



Original Article

Effect of coronavirus disease 2019 pandemic on case volume, spectrum, and perioperative coronavirus disease 2019 incidence in neurosurgical patients: An experience at a tertiary care center in India

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ABSTRACT

Background: The volume and spectrum of neurosurgical procedures being performed during the coronavirus disease 2019 (COVID-19) pandemic have significantly changed as compared to the pre-COVID-19 period. The objective of this study is to examine this change and draw useful conclusions.

Methods: We collected data retrospectively of all patients who attended outpatient clinics and who were operated at our institute under the department of neurosurgery from October 23, 2019, to August 23, 2020. These data were then divided into two groups (pre-COVID period and during the COVID pandemic) and compared.

Results: Out of the 388 surgeries performed, 284 surgeries were performed during the pre-COVID period, and 104 surgeries were performed during the COVID pandemic. During this ongoing COVID pandemic, the total number of surgeries performed by the department of neurosurgery decreased significantly by 63.38%, the proportion of routine surgeries performed decreased from 50.35% to 19.23% and the proportion of minor cases increased from 19.72% to 30.77%. The Outpatient Clinic Workflow decreased by 72.3% as compared to the pre-COVID period, and the perioperative COVID-19 reverse transcription-polymerase chain reaction positive incidence in our neurosurgical patients was 11.71%.

Conclusion: This paper highlights the drastic reduction in the operative workflow and the outpatient clinic workflow during the ongoing corona pandemic which will have significant collateral damages in the long run. We will have to strike the right balance between providing our patients with the best medical treatment while limiting the spread of the COVID-19 infection.

Keywords: Case volume, COVID-19, Pandemic, Perioperative COVID-19 incidence, Spectrum

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a worrisome pandemic and remains a challenge for health-care systems worldwide. Since January 30, 2020, when the first case of coronavirus infection was reported from Thrissur, Kerala; India has rapidly become home to a mammoth COVID-19 outbreak.^[14] At present, on August 30, 2020, 3,619,169 COVID-19 cases have been confirmed in India with 64,617 deaths.^[19] These data show that India is currently the third most

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affected nation in the world, after United States of America (USA) and Brazil.^[15] In the Chhattisgarh State of India, the first case of COVID-19 was reported on March 19, 2020 in Raipur, this virus has since spread exponentially and as of August 30, 2020, 30,092 confirmed COVID-19 cases have been reported from Chhattisgarh, and 10,976 cases from Raipur alone.^[3]

We are facing a global pandemic, and it is very important to be clear that there is no correct roadmap to navigate this difficult situation. Neurosurgeons are facing a unique set of challenges, including working beyond their area of practice, prioritization of neurosurgical cases with limited resources, confronting novel ethical dilemmas, exposing themselves to medicolegal threats, and, in some cases, to financial insecurities. Neurosurgeons, in particular, are unfamiliar and uncomfortable with the idea of suspending or postponing surgeries as they are trained for decades to “run toward the fire” rather than away from it.

In the present study, the authors have evaluated the volume and spectrum of neurosurgical patients who have undergone surgery at their institution during the COVID-19 pandemic. These data were compared with the volume and spectrum of neurosurgical patients operated for the same duration in the pre-COVID period. We also present perioperative COVID-19 incidence in our neurosurgical patients and their management during this ongoing pandemic.

MATERIALS AND METHODS

We collected data retrospectively of all patients who were operated at our institute under the department of neurosurgery from October 23, 2019, to August 23, 2020 (total 10 months duration). These data were then divided into two groups – pre-COVID period (October 23, 2019–March 22, 2020 – 5 months) and during the COVID pandemic (March 23, 2020–August 23, 2020 – 5 months). The diagnosis, surgeries performed, their nature – major or minor, routine or emergency, cranial, or spinal was compared between the two groups. The groups were further subdivided into various categories (CSF diversion procedures, acute neurotrauma, neuro-oncology [brain and spinal tumors], congenital, peripheral, neurovascular, miscellaneous, etc.) and comparison was done between the various categories of the two groups.

Data analysis was done using the Statistical Package for the Social Sciences version 26:0 (International Business Machines Corporation, New York, United States of America). Frequency and percentage (%) were used to describe the qualitative data variables. Mean and standard deviation (SD) were used to describe the quantitative data variables. Wherever applicable, an unpaired *t*-test was applied. Statistical significance was defined as $P < 0.05$.

RESULTS

A total of 388 patients underwent surgery at our institute from October 23, 2019, to August 23, 2020. Out of these, 284 patients underwent surgery during the pre-COVID period and 104 patients underwent surgery during the COVID pandemic. Out of the 284 patients that underwent surgery in the pre-COVID period, 143 were routine surgeries and 141 were emergency surgeries. During the COVID pandemic, out of the 104 surgeries performed, 84 were emergency surgeries, and 20 were routine surgeries.

Effect of COVID pandemic on operative workflow

During this ongoing COVID pandemic, the total number of surgeries performed by the department of neurosurgery declined significantly by 63.38%. When the means of the number of surgeries performed per month in the pre-COVID and during the COVID period were compared using the unpaired *t*-test, it was found to be highly statistically significant ($P = 0.009$) [Table 1]. The proportion of routine surgeries performed during the COVID pandemic decreased from 50.35% in the pre-COVID period to 19.23%. Out of the 284 surgeries, 56 minor surgeries were performed during the pre-COVID period (CSF diversion procedures, chronic subdural hemorrhage burr hole evacuation, and tapping of the abscess under general anesthesia). During the COVID pandemic, 32 out of the 104 surgeries which were performed, were minor. The proportion of minor cases rose from 19.72% to 30.77% during this pandemic.

The proportion of spinal cases (compared to the pre-COVID period) decreased from 27.11% to 18.27%, and the proportion of cranial cases increased from 72.89% to 81.73%. When we compare the various categories in the two groups, we noted that brain tumor surgery cases decreased from 83 in the pre-COVID period to 27 during the pandemic [Tables 2 and 3]. Similarly, spine surgery cases (spine decompression ± fixation and spine tumor surgery) decreased from 59 to 17 [Table 4], cranial neurotrauma cases decreased from 27 to 10 [Table 5] and neurovascular cases decreased from 13 to 6 [Table 2]. Endoscopic procedures (transnasal transphenoidal) decreased from 10 to 4 cases and C1-C2 fixation cases decreased from 13 to 2 [Table 2]. Till now, during this COVID pandemic, no patient has undergone surgery for

Table 1: Comparison of means of the number of surgeries performed per month in the pre-COVID and during the COVID period.

Period	Mean ± SD of number of surgeries per month	P-value (<i>t</i> -test)
October 23, 2019 to March 22, 2020	47.33±21.08	0.009*
March 23, 2020 to August 23, 2020	17.33±9.99	

* $P < 0.05$ was considered as statistically significant

Table 2: Distribution of various surgeries performed in the pre-COVID and during the COVID period.

Various surgeries (diagnosis)	Period		Total
	October 23, 2019, to March 22, 2020	March 23, 2020, to August 23, 2020	
Brain tumor surgery	83	27	110
Spine surgery except tumors	48	14	62
Shunt (CSF diversion procedure)	33	22	55
Acute cranial trauma	27	10	37
Chronic SDH	14	9	23
Vascular cases	13	6	19
Spine tumor surgery	11	3	14
Endoscopic procedures (transnasal trans-sphenoidal)	10	4	14
(Infection) Abscess	11	1	12
Intracranial hematoma evacuation	6	5	11
C1-C2 Fixation for AAD ± BI, # C1/C2	13	2	15
Congenital spinal malformations	5	0	5
Cranioplasty/bone flap replacement	5	0	5
Peripheral (brachial plexus surgery)	2	0	2
Miscellaneous	8	1	9

AAD: Atlanto-axial dislocation, BI: Basilar Invagination, #: Fracture

Table 3: Distribution of brain tumor surgeries performed in the pre-COVID and during the COVID period.

Brain tumor surgeries	Period		Total
	October 23, 2019, to March 22, 2020	March 23, 2020 to August 23, 2020	
Glioma	28	5	33
Meningioma	16	4	20
CP angle schwannoma	9	4	13
Medulloblastoma/ependymoma	3	3	6
Epidermoid	4	1	5
Pituitary macroadenoma	7	1	8
Craniopharyngioma	4	2	6
Trigeminal schwannoma	2	1	3
Intraventricular Neurocytoma	2	0	2
Brain metastases	3	3	6
Miscellaneous	5	3	8
Total	83	27	110

Table 4: Distribution of spine surgeries performed in the pre-COVID and during the COVID period.

Period	Spine surgeries			Total
	Spinal decompression surgery	Spinal fixation surgery ± decompression	Spinal tumor surgery	
October 23, 2019, to March 22, 2020	23	25	11	59
March 23, 2020, to August 23, 2020	8	6	3	17

Table 5: Distribution of acute cranial trauma surgeries performed in the pre-COVID and during the COVID period.

Period	Acute cranial trauma surgeries				Total
	Contusions with midline shift (MLS)	Depressed fracture elevation	Subdural hematoma (SDH)	Extradural hematoma (EDH)	
October 23, 2019, to March 22, 2020	6	5	5	11	27
March 23, 2020 to August 23, 2020	3	4	1	2	10

bone flap replacement/cranioplasty (five cases in the pre-COVID period), congenital spinal malformations (five cases in the pre-COVID period), and brachial plexus surgery (two cases in the pre-COVID period) [Figures 1-4].

Effect of COVID pandemic on outpatient clinic workflow

We attended to 526 patients in the outpatient clinic of our hospital in November 2019, 567 patients in December 2019,

598 patients in January 2020, 620 patients in February 2020, and 475 patients in March 2020 till March 22, 2020. Our Outpatient clinics were closed from March 23, 2020, to May 31, 2020 due to the National Lockdown declared by the Indian Government. In June 2020, we attended to 77 patients in the outpatient clinic of our hospital, in July 2020, the number increased to 233, and in August 2020 (till August 23, 2020), the number stood at 159. We attended

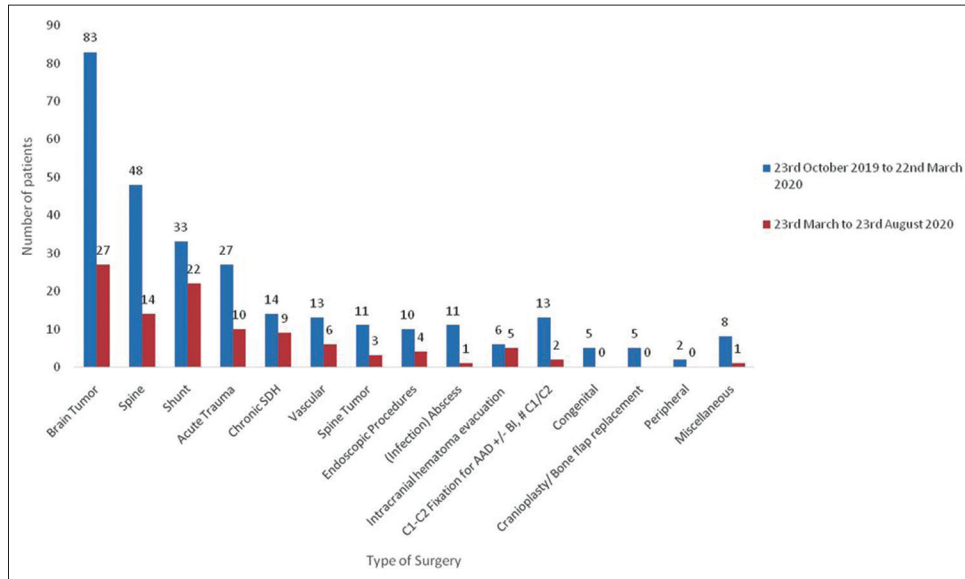


Figure 1: Bar graph showing the volume and spectrum of various surgeries performed in the pre-COVID period and during the COVID pandemic.

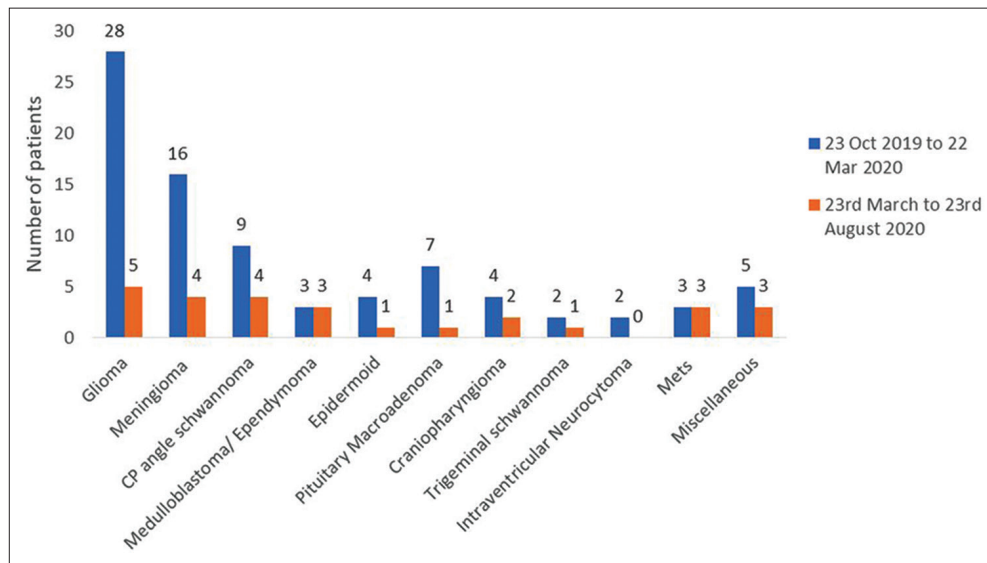


Figure 2: Bar graph showing the volume and spectrum of brain tumor surgeries performed in the pre-COVID period and during the COVID pandemic.

to 1693 patients during the time period from January 1, 2020, to March 22, 2020 (pre-COVID period). During the COVID pandemic, from June 1, 2020, to August 23, 2020, we attended to 469 patients (a decrease of 72.3% Outpatient Clinic Workflow as compared to the pre-COVID period) [Figure 5]. When means of the number of new patients, follow-up patients and referred patients per month in the outpatient clinic during the pre-COVID and the COVID period were compared using the unpaired t-test, it was found to be highly statistically significant ($P = 0.001, 0.002$ and 0.03 , respectively) [Tables 6 and 7].

Management of COVID-positive neurosurgical patients

All preoperative neurosurgical patients are first admitted in the screening ward where COVID-19 reverse transcription-polymerase chain reaction (RT-PCR) test is done. The report is usually available within 24 h.

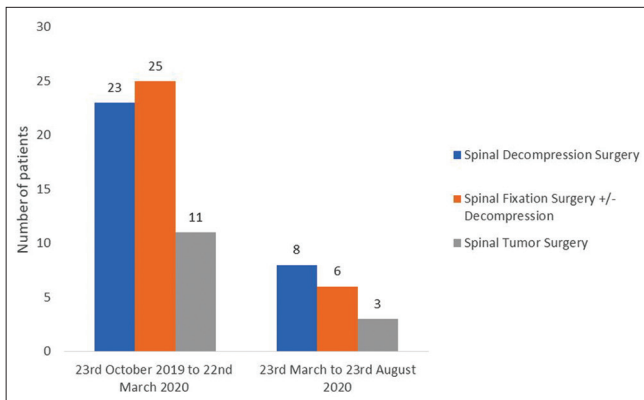


Figure 3: Bar graph showing the volume and spectrum of spine surgeries performed in the pre-COVID period and during the COVID pandemic.

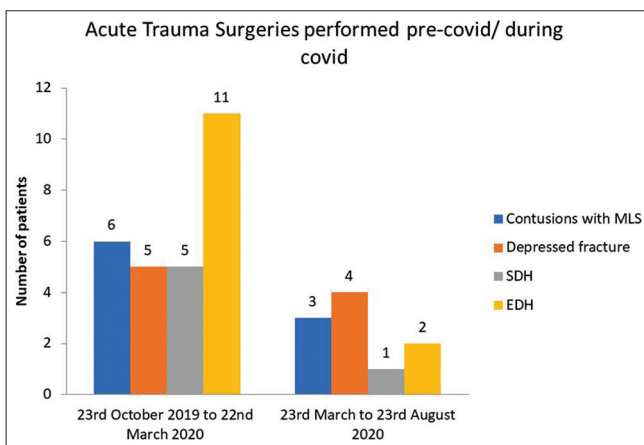


Figure 4: Bar graph showing the volume and spectrum of cranial neurotrauma surgeries performed in the pre-COVID period and during the COVID pandemic.

COVID-19 RT-PCR negative patients are then shifted to the neurosurgery ward, while COVID-19 RT-PCR positive patients are managed in the COVID ward. COVID-19 RT-PCR test is repeated again just before surgery (within 48 h) to reconfirm COVID-19 negative status. As of August 30, 2020, 13 neurosurgery patients have tested COVID-19 RT-PCR positive in the perioperative period. The perioperative COVID-19 RT-PCR positive incidence in neurosurgical patients at our institute, as of now, is 11.71%. Out of these 13 positive patients, only two patients were operated immediately in COVID-19 designated operation theaters as life-saving emergency surgeries (COVID-19 RT-PCR report came positive in the postoperative period) under full personal protective equipment cover. The remaining 11 patients were operated only after 2 COVID-19 RT-PCR swabs came negative. There was 1 mortality out of these 13 positive patients – a young male who presented to the emergency after a road traffic accident (RTA) with a Glasgow Coma Scale score of 6 (E1M4V1), hypovolemic shock, and radiology suggestive of frontoparietal depressed fracture with tentorial SDH with fracture femur, mandible, and multiple ribs. Out of these 13 positive patients, one re-positive case was also identified (a case of metastatic round cell tumor who was COVID-19 RT-PCR positive in June 2020, negative in July 2020, and then again COVID-19 RT-PCR positive after 6 weeks).

Table 6: Distribution of the number of patients in the pre-COVID and during the COVID period in the outpatient department.

Category of patients	Period	
	January 1, 2020, to March 23, 2020	June 1, 2020, to August 23, 2020
New patients	582	181
Follow-up patients	814	166
Referral	297	122

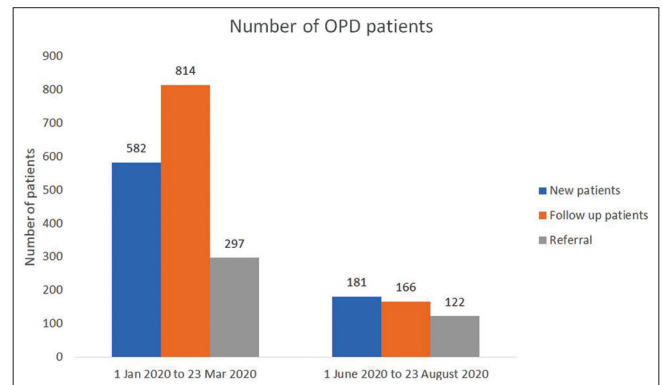


Figure 5: Bar graph showing the volume of patients attending the outpatient clinic in the pre-COVID period and during the COVID pandemic.

Table 7: Means of the number of patients per month in the pre-COVID and during the COVID period in the outpatient department.

Category of patients	Period		P-value (t-test)
	January 1, 2020, to March 23, 2020	June 1, 2020, to August 23, 2020	
	Mean±SD	Mean±SD	
New patients	194±17.77	60.33±23.33	0.001*
Follow-up patients	271.33±53.57	53.33±18.66	0.002*
Referral	99±23.06	40.66±23.86	0.03*

*P<0.05 was considered as statistically significant

DISCUSSION

In this paper, we have presented the experience of our neurosurgery department during the ongoing COVID-19 pandemic by observing how and to what degree the workflow in hospitals has changed. Although there is a worldwide consensus to cut down on “elective” neurosurgical operations, we have to be equally vigilant to decrease the harm caused to the patients due to the delay of elective neurosurgical procedures.^[2,5,11,13,18] Although on a daily basis, neurosurgeons are trained to identify life-threatening emergencies, the definitions of “emergency surgery” and “elective surgery” are not always apparent and when to operate and when to postpone becomes a difficult decision making process. Although some surgeries can be postponed for a significant period of time, delay in appropriate intervention in others may lead to permanent neurological deficits and a considerable decline in the quality of life, or even death. Furthermore, as one cannot foresee the impact of the COVID-19 pandemic over the next few months, it cannot be ruled out that as a consequence of postponing a case, patients might land up with a more advanced disease, thus, making the management of the case more difficult and challenging. The neurosurgeon must view the situation practically and the decision to postpone a surgery must be made keeping in mind the medical and logistical considerations. Each case should be dealt with separately, based on its merits and risks involved.

We started using telemedicine consultations for outpatient appointments that did not require in-person care. The use of telemedicine services and the reluctance of patients and their relatives to visit a facility catering to both COVID and non-COVID patients (though in separate blocks) has resulted in a decrease of 72.3% Outpatient Clinic Workflow as compared to the pre-COVID period.

All new admissions are treated as asymptomatic carriers, and nonemergency surgical procedures are conducted only after a negative COVID-19 RT-PCR test. Nonemergency surgery for those who test positive for COVID-19 infection is postponed until 2 COVID-19 RT-PCR swabs come negative. This is backed by data from a recent article showing that 30-day mortality of elective and emergency surgeries was 23.8% in patients with perioperative COVID-19 infection

and that pulmonary complications were seen in 51.2% of the cases.^[4,20]

Our operative workflow has also significantly decreased. There are many factors responsible for this decrease. Our faculty, residents, and nursing officers have been partially reassigned to COVID wards to help in the care and treatment of patients infected with COVID-19. As the severity of the pandemic is increasing in India, more and more wards in our institute are getting converted to COVID wards, thus reducing the number of beds available for routine neurosurgery work. Non-essential elective surgeries have been restricted. During this ongoing corona pandemic, we found a substantial reduction in neurosurgical emergencies as compared to the pre-COVID era. This could be explained by the national lockdown and the decrease in RTAs including cranial/spinal trauma. The patients and their relatives are also reluctant to seek medical help at a facility that caters to both, COVID and non-COVID patients. All these factors have been responsible for decreasing the operative workflow of our department by 63.38%.

Goyal *et al.*, in their paper, reported that there was a 52.2% reduction in the number of neurosurgeries performed during the COVID pandemic as compared to the pre-COVID era at All India Institute of Medical Sciences, Rishikesh, India.^[7] Burks *et al.*, in their paper, observed that in April 2020, there were 66% fewer cases performed at the Department of Neurological Surgery, University of Miami Miller School of Medicine as compared to the year prior, and in May 2020, there were 50% fewer cases.^[1] At Emory University Hospital, Atlanta, Georgia, USA, there was an 80% reduction in neurosurgical case volume and 66% decrease in hospital revenue between March 16, 2020, and April 15, 2020.^[17] Rothrock *et al.*, in their paper, reported that during the time period from March 16, 2020, to May 5, 2020, there was an 86.4% decrease in open neurosurgical cases and 79.7% decrease in endovascular neurosurgical cases at the Mount Sinai Hospitals, Department of Neurosurgery, New York, USA as compared to a similar time period in 2019.^[16] About 14% of the neurosurgical patients who were operated were COVID-19 positive in this study, which was confirmed with a mean of 1.9 swabs.^[16] Dr. Marcelo Galarza from Regional Service of Neurosurgery, School of Medicine, Murcia,

Spain and Dr. Roberto Gazzeri from the Department of Neurosurgery, National Tumor Institute, Rome, Italy have reported in their correspondence to neurosurgery journal that the number of neurosurgical cases performed in their hospitals had decreased from 30 cases/day to 1–2 cases/day during the COVID-19 pandemic peak in Italy and Spain.^[6] Hoz *et al.*, in their paper, reported a net decrease of 67% of the operative neurosurgical cases at the Neurosurgery Teaching Hospital in Baghdad, Iraq, from January to April 2020 when compared to the same period in 2019.^[9] Elective spinal and peripheral nerve surgeries were most affected with a total decrease of 91%.^[9] Jean *et al.*, in their paper, collected data from 494 respondents of 60 countries by self-reporting surveys.^[10] About 52.5% reported that all elective cases and clinics had been shut down by hospital policy.^[10] About 46.1% reported that their operative volume had dropped more than 50%.^[10] For the COVID-19 ravaged countries, this proportion was even higher, at 54.7%.^[10]

Aerosol generating procedures such as transnasal transphenoidal endoscopic surgeries and surgeries that involve extensive bone drilling, including skull-base surgeries, pose the highest risk for neurosurgeons to get infected with the COVID-19 virus.^[8] Endonasal procedures carry a higher risk of infection due to the disruption of the potential virus-containing nasal mucosa.^[12] At our institute, endoscopic endonasal surgeries are being largely avoided.

The authors strongly suspect that the current COVID-19 health crisis will result in major collateral damages due to the delay in consultation, the failure to diagnose and treat some of the neurosurgical disorders at an early stage, and the presentation of postponed elective cases at a later date with a more advanced disease once the COVID pandemic is over. Moreover, how to deal with the acute surge of accumulated operative cases at the end of the pandemic is an unanswered question at this time.

CONCLUSION

This paper highlights the drastic reduction in the operative workflow and the outpatient clinic workflow during the ongoing corona pandemic at a tertiary health-care institute which will have significant collateral damages in the long run. Every patient presenting for treatment should be considered a probable asymptomatic infected case unless proven otherwise. The current situation demands that neurosurgeons strike the right balance between providing their patients with the best medical treatment while limiting the spread of the COVID-19 infection.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

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