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Does ongoing inflammation in recovered COVID-19 pneumonia cases aggravate underlying hypertension or unmask new onset hypertension? A single center experience of 800 cases

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ABSTRACT

Introduction: New onset hypertension and aggravation of hypertension during the post-COVID-19 period are issues of concern having very limited data published on them. Hence, the current study was conducted with the aim of studying the blood pressure profiles as new onset hypertension, pre-existent hypertension and an aggravation of pre-existent hypertension in post-COVID-19 patients.

Methods: Retrospective cohort study conducted between October 2021 to March 2022, included 800 post-COVID-19 patients above 18 years of age treated at the dedicated COVID-19 care center irrespective of their disease severity and comorbidity after a valid written consent. All the study cases were followed after six months of discharge from hospital. Protocolled recording of covariates such as blood pressure, anthropometric indices, ECG, blood sugar, lipid profile and uric acid were done at entry point. Retrospective data collection of indoor records was done such CT severity assessment as mild (score < 8), moderate (score 9-15) and severe (score > 15); inflammatory markers IL-6, Ferritin, CRP, LDH and D-dimer, interventions used during hospitalization such as oxygen supplementation and oxygen plus BIPAP/NIV. Statistical analysis was done by using a Chi-square test.

Results: In study of 800 post-COVID-19 cases, pre-existent hypertension in 10% (80/800), new onset hypertension in 8.5% (68/800), aggravation of pre-existent hypertension in 47.5% (38/80) cases. Significant association was observed between interventions used as hypertension profile such as cases with oxygen requirement new onset HTN 32/68 (47.05%), pre-existent hypertension in 10/42 (23.80%), aggravation of pre-existent hypertension in 16/38 (42.10%) and oxygen plus BIPAP/NIV requirement in new onset HTN 27/68 (39.70%), pre-existent hypertension in 10/42 (23.80%), aggravation of pre-existent hypertension in 16/38 (42.10%) cases ($p < 0.0001$). Significant association was observed in blood pressure switch during pre-COVID-19 to post-COVID-19 state during follow up from normotensive to hypertensive range ($p < 0.00001$). Comorbidities such as DM, hyperlipidemia and IHD showed significant association with blood pressure profile in study cases in post-COVID-19 setting ($p < 0.00001$). Inflammatory markers during hospitalization (IL-6, CRP, LDH, ferritin, and D-dimer) and uric acid analysis during follow-up documented significant association with new onset HTN, pre-existent hypertension, aggravation of pre-existent hypertension and no hypertension or normal blood pressure cases during post-COVID-19 follow-up ($p < 0.00001$).

Conclusions: COVID-19 infection is probably a risk factor for new onset hypertension and increased prevalence of hypertension was observed in the post-COVID-19 period and considered as unmasking effect on hypertension. Additionally, disease related inflammatory burden, stress and anxiety are associated with aggravation of hypertension in pre-existent cases.

Keywords: COVID-19, hypertension, post-COVID-19, inflammatory makers, uric acid

INTRODUCTION

The world is still recovering from the global pandemic caused by the novel coronavirus–SARS-CoV-2 [1]. The consequences of the COVID-19 infection that exist even after recovering from it, are together called post-COVID-19 syndrome. Despite the unavailability of definition of this syndrome in medical literature due to it being in its early stages, consensus has interpreted it as presence of long-term complications of COVID-19, four weeks after recovery. If system-wise observations are made cardiovascular, renal, endocrine, gastrointestinal, hematologic, musculoskeletal, dermatologic as well as neuropsychiatric complications have been observed in varying proportions [2, 3]. New-onset hypertension is one such complication [1].

A major cause of cardiovascular disease and deaths is hypertension. It is more prevalent in low- and middle-income

countries [4]. Hypertension is a non-communicable disease that affects over a billion people worldwide. This number has increased significantly since the COVID-19 pandemic [5]. The overall prevalence of hypertension in India is estimated to be 29.8 percent, affecting 25-30 percent urban and 10-20 percent rural subjects [6]. Surveys clearly suggest that the prevalence of hypertension increases with the advancing age, with maximum cases seen in age groups 80 and above [7]. Although it is strongly associated with sedentary lifestyle, the actual pathogenesis of hypertension remains uncertain.

SARS-CoV-2 enters our body through the aerosols and binds to the angiotensin converting enzyme 2 (ACE 2) receptors. These receptors are widely expressed in the lungs and the cardiovascular system and are responsible for the infectivity of COVID-19 [8]. Patients suffering from hypertension have increased ACE 2 expression due to associated genetic polymorphism and use of drugs belonging to classes like angiotensin converting enzyme inhibitors and angiotensin receptor blockers. This has been postulated to increase the severity and susceptibility of COVID-19 [9]. Hypertension often causes pathological changes in the cardiovascular system such as left ventricular hypertrophy and fibrosis. This is postulated to make the hypertensive heart significantly susceptible to SARS-CoV-2 [10]. The relationship between hypertension and COVID-19 is not very well defined. Numerous studies have established that hypertension is associated with an increased risk of COVID-19 [11], but very few articles have been published reporting the prevalence of hypertension in post-COVID-19 cases. Hypertension has been independently associated with poor outcome in COVID-19 illness associated with inflammatory markers such as IL-6 [12-16], CRP [17-20], LDH [21-24], ferritin [25-28], and D-dimer [29-32]. Authors have also reported various CT severity assessment phenotypes [25-28] and its correlation with hypertension in recovered COVID-19 cases. The present study was conducted to further clarify the relationship between hypertension and COVID-19 and to find age and sex trends of hypertension in post-COVID-19 populations. This may add knowledge regarding hypertension assessment and management in post-COVID-19 cases as well as in other infectious diseases.

METHODS

Prospective observational study conducted from October 2021 to March 2022 at the dedicated COVID-19 care center (DCC) in pulmonary and internal medicine in MIMSR Medical College, Latur and included COVID-19 reverse transcription polymerase chain reaction (RT PCR) confirmed cases with primary objective to find out the effect of COVID-19 in aggravating known hypertension. Primary objectives were to find the unmasking effect of COVID-19 in new onset hypertension; and secondary objectives were its role in aggravating known hypertension and covariates associated with new onset hypertension and aggravated hypertension in accordance with anthropometry.

Inclusion Criteria

1. Post-COVID-19 patients over the age of 18 attending post-C0VID-19 care outdoor unit for regular follow-up and willing to participate in study were included.
2. All cases hospitalized in DCC irrespective of disease severity and comorbidity were included in the study.

Exclusion Criteria

1. Patients not willing to participate or not willing to follow up in post-COVID-19 care outdoor unit.

All study cases were undergone following assessment before enrolling in study: All post-COVID-19 patients (tested positive COVID-19 RT PCR), who have recovered from COVID-19 and were attending the OPD/IPD for follow-up were included. Retrospective assessment of hospital record such as inflammatory markers assessment CRP, ferritin, LDH, IL-6, and D-dimer were recorded. HRCT Thorax findings were recorded as a protocol to assess severity of lung involvement as per COVID-19 reporting and data system, and categorized as mild if score < 7, moderated if score 8-15 and severe if score > 15 or 15-25. Clinical parameters such as oxygenation status and anthropometry parameters such as height, weight and body mass index (BMI) were recorded. Routine biochemistry measurements were also recorded to assess underlying comorbidity such as hypertension, COPD, IHD, obesity were recorded as covariates. Lastly, interventions required during hospitalization such as requirement of oxygen, oxygen plus ventilatory support were also recorded as protocol.

All case were undergone blood pressure recordings, as follows: The blood pressure of each patient was evaluated using a digital sphygmomanometer by following guidelines mentioned by European Society of Cardiology (ESC), as given below [37]:

1. Two consecutive readings are taken on the same arm, one minute apart.
2. If the two readings differ by 10 mmHg or more a third reading is taken.
3. BP is recorded as an average of the last two BP readings.

Case Definitions

1. New onset hypertension: According to guidelines by ESC, diastolic pressure of > 90 mmHg and/or systolic pressure > 140 mmHg are considered to have clinically significant hypertension. We have used similar criteria in our study.
2. Pre-existent hypertension: Patients with known history of recordings of blood pressure as diastolic pressure of > 90 mmHg and/or systolic pressure > 140 mmHg with or without history of medications are categorized as pre-existent hypertension.
3. Aggravated hypertension: Patient with known history of hypertension and are taking medicines regularly as per their treating physicians' suggestions and recorded increase in systolic blood pressure 20 mmHg and diastolic blood pressure by 10 mmHg. This criterion is also called stage I hypertension. Patients not taking medicines were not considered as aggravated hypertension. We have advised them to continue their regular medicines and followed in outdoor after two weeks to categories exactly aggravated hypertension.
4. No hypertension: According to guidelines by ESC, diastolic pressure of < 80 mmHg and/or systolic pressure < 120 mmHg are considered as normal blood pressure and thus no hypertension is defined.

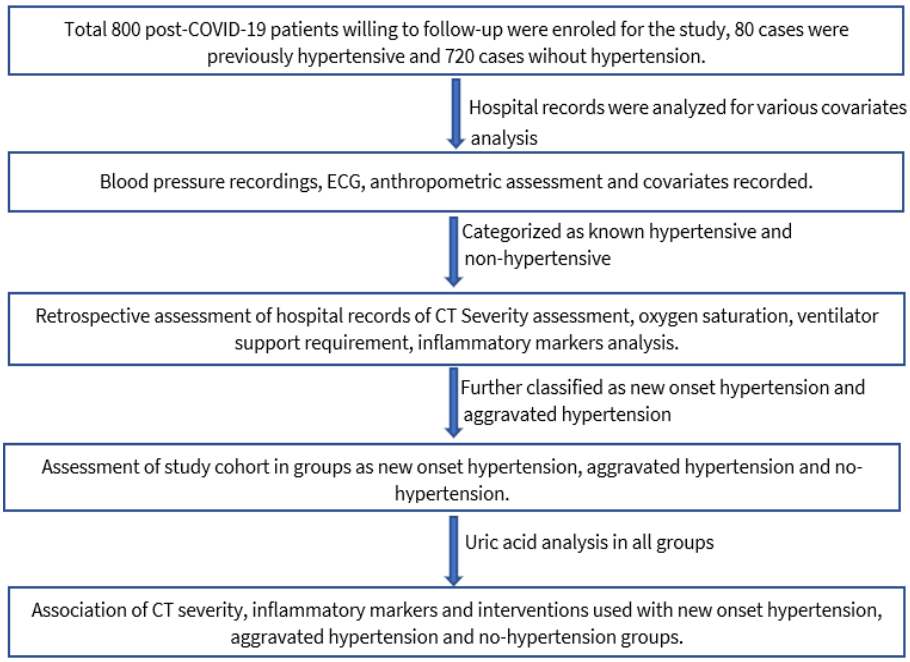

Figure 1. Flow of the study (Source: Authors' own elaboration)

Table 1. Profile of blood pressure status in post-COVID-19 setting with aggravation of previous hypertension

Blood pressure profile	Total post-COVID-19 cases (n = 800)	Percentage (%)
No HTN (n = 652)	652	81.5
Pre-existent HTN (n = 80)	80	10.0
Post-COVID-19 new onset HTN (n = 68)	68	8.5
Pos-COVID-19 aggravated pre-existent HTN (n = 38/80)	38	47.5

Table 2. Interventions required and new onset hypertension in post-COVID-19 cases

Interventions	Cases with new onset HTN (n = 68)	Cases with aggravated pre-existent HTN (n = 38)	Cases without aggravated pre-existent HTN (n = 42)	No HTN (n = 652)
No oxygen or BIPAP (n = 96)	9	6	22	59
Oxygen (n = 594)	32	16	10	536
Oxygen plus BIPAP/NIV (n = 110)	27	16	10	57

Note. $\chi^2 = 23.65$ & $p < 0.00001$

Study Design

Figure 1 shows the flow of the study.

Inflammatory Markers Analysis

Analysis of inflammatory markers were done in Rosch automated biochemistry analyzer. The values of these inflammatory markers were considered significant in presence of four-fold raised titers. We have correlated inflammatory markers titers with cut off of four-fold rise with radiological phenotypes and interventions required during hospitalization.

1. CRP titer: Normal values up to 6 mg/L. (0-6 mg/L)
2. LDH titer: Normal value up to 470 mg/L (90-470 mg/L)
3. Ferritin titer: Normal value up to 14-250ng/ml in males, and Female in age < 45 years old 6-160ng/ml and age ≥ 45 years old 5-200ng/ml
4. D-dimer titer: Normal value up to value up to 470 mg/L (70-470 mg/dL)
5. IL-6 titer: Normal value up to < 7 pg/mL (0-7 pg/ml)
6. Uric acid: Normal range 3.5 to 6.5 mg/L

Statistical Analysis

The statistical analysis was done by using Chi-square test in R-3.4 software. Significant values of χ^2 were seen from probability table for different degree of freedom required. p-value was considered significant if it was below 0.05 and highly significant in case if it was less than 0.001.

RESULTS

In the study of 800 post-COVID-19 cases, pre-existent hypertension in 10% (80/800), new onset hypertension in 8.5% (68/800), aggravation of pre-existent hypertension in 47.5% (38/80) cases (**Table 1**). Interventions required during hospitalizations such as oxygen in 594/800 (74.25%), oxygen plus BIAPAP/NIV in 110/800 (13.75%), no interventions such as oxygen or oxygen plus BIPAP/NIV in 96/800 (12%) cases. Significant association was observed between interventions used as hypertension profile such as cases with oxygen requirement new onset HTN 32/68 (47.05%), pre-existent hypertension in 10/42 (23.80%), aggravation of pre-existent hypertension in 16/38 (42.10%) and oxygen plus BIPAP/NIV requirement in new onset HTN 27/68 (39.70%), pre-existent hypertension in 10/42 (23.80%), aggravation of pre-existent hypertension in 16/38 (42.10%) cases ($p < 0.0001$) (**Table 2**). Significant association was observed in blood pressure switch during pre-COVID-19 to post-COVID-19 state in follow up from normotensive to hypertensive range ($p < 0.00001$).

Table 3. New onset hypertension

	Normotensive	Hypertensive
Pre-COVID-19 (n = 800)	720	80
Post-COVID-19 (n = 800)	652	148

Note. $\chi^2 = 164.87$ & $p < 0.00001$

Normotensive and hypotensive cases in pre-COVID-19 analysis were 720/800 (90%) and 80/800 (10%), and in post-COVID-19 setting were 652/800 (81.5%] and 148/800 (18.5%), respectively (**Table 3**).

Covariates analysis such as age < 65 (365/800) & > 65 (435/800), gender males (482/800) and females (318/800), BMI < 25 (652/800) and > 25 (148/800) observed significant association with cases with new onset HTN 68/800 (8.5%), pre-existent hypertension in 80/800 (10%), aggravation of pre-existent hypertension in 38/80 (47.5%) and no hypertension or normal blood pressure in 652/800 (81.5%) during post-COVID-19 follow-up. Comorbidities such as DM (present in 156/800 & absent in 644/800 cases), hyperlipidemia (present in 82/800 & absent in 718/800 cases) and IHD (present in 112/800 & absent in 688/800 cases) observed significant association with blood pressure profile in study cases in post-COVID-19 setting ($p < 0.00001$). Inflammatory markers during hospitalization (less than fourfold and more than fourfold) and uric acid analysis during follow-up (increased, decreased and normal) documented significant association with new onset HTN, pre-existent hypertension, aggravation of pre-existent hypertension and no hypertension or normal blood pressure during post-COVID-19 follow-up ($p < 0.00001$) (**Table 4**).

DISCUSSION

Profile of Blood Pressure in Study Cases

In study of 800 post-COVID-19 cases, pre-existent hypertension in 10% (80/800), new onset hypertension in 8.5% (68/800), aggravation of pre-existent hypertension in 47.5% (38/80) cases.

Similarly, it was also reported 11.76% incidence of new onset hypertension at the end of approximately 30 days post-COVID-19 [38]. It was found that new onset hypertension in 20.6% hospitalized and 10.85% non-hospitalized patients with COVID-19 [39]. It was documented 21.6% of patients were having uncontrolled BP requiring therapeutic change [40]. It was also documented that 32.3% developed new-onset hypertension [41]. It was conducted a systematic review and meta-analysis including over 19 million subjects and reported an increased risk of new onset hypertension in recovered COVID-19 patients compared to subjects who did not experience COVID-19 infection but developed a pericarditis over the same period [42]. Contradictory to our observations, it was reported that very few individuals associated with hypertension in recovered COVID-19 cases [43]. Still, data on cardiovascular outcomes, especially hypertension, is evolving. More metanalysis is required for confirmation of association of new onset hypertension and COVID-19 illness.

Correlation of CT Severity Scores with Blood Pressure Profile (n = 800)

In the present study, CT severity scores and new onset hypertension have a significant correlation. Scores < 8, 8-15, and > 15 documented new onset and no new onset hypertension in 9/160, 15/212, and 44/428, respectively of total 800 study cases ($p < 0.00001$). Similar results were observed in [41, 44]. The study in [45] reported hypertension as the most common complication following COVID-19 with a prevalence of 56.6%. CT severity has previously been documented as the best visual marker of severity of COVID-19 pneumonia [25-28].

Correlation of BMI With Blood Pressure Profile (n = 800)

In the present study, BMI > 25 had a significant correlation with new onset hypertension. BMI > 25 and BMI < 25 documented new onset hypertension in 43 versus 25 cases of total 68, pre-existent hypertension in 30 versus 12 of total 42 cases and aggravation of pre-existent hypertension in 28 versus 10 of total 38 cases ($p < 0.00001$).

Table 4. Covariates analysis in post-COVID-19 cases

Variables	Cases with new onset HTN (n = 68)	Cases with aggravated HTN (n = 38)	Cases without aggravated HTN (n = 42)	No HTN (n = 652)	p-value
Age < 65 (n = 365)	20	16	13	316	$\chi^2 = 13.16$
Age > 65 (n = 435)	48	22	29	336	$p < 0.0043$
Male (n = 482)	58	29	6	389	$\chi^2 = 59.04$
Female (n = 318)	10	9	36	263	$p < 0.00001$
BMI < 25 (n = 652)	25	10	12	605	$\chi^2 = 300.17$
BMI > 25 (n = 148)	43	28	30	47	$p < 0.00001$
DM (n = 156)	50	27	20	59	$\chi^2 = 257.31$
No DM (n = 644)	18	11	22	593	$p < 0.00001$
Hyperlipidemia (n = 82)	20	30	22	10	$\chi^2 = 356.96$
No hyperlipidemia (n = 718)	48	8	20	642	$p < 0.00001$
IHD present (n = 112)	40	30	14	28	$\chi^2 = 305.92$
IHD absent (n=688)	28	8	28	624	$p < 0.00001$
More than fourfold IM (n = 534)	39	23	7	466	$\chi^2 = 57.49$
Less than fourfold IM (n = 266)	29	15	35	186	$p < 0.00001$
Uric acid normal (n = 398)	8	6	5	379	$\chi^2 = 176.70$ $p < 0.00001$
Uric acid raised (n = 332)	40	20	21	251	
Uric acid decreased (n = 70)	20	12	16	22	
HRCT severity score < 8 (n = 160)	9	20	6	125	$\chi^2 = 32.77$ $p < 0.00001$
HRCT severity score 9-15 (n = 212)	15	9	9	179	
HRCT severity score > 15 (n = 428)	44	9	27	348	

Note. HTN: Hypertension; DM: Diabetes mellitus; IHD: Ischemic heart disease; IM: Inflammatory markers; HRCT: High resolution computerized tomography

Overweight/obese patients were more likely to develop hypertension after an episode of COVID-19 infection. Similarly, it was reported that the reason for revisiting hospital in recovered COVID-19 cases were hypertension and majority of these were obese [46]. The studies in [47, 48] have also reported similar observation as association of high BMI with post COVID-19 sequelae.

Correlation of Age with Blood Pressure Profile (n = 800)

In present study, age > 65 years and new onset hypertension have a significant correlation. Ages < 65 and > 65 years documented new onset hypertension in 48 versus 20 cases of total 68, pre-existent hypertension in 29 versus 13 of total 42 cases and aggravation of pre-existent hypertension in 22 vs. 16 of total 38 cases ($p < 0.0043$). It was also demonstrated age to be one of the most significant risk factors for developing persistent hypertension in hospitalized as well as non-hospitalized patients [39]. It was also published that the risk of new onset hypertension was directly influenced by age [42]. These results may also be attributed to the well-known fact that age is one of the most significant risk factors for primary hypertension.

Correlation of Gender with Blood Pressure Profile (n = 800)

In present study, incidence of new onset hypertension was proportionately higher in males 58/482 versus females 10/318 ($p < 0.00001$). It was reported that persistent hypertension was more likely to be seen in male subjects [39]. Published studies have demonstrated male gender is an important predictor of worse acute outcomes, multiorgan injury, critical illness, and mortality [49-53]. Contradictory results were published in [42] reported female sex to have direct influence over the risk new onset hypertension.

Correlation of Hypercholesterolemia with Blood Pressure Profile (n = 800)

In present study, hypercholesterolemia and pre-existent hypertension 52.38% (22/42), new onset hypertension in 44.11% (30/68), aggravation of pre-existent hypertension in 31.57% (12/38) documented significant correlation ($p < 0.00001$). Normal and abnormal lipid profile documented new onset and no new onset hypertension in 6.68% (48/718) and 24.39% (20/82), respectively of total 800 cases. It was reported that a few patients with pre-existing dyslipidemia developed new onset hypertension during post-COVID-19 [46]. A possible explanation is that COVID-19 infection induced pro-inflammatory cytokines modulate lipid metabolism including oxidation of LDL by reactive oxygen species singling to facilitate LDL clearance.

Correlation of BIPAP/NIV Use with Blood Pressure Profile (n = 800)

Significant association was observed between interventions used as hypertension profile such as cases with oxygen requirement new onset HTN 32/68 (47.05%), pre-existent hypertension in 10/42 (23.80%), aggravation of pre-existent hypertension in 16/38 (42.10%) and oxygen plus BIPAP/NIV requirement in new onset HTN 27/68 (39.70%), pre-existent hypertension in 10/42 (23.80%), aggravation of pre-existent hypertension in 16/38 (42.10%) cases ($p < 0.0001$). It was mentioned that the risk of hypertension significantly increased in cases those required interventions during indoor period than those not required hospitalization or interventions [54, 55].

Correlation of Inflammatory Markers During Hospitalization and Follow-Up and Blood Pressure Profile (n = 800)

Significant association was observed in abnormally increase in fourfold increase in titer of the inflammatory markers with new onset hypertension in 57.35% (39/68) cases, aggravation of pre-existent hypertension in 60.52% (23/38) cases and pre-existent hypertension in 16.66% (7/42) cases ($p < 0.00001$). Published studies have documented similar observations with inclusion of CRP, LDH, ferritin, IL- and D-dimer (12-32).

Similarly, during follow-up; inflammatory marker uric acid analysis has showed significant association in predicting new onset hypertension. Cases with raised uric acid in pre-existent hypertension in 50% (21/42), new onset hypertension in 58.82% (40/68), aggravation of pre-existent hypertension in 52.63% (20/38) ($p < 0.00001$). It was documented similar observation and mentioned that raised or abnormal values are predictors of poor outcome [56]. Contradictory to our findings, it was documented that the low levels of uric acid are the predictor of poor outcome as compared to raised values in published literature [57].

Other Important Observations in Present Study with Plausible Rationales or Mechanisms

1. Severity of illness: Proportionate number of cases with mild COVID-19 illness were also observed to have new onset hypertension in our study. Rational would be inflammatory burden causing override of sympathetic nervous system persisted for longer time. Other possible reason would be the mild disease has progressed to moderate and severe disease with or without treatment which has been observed during second wave of delta variant in which; cases have been progressed to advanced disease in short time interval. Thus, CT severity showing mild disease was just a one-point assessment to disease severity and was not a temporal assessment or predictor of disease outcome as reported in one study [35]. Hence, we recommend to follow all post-COVID-19 cases for possible new onset hypertension irrespective of dieses severity.
2. Gender: Although new onset hypertension 58/68 and aggravation of hypertension 29/38 is more frequently reported in male gender, stable hypertension without aggravation is predominantly reported in female gender. Plausible explanation would be less severe illness with a smaller number of cases required aggressive interventions during hospitalization in females. Another possible reason would be less sympathetic activation is the reason for stable blood pressure in these cases.
3. Age: Blood pressure abnormality documented predominately in geriatric cases (> 65 years of age), proportionate number of cases with < 65 was having new onset hypertension in 29.41% (20/68), aggravation of pre-existent hypertension in 42.10% (16/38) cases. We have documented that the factor such as higher CT severity scores, fourfold raised inflammatory markers, and steroid treatment were associated with hypertension development. Anxiety and disease related stress would be another reason for blood pressure abnormality in young patients.

4. Inflammatory markers: Although inflammatory makers have direct correlation with blood pressure abnormality as it indicates disease related burden and systemic inflammatory response, significant number cases with less than fourfold increase in titer of the inflammatory markers were having new onset hypertension in 42.64% (29/68), aggravation of pre-existent hypertension in 39.47% (15/38) cases. Plausible mechanisms would be an ongoing disease related systemic burden and sympathetic override resulting into blood pressure switch demonstrated with inflammatory markers titers although less than fourfold which is manifested and evolved during COVID-19 illness over a period of time.
5. Uric acid as an important marker: This is a simple, reliable and cost-effective marker of systemic inflammation and very good predictor of ongoing inflammation which is very correlated with inflammatory makers used for analysis of disease severity in COVID-19 illness in acute setting as well. Although raised uric acid titers are positively associated with abnormalities in blood pressure, proportionate number of cases with low uric acid titer in pre-existent hypertension in 38.09% (16/42), new onset hypertension in 29.41% (20/68), aggravation of pre-existent hypertension in 31.57% (12/38) ($p < 0.00001$). Thus, uric acid titer analysis can be used in two ways and ca be used as predictor maker for blood pressure abnormality due to its association with systemic inflammation.
6. Comorbidities and confounding factors aggravated during recovery phase and possible cause for new onset and aggravate hypertension: Comorbidities such as DM, IHD, abnormally high BMI and Hyperlipidemia were observed as risk factors for new onset hypertension, pre-existent hypertension and an aggravation of pre-existent hypertension in post-COVID-19 patients and played a role as confounding factor due its association with blood pressure abnormalities irrespective of COVID-19 illness. Cases without these comorbidities were also documented abnormal blood pressure records such as cases without DM and new onset hypertension 26.47% (18/68), pre-existent hypertension 52.38% (22/42) and an aggravation of pre-existent hypertension 28.94% (11/38), cases with normal lipid profile or cholesterol level and new onset hypertension 70.58% (48/68), pre-existent hypertension 47.61% (20/42) and an aggravation of pre-existent hypertension 21.05% (8/38), cases without underlying IHD and new onset hypertension 41.17% (28/68), pre-existent hypertension 66.66% (28/42) and an aggravation of pre-existent hypertension 21.05% (8/38). Hence, we are labelling these comorbidities as 'confounding factors' because the proportionate number of cases without these abnormalities were also mentioned blood pressure abnormalities.

CONCLUSIONS

COVID-19 illness has documented association with new onset hypertension and aggravation of pre-existent hypertension during follow up in post-COVID-19 care setting. Hypertension should be considered as one of the cardiovascular manifestations of long COVID-19 in recovered cases. All recovered cases should be screened for hypertension following COVID-19 illness and is highly recommended in high-risk cases.

New onset hypertension should be actively sought in cases high CT severity during hospitalization, abnormally raised inflammatory markers during hospitalization and documentations of use of aggressive interventions during hospitalizations such as BIPAP/NIV.

Risk factors as age more than 65, male gender is nonmodifiable factor; BMI more than 25, hypercholesteremia and history of DM or IHD are additional modifiable covariates which have impact on new onset hypertension in recovered COVID-19 cases.

A plausible mechanism for new onset hypertension and aggravation of existent hypertension would be disease related stress, anxiety, sympathetic overactivation or overdrive resulting in blood pressure surge in these cases.

We recommend the use of uric acid as an inflammatory marker to predict new onset hypertension and to suspect the possibility of aggravation in new onset hypertension. Ongoing inflammation and inflammatory abnormality as correlated with uric acid analysis is one of the mechanisms for blood pressure abnormality in post-COVID-19 care settings. Uric acid abnormality can behave in 'double edge sword pattern' as increased and decreased titer is proportionately associated with abnormalities in blood pressure.

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Ethical statement: The authors stated that the study was approved by the Institutional Review Board/Ethics Committee at MIMSR Medical College, Latur, India on 23 July 2021 with approval number 2021-03824. This study was conducted based on ICMR guidelines. Written informed consents were obtained from the participants.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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