Minimally invasive surgery in India during the COVID-19 pandemic: A survey

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Abstract

Background: The coronavirus disease 2019 (COVID-19) pandemic has posed an unprecedented challenge to the healthcare systems worldwide. This uncharted territory has changed the practices in modern healthcare delivery; this is particularly true in the case of minimally invasive surgery (MIS) where various changes are being adopted. This survey was conducted to determine the impact of the pandemic and the changes being adopted in the field of MIS, from a resource-limited developing country, India.

Materials and Methods: The survey was carried out from 27 July to 22 August 2020, amongst MIS surgeons in India using an online questionnaire generated on Google Forms.

Results: The survey was completed by 251 MIS surgeons nationwide. There was a proportional reduction of overall elective surgeries and MIS. Approximately 30% of the surgeons continued to use MIS, as during the pre-pandemic era. Pre-operative tests for COVID-19 (96.1%) and personal protective equipment (PPE, 66%–86%), including respirators (95.2%), are used uniformly across the nation. Almost half (43.1%) of the MIS surgeons are using ≥6 recommended intraoperative modifications in MIS to mitigate the COVID-19 transmission.

Conclusion: MIS surgeons in India have adapted within a short time to the challenge of the pandemic by embracing pre-operative testing, PPE and new techniques/technologies to continue patient care. Innovations and low-cost indigenous customisations are the need of the hour for a developing country like India. Further studies are required to establish the true risk of viral transmission involved in MIS and the efficacies of the techniques/devices to reduce the spread of the virus.

Keywords: Coronavirus disease 2019, India, laparoscopy, minimally invasive surgery

INTRODUCTION

The coronavirus disease 2019 (COVID-19) outbreak was declared as a pandemic by the World Health Organization on 11 March 2020.[1] This pandemic placed unprecedented demands on our healthcare systems and led to the rapid reallocation of resources and personnel to address the surge of COVID-19 patients. The effect of the pandemic on surgical speciality has been so profound and extensive that it has led to the deferment of elective surgeries across the world.[2] All efforts are being made to prioritise cases that...
require surgery,[3] decrease the time necessary for inpatient care, reduce the exposure to healthcare workers and prevent hospital-acquired COVID-19 infection. Minimally invasive surgery (MIS) utilises smaller incision, causes less trauma to tissues, minimises blood loss, reduces inpatient duration and has better short-term and similar long-term outcomes when compared to that of conventional open surgery.[4,5] Hence, MIS can be a potential domain for surgeons to tide over this pandemic.

Previous studies reported the presence of viral particles in the aerosol generated during the use of energy devices.[6,8] A study of surgical smoke found that the particle concentration was more in MIS compared to that of conventional open surgery after the use of electrosurgical devices.[8] Artificial pneumoperitoneum is essential to perform MIS, with which comes the risk of dissemination of aerosol in the operating room. Hence, many surgical societies published guidelines to cautiously use laparoscopy, despite the lack of evidence specific to COVID-19. Some of these recommendations have suggested avoiding laparoscopy,[9] and other societies recommend modification of techniques and use of devices to safely evacuate the smoke to diminish the possible risk of viral transmission.[10,11]

India is a nation of over 1.35 billion population and ranks third in the world for the total number of COVID-19 cases as of 31 August 2020, which places a huge burden on its already-limited health infrastructure.[12] Therefore, the resources are constrained for its population who requires surgical care. Procurement of unanimously recommended negative-pressure operating rooms and smoke evacuation systems are expensive and currently unavailable at many hospitals.

This survey is designed to determine the impact of COVID-19 on overall elective surgeries and MIS, the current practices and the techniques adopted to reduce the transmission of the virus while delivering the appropriate MIS care in India. We intend to compare the difference in practices of the laparoscopic, thoracoscopic and robotic surgeons.

**MATERIALS AND METHODS**

This study is a cross-sectional, descriptive, anonymous survey, conducted amongst the MIS surgeons all over India from 27 July to 22 August 2020 by using an online questionnaire generated on Google Forms and circulated through e-mail. The questionnaire was sent to five subject experts for relevance and feedback. It was then pilot tested among thirty surgeons and refined further in terms of flow, comprehension and content. The questionnaire was organised into three sections [the detailed questionnaire is available in the supplementary material]. The first section comprised the demographic details of the surgeon and his/her workplace, field of practice, MIS pre-pandemic case volume (<20 MIS cases/month considered as low-volume surgical practice, and >20 cases/month as high-volume surgical practice) and years of MIS practice. In the second section, surgeons were enquired about the impact of the COVID-19 pandemic on elective and MIS surgeries. The last section included questions on pre-operative testing for COVID-19, the use of personal protective equipment (PPE) and new technique/technology adopted to mitigate the possible risk of exposure to the COVID-19 virus. The recommended MIS practices (nine practices) at the time of pandemic from various guidelines were tabulated and a score of 1 was given to the appropriate practice.[10]

The sample size was calculated based on centres conducting MISs in Italy, wherein 25.9% of the medical centres reported >50% reduction in activity during the COVID-19 pandemic.[13] Considering the power of the study to be 80%, alpha value = 0.05, absolute risk = 10%, response rate = 90% and at least two surgeons per centre performing MIS in India, the final sample size of 152 MIS surgeons was calculated.

**Statistical analysis**

Descriptive data analysis was done using STATA analysis software version 14.2 (StataCorp, College Station, TX, USA). Categorical variables were summarised as number (percentage) and continuous variables were summarised as mean (±standard deviation). Pearson’s Chi-square test was applied to assess the association between the type of surgical practice, pre-pandemic case volume and type of surgical approach (open or MIS), elective procedures, type of MIS (laparoscopic/thoracoscopic/robotic), pre-operative COVID-19 diagnostic tests, use of PPE and adoption of newer protective techniques during the pandemic. We used the cut-off of 0.05 to draw the statistical significance of our inferences.

**RESULTS**

A total of 1050 MIS surgeons were contacted. Out of them, 289 surgeons responded to the survey (response rate –27.6%). Three surgeons did not consent to the study and 35 (12.2%) were not performing MIS; both these groups were excluded. The final analysis included 251 surgeons across the country, who completed the survey. The demographic characteristics are shown in Table 1.
Reduction in elective and minimally invasive surgery

Majority of the surgeons reported a decrease in the overall elective surgical volume (93.2%) and MIS cases (88.4%) across the country [Figure 1]. Among MIS cases, there was also a proportionate decrease in the reduction in elective and minimally invasive surgery

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Table 1: Demographic details (n=251)

| Parameter                                                                 | n (%)
|---------------------------------------------------------------------------|------|
| Age (years), mean±SD (range)                                              | 38.8±7.44 (27-69) |
| Gender                                                                    |      |
| Male                                                                      | 222  (88.4) |
| Female                                                                    | 29   (11.6)  |
| Workplace                                                                 |      |
| Central government tertiary care institutes                              | 37   (14.7) |
| State government tertiary care institutes                                 | 32   (12.7) |
| Private medical college                                                  | 40   (15.9) |
| Private practice (mid-tier hospitals)                                    | 68   (27.1) |
| Corporate hospitals                                                      | 74   (29.5) |
| Workplace location                                                        |      |
| Metropolitan city                                                        | 121  (48.2)  |
| Urban                                                                    | 87    (34.7) |
| Semi-urban                                                               | 37    (14.7) |
| Rural                                                                    | 6     (2.4)  |
| Approaches to MIS\a                                                      |      |
| Laparoscopy                                                               | 249  (99.2) |
| Thoracoscopy                                                              | 90   (35.9) |
| Robotic                                                                  | 48   (19.1) |
| Field of practice\a                                                       |      |
| Upper GI and oesophagus                                                  | 172  (68.5) |
| Colorectal                                                                | 188  (74.9) |
| Gynaecology                                                              | 119  (47.4) |
| Urology                                                                  | 47   (18.7) |
| Hepato-pancreatico-biliary                                               | 145  (57.8) |
| Thoracic                                                                 | 66   (26.3) |
| Number of years in MIS practice (years)                                  |      |
| ≤5                                                                       | 100  (39.8)  |
| 6-10                                                                    | 88    (35.1) |
| >11                                                                      | 63    (25.1) |
| MIS cases/month before the pandemic                                      |      |
| Low volume (<20 cases)                                                   | 189  (75.3) |
| High volume (>20 cases)                                                  | 62   (24.7) |

\aMore than one response allowed in the category. MIS: Minimally invasive surgery, GI: Gastrointestinal, SD: Standard deviation

Figure 1: Comparison of percentage reduction in elective surgery and minimally invasive surgery

Figure 2: Comparison of percentage reduction of minimally invasive surgery in laparoscopic, thoracoscopic and robotic surgery

Decision to perform minimally invasive surgery

The minimally invasive approach is being continued as before by 29.1% of surgeons, 17.1% are choosing open approach in all cases and 50.2% prefer an open approach in only suspected/confirmed COVID-19 patients. Only 3.6% of the surgeons prefer a minimally invasive approach in suspected/confirmed COVID-19 patients. Surgeons who performed open surgeries in MIS-amenable cases worked at the public sector hospitals (27.9% vs. 13.8%, \( P = 0.02 \)). More than half (56.1%) of the MIS surgeons based their decision on the evidence available at the time of the procedure, while others followed international (24.1%) or national (19.8%) guidelines. Surgeons with >10 years of practice based their decisions on international guidelines more in comparison to surgeons with ≤10 years of practice (32.7% vs. 21%, \( P = 0.01 \)).

Pre-operative testing for COVID-19

Pre-operative testing for COVID-19 was mandated by 86.9% of surgeons in all patients and 9.2% of the surgeons considered testing only in high-risk/suspected cases. However, almost all participants (91.2%) expressed that pre-operative testing should be mandatory in all patients, whereas 7.6% considered it mandatory for high-risk/suspected patients only. The pre-operative tests being conducted are mentioned in Table 2. More than one modality of pre-operative testing is being mandated by ninety (36.7%) surgeons. Computed tomography (CT) chest is being used more in the private sector (39% vs. 18.8%, \( P = 0.002 \)) as compared to that of the public sector. Furthermore, MIS surgeons in private hospitals use more than one modality of COVID-19 diagnostic tests as compared to those in the public sector (49.4% vs. 30.3%, \( P = 0.02 \)).
Personal protective equipment
PPE used by surgeons during MIS procedures is tabulated in Table 3. Most of the MIS surgeons (68.5%) used a disposable particulate filtering facepiece (FFP) such as N95/N99.

New technology/technical variation
The results of the enquiry into new technology/technical variation adopted to mitigate the possible threat of COVID-19 virus in pneumoperitoneum are reported in Table 4. Six or more of these techniques are being employed by 106 (42.2%) surgeons. Surgeons with >10 years of practice reduced the use of energy devices more in comparison to surgeons with ≤10 years of practice (47.6% vs. 33.5%, P = 0.01). A higher proportion of surgeons who continued with the minimally invasive approach as during the pre-pandemic scored ≥6 as compared to those who prefer an open approach in cases amenable to MIS (45.2% vs. 27.9%, P = 0.11). We did not find any significant difference in practice between laparoscopic, robotic and thoracoscopic surgeons [Table 4].

Cost of personal protective equipment and additional devices
The cost of PPE and additional new devices is being borne mostly by the patients (62.9%) and the hospitals (35.1%).

DISCUSSION
The COVID-19 pandemic has substantially changed healthcare delivery in the entire world. Many countries have imposed lockdown to restrict the spread of the virus. India was under a nationwide lockdown from 24 March to 31 May 2020, in four phases, with restrictions on all non-essential services including non-essential healthcare delivery.[14] During the lockdown, The Ministry of Health and Family Welfare of India (MoHFW) issued guidelines to utilise telehealth for patients requiring ambulatory care, prioritise essential non-COVID healthcare and restrict all non-essential care.[15] This study was conducted post lockdown in July and August 2020, during the phase of resumption of surgical care.

The overwhelming increase in COVID-19 cases has impacted elective surgical care profoundly. Guidelines issued by the Royal College of Surgeons,[13] American College of Surgeons[9] and the MoHFW[15] of India suggested postponement of all elective surgeries to accommodate the COVID-19 patients. This study reports a reduction of surgical volume by more than 2/3 in overall elective surgery by 44.2% and MIS by 52.6% of surgeons compared to the pre-pandemic era. The reduction in MIS is proportional to the overall reduction in elective surgery. A similar trend was seen in a survey by Aldrighetti et al.[13] on minimally invasive hepatopancreato-biliary (HPB) procedures during the coronavirus disease 2019 pandemic.

Table 2: Pre-operative tests employed for coronavirus disease 2019

| Pre-operative test                  | n (%)          |
|-------------------------------------|---------------|
| RT-PCR of throat swab              | 218 (86.9)    |
| Rapid spot antibody test           | 12 (4.8)      |
| Rapid spot antigen test            | 33 (13.1)     |
| Inflammatory markers: CRP, PCT     | 14 (5.6)      |
| CT chest                           | 84 (33.5)     |

RT-PCR: Reverse transcription-polymerase chain reaction, CRP: C-reactive protein, PCT: Procalcitonin, CT: Computed tomography

Table 3: Personal protective equipment used during minimally invasive surgical procedures

| Personal protective equipment                  | n (%)          |
|-----------------------------------------------|---------------|
| Gown impervious to liquids                    | 217 (86.5)    |
| Cap/hood impervious to liquids                | 177 (70.5)    |
| Goggles                                       | 167 (66.5)    |
| Face shield                                   | 188 (74.9)    |
| Respirator/mask                               | 12 (4.8)      |
| Standard surgical mask                        | 12 (4.8)      |
| Disposable particulate filtering facepiece (N95, N99) | 172 (68.5)    |
| Reusable elastomeric respirator               | 57 (22.7)     |
| PAPR                                          | 10 (4)        |

PAPR: Powered air-purifying respirator

Table 4: Additional new technology/technical variation to the standard equipment/procedure in minimally invasive surgery procedures during the coronavirus disease 2019 pandemic

| Modification in technique/newer technology | MIS procedure (%) |
|-------------------------------------------|-------------------|
|                                           | Low volume | High volume | Thoracoscopic | Robotic | Total |
| Negative pressure OT                      | 43 (22.8)   | 18 (29)     | 34 (37.8)    | 16 (39.6) | 61 (24.3) |
| Smoke evacuation system such as Airseal, Buffalo and Megadyne | 59 (31.2) | 24 (38.7) | 41 (45.6) | 19 (39.6) | 112 (44.6) |
| Customised smoke evacuation with HEPA filter | 81 (42.9) | 31 (50)   | 41 (45.6)    | 19 (39.6) | 112 (44.6) |
| Pneumoperitoneum pressure kept at minimum | 115 (60.8) | 35 (56.5) | 41 (45.6) | 27 (56.3) | 150 (59.8) |
| Evacuation of pneumoperitoneum before removal of trocars | 161 (85.2) | 55 (88.7) | 78 (86.7) | 43 (89.6) | 216 (86.1) |
| Specimen removal after evacuation of pneumoperitoneum | 103 (54.5) | 45 (72.6) | 56 (62.2) | 26 (54.2) | 148 (59) |
| Small incision to avoid gas leak from trocar insertion site | 131 (69.3) | 47 (75.8) | 67 (74.4) | 35 (72.9) | 178 (70.9) |
| Reduction in the use of energy devices       | 66 (34.9)   | 27 (43.5)   | 30 (33.3)    | 21 (43.8) | 93 (37.1)  |
| Not using port closure devices               | 148 (78.3)  | 37 (59.7)   | 69 (76.7)    | 39 (81.3) | 185 (73.7) |
| Score ≥6                                     | 78 (41.3)   | 28 (45.2)   | 36 (40)      | 21 (43.8) | 106 (42.2) |

MIS: Minimally invasive surgery, OT: Operation theatre, HEPA: High-efficiency particulate air
surgery in Italy. A survey conducted in India during the nationwide lockdown by Manik Nasta et al. reported a higher rate of deferring elective surgery by general surgeons (77%) in comparison to this study. This hints towards the rising trend of the resumption of elective surgical care post lockdown.

The decision to perform MIS varied widely across the country. Surgeons (17.1%) preferring open approach in MIS-amenable cases had lower practice scores and worked in public sector hospitals. The public sector hospitals are overwhelmed with the care of COVID-19 patients; hence, they may currently lack resources and dedicated personnel for MIS, contributing to the decision of surgeons to prefer an open approach over MIS. Approximately 50% of the surgeons preferred an open approach in suspected/confirmed COVID-19 patients, around 30% continued minimally invasive approach as before and only 3.6% preferred to use a minimally invasive approach in suspected/confirmed COVID-19 cases. The latter two seem to be the most logical approaches, as currently there is no available literature in favour of or against MIS over conventional open surgery. However, few proponents of MIS suggest that MIS may be safer than conventional open surgery in COVID-19 patients who require surgical intervention, as it offers a closed system and enables easy evacuation of surgical smoke. As the literature about MIS in the COVID-19 era has been ever changing, most of these surgeons based their decisions on the evidence available at the time of the procedure. The survey in Italy on minimally invasive HPB centres reflected a similar trend.

Most guidelines recommend pre-operative testing for COVID-19 due to the increased perioperative morbidity and mortality in COVID-19-positive patients, and also to reduce the risk of viral transmission to healthcare workers. In this survey, 86.9% of the surgeons mandated pre-operative testing for COVID-19 in all patients. Given the asymptomatic phase in COVID-19 and the current phase of community transmission in India with an increase in the number of cases, universal pre-operative COVID-19 testing is pertinent. This study shows a disparity in the preference of pre-operative testing. Surgeons in the private sector use more than one testing modality (which often included chest CT) compared to the public sector hospitals. The addition of CT chest can be very useful in the early and rapid detection of COVID-19 as reverse transcription-polymerase chain reaction (RT-PCR) has a higher false-negative rate in the asymptomatic initial phase of the disease.

Given the high false-negative rate of RT-PCR in asymptomatic cases, the use of adequate PPE is paramount. There have been reports of widespread shortage and re-use of PPE to circumvent the shortage. This study shows that approximately 66%–86% of surgeons are using the recommended PPE as compared to that of the previous studies conducted during the lockdown, which reported 34%–56.9% usage of PPE. Around 95% of the surgeons are using respirators, such as N95 or respirators, that offer a higher level of protection. This hints towards the better availability of PPE for healthcare workers compared to that of previous reports in India.

The measures recommended while performing MIS during the COVID-19 era are based on previous reports of other viral particles discovered in the aerosol generated from electrosurgical devices. These surgical practices recommended can be categorised broadly into modification in surgical technique (new technique) and aerosol management (new technology). The modification in surgical technique to reduce inadvertent leak of unfiltered CO2 include decreasing the pneumoperitoneal pressure used to the lowest possible level without compromising the visual field, using a small incision to avoid the leak of CO2 from the trocar insertion site, reducing the use of electrosurgical devices, safely evacuating the pneumoperitoneum before extraction of specimen and trocar removal, and avoiding use of devices which lead to the inadvertent leak of CO2 like port closure devices. This study showed differences in the practice of these techniques between high- and low-volume MIS surgeons, although statistically insignificant. The high-volume surgeons could adapt better by embracing the technical changes than the surgeons operating at low-volume centres. However, this cannot be generalised as the high-volume surgeons represented only 24.7% of the MIS surgeons.

New technology includes closed smoke evacuation system, either commercially available or customised to safely evacuate pneumoperitoneum, and negative-pressure operation theatre to prevent the dissemination of inadvertently released aerosol. These technologies, except the customised smoke evacuation, add to the cost of the procedure. Limited infrastructure and additional cost being borne by the patient (62.9%), makes it difficult to implement these technologies in India. A customised smoke evacuation system with high-efficiency particulate air (HEPA) filter is being used by only 44.6% of surgeons. Indigenous low-cost customised smoke evacuation systems are being employed worldwide. The ability of the smoke evacuation device to eliminate the virus is based on the filters used – HEPA/ Ultra-low particulate air (ULPA). ULPA filters can retain 99.9% of the particles.
>0.1 μm, whereas HEPA filters retain particles >0.3 μm.[26] Customised smoke evacuators, also using similar filters, theoretically have similar efficiency in eliminating the virus from surgical smoke. However, there are no studies comparing both the systems. These indigenous techniques can be standardised, compared with the commercially available devices and published alongside the guidelines to encourage widespread use, in a set-up with limited infrastructure.

The only study previously published in May 2020[13] on this recommended new techniques/technology included five of the nine practices studied in this survey. Most of these practices were used less frequently compared to this study, including specific smoke aspirations (48.6% vs. 59.4%), skin incisions appropriate for port dimensions (31.1% vs. 70.9%), energy devices not used (2.7% vs. 37.1%), pneumoperitoneum pressures kept at a minimum (37.8% vs. 59.8%) and pneumoperitoneum aspiration before removal of trocars (55.4% vs. 86.1%). Further, they reported that approximately 26% of the centres were not employing any of the practices recommended as opposed to all the surgeons using at least one of the practices in this study, and 21.9% of surgeons using up to three practices. This reflects that the MIS surgeons are rapidly adapting to the recommendations to decrease the transmission of COVID-19.

The strengths of this study are that it is the largest survey conducted exclusively on MIS surgeons (n = 251) during this pandemic, including a significant proportion of thoracoscopic (n = 90) and robotic surgeons (n = 48). It captures the resumption of MIS care post lockdown in India. The main limitation is lack of generalisability due to the cross-sectional nature of the study and a low response rate.

CONCLUSION

In conclusion, most of the MIS surgeons have adapted to surgical guidelines issued during the pandemic within a short time by embracing pre-operative testing, using PPE and employing new techniques/technologies to continue MIS care in India. Innovations and low-cost indigenous customisations for smoke evacuations may be needed to harness the priceless advantages, which MIS offers at the time of the pandemic, especially in a developing country like India. Further studies are mandatory to establish the true risks involved in MIS during the pandemic and the efficacies of the recommended techniques/devices to reduce the spread of the virus to the healthcare workers.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. WHO Director-General’s Opening Remarks at the Media Briefing on COVID-19; 11 March, 2020. Available from: https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19-11-march-2020. [Last accessed on 2020 Aug 18].
2. Spinelli A, Pellino G. COVID-19 pandemic: Perspectives on an unfolding crisis. Br J Surg 2020;107:785-7.
3. American College of Surgeons; American Society of Anesthesiologists; Hospital AA of periOperative RNA; Roadmap for Resuming Elective Surgery after COVID-19 Pandemic. Available from: https://www.wfsaq.org/images/Join_statement_Roadmap_for_Resuming_Elective_Surgery_after_COVID‑19_Pandemic_41720update. [Last accessed on 2020 Aug 18].
4. Velanovich V. Laparoscopic vs. open surgery: A preliminary comparison of quality-of-life outcomes. Surg Endosc 2000;14:16-21.
5. Bhandari V, Bhandari M. Compare the clinical and postoperative outcomes: Laparoscopic versus open surgery. Int Surg J 2020;2020:861-6.
6. Zheng MH, Boni L, Facs MD, Fingerhut A. Minimally invasive surgery and the novel coronavirus outbreak: Lessons learned in China and Italy. Ann Surg 2020;272:e5-6.
7. Kwak HD, Kim SH, Seo YS, Song KJ. Detecting hepatitis B virus in surgical smoke emitted during laparoscopic surgery. Occup Environ Med 2016;73:857-63.
8. Barrett WL, Garther SM. Surgical smoke - A review of the literature: Is this just a lot of hot air? Surg Endose 200317:979-87.
9. COVID-19: Considerations for Optimum Surgeon Protection Before, During, and after Operation. Available from: https://www.facs.org/covid-19/clinical-guidance/surgeon-protection. [Last accessed on 2020 Aug 18].
10. Francis N, Dort J, Cho E, Feldman I., Keller D, Lim R, et al. SAGES and EAES recommendations for minimally invasive surgery during COVID-19 pandemic. Surg Endosc 2020;34:2327-31.
11. Updated Intercollegiate General Surgery Guidance on COVID-19 - Royal College of Surgeons. Available from: https://www.rcseng.ac.uk/coronavirus/joint-guidance-for-surgeons-v2/. [Last accessed on 2020 Aug 01].
12. Worldometer Coronavirus Cases. Worldometer, 2020. p. 1-22. Available from: https://www.worldometers.info/coronavirus. [Last accessed on 2020 Aug 31].
13. Aldighetti I., Boggi U, Falconi M, Giuliano F, Cipriani F, Ratti F, et al. Perspectives from Italy during the COVID-19 pandemic: Nationwide survey-based focus on minimally invasive HPB surgery. Updates Surg 2020;72:241-7.
14. HHebbar PB, Sudha A, Dsoouza V, Chilgod L, Amin A. Healthcare delivery in India amid the COVID-19 pandemic: Challenges and opportunities. Indian J Med Ethics 2020 May 31;(-):1-4.
15. Enabling Delivery of Essential Health Services during the COVID 19 Outbreak: Guidance note Background. Available from: https://www.mohfw.gov.in/pdf/EssentialservicesduringCOVID19updated0411201. [Last accessed on 2020 Aug 18].
16. Nasta AM, Goel R, Kanagavel M, Easwaramoorthy S. Impact of COVID-19 on General Surgical Practice in India. Indian J Surg. 2020 Jun 26;1-5. doi: 10.1007/s12262-020-02443-0. Epub ahead of print. PMID: 32837079; PMCID: PMC7319195.

17. Mintz Y, Arezzo A, Boni L, Baldari I, Cassinotti E, Brodie R, et al. The risk of COVID-19 transmission by laparoscopic smoke may be lower than for laparotomy: A narrative review. Surg Endosc 2020;34:3298-305.

18. Stawicki SP, Jeannmonod R, Miller AC, Paladino L, Gaieski DF, Yaffe MQ, et al. The 2019-2020 novel coronavirus (Severe Acute Respiratory Syndrome Coronavirus 2) pandemic: A joint American college of academic international medicine-world academic council of emergency medicine multidisciplinary COVID-19 working Group Consensus Paper. J Glob Infect Dis 2020;12:47-93.

19. Ai T, Yang Z, Hou H, Zhan C, Chen C, Lv W, et al. Correlation of Chest CT and RT‑PCR testing for coronavirus disease 2019 (COVID‑19) in China: A report of 1014 cases. Radiology 2020;296:E32‑40.

20. Kucirka LM, Lauer SA, Laeyendecker O, Boon D, Lessler J. Variation in false-negative rate of reverse transcriptase polymerase chain reaction‑based SARS‑CoV‑2 tests by time since exposure. Ann Intern Med 2020;173:262-7.

21. Tabah A, Ramanan M, Laupland KB, Buetti N, Cortegiani A, Mellinghoff J, et al. Personal protective equipment and intensive care unit healthcare worker safety in the COVID-19 era (PPE-SAFE): An international survey. J Crit Care 2020;59:70-5.

22. Coronavirus: India's Race Against Time to Save Doctors - BBC News. Available from: https://www.bbc.com/news/world-asia-india-52215071. [Last accessed on 2020 Aug 18].

23. Porter J, Blau E, Gharagozloo F, Martino M, Cerfolio R, Duvvuri U, et al. Society of robotic surgery review: Recommendations regarding the risk of COVID-19 transmission during minimally invasive surgery. BJU Int 2020;126:225-34.

24. Mintz Y, Arezzo A, Boni L, Chand M, Brodie R, Fingerhut A. A low-cost, safe, and effective method for smoke evacuation in laparoscopic surgery for suspected coronavirus patients. Ann Surg 2020;272:e7-8.

25. Bhattacharjee HK, Chaliyadan S, Verma E, Ramachandran R, Makharia G, Parshad R. Coronavirus disease 2019 and laparoscopic surgery in resource-limited settings. Asian J Endosc Surg. 2020 Jul 27. doi: 10.1111/ases.12835. Epub ahead of print. PMID: 32808489.

26. Mowbray NG, Ansell J, Horwood J, Cornish J, Rizkallah P, Parker A, et al. Safe management of surgical smoke in the age of COVID-19. Br J Surg. 2020;107:1406-13. doi: 10.1002/bjs.11679. Epub 2020 May 3. PMID: 32363599; PMCID: PMC7267397.
1. I agree to participate in this study.

   Tick any one option.

   □ Yes
   □ No

Surgeons who are not practicing MIS due to pandemic will be exclude from this study.

2. I am currently practicing MIS.

   Tick any one option.

   □ Yes
   □ No

Section I:

3. Age

   ____________________

4. Gender

   Tick any one option.

   □ Female
   □ Male

5. I work at

   Tick any one option.

   □ Central Institute
   □ Government Set up
   □ Private Medical College
   □ Private practice
   □ Corporate Hospital

6. My workplace is situated in

   Tick any one option.

   □ Metropolitan city
7. Which district is your workplace situated in?

___________________

8. What all approaches you use in minimally invasive surgery (MIS)?

*Check all that apply.*

- Laparoscopy
- Thoracoscopy
- Robotic

9. What is your area of practice in MIS?

*Check all that apply.*

- Upper GI and esophagus
- Colorectal
- Gynaecology
- Urology
- HPB
- Thoracic

10. What is the percent of cases you perform by minimal invasive (MIS) approach per month?

______________________________

Section II:

11. Did you experience any reduction in elective operations during COVID – 19 pandemic?

*Tick any one option.*

- No
- Yes, reduced by 1/3rd
- Yes, reduced by 1/3rd – 2/3rd
- Yes, reduced by >2/3rd

12. Did you experience any reduction in MIS operations during COVID – 19 pandemic?
Tick any one option.

☐ No
☐ Yes, reduced by 1/3rd
☐ Yes, reduced by 1/3rd – 2/3rd
☐ Yes, reduced by >2/3rd

13. Has your decision to approach by MIS changed during COVID – 19 pandemic?

Tick any one option.

☐ No
☐ Yes: all open by default
☐ Yes: restricted in suspected COVID -19 cases
☐ Yes: MIS preferred in suspected COVID -19 cases

14. Was the change in decision guided by any protocols?

Tick any one option.

☐ By national / state guidelines
☐ By international guidelines
☐ Case to case evidence based
☐ Not applicable

Section III:

15. Are you doing routine preoperative testing for COVID – 19?

Tick any one option.

☐ Yes: in all patients
☐ Yes: Only in high risk / suspected cases
☐ No

16. If yes, which test are you employing?

Check all that apply.

☐ RT PCR of throat swab
☐ Rapid spot antibody test
☐ Rapid spot antigen test
☐ Inflammatory markers: CRP, PCT
☐ CT Chest
17. Do you consider it should be mandatory to test for COVID – 19 before performing a MIS?

Tick any one option.

☐ Yes: In all patients
☐ Yes: Only in high risk / suspected cases
☐ No

18. Type of personal protective equipment (PPE) worn by you during MIS procedures?

Check all that apply.

☐ Gown impervious to liquids
☐ Cap / Hood impervious to liquids
☐ Goggles
☐ Facesheild
☐ Mask / Respirator

19. Type of respirator / mask used by you during MIS procedure

Tick any one option.

☐ Standard surgical mask
☐ Disposable particulate filtering facepiece (N95, N99, ...)
☐ Reusable elastomeric respirator (gas mask)
☐ Powered air purifying respirator (PAPR)

20. Did you add any additional new technology / technical variation to the standard equipment / procedure in minimal invasive surgery?

Check all that apply.

☐ Negative pressure OT
☐ Smoke evacuation system like Airseal, Buffalo, Megadyne...
☐ Customized smoke evacuation with HEPA Filter
☐ Pneumoperitoneum pressure kept at minimum
☐ Evacuation of Pneumoperitoneum before removal of trocars
☐ Specimen removal after evacuation of pneumoperitoneum
☐ Small incision to avoid gas leak from trocar insertion site
☐ Reduction in use of energy devices
☐ Usage of port closure devices
21. If you are using any other customized / innovative device or technique please describe
_____________________________________

22. The cost of PPE and additional devices used is borne by

*Tick any one option.*

- [ ] Hospital
- [ ] Sponsored by manufacturing company
- [ ] Patient
- [ ] Other: _____________________