RESEARCH ARTICLE

RADIOLOGICAL EVALUATION AND CORRELATION OF CT CHEST WITH PROGRESS OF DISEASE IN COVID 19 PATIENTS

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Manuscript Info

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Abstract

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Introduction:

1. Corona virus disease 2019(COVID 19) is an infectious disease caused by corona virus strain known as severe acute respiratory syndrome coronavirus 2(SARS-CoV-2). Before spreading world wide, the first case was discovered in Wuhan, China in December 2019.
2. Throughout the pandemic, the role of imaging has evolved with HRCT serving as different and conceivably superior testing tool to RTPCR testing. As RTPCR will give false negative results in initial days of infection.
3. HRCT Chest aids in diagnosis, complications,detection and prognostication of COVID 19 patients.

Aims And Objectives:
Aim: To characterize HRCT features in patients with COVID 19 infection
Objectives:
1)To investigate and quantify the severity of COVID 19 infection on HRCT.
2)To explore changes in HRCT on spectrum of duration of disease in COVID 19 patients.
MaterialsandMethods: Atotalof RTPCR positive COVID 19 50patientsreferredtotheDepartmentofRadiodiagnosis,Narayana MedicalCollege and Hospital in a period from September2020 toSeptember 2 0 2 1 weresubjectedforthestudy.ThepatientswerestudiedusingHigh resolution CT (HRCT) sections of lung from lung apices to lung bases.Collecteddatawasanalysedfordescriptivestatistics.
Results: The mean age of patients was 50 years. Therewere 31 males and 19 females in this study.Diabetes mellitus is predominant comorbidity among the patients.Moderate illness(30% 15 patients) is seen in most of the patients as per CT severity index in COVID 19 patients.On follow up CT most of the patients are moderately ill(40%) and 36% are severely ill.80% of the patients have typical CT characteristics.GGOs are the predominant CT finding in initial stage of disease while GGOs and consolidation are the predominant CT finding in later stage of disease.Most of the patients presented in early(32%)

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and progressive stages(38%) of disease.Most of the early stage patients progressed to progressive stage(62.5%) while few progressed to peak stage(37,5%) patients.Most of the progressive stage patients progressed to peak stage(52.6%) while few progressed to late stage(31.5%).

Conclusion: The diverse COVID-19 spectrum included symptoms such as fever, coughing, shortness of breath, sore throat, etc.Positive CT findings were more noticeable in symptomatic patients and patients with co-morbid conditions, giving HRCT chest in COVID-19 patients diagnostic and prognostic significance. The CT severity index and the patients' clinical symptoms have a direct correlation. CT imaging is important for monitoring patients' clinical progress. The findings of this study supported the importance of chest CT in the identification and treatment of COVID-19 infection.

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Introduction:-

1. The World Health Organization(WHO) declared it as pandemic on March 11 2020.By October 2022 there were nearly 634 million confirmed cases and 6.5 lakh deaths due to COVID 19 worldwide.
2. SARS-CoV-2 infection can range from asymptomatic illness to serious and deadly disease with acute lung damage being the most common cause of death.
3. Throughout the pandemic, the role of imaging has evolved with HRCT serving as different and conceivably superior testing tool to RTPCR testing. As RTPCR will give false negative results in initial days of infection.
4. HRCT Chest aids in diagnosis, complications,detection and prognostication of COVID 19 patients
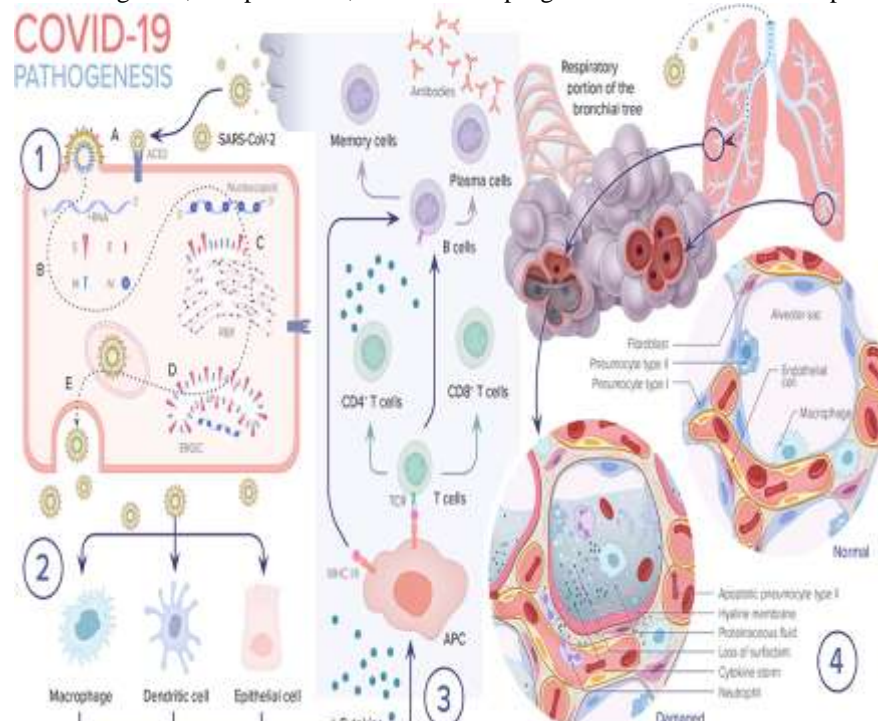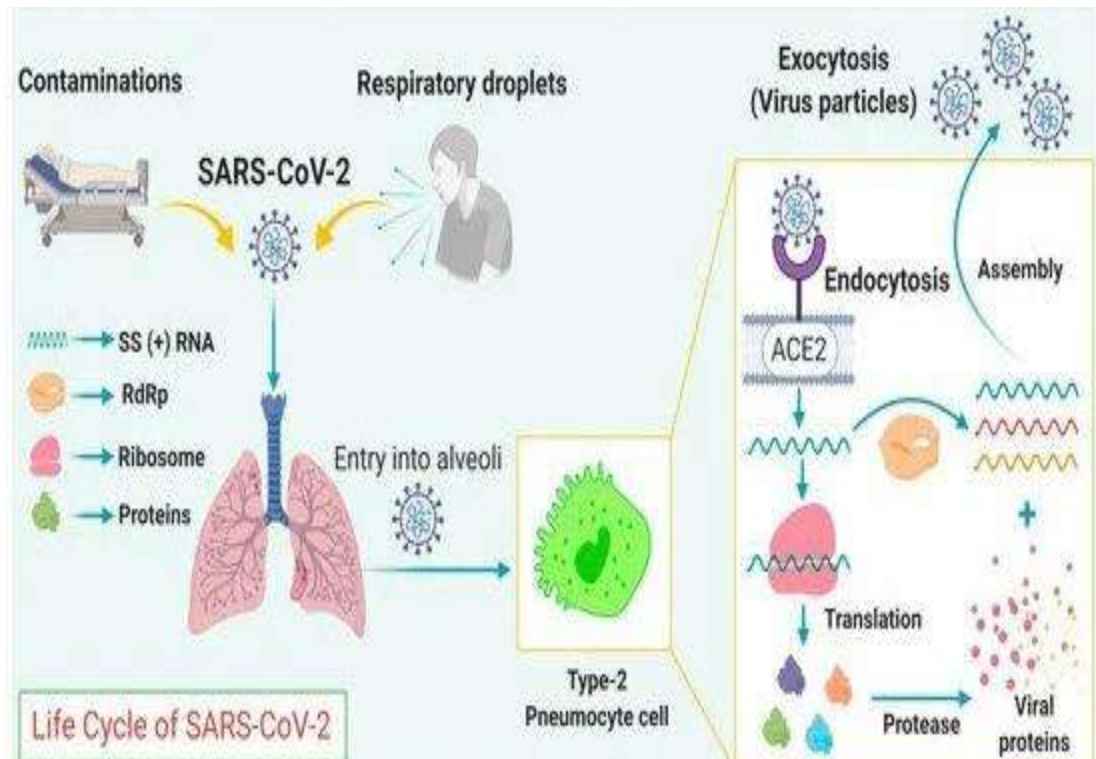
Role Of Ct Chest In Covid 19
1. The diagnosis of COVID 19 is primarily relied on RTPCR test which detects viral load and viral nucleic acid.
2. Imaging, both chest x ray and CT has been as an adjunct to RT PCR.
3. Many CT classification protocols for COVID 19 have been developed as guide for radiologists for better understanding of spectrum of manifestations in COVID 19 patients.
4. CT chest plays an important role in diagnosing, detection of complications and prognosis of COVID 19 patients.
5. The current study is to characterize CT features, to quantify the severity of COVID 19 infection and to look for temporal evolution of changes in COVID 19 patients and how it varies among COVID 19 patients with progress of disease.

Aims And Objectives:-
Aim:-
To characterize HRCT features in patients with COVID 19 infection

Objectives:-
1)To investigate and quantify the severity of COVID 19 infection on HRCT.
2)To explore changes in HRCT on spectrum of duration of disease in COVID 19 patients.

Materials & Methods:-
1. Study design**:** Hospital based retrospective study
2. Duration of study:18 months
3. Sample size:50
4. Source of the data:

The main source of data will be patients referred from departments of general medicine, respiratory medicine, COVID ICU and COVID isolation units to department of Radio diagnosis, Narayana Medical college and Hospital, Nellore with following criteria in period of 2 years will be taken for study

Inclusion criteria:
1.   All patients who are COVID 19 RTPCR positive and willing to participate in study
2.   Patients who are aged between 20-80 years both male and female
3.   All RTPCR positive patients with comorbidities

Exclusion criteria:
1.   Patients who are RTPCR negative
2.   Patients having history of claustrophobia
3.   Pregnant females

Investigations required:
1.   RTPCR for SARS Co V 2
2.   Computed tomography(CT) of chest

CT Severity Score Index In Covid 19
CTSI is a scoring system used to assess lung involvement of COVID 19 based on approximate estimation of areas of lobar involvement

Each lobe of 5 lobes of lung parenchyma has assessed on CT chest and assigned a score from 1 to 5
1.   1: <5% lobar involvement
2.   2: 5-25% lobar involvement
3.   3: 25-50% lobar involvement
4.   4: 50-75% lobar involvement
5.   5: >75% lobar involvement

Total score will be given by adding up the score of each lobe out of total score of 25
MILD:<8
MODERATE:8-15
SEVERE:>15

Classification And Characteristic Features Of Hrct In Covid 19:

Classification	Rationale	CT FEATURES
Typical	Most commonly reported more specific for COVID 19	Bilateral,peripheral,ground glass opacities with or without consolidation Multiple GGOs of rounded morphology with or without consolidation or crazy paving Reverse halo sign
Indeterminate	Nonspecific features of COVID 19	Absence of typical features and presence of following features • Multifocal,diffuse,perihilar or unilateral GGO with or without consolidation without any specific distribution • Nonrounded or nonperipheral morphology of GGOs
Atypical	Uncommon features of COVID 19	Absence of atypical and indeterminate AND presence of following features: • Isolated lobar or segmental consolidation without GGOs • Discrete small nodules(centrilobular nodules with tree in bud pattern) • Lung cavitation • Smooth interlobular septal thickening with pleural effusion
Negative	No features of	No CT features to suggest pneumonia

COVID 19	

Classification Of Lung Abnormalities In Hrct Chest Based On Duration Of Disease
HRCT chest helps radiologists and clinicians as the temporal evolution of disease can be assessed by serial CT scans which aids in prognosis and management plan of COVID 19

Roughly four stages of COVID 19 have been described

Early stage	0-4 days after symptom onset	GGOs, partial crazy paving, lower number of involved lobes
Progressive stage	5-8 days after symptom onset	Extension of GGO, Increased crazy paving
Peak stage	9-13 days after symptom onset	Progressive consolidation
Late stage	>14 days after symptom onset	Gradual decrease in consolidation and GGOs
Signs of fibrosis(parenchymal bands, traction bronchiectasis)
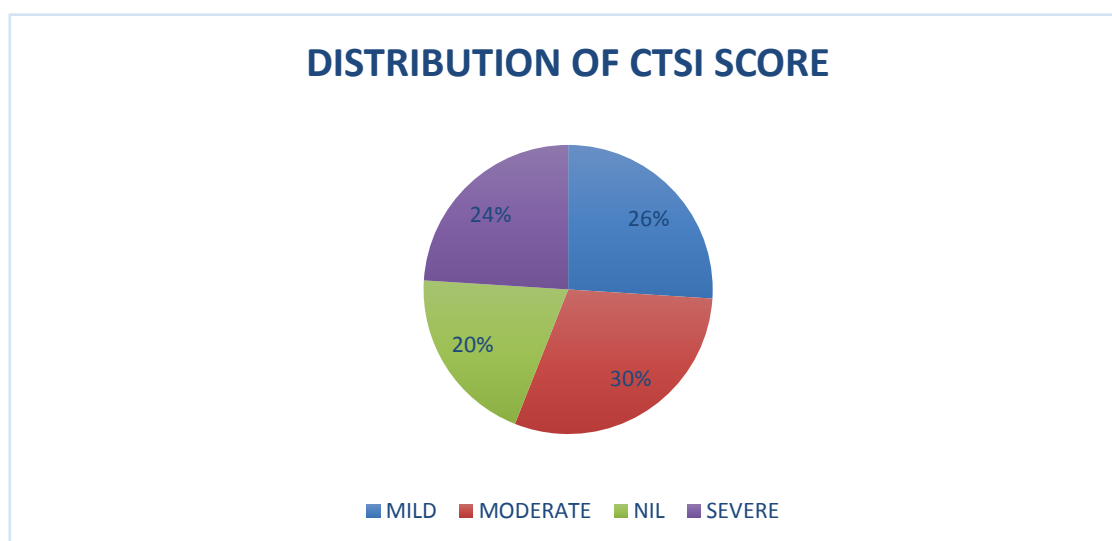
Observations & Results:-
The research population comprised of 50 patients who presented with at Narayana medical college, Nellore, & were referred by & at the request of our institution's doctors between September 2020& September 2021. All patients had RTPCR testing and HRCT of chest in COVID 19 patients.
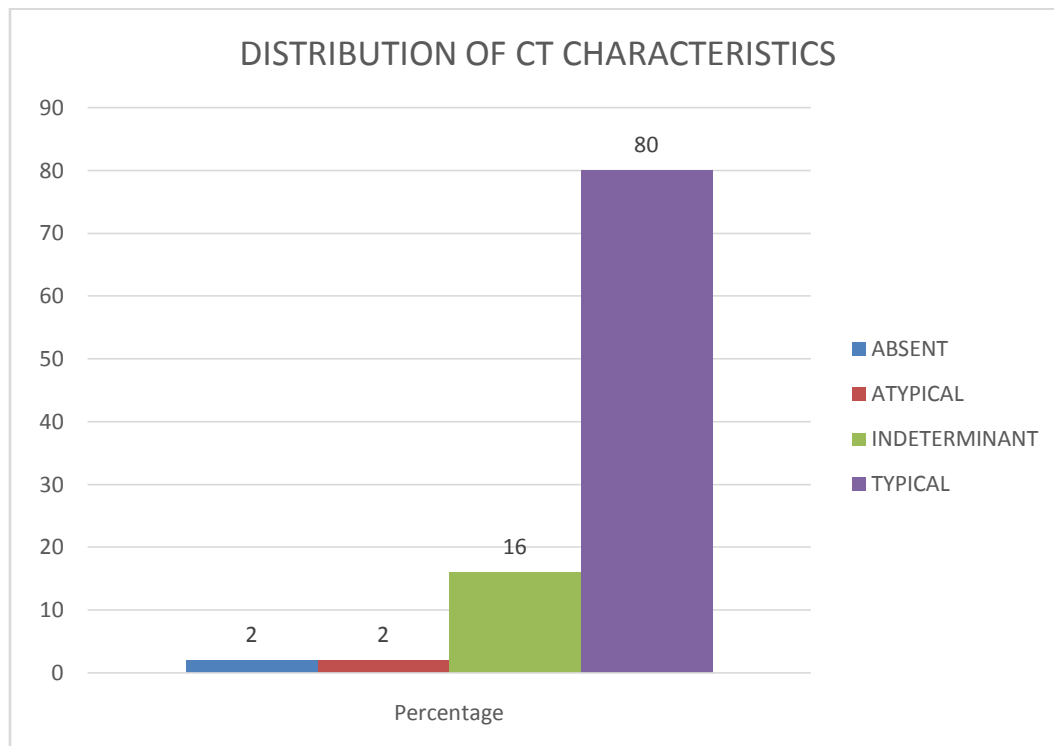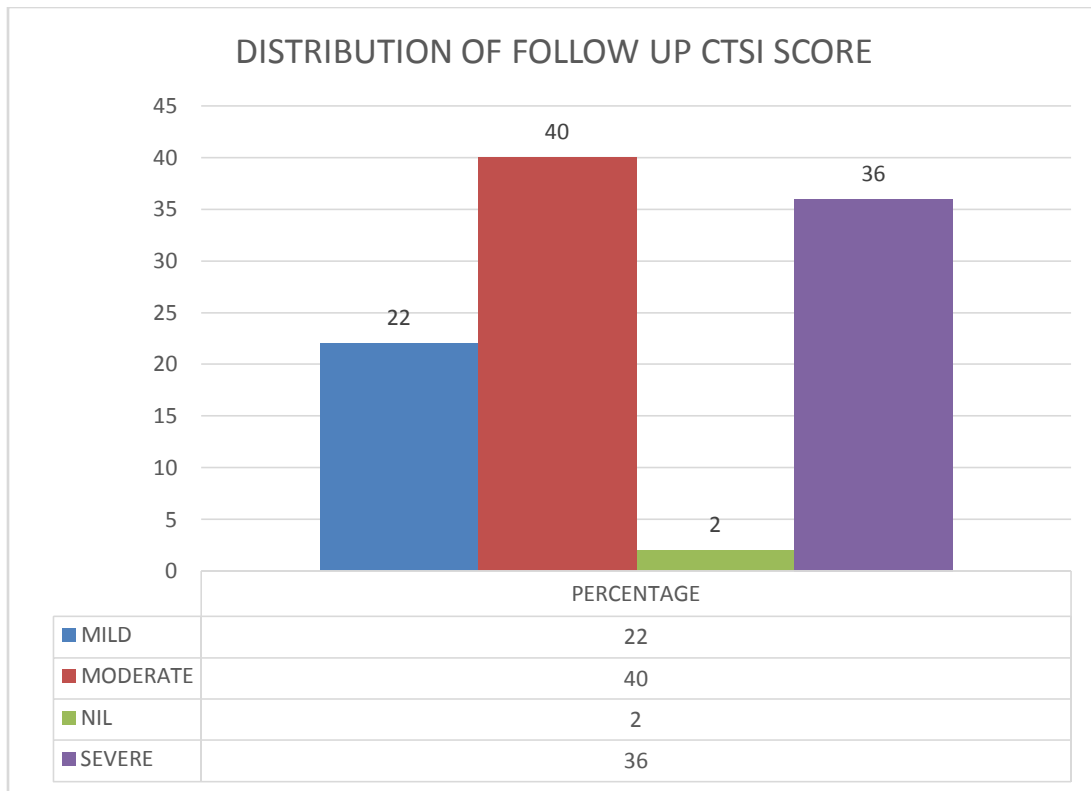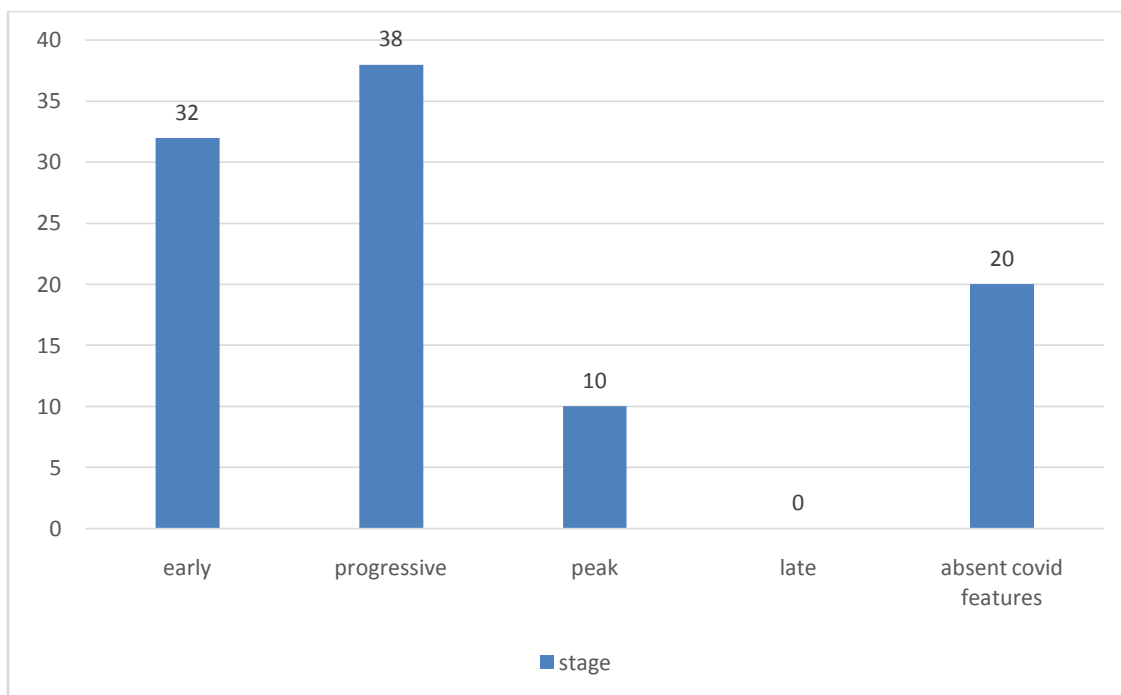
Demographics
Total of 50 patients were evaluated. The age group rangedfrom 30to 70 years with mean age of 50years.There were 31males(62%) and 19females (38%) in this study with a maleto female ratio of 1.6:1.
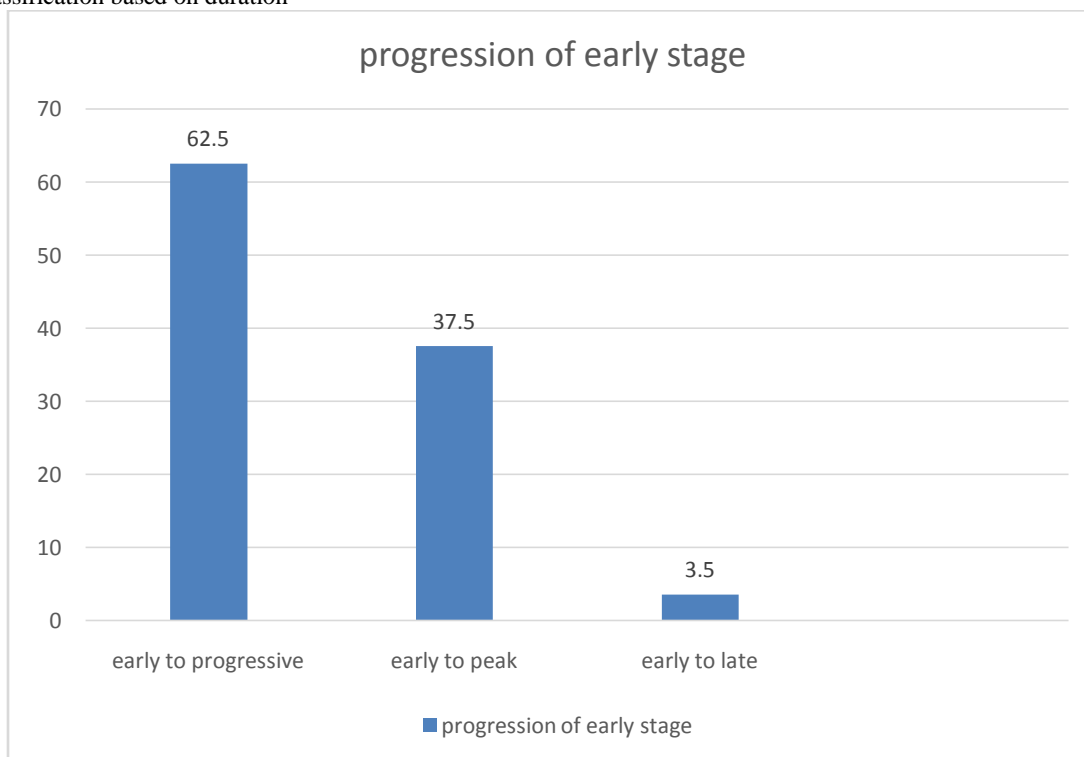
Results:-
50% patients have comorbidities while another 50% do not have comorbidities.Diabetes mellitus(32%) is the predominant comorbidity among them.

DISTRIBUTION OF CTSI SCORE

- MILD 26%
- MODERATE 30%
- NIL 20%
- SEVERE 24%

■ MILD   ■ MODERATE   ■ NIL   ■ SEVERE

DISTRIBUTION OF FOLLOW UP CTSI SCORE

	PERCENTAGE
■ MILD	22
■ MODERATE	40
■ NIL	2
■ SEVERE	36

DISTRIBUTION OF CT CHARACTERISTICS

Legend:
- ■ ABSENT
- ■ ATYPICAL
- ■ INDETERMINANT
- ■ TYPICAL

(ABSENT 2, ATYPICAL 2, INDETERMINANT 16, TYPICAL 80) — Percentage

CT classification based on duration

progression of progressive stage
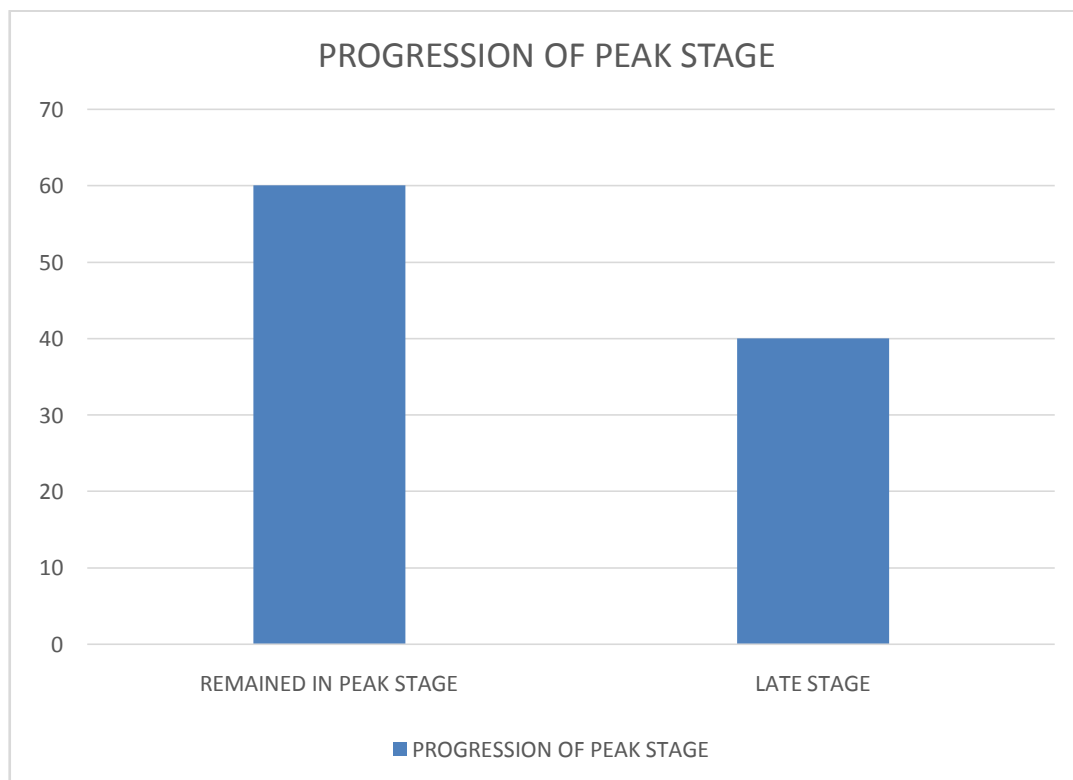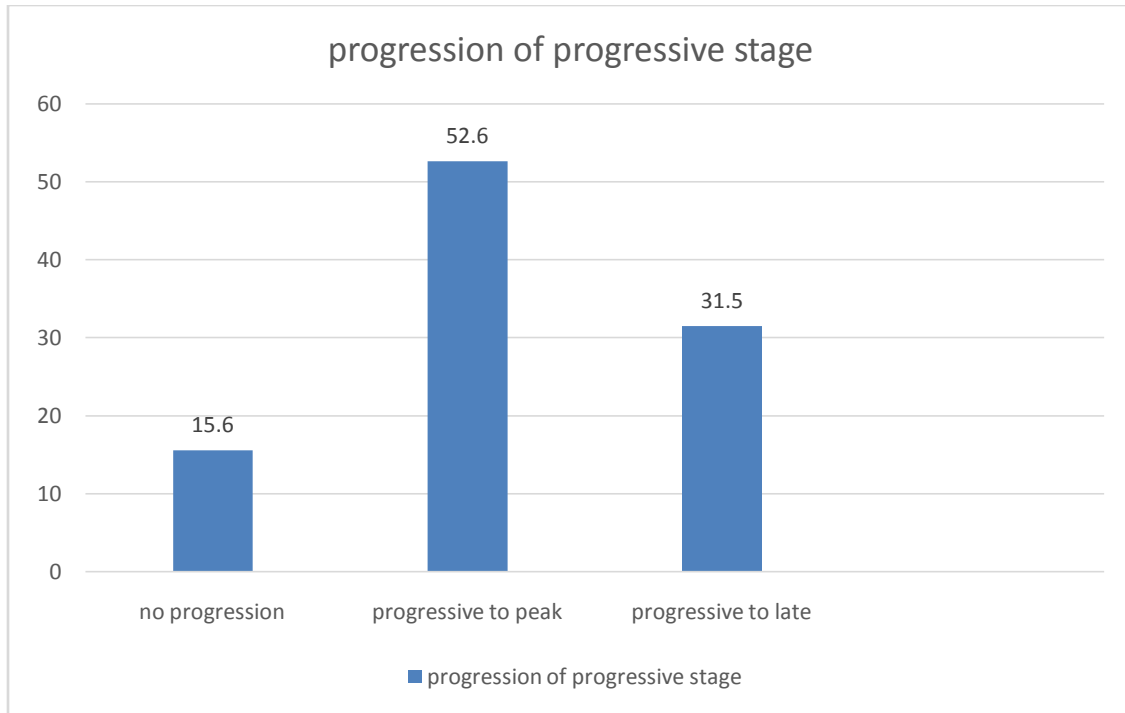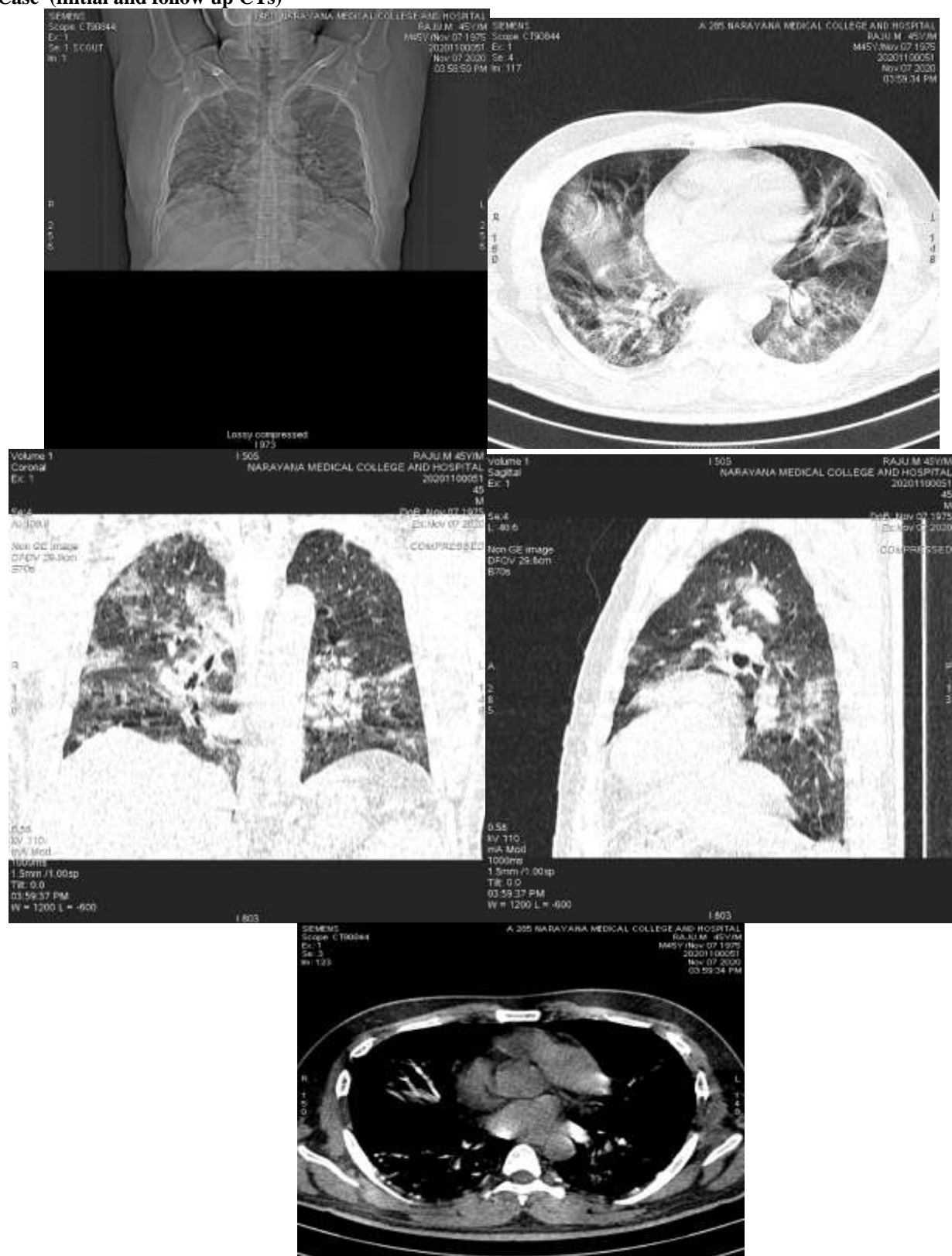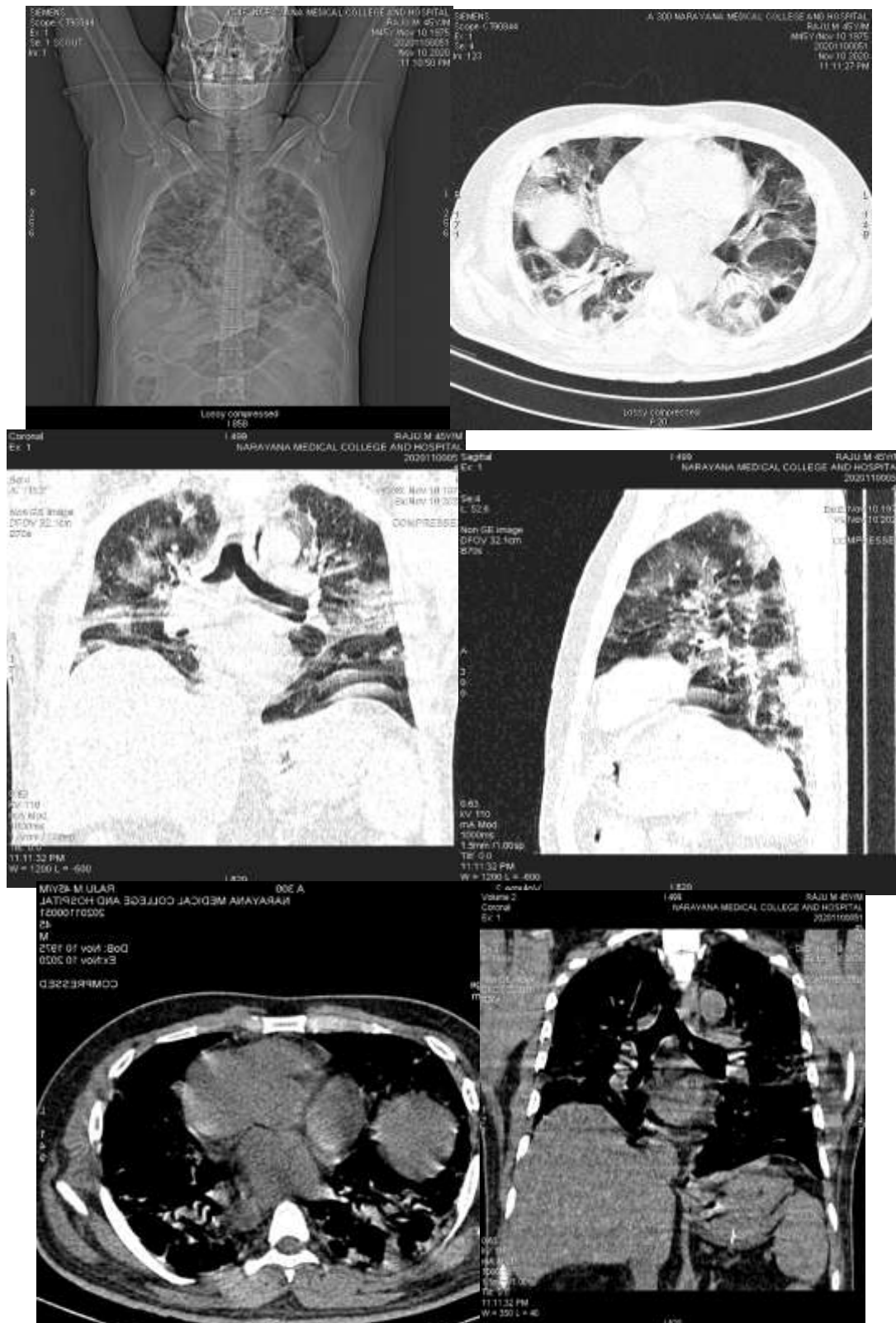

PROGRESSION OF PEAK STAGE

Image Gallery
Case (initial and follow up CTs)

Discussion:-
The fear and terror of COVID-19 initially surfaced in Wuhan, China, and since then it spread like wildfire throughout China's provinces and around the world at a pace that has astounded everyone. Worldwide reports of

COVID-19 cases have been confirmed, and on March 11, 2020, the World Health Organization (WHO) formally proclaimed COVID-19 to be a pandemic. In order to develop diagnostic, therapeutic, and prognostic tools for COVID-19 disease, the present study was attempted to outline the distribution of age, gender, , co-morbidity of patients, HRCT chest findings in COVID-19 patients, severity of patients on the basis of CT imaging, and their correlation with symptomatology and comorbidity of patients. 50 patients in total were examined throughout the duration of the trial.

To test the prognostic and diagnostic value of HRCT chest, serial data from COVID-19 positive patients were gathered, assessed, interpreted, and correlated with one another to identify the severity of disease by radiological imaging with clinical symptoms.

50 patients with laboratory confirmed COVID-19 who had been admitted and came to OPD at Narayana Medical College & Hospital in Nellore, Andhra Pradesh were evaluated in total.**QUANTIFICATION OF DISEASE SEVERITY BASED ON CTSI SCORE**

Involvement of lungs by HRCT chest is assessed by CT Severity index scoring system which is based on approximate involvement of lung lobes by corona virus.Each lobe of 5 lobes of lung has been assessed on CT chest and assigned score of each from 1 to 5.And severity of disease is characterised based of CTSI score with mild disease($<8/25$),moderate($8-15/25$),severe($>15/25$)

Out of 50 COVID RTPCR positive patients who underwent HRCT chest initially.13(26%) patients has score of $<8/25$ CTSI i.e. milder disease,15 patients(30%) has score of $8-15/25$ CTSI i.e. moderate disease,10 patients(20%) has score of $>15/25$ i.e. severe disease. While 12 patients(24%) has no CT changes.

In our study,30% of RTPCR positive patients were of moderate disease,26% were of milder disease,24% has no CT changes and 20% patients were of severe disease.

Patients clinical status was correlated with CTSI of patients on HRCT chest.It was found that most of the patients who were clinically severe has more CTSI score $>15/25$.

Progression Of Disease Based On CTSI
Based on clinical status of patients,follow up CTs were done to assess the progression of disease and involvement of lungs by virus.

Overall,out of 50 patients with their respective CTSI scores on initial CT scan,26 patients out of 50 patients progressed to further stages of disease(iemild,moderate and severe),22 out of 50 patients remained in the same stage of disease with out any progression,2 out of 50 patients showed improvement with regression of stage of disease.

When compared to CTSI scores on initial CT or on presentation,out of 50 RTPCR positive patients who underwent followup CTs,11 patients(22%) showed CTSI of $<8/25$ ie mild disease,20 patients(40%) showed CTSI of $8-15/25$ ie moderate disease,18 patients(36%) showed CTSI of $>15/25$ ie severe disease and 1 patient (2%) has no CT changes as opposed to 13 patients(26%) showed CTSI of $<8/25$ milder disease,15 patients (30%) showed CTSI of $8-15/25$ moderate disease,10 patients (20%)showed CTSI of $>15/25$ severe disease on initial CTs and 12 patients (24%)had no CT changes.

Hence in our study,there are more number of moderate CTSI cases(20) and severe (18) CTSI cases on followup CTs as opposed to 15 moderate CTSI cases and 10 severe CTSI cases.And there is reduction of number of mild cases(11) and radiologically negative cases(1) on serial CTs when compared to number of mild cases(13) and radiologically negative cases(12) which indicates there is progression of disease with more lung involvement compared to earlier, despite treatment.

It was found that CT chest plays a significant role in assessing the severity of disease based on CTSI score and further helps in treatment planning. CT chest also plays an important role to assess the progress of disease and involvement of lung by serial scans at the expense of increased irradiation to patient.

And it was found that clinically deteriorated patients were significantly correlated with HRCT analysis of patients with the help of CTSI score.

Opacity Characteristics And Distribution
Typical imaging of COVID 19 patients on HRCT include bilateral peripheral, subpleural and basal predominant ground glass opacities with or without consolidation.

Out of 50 RTPCR positive patients who underwent HRCT on initial presentation,37 patients had ground glass opacities,13 patients had no ground glass opacities.I have assigned 1+ for cases who had ground glass opacities in bilateral lung parenchyma which are predominantly in basal segments of lungs,2+ for cases who had ground glass opacities not only in basal segments of lungs but also in other segments of lungs.

Out of 37 patients who had ground glass opacities on initial CT,20 patients had bilateral basal predominant ground glass opacities and 17 patients had ground glass opacities in basal segments and also in other segments of lung parenchyma.

Based on clinical status of patients,50 patients underwent follow up HRCT chest at varied intervals,the distribution of ground glass opacities differed among various individuals with some patients progressed to consolidation and some patients had more number of GGOs when compared to initial CT scan.

Out of 50 RTPCR positive patients who underwent repeat HRCT chest based on clinical status,3 patients had no GGOs,30 patients had bilateral,basal predominant ground glass opacities and 17 patients had basal segment GGOs and also in other segments of bilateral lung parenchyma.

Out of 50 RTPCR positive patients who underwent initial CT,30 patients had no consolidation,17 patients had consolidation in bilateral,basal segments of lung and 3 patients had consolidation in bilateral basal segments of lung and also in other segments of lung.

Out of 50 RTPCR positive patients who underwent repeat CT,9 patients had consolidation,23 patients had consolidation in bilateral,basal segments of lung and 18 patients had consolidation in basal segments and also in other segments of lung parenchyma.

Hence,out of 13 patients who do not have ground glass opacities,only 3 patients do not have ground glass opacities on repeat CT,10 patients had either more number of GGOs or progressed to consolidation.

And out of 30 patients who do not have consolidation on initial CT,only 9 patients do not have consolidation on repeat CT,21 patients had progressed to consolidation.

Therefore patients who do not have either ground glass opacities or consolidation on initial CT chest,more than 70% of patients had progressed to more number of GGOs with varied distribution and consolidation on subsequent CT which is correlated with clinical status of patients during the course of disease.

Roughly 4 stages of COVID 19 have been classified based on symptom onset and HRCT abnormalities with duration of disease
Early stage- 0- 4 days after symptom onset with few number of GGOs ,partial crazy paving

Progressive stage-5-8 days after symptom onset with more number of GGOs, complete crazy paving

Peak stage-9-13 days after symptom onset with progressive consolidation

Late stage->14 days after symptom onset. Gradual reduction of GGOs and consolidation with signs of fibrosis

Out of 50 RTPCR positive patients,based on symptom onset,16 patients presented in early stage,19 patients presented in progressive stage,5 patients presented in peak stage,none of them presented in late stage and 10 patients had absent COVID features,

Out of 16 patients who presented in early stage(few no of GGOs on imaging) 10 patients had progressed to progressive stage on followup CTs with more no of GGOs and few areas of consolidation and 6 patients had progressed to peak stage with progressive consolidation,

Out of 19 patients who presented in progressive stage of COVID 19,3 patients remained in progressive stage without much change in no of GGOs,10 patients progressed to peak stage with increased consolidation and 6 patients went into late stage on followup CT with signs of fibrosis(pleuroparenchymalbands,cavities,traction bronchiectasis etc)

Out of 5 patients who presented in peak stage of COVID 19,3 patients remained in peak stage with progressive consolidation and 2 patients entered into late stage with signs of fibrosis.

Out of 10 patients who had absent features of COVID 19 on HRCT chest,1 patient had absent feature even on followup CT,8 patients progressed to progressive stage with more no of GGOs and 1 patients progressed to peak stage with progressive consolidation.

It was found that HRCT chest plays a significant role in quantifying the severity of disease based on CTSI score and prognostication of disease based on CTSI score on follow up CTs and also based on Opacity characteristics on HRCT chest which further decides the treatment plan of COVID 19 patients

Conclusion And Summary:-
The diverse COVID-19 spectrum included symptoms such as fever, coughing, shortness of breath, sore throat, etc. Major concomitant conditions were CAD, COPD/K-Chest, hypertension, diabetes mellitus, and hypertension. Patients with an underlying co-morbid illness had a higher level of clinical disease severity, particularly those with numerous co-morbid disorders. Positive CT findings were more noticeable in symptomatic patients and patients with co-morbid conditions, giving HRCT chest in COVID-19 patients diagnostic and prognostic significance. The CT severity index and the patients' clinical symptoms have a direct correlation. CT imaging is important for monitoring patients' clinical progress. The findings of this study supported the importance of chest CT in the identification and treatment of COVID-19 infection.

According to the follow-up CT exams, the majority of patients showed progressions in the early stages of their illnesses despite rigorous therapy. Our clinical results demonstrate a positive correlation between radiological characteristics and the degree of lung abnormalities as measured on the baseline CT. Being familiarised with the clinical and CT features and the early alterations of the COVID-19 infection is of fundamental relevance.

During period of 1st March 2021 to 18th May 2021,despite meticulous treatment more patients were affected with more severe CTSI scores and rapid progressive changes on HRCT chest.Hence HRCT chest during COVID era plays most significant role in quantifying,characterising and prognosticating the disease which further helps in treatment of disease

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