information collected from database in COVID control room with the permission of Nodal Officer.

Comparison

Echocardiographic studies were recorded for 1552 patients.[26] RA and RV dysfunction [Figure 4] was identified in 77 patients (4.96%) – (M-37; F-40) [Video 4].

LV dysfunction was identified in 92 patients (5.93%) – (M-55; F-37). These results compared with Parulekar *et al.* data. Eighty-three out of 241 cases (37.7%) had RA and RV dilatation. In that study, LVSD was there in 23 cases out of 241 cases (9.5%). Our patients had lower incidence in RA, RV dilation, and LV dysfunction.

Outcome

Outcome for normal hearts was good. Hospital Stay, in Hospital Mortality and Morbidity were increased among abnormal cardiac status when comparing to normal cardiac status. We could use POCUS echo examination as a tool to quickly take a decision for treating patients. One patient with massive PE could be saved by echo diagnosis and echo-guided aspirations.

Treating physicians are comfortable when they are provided with necessary investigations. Hence, it is mandatory to do quick screening of heart by POCUS echo especially when the patient is critically ill and hemodynamically unstable.

Limitations of Study

Cardio sonology – echo technician worked only for 6 h in the morning shift. They could not examine case out of their hours. Health-care provider ward and mild COVID cases were not offered this POCUS echo facility. Duplications could not be avoided in few cases (for example, LVH can be due to aortic stenosis or hypertension). We have not studied the in hospital mortality in correlation with abnormal cardiac conditions.

CONCLUSION

A systematically applied POCUS protocol in COVID patients by a dedicated Cardiac Sonologist assisted by telemedicine [Figure 5] is the best non-invasive bed side diagnostic tool in reducing the mortality thus improving the survival in high risk COVID patients.

In both cardiac patients with COVID and COVID patients diagnosed with cardiac ailments, POCUS has made an impact in the outcome both in the mortality and morbidity. Cardiac POCUS examination by cardiac Sonology Technician supervised by a cardiologist helps the COVID-19 patients in arriving at quick diagnosis of certain cardiac conditions. It is also useful to rule out certain cardiac conditions. Any sick COVID-19 case presents with dyspnea that may not be due to lung involvement alone. Among extra pulmonary involvement, cardiac involvement of COVID in heart may be diagnosed by cardiac POCUS examination. Case management will change if life-threatening situation like cardiac tamponade is diagnosed by cardiac POCUS examination.

It will definitely have good impact on the outcome. In the pandemic situation, cardiologist can use telemedicine as a tool to diagnose abnormal cardiac conditions making use of portable echo machines with the help of cardiac sonology technicians. Further, comparative studies will show survival benefit. Being harmless, non-invasive, and reproducible procedure, cardiac POCUS can be advised as a screening tool in emergencies by a technically qualified and trained cardiac sonologist in telemedicine under supervision of cardiologist.

POCUS usefulness as an adjunctive tool in the management of COVID-19 is indispensable. The portability, availability, and the real-time nature of ultrasound provides physicians with a safe imaging modality for pulmonary, cardiac, and vascular COVID-19 manifestations. With no risk of radiation exposure, ultrasonography is beneficial when used to assess lung involvement in pregnant women. In addition, ultrasound is practical and effective for use in pregnant and pediatric COVID-19 patients.

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This study was approved by the Institutional Ethics Committee of Madurai Medical College and Government Rajaji Hospital.

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