



To assess the efficacy of safety measures adopted during endoscopy in the Corona Virus Disease-19 era for health care professionals—A single-centre tertiary care hospital experience

Mohan Ramchandani¹ · Hardik Rughwani¹ · Harsh Vardhan Tevethia¹ · Sundeep Lakhtakia¹ · Rakesh Kalapala¹ · Aniruddha Pratap Singh¹ · Pradev Inavolu¹ · Shujaath Asif¹ · Azimudin Haja¹ · Nitin Jagtap¹ · Zaheer Nabi¹ · Deepika Gujjarlupudi² · Y. V. Sadhana³ · Pragathi Kottapalli³ · Naveen Chander Reddy⁴ · Anuradha Sekaran⁵ · Santosh Darishetty⁶ · D. Nageshwar Reddy¹

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Abstract

Background and objectives During Corona Virus Disease-19 (COVID-19) pandemic, it has been estimated that approximately 10% of health care professionals (HCPs) have been diagnosed contacting COVID-19. Aerosol-generating procedures have led to change in safety practices among HCPs. We thus evaluated the efficacy of the endoscopic safety measures among HCPs posted in the endoscopy unit.

Methods In this retrospective analysis, all endoscopic procedures performed over a period of 4 months, from 1 April to 31 July 2020 were included. We noted indications and number of COVID-positive procedures as well as comprehensive screening of HCPs posted in our endoscopy unit. The aim of the study was to evaluate the incidence and outcome of COVID-19 among HCPs.

Results Three thousand four hundred and sixty procedures were included in the analysis. Indications were divided as urgent ($n = 190$, 5.49%), semi-urgent ($n = 553$, 16%) and non-urgent group ($n = 2717$, 78.52%). Thirty-four procedures (0.98%) were done on diagnosed COVID-19 patients. The most common indications were gastrointestinal bleed ($n = 12/34$, 35.30%) followed by biliary sepsis ($n = 9/34$, 26.5%). Among the HCPs, the incidence of symptomatic COVID-19 was 6.58% ($n = 5/76$). All HCPs recovered with excellent outcomes. A comprehensive screening showed 7.90% ($n = 6/76$) HCPs having Immunoglobulin G (IgG) antibody in their sera.

Conclusion Addition of safety measures in endoscopy leads to low risk of transmission among HCPs.

Keywords COVID-19 · Endoscopic procedures · Gastrointestinal endoscopy · Pandemic · Personal protective equipment · RT-PCR · SARS-CoV-2

✉ Mohan Ramchandani
ramchandanimohan@gmail.com

¹ Department of Medical Gastroenterology, Asian Institute of Gastroenterology Hospitals, Gachibowli, Hyderabad 500 032, India

² Department of Biochemistry, Asian Institute of Gastroenterology, Hyderabad 500 032, India

³ Department of Microbiology, Asian Institute of Gastroenterology, Hyderabad 500 032, India

⁴ Department of Internal Medicine, Asian Institute of Gastroenterology, Hyderabad 500 032, India

⁵ Department of Pathology, Asian Institute of Gastroenterology, Hyderabad 500 032, India

⁶ Department of Anaesthesiology, Asian Institute of Gastroenterology, Hyderabad 500 032, India

Bullet points of the study highlights***What is already known?***

- Approximately 10% of health care professionals (HCPs) have been diagnosed having corona virus disease-19 (COVID-19).
- Endoscopy procedures involve a high risk of exposure to severe acute respiratory syndrome corona virus-2, due to aerosol generation.

What is new in this study?

- Indications of procedures, number of procedures on patients with COVID-19 as well as comprehensive screening of HCPs posted in our endoscopy unit were studied to evaluate the efficacy of the endoscopic safety measures.

What are the future clinical and research implications of the study findings?

- Studies on development of novel devices and demonstration of the mechanistic role of various safety measures in preventing COVID-19 transmission are needed.

Introduction

The world has been grappling with the spread of Corona Virus Disease-19 (COVID-19) since December 2019, which subsequently was declared a pandemic on March 11, 2020, by the World Health Organization [1]. These are unprecedented times with nearly thirty million people infected to date along with significant mortality noted in patients with COVID-19 [2]. At present, India is the 2nd most affected country in the world after the USA. It has also been estimated that approximately 10% of health care professionals (HCPs) have been diagnosed having COVID-19 in Western countries [3]. It therefore becomes pertinent that HCPs continue to be vigilant and take all safety measures while dealing with the patients. In gastrointestinal (GI) endoscopy units, several staff members, including physicians and other HCPs, often work at very short physical distance from patients. These procedures involve a high risk of exposure to COVID-19, given high generation of aerosols during endoscopy [4–6].

Various gastroenterology societies published guidelines regarding the safety measures, prevention and management required while performing endoscopy during the COVID-19 pandemic [7–9]. During the initial phase of the pandemic, it was recommended that emergency procedures should be done using appropriate personal protective equipment (PPE) whereas all non-urgent procedures were to be decided on case-to-case basis. The pandemic is still continuing around the world, and now with GI endoscopy units resuming operation across the globe, it becomes imperative that we should look into data regarding the safety

measures and their effectiveness in preventing transmission of COVID-19 to the HCPs. The aim of this study was to assess the efficacy of safety measures by evaluating the incidence and outcome of COVID-19 among HCPs during endoscopic procedures in one tertiary care referral centre in India.

Definitions

1. Standard PPE—surgical mask or N95 mask, isolation gown, gloves, standard endoscopy room [9].
2. Enhanced PPE—N95 mask, isolation gown, gloves, goggles or face shield, head cap, shoe cover, negative pressure room (if available) [9].
3. Coverall PPE—for confirmed COVID-19 patients. Coveralls covers the whole body, including back and lower legs and head and feet as well, N95 mask, gloves, face shield, goggles [10].
4. Confirmed COVID-19 (CCP)—laboratory confirmation of COVID-19 reverse transcription-polymerised chain reaction (RT-PCR) (Allplex 2019-nCoV Assay [Seegene Inc., Seoul, Korea]) [11].
5. COVID-19 Reporting and Data System (CO-RADS)—for use in the standardized assessment of pulmonary involvement of COVID-19. CO-RADS assesses the suspicion for pulmonary involvement in COVID-19 on a scale from 1 (very low) to 5 (very high) [12, 13]. CO-RADS 4/5 is taken as COVID-19-positive in the absence of positive

test. The system is meant to be used in patients with moderate to severe symptoms of COVID-19.

Methods

We conducted a retrospective analysis of all the endoscopy procedures done over a period of 4 months, from 1 April to 31 July 2020, and assessed the effectiveness of the safety measures adopted for the HCPs by the institute. Study was done at a single-centre Asian Institute of Gastroenterology (AIG) hospital, Gachibowli, Hyderabad, India. All patients undergoing diagnostic and therapeutic endoscopy procedures were included. We noted indications and number of COVID-positive procedures as well as comprehensive screening of HCPs posted in our endoscopy unit. The aim of the study was to evaluate the incidence and outcome of COVID-19 among HCPs.

Retrospective collection of data was done from Hospital Information System (HIS, twenty-first Century Software Solutions, Vizag, India) and clinical records of patients.

Safety measures: [14–17]

1. Endoscopy day care: All the beds of the day care are 6 ft apart from each other with curtains and doctors/nurses wear surgical masks/face shield (plastic)/gloves/sanitized gowns at all times. All doctors/nurses/patients sanitize their hands periodically. There is periodic cleaning with ethanol (62% to 71% concentration) of the nursing stations every 3 h. All patients are given masks before entering the endoscopy theatre. After the patient has undergone screening and test, he/she is taken to the endoscopy room by a dedicated team of endoscopy general duty assistants who also wear surgical masks/gloves/sanitized gowns.
2. Endoscopy theatre: Once the patient reached the endoscopy suite, the patient was put in the recumbent position as demanded by the procedure. A nurse wearing a PPE kit (enhanced/standard depending on the indication) prepared the patient. An anesthetist wearing a PPE kit (same as above) gave the necessary anesthesia to the patient for performing the procedure. The staff was limited to 2 with one nurse and one endoscopy technician.
3. Endoscopist: The endoscopist wore the appropriate PPE, as per the indication. A total of 16 endoscopists carried out the endoscopy and colonoscopy procedures while 10 of them also carried out the advanced endoscopy procedures. The 6 endoscopists who carried out endoscopy/colonoscopic (diagnostic/therapeutic) procedures have carried out more than 500 procedures whereas the 10 endoscopists performing the advanced endoscopy

procedures have carried out more than 1000 advanced endoscopy procedures.

4. Special precautions [18]: Special precautions were used while conducting the endoscopic procedures. After placing the oxygen cannula and the mouth guard, a plastic sheath was placed over the patient once sedated/intubated. The dimensions of the plastic sheath were 75 × 75 cm, which was modified by folding it in half and placing a small 12 to 18-mm tape creating an entry hole for the endoscope. The previously lubricated endoscope was inserted through the hole created. The nurse fixed the plastic to avoid displacement during the procedure. This covers the whole face with only the portion from where the endoscope is inserted being visible. These measures ensured minimal exposure to the entire endoscopy team while performing the procedures.
5. Post-endoscopy disinfection: After the procedure was completed, the wrapping manoeuvre of the plastic sheet was done carefully and disposed in a separate dedicated dumping bag. Standard endoscopy room disinfection policy was followed with noncritical environmental surfaces frequently touched by hand (e.g. bedside tables, bed rails, cell phones and computers) and endoscopy furniture disinfected at the end of each procedure. Removal of PPE is done in a doffing area that is separate from the procedure room.
6. Post-endoscopy day care: On regaining consciousness, the patient wearing a mask was transported to the endoscopy day care unit by another nurse wearing a PPE kit. The patient was kept under observation depending on the procedure (longer in endoscopic retrograde cholangiopancreatography/endoscopic ultrasound [ERCP/EUS]) and was later discharged. The patient continued to wear facemask along with periodic hand sanitization.

Management protocol

At the AIG hospital a robust safety mechanism has been put in place during the pandemic (Fig. 1):

1. All patients were screened at the entry to the hospital by a team of dedicated doctors in enhanced PPE kits. If the patient had symptoms, and recent contact with COVID-19 patients based on their history, they were then directed to a dedicated COVID-19 clinic. All patients underwent body temperature, oxygen saturation (SpO₂), pulse and blood pressure measurement upon arrival. All the patients/attendees were mandated to wear masks and clean hands with sanitizer on entry.
2. The patients were screened and classified as high risk if they had any of the following history—(1) fever of more than 37.5° C (or within 14 days), (2) travel history or residence in a location reporting community transmission of COVID-19 during previous 14 days, (3) occupational

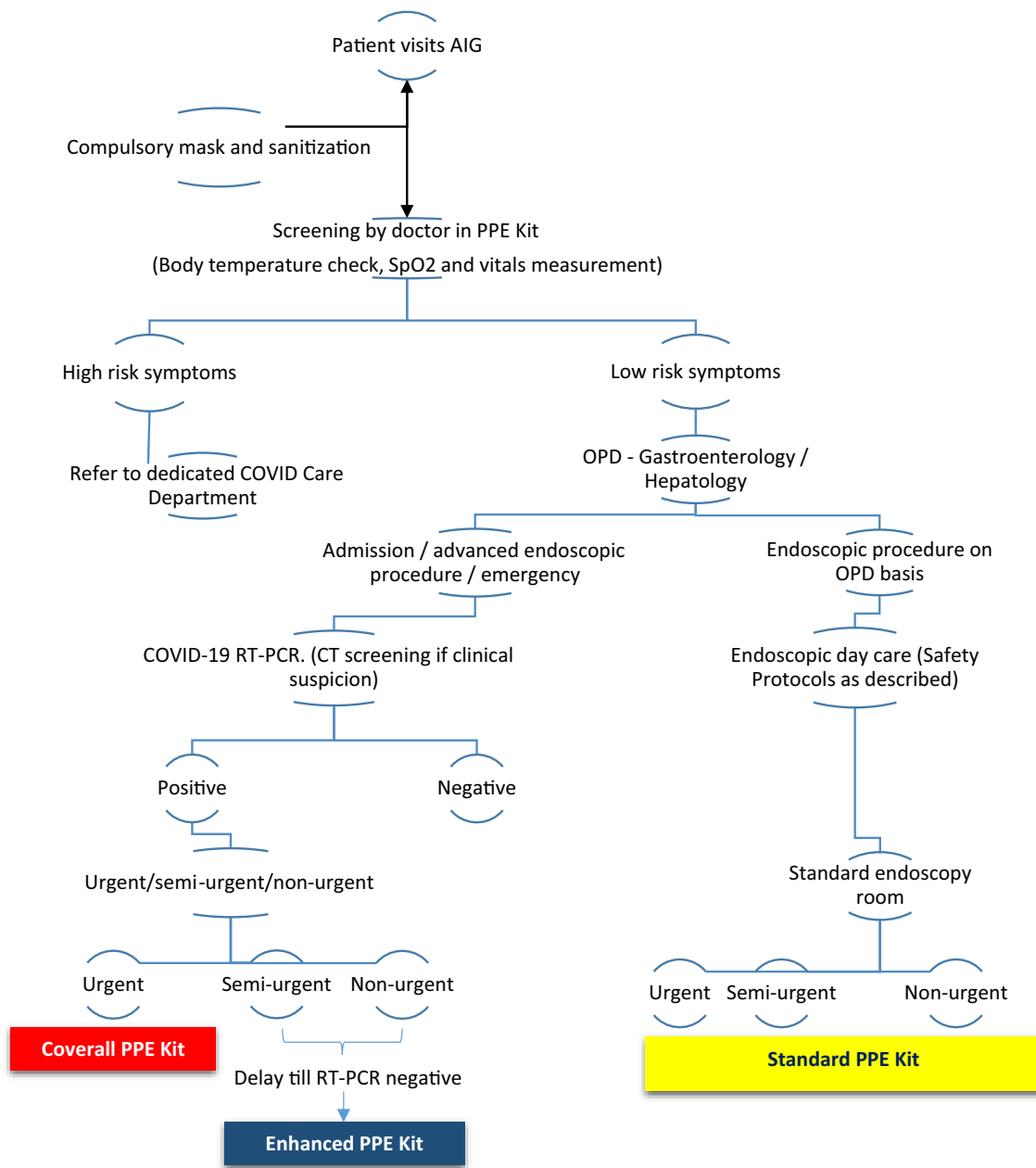


Fig. 1 Flow diagram showing the COVID-19 management protocol. *OPD* outpatient department, *PPE* personal protective equipment, *AIG* Asian Institute of Gastroenterology, *SpO2* oxygen saturation, *COVID-19* Corona virus disease - 19, *RT-PCR* reverse transcription-polymerised chain reaction

exposure, (4) contact history with COVID-19 patient, (5) diarrhea [19, 20], (6) shortness of breath.

Low risk symptoms—patients not having COVID-19 on laboratory testing or non-availability of laboratory confirmation and not having any of the factors on history as mentioned above.

3. Once the patients were screened and determined to be low risk for COVID-19, they were then directed to the respective outpatient departments (OPD). All patients who were advised

endoscopy at the OPD were then separately evaluated by a team of doctors at the endoscopy day care facility, following which all the procedures were performed using standard PPE kit. If the patient had to undergo an advanced endoscopy procedure/referred from emergency or advised admission, before procedure, they were all tested for COVID-19 RT-PCR/computerized tomography (CT) screening (if clinically indicated). If found positive and there was an urgent indication to undergo endoscopic procedure, then Coverall PPE was used. If the indications were semi-urgent or non-urgent, then the procedure was delayed until the RT-PCR was found

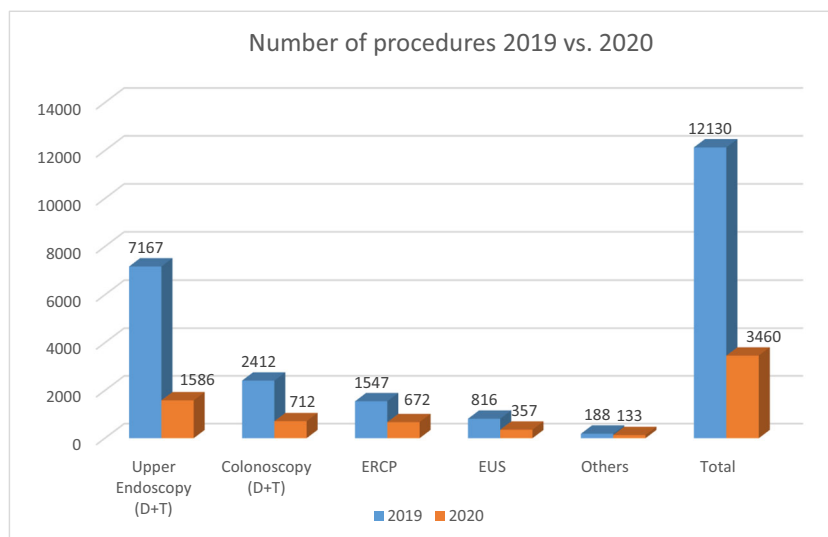
to be negative with the repeat sample being done after 14 days of hospitalization, whereas on initial swab testing (negative)/no clinical suspicion of COVID-19 (low risk), all advanced endoscopic procedures/inpatients/referred from emergency were performed with a standard PPE kit.

4. Throughout the pandemic, periodic screening of symptoms of HCPs was done. If HCPs showed high-risk symptoms consistent with COVID-19, they underwent RT-PCR. Even if they were negative, because of their symptoms, they were kept in isolation for 14 days. The hospital also conducted a comprehensive screening for all HCPs posted in the endoscopy theatre, which included RT-PCR and SARS CoV-2 immunoglobulin G (IgG) assay.
5. For RT-PCR, two separate nylon flocked swabs were taken, from nasopharynx and oropharynx into VTM vial (viral transport medium), following which extraction of ribonucleic acid (RNA) and amplification was done by the RT-PCR apparatus (Allplex 2019-nCoV Assay [Seegene Inc., Seoul, Korea]). The sensitivity and specificity of RT-PCR apparatus used was 94% and 100%, respectively.
6. SARS CoV-2 IgG assay—The SARS CoV-2 IgG assay (Abbott Laboratories, Illinois, USA) is a chemiluminescent microparticle immunoassay (CMIA) intended for the qualitative detection of IgG antibodies to SARS CoV-2 in 3 mL of human serum. The SARS-CoV-2 IgG assay is intended for use as an aid in identifying individuals with an adaptive immune response to SARS CoV-2, indicating recent or prior infection [21].

Ethical considerations

After being explained the procedure and complications, all the patients provided written consent before undergoing endoscopy. The study was approved by the institutional review board.

Fig. 2 Comparison of total procedures done during study duration in 2019 vs. 2020. *D+T* diagnostic + therapeutic, *ERCP* endoscopic retrograde cholangiopancreatography, *EUS* endoscopic ultrasound, other procedures—includes *POEM* (per oral endoscopic myotomy), GERDx (endoscopic full thickness plication), nasojejunal tube placement, spy glass cholangioscopy, etc.



Statistics

The study was a single centre retrospective analysis. The data were entered in Microsoft Excel (Microsoft, Redmond, Washington, USA), data entry was done at the Department of Gastroenterology, AIG Hospitals, Gachibowli, Hyderabad, India. Data entry was verified. Continuous measures were summarized as, mean, median, standard deviation (SD), minimum and maximum. Categorical measures were presented as numbers and percentages of subjects in each category. All authors had access to the study data; all of them reviewed and approved the final manuscript.

Results

A total of 3460 procedures including diagnostic, therapeutic and advanced endoscopic procedures were performed during 1 April–31 July 2020. In the year 2019, during the same study period, 12,130 procedures were performed; the comparison of number and type of procedures done in both years is shown in Fig. 2. The indications of procedures were divided into 3 groups—urgent, semi-urgent and non-urgent as per the guidelines [9]. The indications and procedures done are mentioned in Tables 1 and 2. The number of patients in the urgent, semi-urgent and non-urgent groups were $n = 190$ (5.49%), $n = 553$ (16%) and $n = 2717$ (78.52%), respectively. The number of procedures in months of April, May, June and July 2020 were 257, 866, 1424 and 913, respectively. The increase in procedures in June and July was due to unlocking 1.0 of lockdown in India from 8 June 2020 onwards. Upper GI endoscopy was the most common procedure performed. Among the advanced endoscopic procedures, ERCP was the most frequently performed procedure with increasing trends of plastic stent placement. A cross-sectional study by Goenka et al. [22] showed a dramatic reduction in the procedures in April 2020 and also

Table 1 Procedures performed in the study period. *ERCP* endoscopic retrograde cholangiopancreatography, *NBT* nasobiliary tube, *EUS* endoscopic ultrasound, *SBE* single-balloon enteroscopy, *NMSE* novel motorized spiral enteroscopy, *POEM* per oral endoscopic myotomy, *EMR* endoscopic mucosal resection, *ESD* endoscopic submucosal dissection, *STER* submucosal tunneling endoscopic resection, *NJ* nasojejunal, *GERDx* endoscopic full thickness plication

Procedures	<i>n</i>
Upper endoscopy (therapeutics)	1586 (127)
Colonoscopy (therapeutics)	712 (22)
ERCP (\pm stenting/NBT)	672
EUS diagnostic	357
EUS drainage	26
Small-bowel enteroscopy (SBE/NMSE)	23
Spy glass cholangioscopy	10
NJ placement	53
POEM/EMR/ESD/STER	16
GERDx	5
Total	3460

changes in the GI endoscopy practice throughout the country, mainly due to the effect of lockdown due to COVID-19.

In the urgent endoscopy group, biliary sepsis was the most common indication (39.1%), while GI bleed being the next (28.1%). In the semi-urgent endoscopy group, diagnostic and therapeutic procedures for patients diagnosed with neoplastic conditions, dominated comprising nearly 80% of all the indications. In the non-urgent group, surveillance procedures along with chronic symptoms like dyspepsia were the most common indications.

During the study period, 34 procedures were done for confirmed COVID-19 patients (0.98%); based on RT-PCR or CT findings, the details of the procedures are mentioned in Table 3. Among patients diagnosed with COVID-19, mean age was 46.9 years (16–74), with males being predominant $n = 23/34$ (67.64%). Among patients diagnosed with COVID-19, GI bleed was the most common indication ($n = 12/34$, 35.30%) with biliary sepsis ($n = 9/34$, 26.5%) as the next common indication. One case of insulinoma (postoperative status with recurrence) awaiting EUS radiofrequency ablation (RFA) came positive; hence, the procedure was deferred as it was classified non-urgent and performed after 14 days once his RT-PCR came negative. Another case of necrotizing pancreatitis with walled-off necrosis (WON) came positive on admission and underwent EUS-guided drainage after 14 days when RT-PCR was negative. Out of the 16 COVID-19-positive cases, 6 cases came positive 1–3 days after the procedure (EUS biopsy, 2 diagnostic EUS for common bile duct [CBD] stone, 2 endoscopic variceal ligation [EVL], 1 colonic stent repositioning). Since previous swab reports of these cases were less than 5 days old, procedures were carried out without repeating the test. Since the patients required

admission post-procedure, mandatory COVID-19 RT-PCR was done which turned out to be positive. As the cases were urgent or semi-urgent, the procedures were done using standard PPE. Following the accidental exposure, the endoscopist, anesthetist and 2 staff involved in the procedure were observed for 5 days for any symptomatology of COVID-19 and RT-PCR was done at day 5, which came negative in all 6 cases. As the tests were carried out within 24 h of the procedure, it would be difficult to ascertain the route of transmission with most likely cause being a false negative report before the procedure. Also, the RT-PCR test can come negative in the initial phase of infection, especially if the viral load is low and can subsequently come positive after 2–3 days.

During the study period, $n = 5/76$ (6.58%) of our endoscopy unit staff showed evidence of COVID-19 with RT-PCR swab positive along with high-risk symptoms, details of which are mentioned in Table 4. Among them, there were 1 endoscopy technician/1 anesthetist/3 nurses. All 5 recovered (mild disease) after 14 days with a stable course.

All the staff of our endoscopy unit underwent periodic screening for symptoms of fever, cough, diarrhea and shortness of breath from April 2020. Two out of 76 (2.6%) HCPs including 1 endoscopist/1 anesthetist developed high-risk symptoms and were suspected to have COVID-19. In spite of COVID-19 RT PCR swab negative, they were kept in isolation for 14 days. On subsequent screening after they recovered, both were found to have IgG antibody titre. None of the HCPs had any adverse outcomes.

Subsequently, a comprehensive screening test for COVID-19 including laboratory confirmation in the form of RT-PCR, IgG antibody was done which showed 6/76 (7.90%) having IgG antibody titres. COVID-19 RT-PCR was negative in all the HCPs tested (Table 5). One endoscopy technician was found to have IgG antibody titres with no prior symptom/RT-PCR swab negative. Interestingly in the patients with confirmed COVID-19, only 3/5 developed IgG antibodies whereas both HCPs with high-risk symptoms developed antibodies. Two out of 5 HCPs with positive PCR turned out negative for IgG. One HCP was an anesthetist whose screening showed IgG negative 1 month after RT-PCR positive status, which can be seen as IgG develops in around 80% patients after an acute infection mostly by the 2nd–3rd week of infection [21]. The second HCP was a nurse whose screening showed absence of IgG 10 days after RT-PCR-positive status. Usually, IgG positivity is seen in the 2nd or 3rd week onwards after acute infection [21].

Discussion

This is a novel study to evaluate the incidence of COVID-19 among in HCPs and the role of safety measures while performing endoscopy during the COVID-19 pandemic. The

Table 2 Urgent, semi-urgent, and non-urgent procedures performed during the study period [9]. *ERCP* endoscopic retrograde cholangiopancreatography, *EUS* endoscopic ultrasound, *SBE* single balloon enteroscopy, *NMSE* novel motorized spiral enteroscopy, *POEM* per oral endoscopic myotomy, *EMR* endoscopic mucosal resection, *ESD* endoscopic submucosal dissection, *STER* submucosal tunneling endoscopic

resection, *NJ* nasojejunal. *EVL* endoscopic variceal ligation, *NBT* nasobiliary tube, *PEG* percutaneous endoscopic gastrostomy, *HPB* hepato-pancreato-biliary, *CCP* chronic calcific pancreatitis, *GERDx* endoscopic full thickness plication, *GI* gastrointestinal, *APC* argon plasma coagulation, *WON* walled-off necrosis, *SEMS* self-expanding metal stent, *SVS* side viewing scope

Indications	Procedures	Total
Urgent endoscopy		
Evidence of acute GI bleed	EVL (28), Endoscopic glue injection (3), APC (13) Hemoclipping (7) Endoloop (2) EUS (1)	54 (28.1%)
Biliary sepsis	ERCP NBT/stenting (74), EUS (2)	76 (39.5%)
Foreign body removal	Endo/colon	4 (0.2%)
GI obstruction with stenting	Colonic metal stenting	1 (0.05%)
GI access for urgent feeding	PEG (2) NJ feeding (53)	55 (28.6%)
		190 (5.49%)
Semi-urgent endoscopy		
Endo/colon for GI neoplasia (EMR/ESD)	EMR	2 (0.03%)
Endo/colon/SVS for highly suspicious case of neoplasia	Endo/colon/SVS with biopsy	323 (58.4%)
Small-bowel enteroscopy for occult GI bleed	SBE/NMSE	12 (0.2%)
ERCP for HPB neoplasia	ERCP with NBT/stenting (plastic/SEMS)	126 (22.7%)
Diagnostic EUS (symptomatic pancreatic fluid collection/diagnosis or staging of malignancy/failed ERCP/CCP with new-onset pain)	EUS with biopsy/fluid aspiration	62 (11.2%)
WON/pseudocyst	EUS drainage	26 (4.7%)
Indeterminate biliary stricture	Spy glass cholangioscopy with biopsy	2 (0.03%)
		553 (16%)
Non-urgent endoscopy		
Dyspepsia/chronic diarrhea/surveillance/non cancer therapeutics	Endoscopy/colonoscopy	1913 (70.4%)
Asymptomatic CBD stones, therapy for CCP, Stent exchange, benign biliary strictures	ERCP with stenting (plastic/SEMS)	472 (17.3%)
Indeterminate strictures	Spy glass cholangioscopy	8 (0.2%)
Diagnostic EUS for benign conditions	EUS	292 (10.7%)
Chronic pain abdomen, Chronic diarrhea	Small-bowel enteroscopy	11 (0.4%)
Endotherapy for benign GI disorders	EMR/ESD/POEM/STER/GERDx	21 (0.7%)
		2717 (78.52%)
Total		3460

results suggest that after putting in place a multi-level safety measure, endoscopic procedures can be performed safely even during this ongoing pandemic. A total of 3460 procedures including diagnostic, therapeutic and advanced endoscopic procedures were performed during the study period, which is far less than the number of procedures done in 2019 during the same period (Fig. 2), reasons being the COVID pandemic and the lockdown following it.

In our study, a total of 6.8% (5/58) of the HCPs had confirmed COVID-19 while another 2.3% (2/58) showed high-risk symptoms. Thirty-four (0.98%) procedures performed

were on confirmed COVID-19 patients (laboratory or radiological). The most common indications included GI bleed (35.3%), biliary sepsis (26.5%) and infected WON (11.1%), all of which were urgent and potentially life-threatening. Even in the urgent category, biliary sepsis (39.1%) and GI bleed (28%) dominated along with foreign body removal. The data seems consistent with Dolinger et al. [23] who also reported an incidence of less than 1% of COVID-19 patients undergoing endoscopic procedure during the pandemic. Even though the data continues to emerge, what was interesting was to look at the semi-urgent/non-urgent

Table 3 Diagnosed COVID-positive patients (RT-PCR/Radiological). *ERCP* endoscopic retrograde cholangiopancreatography, *EUS* endoscopic ultrasound, *NJ* nasojejunal. *EVL* endoscopic variceal ligation, *NBT* nasobiliary tube, *PEG* percutaneous endoscopic gastrostomy, *HPB* hepato-pancreato-biliary, *WON* walled-off necrosis, *SEMS* self-

expanding metal stent, *RFA* radiofrequency ablation, *GI* gastrointestinal, *COVID-19 RT-PCR* corona virus disease-19 reverse transcriptase polymerase chain reaction, *CO-RADS corona virus disease - 19 reporting and data system*

Indications	Procedures	N
COVID-19 RT-PCR positive		
Evidence of GI bleed	EVL (4), Dieulafoy’s lesion hemoclipping (1), hemorrhoidal banding (1)	6
Biliary sepsis	ERCP with plastic stent (3)/SEMS (1), EUS for biliary stone (2)	5
Suspected HPB cancer	EUS with biopsy	1
Necrotizing pancreatitis with WON	EUS guided drainage	1
Nutrition	NJ placement	1
Insulinoma (pain abdomen)	EUS RFA	1
Colonic SEMS reposition	Colonoscopy	1
Total		16 (0.46%)
CO-RADS 4/5 (Subheading as COVID-19 positive)		
Evidence of GI bleed	EVL (4), hemoclipping (1), hemorrhoidal banding (1)	6
Foreign body removal	Endoscopy	1
Biliary sepsis	ERCP with stenting (plastic/SEMS)	4
Nutrition	NJ placement	3
Severe pancreatitis with symptomatic fluid collection	EUS diagnostic	2
Suspected HPB malignancy	EUS biopsy	2
Total		18 (0.52%)

category which showed predominantly patients with neoplastic conditions/indeterminate strictures along with other indications like dyspepsia and chronic diarrhea. As the endoscopy units are resuming operations in the ongoing pandemic, more endoscopic procedures are now inclusive of elective indications as they cannot be delayed indefinitely.

Endoscopy is an aerosolizing procedure with the virus being detected in air within 3 h [24, 25]. Workman et al. [26] initially showed that both intact surgical mask and a

modified mask with a glove window were successful in eliminating all detectable spread of the particles. Since there is a high viral load in the upper respiratory tract as well as potential for asymptomatic persons to shed and transmit virus, protection during GI endoscopic interventions becomes imperative. Some direct evidence of the safety of the mask was also seen in subsequent studies. However, data continue to be scanty with regard to its safety for HCPs in an endoscopic setting. Our study showed

Table 4 Timeline of infection amongst health care professionals

	HCP	Symptoms	RT-PCR	Follow-up	IgG (screening on 25/7/20)
1.	Endoscopy technician-1	Yes	Positive on 15/4/20	Recovered	Positive
2.	Nurse-1	Yes	Positive on 19/5/20	Recovered	Positive
3.	Nurses-2	Yes	Positive on 25/5/20	Recovered	Positive
4.	Anesthetist-1	Yes	Positive on 25/6/20	Recovered	Negative
5.	Endoscopist	Yes	Negative (high-risk symptoms on 30/6/20 and isolated for 14 days)	Recovered	Positive
6.	Anesthetists-2	Yes	Negative (high-risk symptoms on 3/7/20 and isolated for 14 days)	Recovered	Positive
7.	Nurses-3	Yes	Positive on 15/7/20	Recovered	Negative
8.	Endoscopy technicians-2	No	Negative (on screening)	–	Positive

HCP health care professional, RT-PCR reverse transcriptive polymase chain reaction, IgG immunoglobulin G

Table 5 Health care professionals —comprehensive screening programme (on 25/7/20)

HCPs	<i>n</i> =76	Symptoms	RT-PCR	IgG
Endoscopists	16	–	Negative	Positive-1
Anesthetists	10	–	Negative	Positive-1
Endoscopy medical officers	4	–	Negative	Nil
Endoscopy unit staff (including nurses and technicians)	46 (nurses 20, technicians 26)	–	Negative	Positive-4
Total	76	0	0	6/76 (7.89%)

*The screening included HCPs with both prior confirmed COVID-positive as well as HCPs with high-risk symptoms. *HCP* health care professional, *RT-PCR* reverse transcriptase polymerase chain reaction, *IgG* immunoglobulin G

HCPs had a positivity rate of 6.8% which was much lower than the previous data published by Gines et al. [27]. The infectivity rate was slightly higher to the landmark study by Repici et al. [28]. It must however be argued that the number of procedures performed in our cohort was significantly higher than that in the previously mentioned studies with more number of confirmed COVID-19 as well as urgent cases/semi-urgent cases. What is encouraging is that at the time of writing the article, even though the cases are rising in India, we were able to safely perform these high-risk procedures and ensure safety of our HCPs over a sustained period. Use of appropriate type of PPE as indicated by the clinical settings will ensure low risk of transmission of infection among HCPs. Even though the data continue to emerge regarding the safety practices, with our study, we have presented an effective way of prevention of transmission among HCPs with excellent outcomes. One explanation could be the type of PPE used, frequent sanitization or use of simple techniques like placing plastic sheet for limiting aerosol generation along with robust screening measures put in place. The comprehensive screening of all HCPs was an important step in ensuring it. Results of the screening showed that most HCPs did not have COVID-19 and were not asymptomatic carriers as well. Majority of HCPs showing IgG (6/76, 7.89%) were symptomatic ($n = 5$, 6.57%). We were able to demonstrate that even in procedures which require endotracheal intubation with general anesthesia ($n = 22$, 0.63%) like motorized spiral enteroscopy, GERDx™ (procedure for gastroesophageal reflux disease), risk of transmission to HCPs remains extremely low. Future trials need to address these specific questions comparing duration of exposure with risk of transmission to HCPs.

The limitations of our study is its retrospective nature, and lack of demonstration of the mechanistic role regarding the various safety measures in preventing COVID-19 transmission. It would be interesting to compare each of the safety net including types of mask, face shields and their role in preventing COVID-19.

In conclusion, our study shows the effectiveness of safety protocols while performing endoscopy during the COVID-19 pandemic for HCPs. As more and more elective procedures are being done, a robust screening programme of patients, triaging them based on indications, COVID seropositivity (and or CT findings) and observing barrier methods during endoscopy to reduce the risk to HCPs. As this pandemic continues in future, such measures will allow us to do the diagnostic and therapeutic endoscopy with minimal risk of transmission. Further prospective trials from various endoscopy centres are needed to assess the efficacy of these safety measures.

Compliance with ethical standards

Conflict of interest MR, HCR, HVT, SL, RK, APS, PI, SA, AH, NJ, ZN, DG, YVS, PK, NCR, AS, SD, and DNR declare that they have no conflict of interest.

Ethics statement The study was performed conforming to the Helsinki declaration of 1975, as revised in 2000 and 2008 concerning human and animal rights, and the authors followed the policy concerning informed consent as shown on Springer.com.

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