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Radiographic Imaging of Covid-19: Negative Chest Radiograph in Majority of Covid 19 Cases in a Dedicated Covid Care Centre of North India – A Indicator of Favourable Outcome

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Abstract

The Corona Virus disease (COVID19) is declared as pandemic by WHO on 11th march 2020. This is an infectious disease with acute respiratory and systemic illness caused by novel Corona Virus SARS- Cov-2. Definitive diagnosis of COVID19 requires a positive RT-PCR test. CT chest & X-ray chest is not used to diagnose COVID19 but helpful in assessing disease progression and complications. Children seem to be relatively unaffected by this virus or other closely related corona viruses. CT chest is more sensitive than chest X-rays. As the pandemic progresses, portable chest X-ray (CXR) will help more to COVID19 patients because of its ready availability & less infection control issues besides easy follow up of lung abnormalities and in critically ill patients.

Material & method: A single Centre retrospective, observational study of confirmed COVID19 patients admitted to the SSPH & PGTI, Noida, North India during 19/3/2020 to 30/6/2020 were included in this study, where confirmed COVID 19 patient chest X-rays were analyzed for their pattern of manifestations of the disease and severity also. Further, CXRs are assessed as follow up of COVID 19 patients, who need further management, CXR is seen as first line tool in areas of world where limited access to RT-PCR is there or long turnaround time of RT-PCR result.

Result: CXR establish that abnormal CXR found in (no=86, 46%) COVID 19 cases & thus identifies COVID 19 lung abnormalities easily with less chance of infection around the world, where limited access to RT-PCR is there or RT-PCR turnaround time is long.

Further, consolidation is the most common finding which has lower zone predominance & is peripheral and bilateral

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in majority cases.

Also CXR assess follow up majority of lung abnormalities, when the COVID 19 patients are followed till discharge/ transfer to higher Centre. Also CXR trend is followed in critically ill COVID 19 patients. In cases where there is strong clinical suspicion of COVID 19, a positive CXR helps in reducing the number of chest CT cases in such patients, thus reducing the burden of CT& cross infection.

Conclusion: Due to widespread availability of portable X-ray, with low cost & reduced infection chance, there will be world-wide use of CXR for identification and follow up of lung abnormalities demonstrating, peripheral, lower zone, bilateral consolidation with other few associated features if any. In almost all COVID-19 patients, negative chest X-ray the outcome are favorable with negative RT-PCR resulting ultimate cure.

Introduction

Corona Virus Disease (COVID 19) is a global health crisis. WHO declared corona virus diseases (COVID 19) as global pandemic on 11th march 2020. COVID 19 is caused by novel corona virus (SARS- Cov-2) and manifests as acute respiratory & systemic illness presenting as consolidation & ARDS. Systemic illness with multisystem involvement noted with features of DIC & pulmonary thromboembolism. Large number of deaths recorded throughout the world due to this pandemic.

The American College of Radiology (ACR) noted that CT suite decontamination required after scanning of COVID 19 patients may disrupt the radiological service availability & suggest that portable chest X-ray may be used to minimize the risk of cross infection [1].

Italian & British hospitals have started to use CXR as a first line triage tool due to long time period of RT-PCR [7,8].

Till date, the literature in Radiology is mostly focused on CT chest in COVID 19 [4,10-12] patients, which is more sensitive than CXR, though there are infection control issues related to the patient transport to CT suite. Therefore, as the global pandemic of COVID 19 progresses with increase number of worldwide deaths, CXR considered to reduce the risk of cross infection. Portable X-ray has become the most common modality for early disease detection [2] and follow up of lung abnormalities. CXR provides base line for future comparison & may help in finding out comorbidities and help in monitoring clinical improvement/ worsening.

CXR plays a pivotal role by elimination of repeat need for chest CT & in cases of strong clinical suspicion may even remove the need for chest CT [2], CXR also utilized around the world in areas where there is little access or delay in RT-PCR results. Further, CXR is also utilized in areas of world where there is little access to chest CT, for easy follow up and monitoring patients. Further CT chest include the risk of radiation, risk of cross infection, high cost, consumption of PPE & need for cleaning/ disinfection and down time of radiology rooms in resource constrained sites.

AIM

1. To establish that the negative CXRs in COVID-19 patients admitted in our hospital have better outcome.
2. To establish the role out of CXR as a first line tool for detection of COVID 19 in around the world in areas of long turnaround time of RT-PCR or with limited access to RT-PCR.
3. To find out the patterns of manifestations and severity of lung abnormalities in COVID 19 patients.
4. To assess the CXR in follow up of lung abnormalities in COVID19 monitoring and to establish the role of CXR in critically ill patients.

Material & method

A single centre, retrospective observational study of COVID 19 patients from our COVID care hospital, SSPH&PGTI, Noida, North India, has been done where all the lab confirmed cases have been included. CXRs taken from 19/03/2020 to 30/06/2020 were collected and analyzed. The additional CXRs that were taken during disease course were also analyzed.

The diagnosis of COVID 19 was according to Ministry of Health & family Welfare (MOHFW) Govt. of India (GOI) guidelines and confirmed by RT-PCR performed on nasopharyngeal and throat swab samples of the patients.

The CXRs were done by a portable 100mA X-ray machine stationed in COVID 19 ward whenever there is need during the clinical course. The chest X-rays were analyzed & degree and type of lung involvement on right & left lung were found in CXR & follow up CXRs.

The demographic data, and radiological finding of the enrolled patients were recorded. The patterns of manifestations and the degree of severity were documented and the lung abnormalities in follow up CXRs were also recorded with recording of CXR finding for monitoring severely ill patients.

Results

Table 1: Demographic Profile of the cases under study.

Sl.no.	Age group	No. of Patients
1.	0 – 1 Month	2 (0.7%)
2.	1 month – 1year	3 (1.1%)
3.	1 year – 18 years	42 (16%)
4.	19 years – 40 years	131 (52%)
5.	41 years – 60 years	55 (22%)
6.	> 60 years	19 (7.5%)

Table 1 is providing much information in that the patients of pediatric age group are less in number than adults. The youngest case is of 3 days who recovered in due course of time and the age range is 3 days – 81 years.

Mean age is 40.5 years

Table 2: Ratio of male to female patients.

Sl.no.	Gender	No.	%
(1)	Male-	100	54%
(2)	Female -	86	46%

Male patients constitute 54% of the COVID-19 patients whereas the percentage of Female patients are 46% (Table – 2).

Table 3: Radiographic findings on CXR in 186 patients.

Findings as on CXR -	No.	%
(a) No. of patients with normal CXRs -	100	54%
(b) No of patients with abnormal CXRs -	86	46%
(c) No of patients with normal CXRs - who later became abnormal	4	2%

As we get large number of patients with mild symptoms, the CXR finding are normal (n=100, 54%) in our study with CXR changes mild in (n = 86, 46%) of cases.

Table 4: CXR features (most common findings in CXRs).

Findings as on CXR-	No.	%
(a) Consolidation	86	96%
(b) Nodular opacities	4	2%

Consolidation account for 96% of findings in CXRs of COVID-19 patients, though few % of patients have nodular opacities.

Table 5: Showing the degree of severity of lung consolidation as per visual assessment of lung involvement.

	No.	%	Severity score
(a) Abnormal X-rays, mild (<25%)	72	80.4%	1 each lung
(b) Abnormal X-rays, moderate (25-50%)	12	13.3%	2-3 each lung
(c) Abnormal X-rays, severe (>75%)	2	2.2%	> 4 each lung

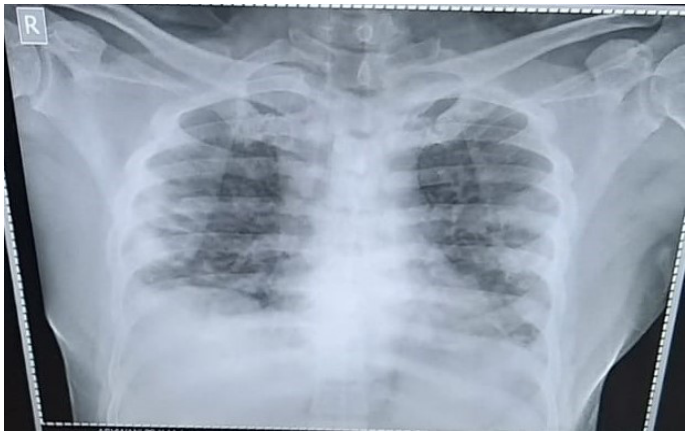

Figure 1: Bilateral peripheral consolidation

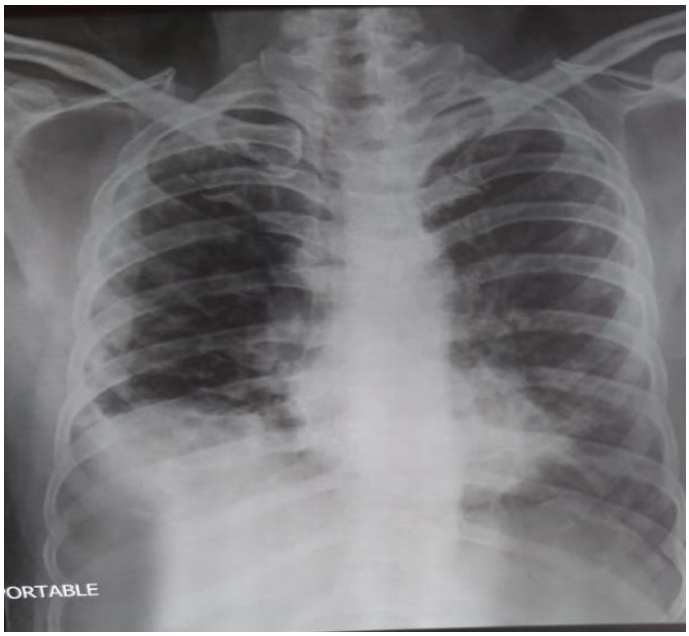

Figure 2: Right ill-defined nodular opacities.

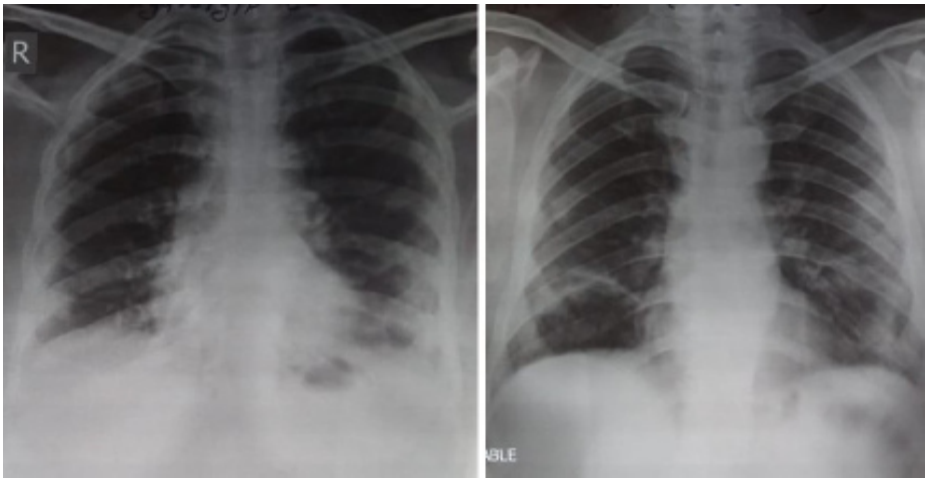

Figure 3: Mild involvement lungs in two different cases.

In patients with moderate and severe lung involvement repeat CXRs have been taken and assessed as in patients with comorbidities.

To quantify, the extent of infection, a severity score was used, depending on extent of lung involvement by consolidation, nodular opacities. score 0-4 was assigned to each lung.

In our study we found the severity score of >4 (one lung) only in two cases, purpose of the score is to convey severity & compare between serial radiographs & frequency of further CXR based on clinical necessity & radiographic changes, mild cases (score one) in 76 cases (84.4%), this is because in our study mildly symptomatic cases are maximum.

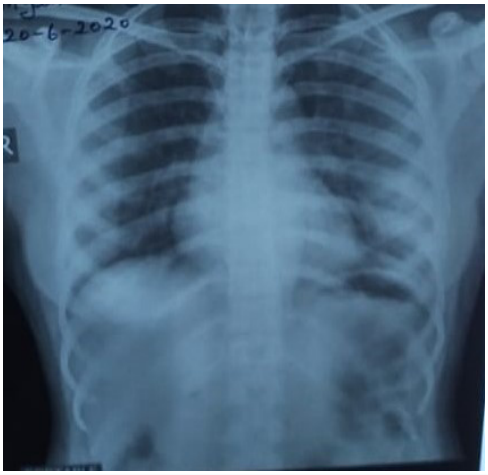

Figure 4: Peripheral bilateral LZ consolidation and LMZ peripheral consolidation.

Table 6A: Localization of abnormalities in CXRs.

	No
(a) Lower Zone	65
(b) Middle Zone	24
(c) Upper Zone	1

Table 6B: Distribution of lesions in CXR.

	No	%
(a) Peripheral distribution -	65	72%
(b) Perihilar distribution -	8	8.8%
(c) Multi focal involvement -	17	18.8%

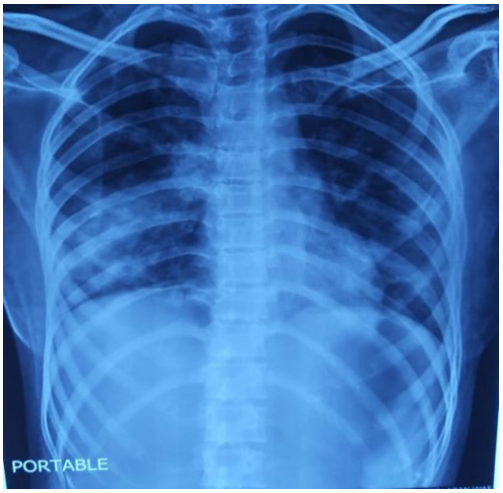

Figure 5: Mild perihilar opacity.

Figure 6: Bilateral multifocal lung involvement.

Table 6C: Involvement of lung in CXRs.

	No	%
(a) Bilateral lung	24	27%
(b) Right lung	28	31%
(c) Left lung	38	42%

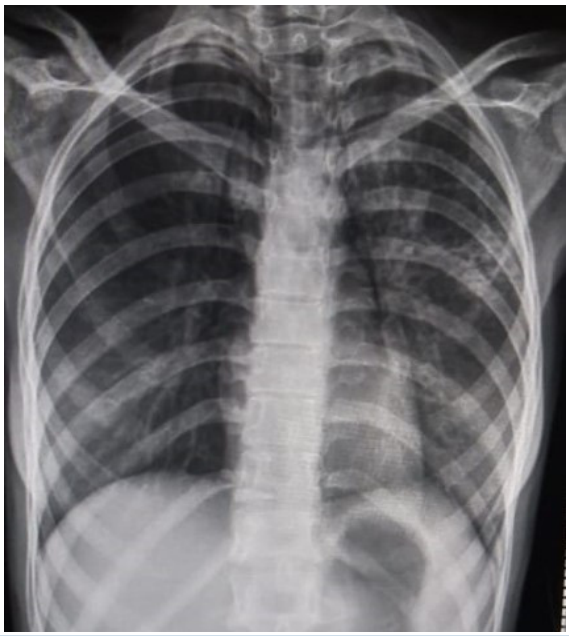

Figure 7: InfiltrationLLZ, LMZ with thin walled cavity.

Pleural effusion is relatively uncommon and found in 5 cases (5%)

Table 6D: Other less common findings on CXRs

	No	%
(a) Pleural effusion	5	5%
(b) Lymphadenopathy	3	3%
(c) Cavity	1	1%

Table 7: Other findings associated with CXRs due to preexisting Radiologically active/inactive lesion in Indian scenario.

	No	%
(J) Cavity (s/o active TB) -	1	1%
(k) Parenchymal calcification (Diffusion s/o old TB) -	1	1%
(l)Fibrotic strands with hilar Lymphadenopathy (TB) -	1	1%

Figure 8: Bilateral parenchymal calcification.

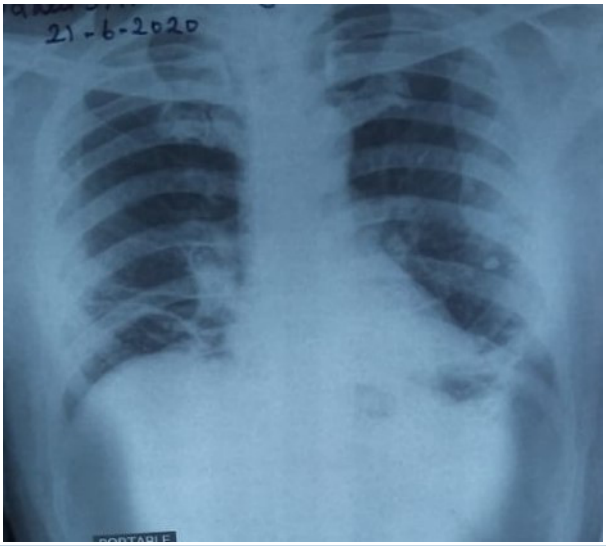

Figure 9: Fibrotic strands with right hilar enlargement.

India being a country where tuberculosis is rampant, radiologically active TB was found in one case and radiologically inactive TB found in 1 patient and suspected TB in one case (with hilar gland enlargement and fibrotics strands).

Discussion

COVID-19 pandemic has came out with an unprecedented health crisis after the world faced Severe Acute Respiratory Syndrome (SARS) in 2002-2003 and Middle East Respiratory Syndrome (MERS).

Patterns of manifestations of COVID-19 lung abnormalities can be identified on conventional chest radiograph as well as CT chest [2]. It can be of immense help to the clinicians & clinicians will definitely & frequently rely on portable chest X-ray due to its easy availability & reduced infection control issues than CT [2]. Our Study also revealed that CXR plays an important pivotal role as a screening method of COVID-19 as was found by wong et al [9]. The first US patient with lab confirmed Coronavirus was diagnosed in part via chest radiography according to a recently published case study [24]. In our study we found that patient showing abnormal chest radiographic findings (n=86,46%) is almost same in the case series of 9 patients published by yoon et al [15].

There is evidence of greater area of lung involvement in CXRs in severe COVID-19 disease which is denser peripherally and in lower zones [2]. There is paucity of data on accuracy of CXRs in COVID-19 with less number of cases as compared to CT research.

Sensitivity studies in COVID-19 cases as studied by different authors is as follows-

Wong et al [9] with 64 number of patients had 44 positive CXR.

	CXR cases	Positive CXR	Sensitivity	RTPCR Study
Wong et al [9]-	64	44	69%	Done
Yoon et al [15]-	9	3	50%	Done
Lomoro et al [32]-	32	27	84%	Done
Bandirali et al [28]-	170	100	59%	Only CXR

Sensitivity of CXR depend on stage and extent of COVID-19 infection. Wong et al [9] found sensitivity of 69% of CXRs of mild to moderate COVID-19 patients. Yoon et al [15] done analysis of 9 patients treated in Korea found 50% sensitivity (n=3) with RTPCR positive study,

Whereas Lomoro et al [32] found CXR sensitivity of 84% (27 out of 32). Bandirali et al [28] found CXR sensitivity of 58.8%, without RT-PCR confirmation. In our study of 186 patients who are RTPCR positive with CXRs, abnormal CXRs account for (n-86,46%) which is similar to the study of Yoon et al [15]. This is because we found large number of CXRs as normal (n-100, 54%) as there is mild presentation of cases at the admission in Noida, North India, with abnormal CXRs (n-86,46%). CXRs may be normal in cases of confirmed COVID-19, in mild cases & in early during the disease course as seen in our study. It has been found that the majority of COVID-19 patients are having mild symptoms or asymptomatic with minority of cases present as or may progress to severe respiratory distress [30] as in ours. Thus making CXRs important in arriving clinical decision making in the diagnosis and guiding treatment of COVID-19 patients.

Thus portable CXR remove the need of CT chest in certain cases as has been highlighted by Adam Jacobi et al [2] which is true in our case especially in patients admitted with mild symptoms and progress moderately or so.

Yoon et al [15] noted out of 9 patients 3 patients had lower zone consolidation. In our study we had (n=65, 72%) lower zone involvement, whereas Wong et al [9] found in 63% cases.

Patterns of manifestations of COVID-19 lung abnormalities can be found in CXR & in CT chest [2]. We also noted that our findings in CXR are peripheral, bilateral and lower zone involvement also well noted in CT by authors [12,23,26,27].

Wong et al [9] in 64 patients in retrospective study had found bilateral lung involvement in 63% of cases which is not similar to our study (n=24, 27%) due to mild (few moderate) disease manifestation in CXR.

Wong et al [9] opined that imaging should be used as an adjunct to clinical parameters in monitoring of the disease course. In addition to this we further agree that CXR is of immense help to clinicians in places where large turnaround time of RT-PCR is found.

It is found, involvement of CXRs with abnormalities greater on one side of the chest in 46% [28]. In our study also, the CXR abnormalities show greater on left side (n=38, 42%) which is similar to the study done in Condogno, Italy which is not RT-PCR tested.

In our study in India, we found 1case of old TB (with diffuse parenchymal Calcification) and one case of active TB (with cavity) associated with COVID-19, as TB is rampant in Indian scenario also we suspect one case of TB (hilar gland enlargement with fibrotic strands).

Follow up of the COVID-19 patients with CXR helps in clinical monitoring of the cases. We differ with the study of Wong et al [9] that the role of CXR in clinical monitoring is less clear probably because of small number of patients studied by them and large number of mildly symptomatic cases found in India. When no finding in CXR noted, COVID-19 is not excluded as per British Society of Thoracic Imaging version-2 [16].

In our study as discussed earlier, the number of patients with normal CXR with positive RTPCR were more (n=100,54%), compared to patients with abnormal CXR findings (n=86,46%) who were discharged after treatment this correlated with the study of Toussie D et al [3] and other authors [6,9]. Further, large number of our patients are young (19-40 years and mean age was 40.5 years. In India as per MOHFW dated 24th July 2020, the fatality rate is 2.38% and the recovery rate of India rises to 63.34%.

Thus, it has now been well emphasized that, CXR should be the first line imaging modality and chest CT need to be reserved for more severely ill patients or when CXR and clinical presentation is inconclusive [29].

Conclusion

CXR literature in COVID-19 is limited. Due to early availability of CXR, with low cost, in majority of areas of world and due to less infection issues and also due to long turnaround time of RT-PCR, CXR helps clinicians in conjuction with other clinical parameters to diagnose COVID-19.

- CXR can be used in assessing disease progression/severity
- When no findings on CXR is noted, COVID-19 is not excluded.
- Most common patterns of manifestation of CXR-

(a) Peripheral predominance

(b) Lower zone involvement

(c) Bilateral consolidation/ground glass appearance

(d) Sometimes (rarely) uncommon findings eg. Pleural effusion, lymphadenopathy etc. may be found.

- It further helps in reducing the infection in comparison to CT.
- In almost all COVID-19 patients, with negative chest X-ray the outcome are

favorable with negative RT-PCR resulting ultimate cure.

Limitation of the study

There is sparse literature available in use of CXR in COVID-19. The study is of observational study & it is a retrospective study of single center & there is absence of basic chest X-Ray to identify chronic lung conditions if any. Further, some of the radiographs have very minimal/subtle changes to detect, hence limiting the value. Further not all COVID-19 patients followed to their final course/outcome.

Known facts about the topic

Chest X-Ray by portable X-Ray unit is the commonly used modality for detection & follow up of lung abnormalities to avoid the risk of cross infection (American college of Radiology). Due to infection control issues by patient transport to CT suite, & non availability of CT in parts of world, CXR has proved to be one of the early and useful method of identification of lung lesions even though negative CXR does not exclude diagnosis of COVID-19.

Pediatric cases in Indian population also seen as the pandemic is spreading with gradual involvement of pediatric population.

Added information from the study

This study from a dedicated Covid care center of Noida, North India, is obtained to establish role of CXR as first line tool for detection of lung abnormalities due to easy availability of portable X-ray units worldwide and further helps in removing the need for CT, avoiding unnecessary burden to CT and reducing the rate of infection. Further CXR plays an important role in follow up study of COVID-19 patients & in monitoring the severely ill patients.

Ethics Committee approval

Approval of exemption for informed consent applied to ethics committee. It is a retrospective study and an observation study with no direct involvement of patients and hence no patient identifiers were included.

Author Contribution

The authors of the manuscript declare an equal contribution to the study.

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