



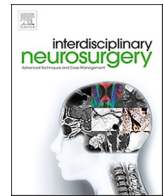
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Analyzing outcomes of neurosurgical operations performed before and during the COVID-19 pandemic in Egypt. A matched single-center cohort study

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ABSTRACT

Background: Since the emergence of the first COVID-19 case in Wuhan, the virus affected several health care systems. Globally, the COVID-19 has a transforming effect on health care provision. Substantial evidence was clear that the global surgical services were impacted. The field of neurosurgery was primarily affected, and most elective surgeries were suspended. There are no current reports from Egypt that describe the mortality outcome of neurosurgical procedures in the context of the pandemic.

Methods: We performed that study at a large tertiary center in Egypt (Cairo University Hospital). It is a single-center matched cohort study.

Results: Our results examined about 346 patients earlier during the COVID-19 pandemic. About 46 (13.29%) were unmatched, so we excluded them from the final analysis of the data. About 300 patients' were matched to 304 patients' before the pandemic in 2019. The mortality outcome of neurosurgical interventions was higher during the pandemic.

Conclusions: Amid the COVID-19 pandemic, the mortality outcome of neurosurgical procedures was higher than on regular days at our center. The anesthesia time was prolonged while the operation time was shortened. We strongly suggest further multicenter studies to assess the effect of COVID-19 on neurosurgical mortality and functional outcome.

1. Introduction

Since the emergence of the first COVID-19 case in Wuhan, the virus affected health care systems [1]. Globally, the COVID-19 has a performative effect on health care provision [2]. Substantial evidence was clear that the global surgical services were impacted [3]. Although the vanguards involved were the ICU, emergency, and chest physicians, neurosurgeons were indirectly involved [4]. The field of neurosurgery was primarily affected, and most elective surgeries were suspended [5].

Furthermore, neurosurgeons were allocated to work as intensivists, and patients were subject to testing for COVID-19 even before urgent surgeries [6–8]. The neurosurgical education was also dramatically

afflicted [9–11]. Unlike other surgical specialties, neurosurgery is an ICU-demanding specialty. The patient may need an ICU bed at varying stages, whether preoperatively or postoperatively. The pandemic has changed several aspects of neurosurgical services, predominantly in developing countries.

In Egypt, the first case of COVID-19 was reported in February 2020 [12]. By December 2020, Egypt confirmed about 22,151 reported COVID-19 cases [13]. Egypt has a total population of more than 100 million [14]. To reduce the pandemic impact, the Egyptian government has forced lockdowns. Neurosurgery is not a commonly served specialty in many regions in Egypt. Tertiary university centers are entrusted with most of the neurosurgical services there. Several studies explain how

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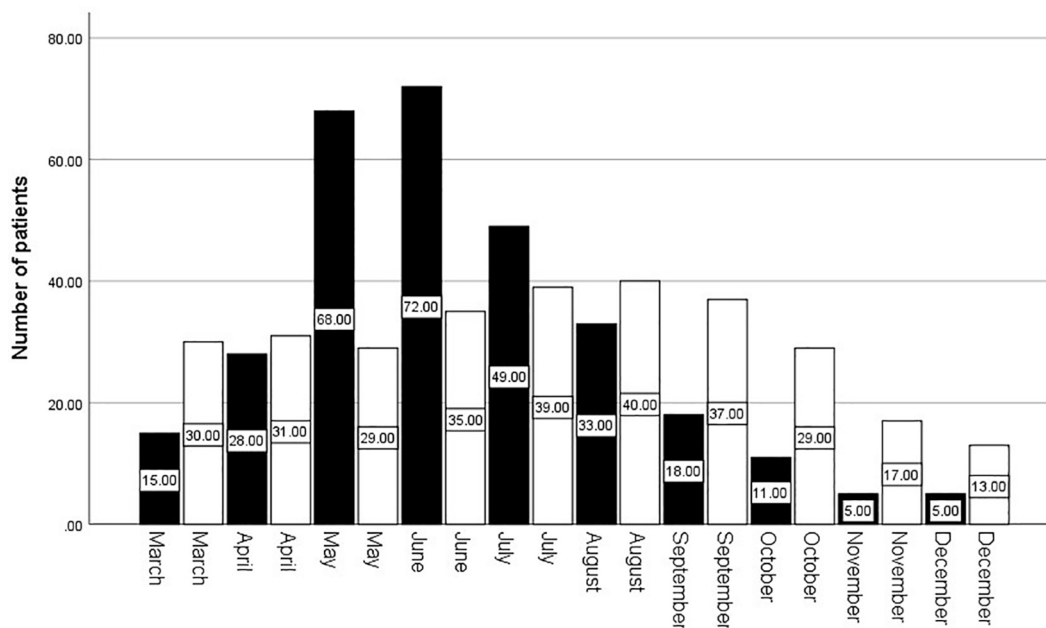


Fig. 1. Distribution of the patients' among the pandemic (black) and matched (white) groups. The partial lockdown period of COVID-19 was between April 2020 and June 2020.

centers worldwide reestablished their strategies to offer maintained neurosurgical service [4,15,16]. There are no current reports from Egypt that describe the mortality outcome of neurosurgical procedures in the context of the pandemic. We tried to compare the outcomes of patients admitted for neurosurgical procedures amid the summit of the pandemic against a matched cohort before the pandemic.

2. Methods

2.1. Study design

We performed that study at a large tertiary center in Egypt (Cairo University Hospital). It is a single-center matched cohort study. We obtained institutional review board approval from the ethical committee at Cairo University (Number = 2021089). Cairo University hospital is a large center in Egypt. It receives a lot of neurosurgical patients from

urban and rural areas.

2.2. Patients and data acquisition

Surgical procedures performed during the pandemic period were matched with an expected time before the pandemic. We examined the cases in the period from March to December in 2020 for the pandemic. The period from March to December in 2019 represented before the pandemic time. We matched patients regarding age, sex, neurosurgical subspecialty, mean operative and anesthesia time, and a one-month mortality outcome. Procedures included all that done under general anesthesia. We excluded the outpatient or the ward-based simple procedures.

We categorized patients into a pandemic and matched groups from the hospital admission records. Also, the demographic, clinical, and operative data were extracted from the patients' files. Demographic data

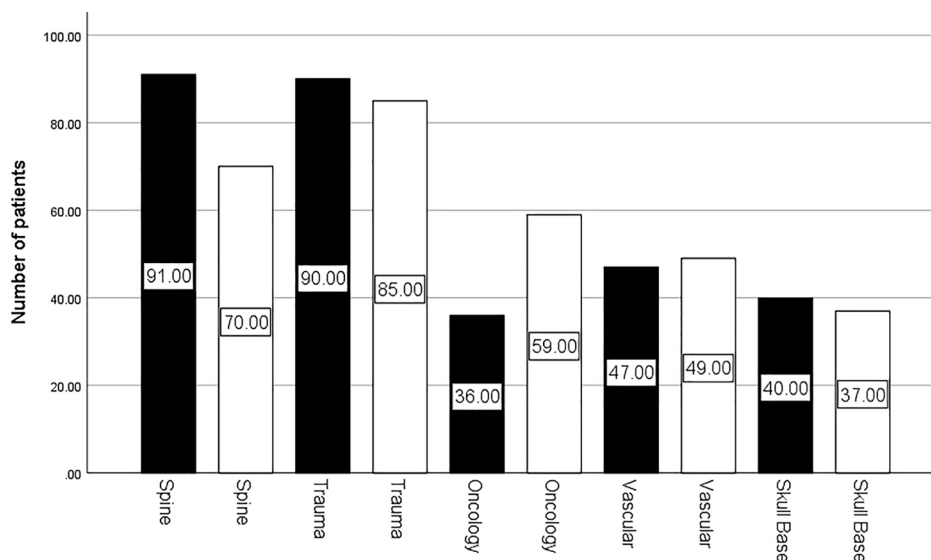


Fig. 2. Distribution of the patients according to the subspecialty. Black (pandemic group) and white (matched group).

Table 1

Major outcomes and GOS comparison for both of the pandemic and matched cohort groups.

	Pandemic (n = 304)	Matched (n = 300)	Statistical Significance (P-value)
One-month mortality	45 (14.8%)	27 (9%)	0.04
Post-operative pulmonary complications	37 (12.17%)	32 (10.66%)	0.03
GOS 4–5	255 (83.9%)	273 (91%)	0.033
GCS 1–3	37 (12.17%)	20 (6.66%)	0.068

included age and sex. Operative data included the operating staff rank, the primary subspecialty, the operative time, and the anesthesia time. We categorized the operating staff as per Cairo University Hospital into junior, senior resident, junior, senior registrar, and junior, senior consultant. We defined the preoperative anesthetic time as admitting the patient into the operation room until the start of the skin incision. The operative time was considered from the beginning of the skin incision till closure. We considered patients COVID-19 positive according to the nasopharyngeal PCR swab results. We divided the patients as per specialties into trauma, spine, oncology, vascular, and skull base surgery. Mean age for pandemic group was 58.46 (10.3), 198 (65.1%) were males. Mean age for matched group was 49.38 (8.91), 136 (45.3%) were males.

2.3. Statistical methods

We conducted this study according to Strengthening the Reporting of Observational Studies in Epidemiology guidelines for cohort studies (STROBE). We did all statistical analysis using SPSS 26.0. Patients with missing data were excluded from the study. We considered statistical significance as P greater than 0.05. We used Chi² test for our statistical analysis.

3. Results

Our results concluded that 346 patients during the early phase of the COVID-19 pandemic. 46 (13.29%) were unmatched, so we excluded them from the final analysis of the data. About 300 patients' were matched to 304 patients' before the pandemic in 2019.

The mean age of the participants in the pandemic group was 48 years (SD = 5.2). The matched group had a mean of 50 years (SD = 3.4). We did not find any statistical significance between the age of either group (p = 0.159 (95% CI = -1.2 - 1.9)). In the matched group, 156 (52%) were males, while 170 (55.9%) were males in the pandemic group. No statistical significance between gender in both groups was found (p = 0.65). The distribution of the patients according to the month and subspecialty in both the pandemic and matched groups is listed Fig. 1 and Fig. 2. About 288 (94.7%) of the pandemic group patients were urgent neurosurgical cases. While in the matched group, 268 (89.3%) of the cases were urgent neurosurgical cases.

3.1. Major outcomes

We found a statistical significance in one-month mortality and postoperative pulmonary complications between the pandemic and matched groups Table 1.

3.2. Minor outcomes

Glasgow Outcome Scale (GOS) results are listed in Table 1. The mean Length of Stay for the pandemic group was seven days (SD = 3.5); the mean length of stay for the matched group was nine days (SD = 4.8). There is no statistical significance between either the pandemic and

Table 2

Surgical operations-related data.

	Pandemic (n = 304)	Matched (n = 300)	Statistical Significance (P-value)
Neurosurgeon's Grade			
Junior Resident	30 (9.86%)	28 (9.33%)	0.6
Senior Resident	46 (15.13%)	32 (10.66%)	0.7
Junior Registrar	59 (19.4%)	49 (16.33%)	0.04
Senior Registrar	33 (10.85%)	54 (18%)	0.03
Junior Consultant	38 (12.5%)	66 (22%)	0.1
Senior Consultant	98 (32.23%)	71 (23.66%)	0.005
Mean pre-operative anaesthesia time by minutes (SD)	48 (12.3)	44 (10.5)	0.026
Mean operative time by minutes (SD)	94.3 (11.4)	98 (8.3)	0.07
Mean post-operative anaesthesia time by minutes (SD)	23 (5.8)	15 (8.9)	0.016

matched groups (p = 0.06). Surgical operations-related data are listed in Table 2.

3.3. Covid-19

From the pandemic group, 21 patients (6.9%) tested COVID-19 positive. Swab test was done in both pre and post-operatively Table 3.

4. Discussion

Despite the global effect of the COVID-19 pandemic, several aspects of knowledge are still deficient in developing countries. Several studies identified different COVID-19 risk factors and complications [17–19]. Variable reports have discrete results about the risk factors and mortality rates of COVID-19 internationally [20–24]. Due to the complexity of problems requiring neurosurgical interventions and the associated morbidities, it is imperative to assess the effect of COVID-19 on mortality outcomes.

In our center, during the pandemic, any leaves or unnecessary work vacations were canceled to exploit all the workforce. Strict regulations were applied to stop any gatherings and to apply social distancing with two meters allowed between each person. Transmission of medical data was through electronic routes as emails, chatting, social media, and messaging groups that aided in tracking new events. That abated the need for meetings that may expose healthcare workers to infection hazards. Documents and essential questionnaires were collected electronically to be available later for documentation. All staff involved in patient care used PPEs as much as possible. During intubation and extubation, the anesthetic team had complete personal protective equipment (PPE) to avoid exposure to the aerosol.

We tried to evaluate the outcome of operative neurosurgical procedures in the setting of the COVID-19 pandemic. We found that the mortality outcome was affected by the pandemic compared with the non-pandemic time. This is the first study to examine the effect of COVID-19 on mortality outcomes in neurosurgical patients in Egypt.

The only significant result in this study is related to the outcome. We noticed that the mortality rate was higher in the pandemic group. We also found that pulmonary complications were more in the pandemic group than in the matched cohort. We can relate that to the extreme strain over the hospital care services during the pandemic that dismantled the delivery of proper care to post-surgical patients. A study at University Hospitals Birmingham (UHB) found no difference in the mortality outcome of patients undergoing neurosurgical procedures [25]. Frederick Rault reported that the number of deaths among traumatic brain injury (TBI) patients was reduced during the first pandemic lockdown in France [26]. Teemu Luostarinen et al. found no change in

Table 3
COVID-19 positive cases details.

Patient ID	COVID-19 pre-operative swab	COVID-19 post-operative swab	Post-operative pulmonary complications	One-month mortality	GOS at discharge	Length of stay
1	Positive	Positive	Pneumonia	Survived	5	21
2	Positive	Positive	Pneumonia	Survived	5	18
3	Positive	Positive	ARDS	Survived	3	20
4	Positive	Positive	ARDS	Survived	2	15
5	Negative	Positive	Unexpected postoperative ventilation	Mortality	4	0
6	Positive	Positive	Pneumonia	Survived	5	33
7	Negative	Positive	Pneumonia	Survived	1	28
8	Positive	Positive	Pneumonia	Survived	3	23
9	Negative	Positive	Unexpected postoperative ventilation	Mortality	3	0
10	Positive	Negative	Pneumonia	Survived	3	21
11	Positive	Positive	Pneumonia	Mortality	2	0
12	Positive	Positive	Unexpected postoperative ventilation	Survived	5	19
13	Negative	Positive	Pneumonia	Survived	4	21
14	Positive	Positive	Unexpected postoperative ventilation	Survived	1	24
15	Positive	Positive	ARDS	Survived	1	25
16	Positive	Negative	Pneumonia	Survived	5	27
17	Negative	Positive	Unexpected postoperative ventilation	Survived	3	31
18	Positive	Positive	Pneumonia	Survived	1	34
19	Positive	Negative	ARDS	Survived	4	14
20	Negative	Positive	ARDS	Survived	5	14
21	Negative	Positive	Pneumonia	Survived	2	21

ARDS: Acute Respiratory Distress Syndrome; GOS: Glasgow Outcome Scale.

TBI and aneurysmal subarachnoid hemorrhage prognosis during the pandemic [27]. Azab et al. in their meta-analysis found that complications and mortality were higher in COVID-19 negative glioma patients [28], which is not the same as in this study.

The preoperative anesthesia time was prolonged in the pandemic group compared to standard practice. We can relate that to the time spent by the staff in applying PPEs and precautions to limit exposure to the aerosol. Moreover, we noticed also that the operative time in the standard practice was longer. Most surgeons at our center tried to limit the time spent with the patients in the operating room to reduce the contact. The study conducted in the University Hospitals Birmingham (UHB) did not find any change in the anesthesia or operating time [25].

This study has several limitations. Other factors that may increase the mortality in the pandemic group as medical comorbidities were not matched in our study. This is a single-center study that is why the authors strongly recommend that larger, multicenter studies should be recruited. The sample size of this study is small and more data will be further needed to support the results of this study. The medical records at Cairo University are disorganized, which makes data acquisition a difficult process.

5. Conclusion

Amid the COVID-19 pandemic, the mortality outcome of neurosurgical procedures was higher than on regular days at our center. The anesthesia time was prolonged while the operation time was shortened. We strongly suggest further multicenter studies to assess the effect of COVID-19 on neurosurgical mortality and functional outcome.

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Author contributions

All authors contributed to the article and approved the submitted version.

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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