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Patients awaiting surgery for neurosurgical diseases during the first wave of the COVID-19 pandemic in Spain: a multicentre cohort study

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ABSTRACT

Objectives The large number of infected patients requiring mechanical ventilation has led to the postponement of scheduled neurosurgical procedures during the first wave of the COVID-19 pandemic. The aims of this study were to investigate the factors that influence the decision to postpone scheduled neurosurgical procedures and to evaluate the effect of the restriction in scheduled surgery adopted to deal with the first outbreak of the COVID-19 pandemic in Spain on the outcome of patients awaiting surgery.

Design This was an observational retrospective study.

Settings A tertiary-level multicentre study of neurosurgery activity between 1 March and 30 June 2020.

Participants A total of 680 patients awaiting any scheduled neurosurgical procedure were enrolled. 470 patients (69.1%) were awaiting surgery because of spine degenerative disease, 86 patients (12.6%) due to functional disorders, 58 patients (8.5%) due to brain or spine tumours, 25 patients (3.7%) due to cerebrospinal fluid (CSF) disorders and 17 patients (2.5%) due to cerebrovascular disease.

Primary and secondary outcome measures The primary outcome was mortality due to any reason and any deterioration of the specific neurosurgical condition. Second, we analysed the rate of confirmed SARS-CoV-2 infection.

Results More than one-quarter of patients experienced clinical or radiological deterioration. The rate of worsening was higher among patients with functional (39.5%) or CSF disorders (40%). Two patients died (0.4%) during the waiting period, both because of a concurrent disease. We performed a multivariate logistic regression analysis to determine independent covariates associated with maintaining the surgical indication. We found that

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This was a multicentre, tertiary-level, observational retrospective study of patients awaiting any neurosurgical procedure during the first wave of the SARS-CoV-2 pandemic in Spain.
- ⇒ The primary outcome was mortality due to any reason and any deterioration of the specific neurosurgical condition.
- ⇒ This study is a snapshot of an evolving pandemic with huge variation of its effects between centres according to the community SARS-CoV-2 incidence at the time of the first peak of the pandemic and hospital size.
- ⇒ The quality of the data depends on the accuracy of data collection by the collaborators, although active supervision and discussion of discordant information were performed during the study.

community SARS-CoV-2 incidence (OR=1.011, p<0.001), degenerative spine (OR=0.296, p=0.027) and expedited indications (OR=6.095, p<0.001) were independent factors for being operated on during the pandemic.

Conclusions Patients awaiting neurosurgery experienced significant collateral damage even when they were considered for scheduled procedures.

INTRODUCTION

The SARS-CoV-2 pandemic has affected healthcare systems worldwide more severely than ever in recent history. Spain was one of the developed countries most severely stricken by the first outbreak.[1] On 30 June 2020, 252 878 cases had been diagnosed, 103 225 were hospitalised, 8372 were admitted to intensive care units (ICUs) and 29 567 had died from the disease.[2]

Difficulties accessing and the fear of non-infected patients visiting the emergency service caused a delay in the diagnosis and treatment of new cases.[3] The large number of infected patients requiring hospital admission and mechanical ventilation resulted in scheduled procedures being postponed, conversion of operating rooms into ICUs and task shifting from surgery to COVID-19 of staff members of surgical teams.[4 5] Thus, surgery might be disproportionately affected by the pandemic more than other medical processes. In addition, outpatient clinics were initially halted until telemedicine emerged as a method to follow the neurological condition of patients awaiting surgery and prioritise patients who should have undergone scheduled surgeries despite the pandemic.[6–8]

Special attention has been given to the effect of COVID-19 on patients undergoing surgery during the first wave of the pandemic,[9 10] but limited information is available about scheduled case management and the effect on patients awaiting surgery at the same stage of the pandemic. High levels of stress due to the waiting time and fear of clinical worsening during the waiting period, even higher than the worry of being infected during hospitalisation, have been documented in neurosurgical patients.[11]

The aims of this study are to investigate the factors that influence the decision to postpone scheduled neurosurgical procedures and to evaluate the effect of the restriction in scheduled surgery adopted to deal with the first outbreak of the COVID-19 pandemic in Spain on the outcome of patients awaiting surgery.

MATERIALS AND METHODS

Study design

On June 2020, a national call for data collection of patients with any neurosurgical disease evaluated during the first wave of the COVID-19 pandemic (COVIDNeurosurg registry) was launched. It was supported and promoted by the Sociedad Española de Neurocirugía and the Sociedad de Neurocirugía de la comunidad de Madrid. A provider-profiling questionnaire was administered in all of the institutions that accepted the invitation to collaborate to evaluate the characteristics of each neurosurgical service and the maximum percentage of hospital beds dedicated to patients with COVID-19 during the first wave of the pandemic (online supplemental file 1).

This was an observational, retrospective, multicentre study conducted according to Strengthening the Reporting of Observational Studies in Epidemiology guidelines.[12] Patients who fulfilled the following inclusion criteria and none of the exclusion criteria were recorded in the registry.

Patient inclusion criteria:

- ► Children and adult patients awaiting any neurosurgical procedure registered in the surgical lists between 1 March and 30 June. Patients included in the surgical list before the pandemic started but who did not undergo surgery during the period of study were also included in this subgroup of patients.
- ► Patients who underwent any neurosurgical procedure, irrespective of their urgency and complexity, during the same period of the study.
- ► Confirmed diagnosis of any neurosurgical disease: intracranial and spinal tumour, haemorrhagic cerebrovascular disease, traumatic brain injury, acute spine injury, degenerative spine disease, cerebrospinal fluid (CSF) disorders and functional neurosurgery.

Patient exclusion criteria:

- ► Patients with any neurosurgical disease for which conservative management was preferred before the pandemic started.

Patient subgroups (non-operated and operated) were created according to their situation at the end of the period of study, as explained in figure 1.

An online database was used to collect anonymised data and stored on a secure data server running the Research Electronic Data Capture web application of data platform.[13] The data were audited for duplicates or discordant information.

Data variables

Demographic characteristics, medical history, clinical data, date of diagnosis and inclusion in the surgical list, emergency of the procedure, reason to not perform the surgery during the first peak of the pandemic and

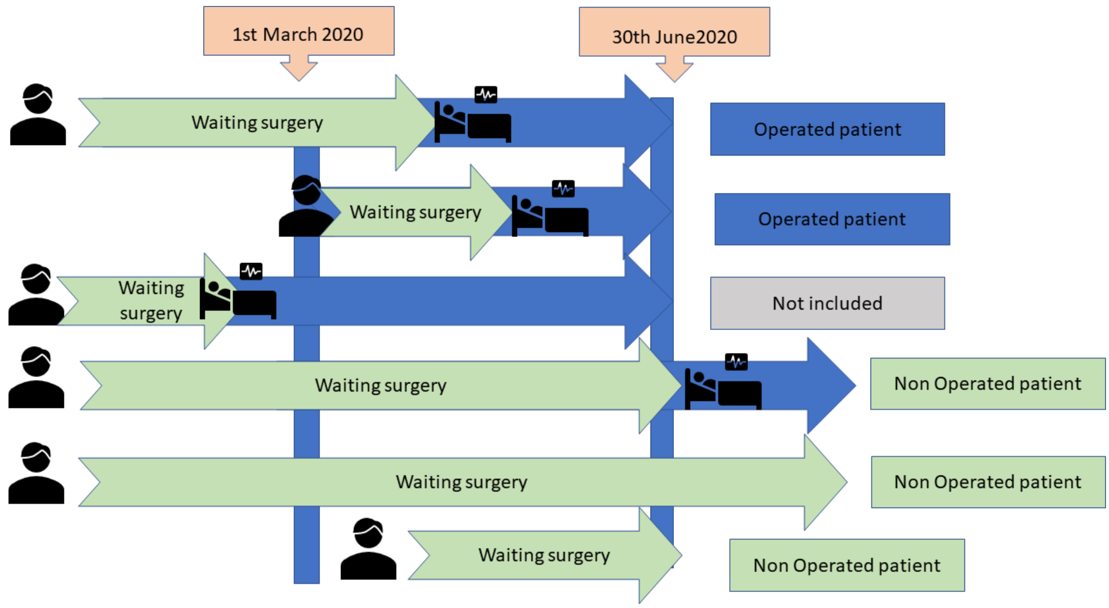

Figure 1 Patient subgroups according to their condition of being operated or not operated during the study period. Created by the authors.

alternative treatment while the patient was awaiting surgery (online supplemental file 2) were recorded. Emergency procedures were defined by the following criteria, and they were assigned by the referring surgeon:

- Immediate: for conditions that are life-threatening.
- Urgent: for conditions that have the potential to deteriorate quickly and should be planned within 48 hours after diagnosis.
- Expedited: conditions requiring surgery desirable within 4 weeks after diagnosis.
- Elective: conditions that can wait more than 4 weeks after diagnosis to be planned.

Community SARS-CoV-2 incidence

The community SARS-CoV-2 incidence within each participating hospital was extracted from the Ministry of Health official data.[2 14] SARS-CoV-2 incidence was calculated for each epidemiological 1-week (from Monday to Sunday) window based on the number of confirmed SARS-CoV-2 cases at the smallest available administrative level (province). Then, each patient was assigned the 7-day incidence of the week he or she was included in the surgical list.

Outcome measures

Patient outcomes were reviewed at least up to the end of the period of inclusion of the study. All patients were followed by clinical telephone interviews, and imaging studies were performed in cases of suspicion of worsening according to the attending neurosurgeon.

The primary outcome was mortality at the end of the period of follow-up due to any reason and clinical deterioration or radiological progression of the specific neurosurgical condition according to the opinion of the attending neurosurgeon. In addition, we analysed the rate of confirmed SARS-CoV-2 infection defined by a positive swab test and/or CT thorax imaging highly suggestive of SARS-CoV-2 infection.

Statistical analysis

Descriptive statistics are represented as the median and IQR for quantitative measures and absolute frequency and its relative percentage for qualitative measures.

The COVIDNeurosurg registry covered operated and non-operated patients evaluated in the collaborative centres in the period of the study. Although the main objective of this study was non-operated patients, we recruited operated and non-operated patients from the registry to determine which factors were independently associated with not postponing a scheduled procedure during the pandemic. First, we excluded immediate and urgent surgeries that can bias the evaluation of imbalance between operated and non-operated patients. Then, differences in quantitative and categorical data were calculated by the Mann-Whitney U test and X^2 test, respectively. Finally, a multivariable logistic regression analysis was used to calculate ORs and 95% CIs for each independent covariate significantly related to being operated on during the pandemic. Additionally, we investigated whether surgery is a risk factor for acquiring SARS-CoV-2 infection. Thus, we performed a logistic regression analysis including the community SARS-CoV-2 incidence, preoperative swab test and being operated on during the study period to determine their effect on acquiring the infection.

All statistical analyses were performed using SPSS V.25 (IBM).

Patient and public involvement

Patients were not involved in setting the research question, definition of outcome measures, design or implementation of this study. After the publication of the study, there are plans for the results to be disseminated to the patient community affected by this research, which would help to motivate them to inform their physician when they experience any kind of worsening.

RESULTS

Centres and setting

Eight hospitals from six provinces (attending an approximate population of 10 483 134 people[15]) accepted the invitation to collaborate and registered patients who were included in the surgical list but finally were not operated on during the period of study. All the participating centres are based on the public health system and are tertiary-level hospitals. Madrid is the region with the highest number of participating centres (three centres).

The burden of the COVID-19 pandemic was estimated by means of the total number of in-hospital beds dedicated to patients with COVID-19 during the first wave of the pandemic. Four centres had occupations above 80%, one centre had occupations between 50% and 80%, and three centres had occupations below 20%.

Patient characteristics

Among 1593 patients included in the COVIDNeurosurg registry, 680 (42.7%) patients were awaiting surgery at the end of the period of inclusion of the study. The sex distribution was 350 (51.5%) and 330 (48.5%) for men and women, respectively. The median age was 56 years old (IQR=21), with 652 adult patients and 28 children. The American Society of Anesthesiologists (ASA) category was grade I or II in most patients (521, 76.7%). According to the patients' medical history, 164 patients (24.1%) had none of interest. Frequently found pre-existing medical conditions were hypertension (245 patients, 36%), smoking (160 patients, 23.5%), diabetes mellitus (88 patients, 12.9%) or dyslipidaemia (48 patients, 7.1%).

Regarding neurosurgical disease, 470 patients (69.1%) were awaiting surgery because of spine degenerative disease, 86 patients (12.6%) due to functional disorders, 58 patients (8.5%) due to brain or spine tumours, 25 patients (3.7%) due to CSF disorders and 17 patients (2.5%) due to cerebrovascular disease. A minority of patients with traumatic spine injury (six patients, 0.9%), traumatic brain injury or its consequences such as calvaria defects (five patients, 0.7%) or infectious disease (two patients, 0.3%) were waiting for surgery.

Patient characteristics are detailed in table 1.

Scheduled procedures and reason to delay surgery

In relation to the emergency of the procedures, most cases (646 patients, 95%) were considered elective surgeries, and 34 patients (5%) were considered expedited surgeries. When we asked about the main reasons to postpone the procedures to the end of the pandemic, no bed or theatre space available was noted for 417 patients (61.3%). Patient choice to avoid the surgery was indicated for 115 patients (16.9%), but the surgeon's decision to delay the surgery due to risk to patients was reported for 256 patients (37.6%). A change in clinical status due to other medical conditions (12 patients, 1.8%) was another reason to not operate.

Among the 470 patients with degenerative spine disease, 120 patients (25.5%) were included in a rehabilitation programme, 139 patients (29.6%) were evaluated by chronic pain units and 268 patients (57%) were followed by the attending surgeon during the waiting period. Among the 58 patients with a diagnosis of brain or spine tumours awaiting surgery, 3 patients (5.1%) received neoadjuvant chemotherapy, and 2 patients (3.4%) received neoadjuvant radiation. None of the patients with a diagnosis of cerebrovascular disease were redirected to radiation therapy or endovascular treatment.

Outcome

At the end of the follow-up, 173 patients (25.4%) experienced clinical deterioration, and for another 6 patients (0.9%), radiological progression of the neurosurgical disease was detected during the waiting period. Twenty-six patients (3.8%) experienced worsening due to concurrent disease not related to COVID-19. The subgroups of patients with the highest rate of deterioration were those waiting for functional neurosurgery (39.5%) and those with CSF disorders (40%). Among functional neurosurgical diseases, 60% were patients with chronic pain (such as chronic back pain, complex regional pain syndrome, trigeminal neuralgia), 28% were patients with refractory epilepsy and 12% were patients with Parkinson's disease or other movement disorders. Among these three main categories, the group with the highest rate of worsening was the epilepsy subgroup of patients (45.8% experienced deterioration).

Six patients (0.9%) had confirmed SARS-CoV-2 infection while they were waiting for surgery. Two patients died (0.4%) during the waiting period, both because of a concurrent disease. Outcome measures are detailed in table 2.

Comparison between operated and non-operated patients

Emergent and urgent surgeries were discarded to investigate factors related to not postponing a scheduled procedure (expedited or elective surgeries). By means of the univariate analysis, non-operated patients showed a higher rate of hypertension (36% vs 30.7%, p=0.043), current smoking (23.5% vs 15.5%, p<0.001), asthma (5.7% vs 2.8%, p=0.011) and obesity (4.6% vs 1.8%, p=0.026). However, we found that non-operated patients had a lower rate of arrythmia (0.7% vs 2.2%, p=0.030). A trend for a higher rate of congestive heart failure (2.9% vs 1.5%) and chronic kidney disease (3.2% vs 1.7%) was also noticed for non-operated patients. The distribution of the ASA grades was also significantly different, with higher grades to the operated subgroup, probably in relation to the severity of the neurosurgical disease that was being treated. According to the specific neurosurgical disease, we observed a different distribution between

Table 1 Patient demographics and clinical characteristics: comparison between operated and non-operated patients

Number of patients	Non-operated 680	Operated 913	Comparison between groups (p value)
Age (median. IQR)	56 (21)	56 (29)	0.992
Sex	Male 350 (51.5%) Female 330 (48.5%)	Male 487 (53.3%) Female 426 (46.7%)	0.460
Epidemiological week*	4 (7)	19 (10)	<0.001
Community SARS-CoV-2 incidence*	7 (31)	33 (20)	<0.001
Weight/BMI	75 kg (21)/ 29.5 kg/m^2 (6.3)	70 kg (22)/ 26.1 kg/m^2 (9.5)	0.026 0.051
ASA grade			
Unknown	9 (1.3%)	18 (2%)	<0.001
Grades I and II	521 (76.7%)	582 (63.7%)	
Grades III and IV	149 (22%)	305 (33.4%)	
Grade V	0	8 (0.9%)	
Medical history			
None	164 (24.1%)	208 (22.8%)	0.533
Hypertension	245 (36%)	303 (33.2%)	0.238
Diabetes	88 (12.9%)	152 (16.6%)	0.041
Dyslipidemia	48 (7.1%)	75 (8.2%)	0.393
Current smoker	160 (23.5%)	134 (14.7%)	<0.001
COPD	37 (5.4%)	34 (3.7%)	0.100
Asthma	39 (5.7%)	28 (3.1%)	0.009
Ischaemic heart disease	32 (4.7%)	36 (3.9%)	0.456
Obesity	31 (4.6%)	23 (2.5%)	0.026
Congestive heart failure	20 (2.9%)	19 (2.1%)	0.272
Chronic kidney disease	22 (3.2%)	18 (2%)	0.111
Arrhythmia	5 (0.7%)	25 (2.7%)	0.004
Specific pathology			
Oncology	58 (8.5%)	286 (31.3%)	<0.001
Degenerative spine	470 (69.1%)	163 (17.9%)	
TBI	5 (0.7%)	111 (12.2%)	
Haemorrhagic cerebrovascular disease	17 (2.5%)	115 (12.6%)	
CSF	25 (3.7%)	93 (10.2%)	
Functional	86 (12.6%)	42 (4.6%)	
Traumatic spine injury	6 (0.9%)	40 (4.4%)	
Infectious	2 (0.3%)	24 (2.6%)	
Paediatric specific	11 (1.6%)	39 (4.2%)	
Priority of the surgery			
Emergent	0	193 (21.1%)	<0.001
Urgent (<48 hours)	0	120 (13.1%)	
Expedite (<4 weeks)	34 (5%)	248 (27.2%)	
Elective (>4 weeks)	646 (95%)	352 (38.6%)	
SARS-CoV-2 infection			
Not confirmed/suspected	674 (99.1%)	889 (97.4%)	Not appropriate
Awaiting surgery	6 (0.9%)	5 (0.5%)	
Preoperative screening	0	6 (0.7%)	
In-hospital admission	0	5 (0.5%)	
After hospital discharge <30 days	0	7 (0.8%)	
After hospital discharge >30 days	0	1 (0.1%)	

*median week and SARS-CoV-2 rate of new cases at provice level by the time which the procedure was performed for Operated patients or patient was included into the surgical list for Nonoperated patients.
ASA, American Society of Anesthesiologists; BMI, body mass index; COPD, chronic obstructive pulmonary disease; CSF, cerebrospinal fluid; TBI, traumatic brain injury.

Table 2 Outcomes of non-operated patients at the end of the study period

	Clinical deterioration and radiological progression	Clinical deterioration without radiological progression	Radiological progression without clinical deterioration	New-onset disease, non-related to COVID-19	Non-deterioration	Death
Oncology	1 (1.7%)	2 (3.4%)	0	1 (1.7%)	53 (91.4%)	1 (1.7%)
Degenerative spine	12 (2.6%)	110 (23.4%)	5 (1.1%)	16 (3.4%)	326 (69.4%)	1 (0.2%)
TBI	0	1 (20%)	0	0	4 (80%)	0
Haemorrhagic cerebrovascular disease	1 (5.9%)	0	0	3 (17.6%)	13 (76.5%)	0
CSF	0	10 (40%)	0	2 (8%)	13 (52%)	0
Functional	0	34 (39.5%)	0	3 (3.5%)	49 (57%)	0
Traumatic spine disease	0	1 (16.7%)	0	1 (16.7%)	4 (66.7%)	0
Infectious	0	0	1 (50%)	0	1 (50%)	0
Paediatric	0	1 (0.1%)	0	0	10 (90.9%)	0

CSF, cerebrospinal fluid; TBI, traumatic brain injury.

subgroups, which was especially relevant to degenerative spine disease (69.1% vs 25.8%) and neuro-oncology (8.5% vs 43.5%). Among oncology patients, we found that the percentage of surgeries indicated for a tumour with suspicion of malignancy was significantly lower in the non-operated subgroup (5.2% vs 46.7%, $p<0.001$). No significant difference was observed in the rate of surgical indication for relapsed tumours between non-operated and operated patients. A comparison of operated and non-operated patients in this new dataset after exclusion of immediate and urgent cases is detailed in online supplemental file 3.

In figure 2, we display for each epidemiological week the number of new inclusions in the surgical list, number of patients being operated on and the remaining number of patients waiting for surgery and its relationship with community SARS-CoV-2 incidence. Data regarding the epidemiological weeks before the start of data collection in this study are limited to those patients who were included in the surgical list during those weeks and were not operated on by the end of the time frame of this study. Thus, we found that there was a reduction in the number of new inclusions in the surgical list while the first wave of the pandemic evolved. This occurred even when the community SARS-CoV-2 incidence declined significantly, leading to a partial recovery of scheduled surgical activity. However, we also compared the total number of patients who were waiting for a scheduled procedure at the end

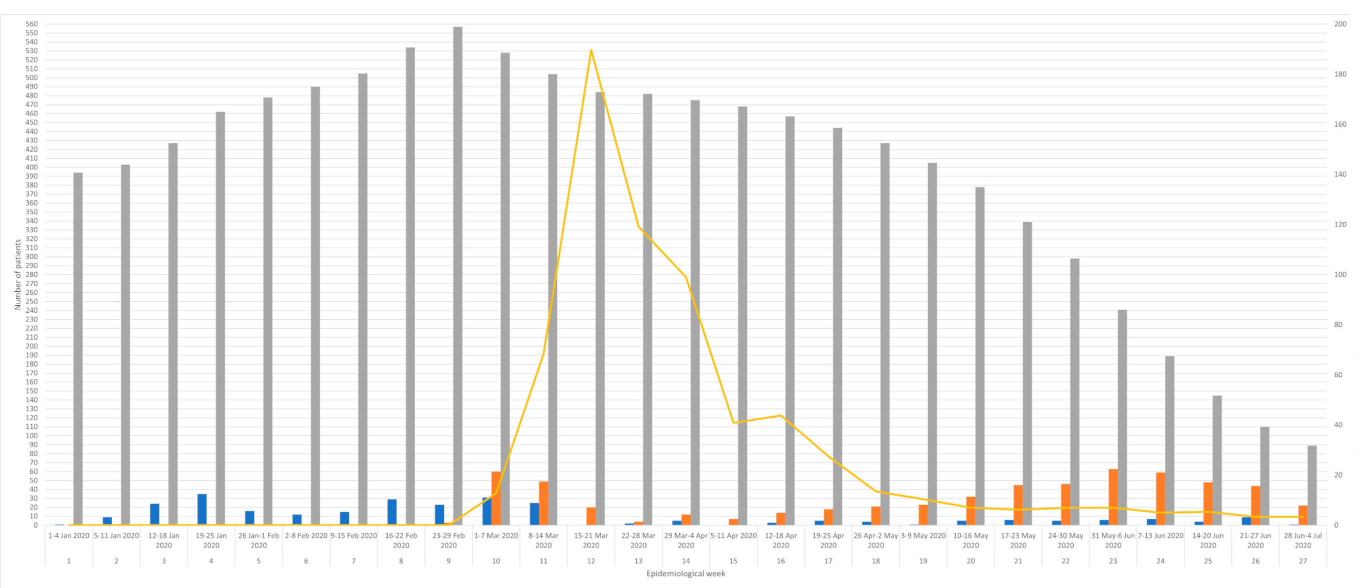

Figure 2 Bar plot of the number of new inclusions (blue), cumulative number of patients in the surgical list (grey) and number of operated patients (orange) per epidemiological week and their association with community SARS-CoV-2 incidence. Created by the authors.

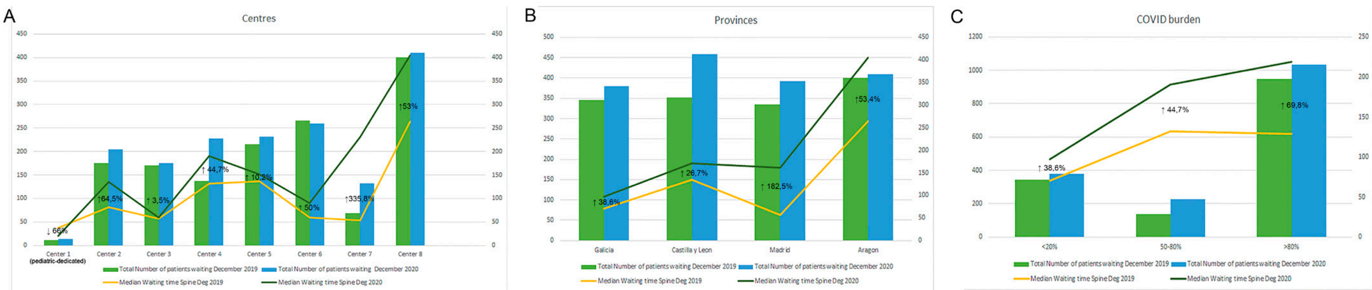

Figure 3 Bar plot of the median number of total number of patients who were waiting for a scheduled procedure at the end of 2019 and 2020 and the median waiting time for degenerative spine disease for the same periods. (A) Data for each collaborative centre, (B) data for each province, (C) data according to COVID-19 burden (percentage of hospital beds occupied by patients with COVID-19). Created by the authors.

of 2019 and 2020 and the median waiting time for degenerative spine disease for the same periods (data available from our Ministry of Health). We detected an important increase in median time that patients were waiting to be operated on for degenerative spine disease proportional to the COVID-19 burden (figure 3).

Afterwards, we performed a multivariate logistic regression analysis to determine independent covariates associated with maintaining the surgical indication. All covariates associated with being operated on according to the univariate analysis by a p value of <0.10 were included in the model. We found that community SARS-CoV-2 incidence (OR=1.011, 95% CI 1.006 to 1.016, p<0.001), degenerative spine (OR=0.296, 95% CI 0.101 to 0.869, p=0.027) and expedited indications (OR=6.095, 95% CI 3.956 to 9.389, p<0.001) were independent factors for being operated on during the pandemic.

In relation to COVID-19, a higher percentage of operated patients (24 patients, 2.6%) acquired the infection at different time points compared with non-operated patients (6 patients, 0.8%). Although it seemed to be a significant difference according to the univariate analysis (p=0.037), when we ran a logistic regression analysis including the community SARS-CoV-2 incidence, the results from the screening swab test and being operated on in the model, we found that the only factor independently related to the acquisition of the infection was the community SARS-CoV-2 incidence (OR=1.012, 95% CI 1.06 to 1.018, p<0.001).

Details of the logistic regression analyses are described in table 3.

Table 3 Logistic regression analysis for determining factors associated with being operated on and acquiring SARS-CoV-2 infection during the first outbreak of the pandemic

Multivariate logistic regression analysis for being operated during the first outbreak of the pandemic			
	OR	**95% CI**	**P value**
Community SARS-CoV-2 incidence	1.011	1.006 to 1.016	<0.001
Weight			0.449
Hypertension			0.154
Current smoker			0.373
Asthma			0.586
Obesity			0.422
Congestive heart failure			0.22
Chronic kidney disease			0.405
Arrhythmia			0.063
ASA grade			0.717
Degenerative spine disease	0.296	0.101 to 0.869	0.027
Expedited indication for surgery	6.095	3.956 to 9.389	<0.001
R^2 Nagelkerke			0.418
Multivariate logistic regression analysis for acquiring SARS-CoV-2 infections during the first outbreak of the pandemic			
	OR	**95% CI**	**P value**
Community SARS-CoV-2 incidence	1.012	1.06 to 1.018	<0.001
Screening swab test			0.604
Surgery			0.991
R^2 Nagelkerke			0.167

ASA, American Society of Anesthesiologists.

DISCUSSION

Summary of key results

A rise in mortality and complications in patients undergoing any kind of surgery and being infected by SARS-CoV-2 in the perioperative period has been previously reported.[9] Additionally, the detrimental effect of the pandemic, even in the absence of perioperative infection on patients undergoing neurosurgery, was also described by our group. This fact is probably secondary to the overload of the healthcare system with the shifting of personal and hospital resources to patients with COVID-19.

To our knowledge, this is the first multicentre study to evaluate the consequences of the restriction to scheduled surgery developed to cope with the pandemic outbreak. The results of our study are a glimpse of the impact of the first peak of the COVID-19 pandemic in neurosurgery patients in Spain. Neurosurgeons are trained to recognise emergencies and those operations that will need ICU management and therefore mechanical ventilation support. Only two patients died during the study period, one oncology patient and one patient with degenerative spine disease, and both deaths were related to concurrent diseases. We consider that telephone supervision is effective in detecting life-threating worsening that could be managed even during healthcare crises. However, more than a quarter of the patients awaiting surgery during this period of the pandemic experienced a deterioration of their clinical condition that could not be dealt with during the pandemic. This occurred even though periodical telephone interviews were established as a method to follow up in most of the collaborative centres, and most patients were considered for scheduled surgeries. Differences in baseline patient characteristics were observed between non-operated and operated patients, but patient comorbidities did not remain as independent factors related to being operated on. Interestingly, being operated on during the first peak of the pandemic was not a risk factor for acquiring COVID-19 according to our data. Then, hospitals were a safe place for COVID-19-free patients when their neurosurgical conditions needed attention. This finding can likely be explained by the establishment of a preoperative swab test and separated circuits and dedicated professionals for non-infected and infected patients.[9] According to the results displayed in figure 2, the number of new inclusions in the surgical list remained reduced compared with the pre-pandemic levels, although the community SARS-CoV-2 incidence significantly decreased after the lockdown. We hypothesise that this can be partially explained by the residual effect from the first outbreak on a limited recovery of the availability to neuroimaging and other diagnostic processes in combination with the drop in outpatient activity of those departments that usually transfer patients to the neurosurgery department, such as family medicine, neurology and orthopaedic surgery. Additionally, uncertainty about the next waves to overcome could strengthen the reluctance of neurosurgeons and patients to increase the surgical list.

Only 58 (8.5%) patients awaiting surgery were neuro-oncology patients. Most of them were suggestive of meningioma (14, 24.6%), pituitary adenomas (12, 21%) or schwannoma (10, 17.5%). How to triage neuro-oncology cases has been recommended by different associations focusing on malignant tumours or those patients with symptoms related to raised intracranial pressure.[16 17] Accordingly, surgical resources have been almost entirely dedicated to malignant neuro-oncology cases (high-grade gliomas, metastasis). However, this shift can be debated, as surgical treatment improves progression-free survival more significantly than overall survival.[18] We detected that 8.6% of patients experienced deterioration, and thus it is critical that outpatient radiology and contact with the attending neurosurgeon remain accessible for patients even during the worst phases of the pandemic.

For the rest of the neurosurgical conditions, the determination of clinical or radiological factors to recommend the delay of the procedure is more challenging. Several surgical and neurosurgical societies have proposed different algorithms and triage systems to prioritise among the variety of conditions considered, but they lack applicability to evaluate individual risks.[8 19–21] Then, mild disagreement was noticed in a survey among neurosurgeons who were asked to determine the risk and urgency of different scenarios.[22] According to our data, the largest shift to being non-operated during the first peak of the pandemic was experienced by patients with degenerative spine disease, and it remained the only clinical condition independently associated with postponed procedures. When we compared the pre-pandemic and pandemic conditions (figure 3), the median waiting time of these patients raised significantly, especially in centres with high burden of patients with COVID-19. Of these patients, 27% experienced deterioration during the waiting period even when telephone follow-up was provided to them. We could not imagine the application of another triage structure that would have allowed these procedures to be performed when resources were extremely limited. However, the aim of this study is to evaluate the consequences of that measure on patient outcomes and to be aware of the further effect of going on with this measure during future waves. Although these conditions are not life-threatening, delayed treatment can influence definite loss of functionality[23] and increase indirect costs related to work absenteeism. Consequently, psychological symptoms, such as anger and sadness, and the economic impact due to surgical cancellation of elective surgeries have also been documented.[24]

On the other hand, clinical deterioration was even more frequently observed in patients with functional (39.5%) or CSF disorders (40%). These subgroups of patients can be considered more vulnerable to becoming critically ill if they become infected, but treatment on time can reduce mortality and the need for residential nursing care. Attention to the consequences of postponing surgical treatment in normal pressure hydrocephalus was brought up before by La Corte and Palandri.[25] They found an increase of 60% in visit appointments due to clinical deterioration, which is a higher rate compared with our findings, as 40% of patients with CSF disorders experienced worsening during the waiting period.

The collateral damage of the COVID-19 pandemic in patients with other diseases is probably not feasible to accurately measure due to several factors: the sum effect of deaths of unknown cause before reaching the hospital during lockdown, delayed diagnosis, difficulties in accessing care, postponed scheduled procedures and increased mortality in the perioperative period owing to SARS-CoV-2 infection and reallocation of resources. However, the silent detrimental effect of the pandemic in patients without COVID-19 will continue for the near future as subsequent waves beat a weakened health system and professionals. After several waves, the number of patients awaiting surgery increased exponentially to a higher level compared with the pre-COVID-19 era due to the ratio of inclusion in surgical lists/scheduled surgeries and the partial resumption of diagnostic tests and outpatient clinics. We still claim to heads of the healthcare systems and governments to ensure the care of patients with neurosurgical diseases. In these conditions, early treatment determines a favourable prognosis in terms of neurological recovery, quality of life and reduction of indirect cost. Strategies could be based on the sparing of theatre capacities, working hours and hospitals dedicated to surgical patients.

Limitations

This study has some limitations. First, this study is a snapshot of an evolving pandemic with huge variation of its effects between centres according to the community SARS-CoV-2 incidence at the time of the first peak of the pandemic and hospital size. Although we launched a national call to collaborate, the registry covered data from neurosurgical departments from 6 out of 17 Spanish main regions; thus, there is a risk of bias to over-representation of centres more severely affected by the first wave of the pandemic, as represented by the percentage of total beds dedicated to patients with COVID-19. Second, the definition of deterioration is based on the opinion of the attending neurosurgeon for each patient, and we were not able to discern the symptoms or radiological changes experienced by each patient. Finally, the quality of the data depends on the accuracy of data collection by the collaborators, although active supervision and discussion of discordant information were performed during the study.

CONCLUSIONS

More than one-quarter of patients awaiting scheduled neurosurgery experienced clinical or radiological deterioration. The rate of worsening was higher among patients with functional or CSF disorders. Apart from measures related to the state of the community SARS-CoV-2 epidemiology, the diagnosis of spine degenerative disease was the single independent factor to be not operated during the first peak of the pandemic.

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