

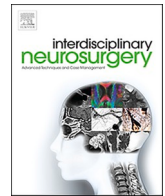


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# Interdisciplinary Neurosurgery: Advanced Techniques and Case Management

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Research Article

## Modification of neurosurgical practice during corona pandemic: Our experience at AIIMS patna and long term guidelines

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## ARTICLE INFO

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## ABSTRACT

**Background:** First case of covid-19 was confirmed on 30th January 2020 in India. Our state, Bihar reported its first confirmed case of covid on 22nd march 2020 at AIIMS Patna. For safety, Electives surgeries and outpatient department was suspended temporary since 25th March. Standard operating procedure (SOP) was framed for covid suspected, covid positive and negative patients. Neurosurgery department formulated their own strategy for successful and covid free management of neurosurgical patients along with zero transmission rate among doctors and staff.

**Methods:** All Neurosurgical patients who got attended, admitted and operated from 25th March to 30th June 2020 (Period of lockdown) were taken in this study. Categorizations of the patients were done according to the urgency and elective nature of pathology after corona screening and RT-PCR testing of covid-19. A proper training to all neurosurgical staff and residents were given for management of patients (admission to operation to discharge).

**Results:** Total 133 patients were attended and 90 were admitted. We operated 76 cases (major – 52, minor – 24) during the lockdown period. Out of this 2 were corona positive (both eventually succumbed) and rest 74 was corona negative. One patient who was operated with corona negative report became positive after 10 days of surgery inward. All the residents, faculty and nursing staff remain asymptomatic throughout the lockdown period with zero infection rate and zero transmission rate.

**Conclusion:** Following a properly made standard operating procedure and strictly implementing it can avoid any type of misadventure in neurosurgery during corona pandemic.

### 1. Key message

Adequate planning and sufficient training is necessary to avoid any untoward incident of infection. Proper utilization of limited human resources and infectious kit is needed at this time.

### 2. Introduction

The first case of COVID-19 was reported in India on 30 January 2020. As of 31st May 2020, the Ministry of Health and Family Welfare have confirmed a total of 182,143 cases, 86,984 recoveries (including 1 migration) and 5,164 deaths in the country [1]. India currently has the largest number of confirmed cases in Asia with number of cases breaching the 100,000 mark on 19th May 2020 and 2 million in August [2]. After successful trial of brief curfew on 22nd march, Indian Prime

Minister Narendra Modi followed it with complete nationwide lockdown from 25th march for 21 days. The period of lockdown was subsequently increased three times in two months [3,4]. First proven case of covid in Bihar was reported on 22nd march at our institute, All India Institute of Medical Sciences, Patna. He was 38-year-old male with a travel history to Qatar [5]. The virus has spread in 38 districts of the state, of which Patna has the highest number of cases [6].

The state with a population of more than 120 million people was under complete lockdown from 25th March to 31st may. It remained in partial lockdown status till 31st July 2020. Approximately 10,000 people got infected with covid 19 till 30th June 2020. After 30th June our hospital got converted into covid dedicated hospital. The state government has responded to the outbreak by following a contact-tracing, testing and home to home surveillance model. All outpatient services were shut down in our hospital since 25th march 2020.

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However emergency services were continued and standard operating procedure (SOP) was made both for the institute and our department. As our department is the only neurosurgical unit dealing vascular neurosurgery in the whole region of 120 million, our responsibility was more as compared to other hospitals. To avert crisis during such pandemic, hospital and department both need a strategy to meticulously manage their staff, emergency, operation theatre complex (OTC), Intensive care unit (ICU) and wards. Here we are discussing our department response, guidelines, drawbacks and analysis of one of the most important emergency services at AIIMS Patna with safe execution and management of neurosurgical patients. We also finalized a roadmap for future management of neurosurgical patients for next few months till this pandemic gets over.

### 3. Materials and methods

Consecutive patients of Neurosurgery (both traumatic and non-traumatic) at our institution were considered for the study. All patients who attended, admitted and operated from 25th March to 30th June 2020 (Period of lockdown) were taken in this study. All patients were managed on the basis of SOP of the institute and department. From 1st July 2020, our hospital got converted from covid care center to covid dedicated Hospital. Post this all emergency services and operations were suspended for indefinite period.

Inclusion Criteria –

1. All pediatric and adult patients with features of raised ICP, like stroke, abscess, tumor, subdural hematoma, Hydrocephalus.
2. All traumatic cases needing observation or emergency operation.
3. All spinal compressive myelopathy (both traumatic and non-traumatic), included in our study Population.
4. Ruptured intracranial aneurysm, ruptured arteriovenous malformations.

Exclusion Criteria – All spinal trauma patients attended and admitted by department of orthopedics.

**Table 1**  
Showing categorization for management of Neurosurgical patient.

Category	Description	Examples	Management
I	Require immediate surgery (within 12–24 h) (Only covid screening + nasopharyngeal swab sent)	Cranial Trauma cases with dropping GCS. (Large EDH, Acute SDH), Aneurysmal rupture with IVH, Intracerebral Hematoma,	Craniotomy, EVD insertion
II	Require surgery within 5–7 days (After RT-PCR result) [After incubation period and within infective period (4–14 days)]	Pituitary apoplexy, Aneurysm rupture, Traumatic spinal injury. Posterior fossa tumors with Hydrocephalus, Giant meningioma.	Cranial and spinal surgery, Avoiding transnasal and anterior cervical approach
III	Surgery can be done after 14 days but within 1 month [After infective period]	AVM rupture, Lumbar listhesis, Spinal tumors.	All types of surgery except transnasal approach
IV	Surgery can be done after 1 month [Twice the infective period]	Degenerative spine pathology, Supratentorial gliomas, Benign brain tumors.	All types of surgery
V	There is no need for surgery/ surgery is not beneficial	Minor head injuries, traumatic spine injury with any vertebrae fracture or dislocation, stroke, inoperable GBM.	NA

**Table 2**

Showing total patients operated under various categories.

Category	Total patients (76)
I	16 (21.05%)
II	31 (40.8%)
III	16 (21.05%)
IV	13 (17.1%)
Total	76 (100%)
V	14

All admitted patients were categorized on the basis of emergency for intervention

### 4. Data collection methods

Data was collected prospectively when the patient was in emergency and trauma in the form of demographic profile at the time of admission and operation, comorbidity, GCS at the time of surgery. All patients were assessed on the basis of severity and admission was done. All admitted patients were categorized on the basis of protocol we made for department. (Table 1) Management was done on the basis of this protocol.

Categorization was done on the basis of Reverse Transcription Polymerase chain Reaction (RT-PCR) Test, viral incubation period (4–5 days) and viral infectivity period (14–15 days) along with urgency of the cases. In Category I, patients were operated in emergency within 24 h with only corona screening. In these patients, nasopharyngeal swab were sent before taking up for surgery. External ventricular drain insertion, VP shunting (ventricular-peritoneal shunting), EDH (extradural hematoma) evacuation and decompressive craniotomy were included in this category. In Category II, patients were operated on urgent basis within 5–7 days after admission. Results of RT-PCR were assessed before taking up for surgery. Category II was formalized by keeping incubation period of covid –19 in minds (4–5 days). If patient develop symptoms of covid infection, test was again repeated and patient was transferred to covid suspected/positive ward before proceeding for surgery. Aneurysmal surgeries, spinal fracture, pituitary apoplexy, meningioma causing mass effect and vision loss were included in this category. Category III patients were semi urgent which was operated between 14 days to 1 month after confirmation that corona virus had cross the infective period (14 days). AVM ruptures, spinal tumors, lumbar listhesis with focal deficits were included in it. In

**Table 3**  
Showing various operative procedures.

Diagnosis (Major Operations)	Total patients
Acute EDH (craniotomy + hematoma evacuation)	4
Acute SDH (decompressive craniotomy)	3
Intracranial SOL (craniotomy + Tumor Resection)	10 (Meningioma-4, pituitary apoplexy-4, Glioma –2)
Intracranial Aneurysm + avm (Aneurysm Clipping + AVM excision + Coiling)	15 (10 + 1 + 4)
Posterior fossa Hematoma (decompressive)	1
CP angle schwannoma (RMSOC + tumor excision)	5
Cervical spine fracture + spinal tumor (laminectomy + fixation/tumor resection)	4 (2 + 2)
Posterior fossa tumor ( Suboccipital craniotomy + Tumor resection)	8 (medulloblastomas + ependymomas)
Intracerebral Hematoma ( craniotomy + Hematoma evacuation)	2
<b>Minor Operations</b>	<b>Total patients</b>
Hydrocephalus (VP shunting)	13
Hypertensive bleed with intraventricular extension (EVD insertion)	3
Chronic SDH (Burr hole)	4
Abscess Drainage (Burr hole)	4

Category IV, Patients were operated after 1 month. This includes degenerative spine disease with pain, supratentorial space occupying lesions with headache and seizures. Category V patients were stable non operable patients like minor head injuries or stable spinal injuries, inoperable glioblastomas, stroke. (Table 1)

The surgeries needing more than 1–2 h of exposures were categorized in major group and less than 1 h were categorized in minor group.

### 5. Results

In emergency, total 133 patients were attended during lockdown period. Out of this, 90 were admitted in which 38 were female and 52 were male. Mean age was 36.33 years. Total 76 patients underwent procedures/operations (Table 2). Out of this 16 patients (21.05%) were operated within 24 h without waiting for result of RT-PCR (Category I). Majority of the cases were done after spending first 5–7 days (category II) after admission (40.8%). Around 21.05% patients were operated after 14 days and before 1 month (Category III). Only 13 patients were operated after 1 month of their admission (Category IV). Around 14 patients were admitted, observed and got discharged. (Category V) There were 52 major operations and 24 minor operations (Table 3.). Out of 90 patients that got admitted, two came out as positive and rest 88 were negative. One was having hypertensive bleed with intraventricular extension. In this patient EVD was inserted after wearing full PPE kit. Other was chronic SDH with severe mass effect which came with poor GCS (GCS-5). Here twist drill was done and hematoma evacuated. But both the patients eventually succumbed. One Covid negative patient became covid positive at 10th postoperative day on routine testing. However she was asymptomatic. She was transferred to covid positive ward and discharged from there after testing negative on RT-PCR.

### 6. Discussion

After lockdown from 25th march, the whole Outpatient Department (OPD) was closed. All patients with minor ailments were advised to stay at home and only emergency patients were getting attended at trauma and emergency. From the beginning, contact details of the department

arriving in emergency. After triage from institute, our department was also categorizing the patient on the basis of severity.

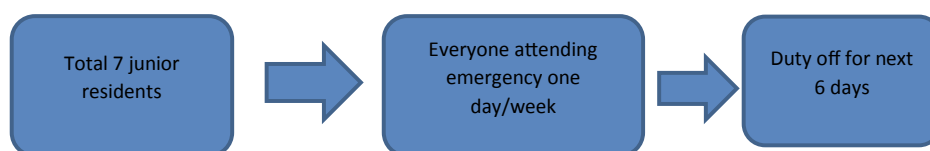
It was observed that just by differentiating the cases into emergency and elective procedure, we are just avoiding the bay and not the storms. Most of patients with benign intracranial or spinal pathologies will land up in emergency within days or months. So by doing triage we are just segregating emergency and urgent cases at that particular point of time. Even after development of vaccine, covid-19 is going to stay for a longer period of our life. So we needed a triage system where we can deal with all types of cases with avoidance of covid exposure.

The study from Italy has provided a framework for creating an emergency task force, streamlining a stringent protocol and adequate training to achieve zero infection and transmission rate [7,8]. They have created treatment hubs with interchanging of neurosurgeons along with transport of patients from one hospital to other hospitals. They also created a task force which helped in reducing non-urgent cases. Most of the urgent neurosurgical procedures were performed by a strict number of operators [7]. It was not possible for us, because our institution is the only institution where active and specialized neurosurgical procedures is happening presently in the whole state of Bihar having a population of more than 120 million.

#### 6.1. Health system organization in neurosurgery department (at AIIMS Patna) during covid crisis as per recommendations

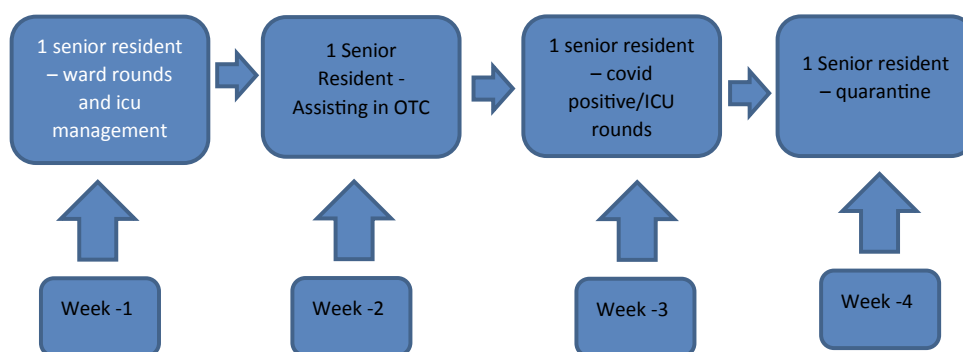
1. Our team was composing of seven junior residents, four senior residents and two actively working faculties. We made a team of seven residents who were attending and admitting the patients from emergency. All emergencies were first attended by our junior residents. One resident was given an emergency duty of 24 h followed by 6 days off. They were exempted from duties of ward and ICU. Each resident was covered by senior resident and one faculty on alternate days.

2. All senior residents were rotated weekly. One Resident was fixed for taking rounds of covid negative patients in the ward and ICU for 1 week. In second week he got shifted to operation theatre. His assistance



were getting circulated in local newspapers for benefit of the patients. For initial 15 to 20 days, patients having traumatic head injury and spinal injury were getting admitted. Than later on stroke, aneurysm rupture and large intracranial space occupying lesions also started

was utilized for 1 week. During third week he got shifted to covid ward and he was taking rounds of covid positive/covid suspected patients followed by 1 week of quarantine.





**Fig. 1.** Neurosurgery resident in Level – 3 protection kit (PPE kit) during rounds.

Above mentioned cycle was followed by each resident and it got repeated every month.

3. Two Faculties were actively working in the department. Both of them took alternate turns for operation theatre/ward rounds. Faculty A was posted on 1st and 3rd week, Faculty B on 2nd and 4th week. Both the faculties were getting 1 week of quarantine.

Following this protocol we maintained minimal interaction between faculties, senior residents and junior residents. It was followed till 30th June 2020. After that our hospital got converted from covid care center into covid dedicated hospital and all emergency services were closed.

## 6.2. Preoperative period

All preoperative patients were received in trauma and emergency and flu clinic as outpatient services were closed. At first step corona screening was done. It included clinical history, clinical examination and thermal screening. Patients coming positive on corona screening were admitted under corona suspected ward/ICU (Total 10 patients). Nasopharyngeal swab was sent from respected ward/ICU. Out of these two came out positive on RT-PCR. It was attended by neurosurgical residents after wearing Level – 3 protection kit (full body suit, N-95 mask, head and shoe cover, goggles). (Fig. 1) Lifesaving procedures were done in corona suspected ward, bed side only like EVD (external ventricular drain) insertion, twist drills. If RT-PCR comes positive, then patient is shifted in corona ward/corona ICU for further management. Category I patients were planned for urgent surgeries and category II patients were planned for surgery within 5–7 days. These patients were



**Fig. 2.** Patients in Neurosurgical ward with adequate physical distancing between beds (yellow arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

operated under strict covid protocol and again shifted back to covid ICU. A dedicated transportation route is recommended during this covid pandemic [9,10]. And our department complied with it and neurosurgical patients were carried to operation theatre complex (OTC) from different route. The whole route was sanitized once the transportation was completed. It is advised to do CT chest for all the patients [9–12]. But it was not possible at our institute. Patients who were negative on corona screening were attended by our junior residents after wearing N-95 mask and head shields. Consultations regarding all patients were taken telephonically to senior residents and faculties (along with video calls if necessary). (Flow chart attached) Tele-consultations were highly encouraged. Triage was done for all patients and patients with mild or suboptimal symptoms were discharged from holding areas. Rests of the patients were admitted in non covid trauma ward/Trauma ICU maintaining social distancing. (Fig. 2) Nasopharyngeal swab for all the patients were sent.

In Trauma ward/ICU total 80 admissions took place. On RT-PCR all came out as negative. Negative patients were shifted to neurosurgical ward/Neurosurgical ICU.

Sensitivity of RT-PCR of different body fluids had been analyzed and published in JAMA. In this bronchoalveolar lavage fluid is the most sensitive specimen (93%), followed by sputum (72%), nasal swab (63%), fibrobronchoscope brush biopsy (46%), pharyngeal swabs (32%), feces (29%), and blood (1%) [13]. But we don't recommend multiple testing from different sites even if it can improve sensitivity and reduces false-negative results. However we recommend multiple modalities of investigations like chest X ray, RT-PCR from swab along with thermal screening and most important clinical assessment. At our institution only corona screening, chest X ray and RT-PCR for nasopharyngeal swab was done for all the patients. Recent guidelines at present recommend a single upper respiratory nasopharyngeal swab for suspect cases [14]. Also a recent survey has indicated that, nasopharyngeal swab was the preferred method for screening (86%), followed by CT scan (26%), and chest radiograph (25%). Some respondents indicated more than one screening method, especially those from Italy (57%) and India (19%), where the most common combination was the nasopharyngeal swab with chest radiograph [9].

The most important thing during preoperative period is mobilization of patients. It is the most important factor as patient can acquire these infections from hospital surroundings. We suggest that mobilization should be grossly restricted. Radiological investigations like chest X ray, CT, MRI and DSA should be done after keeping in mind the usefulness of these in planning surgery. If possible, all should be done in single transportation and sittings [9,12].

*Flow chart showing how institute and department handled the*

**cases. (Preoperative period)**

**Intraoperative precautions and post-operative management of patients**

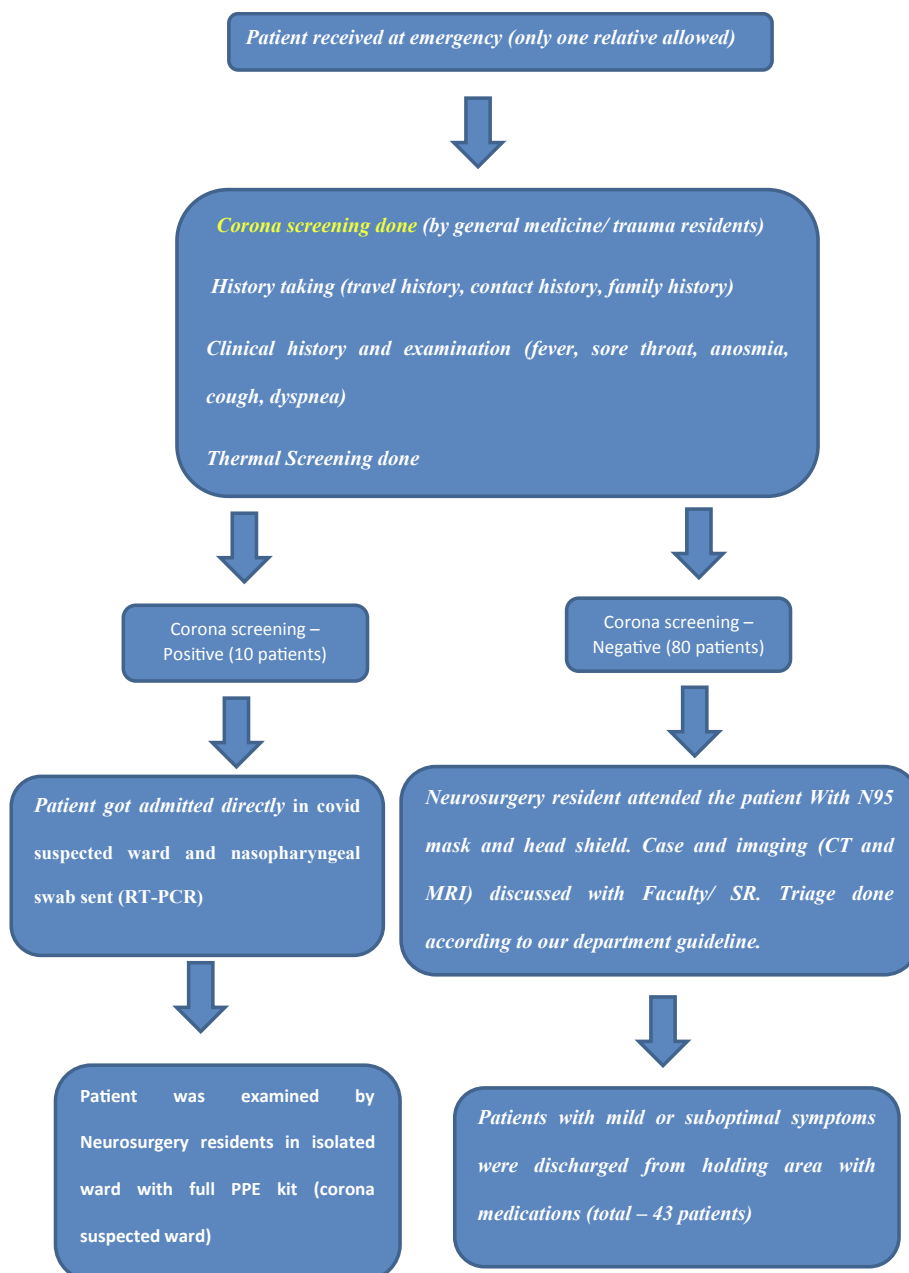
All Patients were operated under strict Covid operating room protocol.

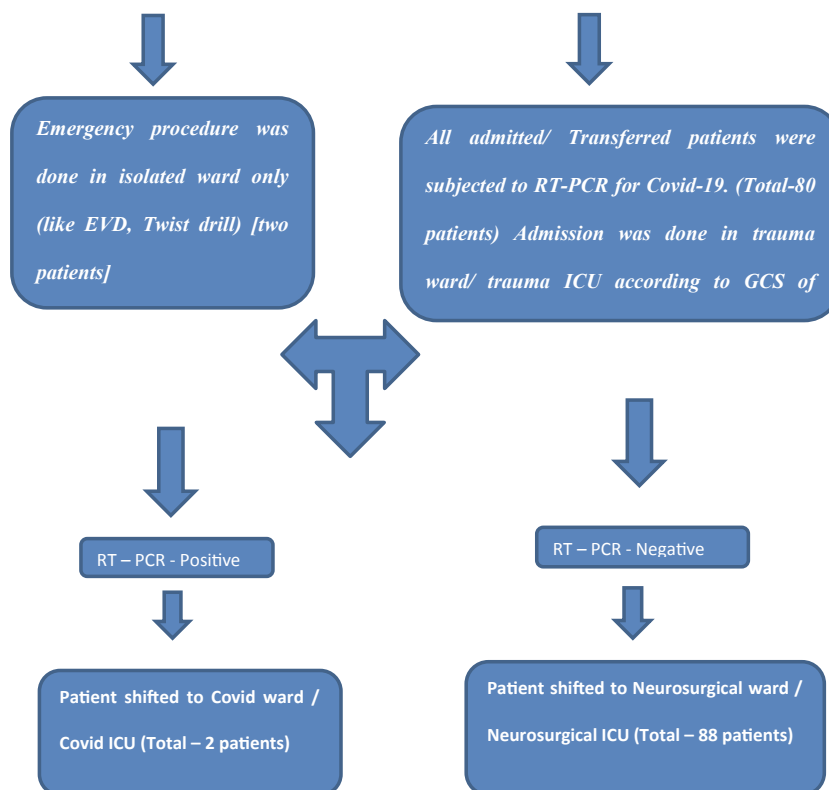
**Training** – It has been shown by Hoz et al that without sufficient quantity of PPE kit and also without adequate training, the whole system will collapse and staff will suffer along with the patients [15].

So a proper training is mandatory for the whole surgical team before going for any surgery. A rigid training was given to all dedicated neurosurgical staff, technicians, residents and faculties to prepare for emergency cases. All steps (in sequence) were revised for many days in a dummy class by neurosurgical residents and faculties. Multiple classes were taken for proper donning and doffing sequence of PPE kit for all the staff. Already neurosurgical procedure needs a very smooth coordination of staff and operating surgeon which was stressed during this

pandemic. Movement of technicians and staff were kept very minimal. And neurosurgical nursing staff was allowed to assist only on the allotted specific days for surgery for a week followed by quarantine on next week. For initial 1 month preferably accidental cases were taken for surgery, as this surgery needs less expertise from neurosurgical point of view. It will also give neurosurgical team and staff to acclimatize to work in pandemic atmosphere. Avoiding surgeries is neither beneficial for the surgeons and nor for the patient. So battling the fear and rigorous training can only help us achieving zero infection rates with good post-operative results.

**Operation theatre complex (OTC)** – Negative pressure operation theatre complex (OTC) is needed during such pandemic to avoid transmission of infection [9,11,12]. It was advised to have dedicated Operation theatre for neurosurgery during this pandemic [9,12]. But Survey has indicated that majority of institutions and centers had not done it [9]. However as it was getting not possible in our institute, we opted for High air flow OTC to reduce viral load. After each operation





the OTC was fumigated twice with sodium hypochlorite (1%) before taking up another case. In OTC, all major Neurosurgical equipment was covered with sterile covers. Operating microscope was covered with drape and vision guard. C-arm was draped with sterile covers.

**Anesthesia** – Patient got intubated by anesthetists after wearing Personal Protection Equipment (PPE). Patient face was covered with square transparent box during intubation. As anesthetist are in direct contact, risk of aerosol dispersion is maximum during intubation, hence it has been suggested that the whole face area may be covered by a transparent sheet and the hands may be inserted under the sheet to intubate the patients, while the edges should be stuck to the surface. A preferred protocol is the use of a separate room for intubation and then bringing the patient to the OR, so the risk is minimized to the surrounding health personnel [11,12]. However as it was not possible at our center, our anesthetist opted for intubation after wearing PPE kit and head shield. During anesthetic procedure (intubation, arterial line insertion, Central line insertion), all neurosurgical team was advised to stay outside.

**Operative procedure** – Patient positioning was done after wearing N95 mask and head shield. During initial phase while we were not having any PPE kit for OTC, we utilized “Universal Precaution Kit” for performing surgeries. Later on we switched over to PPE kit. It has been advised that surgical procedure should be performed after wearing level – 3 protections Kit [11,12,16–18]. Only disposable items were utilized in surgeries like coverings, draping and gowns at our center. It is mandatory to wear two layers of surgical gloves to avoid infection from breakage of gloves. All surgeries should be performed after proper distribution of various stages to different surgeons. Aerosol dispersal and blood spillage should be minimal [17,18].

At our center, only one surgeon at a time was involved in operative procedure. Opening and closure was done by senior residents. Middle portion of surgery was performed by the faculty. For complicated and long procedure, other faculty was kept on standby. During Macroscopic phase (craniotomy, laminectomy) of surgery, head shield and eye goggles were utilized. (Fig. 3) Throughout the drilling process, copious

irrigation was continued to allow minimal dispersal of aerosols. Drilling was kept at minimal level to avoid dispersal of aerosol. Operative procedure was done slowly and meticulously, especially the opening phase to avoid blood loss and spillage. (Fig. 4A and 4B) Craniotomy utilizing Hudson burr and gigli wire/saw should be avoided. It causes inappropriate dispersal of bone dust and blood. Also it is very cumbersome to use and injury prone.

**Transnasal vs transcranial approach** – Throughout the pandemic and even after opening of lockdown, we are continuously giving transnasal approach (both microscopic and endoscopic) a back seat. Transcranial and spinal procedures are considered as safe. CSF dissemination of virus has been rarely reported. Only one case from china and one from japan has been reported with covid meningitis [17]. However during pandemic, we should treat all cases of neurosurgery as covid positive case. By avoiding transnasal route we are also nullifying the chances of invasive covid meningitis.

**Operative time** – Many of the neurosurgical procedures needing longer stay in OTC can be deferred. However some of them needing urgent intervention like Giant craniopharyngiomas, skull base tumors (giant vestibular schwannomas, glomus jugulare), bypass for giant aneurysms, multiple intracranial tumors (neurofibromatosis) and multiple aneurysms can be staged. Longer contact period with the patient on OT table is one of the factors for surgeons getting infected with covid [10,18]. Young neurosurgeons with good experience, precision and adequate speed should perform major surgeries, as they can sustain longer time and contact period in OTC. Neurosurgeons with comorbidities (Like COPD, hypertension, and diabetes mellitus) and age more than 50 years should not opt for performing major surgeries at this time of pandemic. However trainees should be given a back seat at this moment of epidemic.

**Postoperative period** – Ideally all post-operative patients should be categorized as covid suspected. They should be quarantined in ward. It has been recommended to take throat swab and do a CT chest at least thrice weekly [9,10,12]. Majority of the patient in neurosurgery get shifted in ICU. So ventilators and monitors are necessary equipment.



**Fig. 3.** Main and assisting surgeon in Operation theatre complex showing full body coverage + N-95 mask + head shield + goggles (During macroscopic phase).

Also nutritional support is very important to regain natural immunity in post-operative period [9,10,12].

At our center, all patients were shifted to Neurosurgical ICU in post-operative period. Air duct of ventilators were getting replaced daily. Nasopharyngeal swab was sent and chest X ray also done but only once

in two weeks. We avoided unnecessary mobilization of patient post-operatively for multiple investigations. All the patients were started with early feeding, either orally or Ryle's tube feeding. Immunosuppressive drugs like steroids were avoided in majority of the patients in post-operative period.

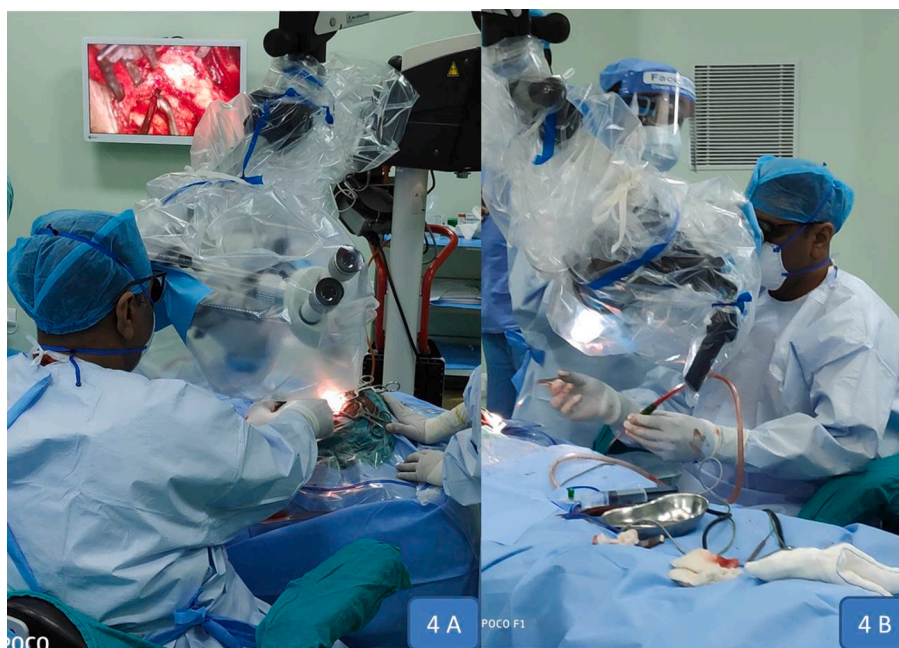
Mobile CT machine and Mobile X ray machines should be used aggressively during this pandemic and cover should be destroyed after each round of utilization [9,10,12]. We kept a separate X ray machine and technician for neurosurgical ICU. As mobile CT was not available, timing slots were given to respective departments. Our patients were mobilized for postoperative or preoperative NCCT head or MRI/DSA at allotted time slots.

None of the patients came positive on immediate postoperative swab. However one patient of ICA cavernous segment aneurysm (ICA trapping was done) came positive in the ward after 15 days. On repeating PCR of rest of the patients in adjacent bed, it came negative. We fumigated that section of ward covered with glass shield.

Multiple articles have suggested that patients with stable condition should be postponed [7–10,12,18,19–21]. The COVID-19 outbreak had a relevant impact on surgical planning. In survey by Fontanella et al most have responded with a significant change in surgical activity in their institutions (92%) [9]. The majority (94%) performed only urgent and emergency procedures; with few had (6%) completely closed the entire neurosurgical department. There is 70% reduction of surgical interventions. Delaying elective procedures will contain the spread of SARS-CoV-2 by reducing no of visits and it will also reduce possibility of treating asymptomatic carriers [19–21]. By following this zero infection and transmission rate can be achieved.

However, as ours is an apex center catering around 120 million population, we developed our own triage system. We categorized the patients according to the condition of the patient. Stable patients were postponed but not cancelled indefinitely. They were taken up at later date after doing an RT-PCR of nasopharyngeal swab just before the operative procedure. At our department, the number of cases dipped minimally. However, number of elective cases went down but emergency cases went up significantly. As most of the private hospitals in our state got closed, our load remained fairly constant.

**Academic Activities** – Intra-hospital and intradepartmental movements were restricted and minimum residents were kept for functioning



**Fig. 4.** A and 4B – Intraoperative photograph during microscopic phase. Head shield is out. Sterile drape covering over microscope can be appreciated.



of the department. It is suggested that all the academic activities like mortality meetings, journal club, and case discussions should be done through video conferencing and webinars. It is also recommended that physical distancing should be maintained during rounds and departmental meetings also [22]. We strictly adhered to it. However from 1st July, all rounds, operative teachings and classes were suspended. All the residents came into common pool and got involved in covid patient care only. But we are still continuing with webinars and online classes.

**Future plan** – It has been outlined that Telemedicine and telephonic communication is the future [9,22]. Our department is planning to initiate telemedicine for patients both telephonically and on video calls. It will help us to follow our post-operative cases. Through this assessment of preoperative cases can be also be done and they can be given appointment for surgeries especially elective cases. Semi urgent cases can be followed weekly and in case of deterioration they can be called up to emergency directly. Our department is already having policy of giving contact details of our common duty mobile number to all our preoperative and post-operative patients and their relatives. During this pandemic we encouraged these types of communications significantly. This cell phone is carried by neurosurgical resident and covered by one of the faculty daily.

It was planned to give dates to all elective cases, so that they can plan their transportation and safety before arriving in OPD. They will come one day before opd and get themselves tested for covid-19. Maximum 20 new cases and 10 old cases will be entertained per day. We have planned to erect glass shield along with microphones so that clinical history can be taken maintaining physical distancing. Clinical examination will be done after wearing protection kit. MRI, CT scan, DSA will be done at our center. It will minimize our contact with fomites. If already done outside, every patient will be advised to carry DVD/CD of their imaging. Majority of these things we had already started and practicing in our institute and department. However due to conversion of hospital into covid dedicated center, it took back seat. As patients are piling up, sooner we will restart our department and center with same protocol. However as more cases of covid related encephalitis are getting reported, it may get delayed [23].

## 7. Conclusion

During corona pandemic, it is advised to do meticulous triage of neurosurgical patients. Adequate planning and sufficient training is necessary to avoid any untoward incident of infection. Proper utilization of limited human resources and infectious kit is needed at this time. Our planning, distribution of duties, triage of patients with safety in operation theatre complex has shown that zero infection and zero transmission rates can be achieved along with successful patient management.

Telemedicine and social media hold the crux for both patient management and student teaching in future. Also Covid – 19 has taught us that life always finds a way to live, to work and to enjoy.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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