



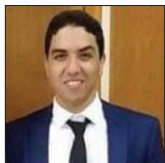
Original Article

Will the high acceptance rate of coronavirus disease 2019 vaccine in Morocco accelerate the recovery of neurosurgical practice?

Farid Zahrou, Yassine Ait M'barek, Tarik Belokda, Badr Draï, Hasna Abdourafiq, Lamia Benantar, Khalid Aniba

Department of Neurosurgery, Ibn Tofail Hospital, Mohammed VI University Hospital, Marrakesh, Morocco.

E-mail: *Farid Zahrou - farid.zahrou87@gmail.com; Yassine Ait M'barek - yassineaitm1@gmail.com; Tarik Belokda - tarikbelokda@gmail.com; Badr Draï - drbadrai2@gmail.com; Hasna Abdourafiq - hasnabdourafiq@gmail.com; Lamia Benantar - lamiaabenantar@gmail.com; Khalid Aniba - aniba.khalid@yahoo.fr



*Corresponding author:

Farid Zahrou,
Department of Neurosurgery,
Ibn Tofail Hospital, Mohammed
VI University Hospital,
Marrakesh, Morocco.
farid.zahrou87@gmail.com

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ABSTRACT

Background: In developing countries, where there is a chronic shortage of neurosurgeons and medical infrastructures, the pandemic has taken a heavy toll on neurosurgical activities. In the absence of a curative treatment, reaching herd immunity through mass vaccination campaigns is the best hope we have of ending this pandemic. Therefore, the purpose of our study was first to assess the effect of coronavirus disease 2019 (COVID-19) outbreak on neurosurgical services of a Moroccan tertiary hospital. Secondly, we aimed to describe current vaccination compliance rate in our country, and its impact on the recovery of neurosurgical practice.

Methods: To examine how COVID-19 challenged the neurosurgical delivery of care in our unit, we compared emergency and elective admissions during COVID-19 and pre-COVID-19 period using the registry of neurosurgery department. Second, after evaluating vaccine acceptance rates among 1463 healthcare workers and patients admitted to our hospital, we compared the number of surgeries performed in our department after implementation of a mass vaccination campaign.

Results: The overall number of procedures dropped from $n = 197$ (pre-COVID-19) to $n = 150$ during COVID-19. The number of elective surgeries declined from an average of 10.5 operations per week before COVID-19 to four surgeries per week during the COVID-19 pandemic. Conversely, an average of 3.5 emergency operations was performed each week before COVID-19 compared to 5.6 per week during the pandemic. On the other hand, our results showed that willingness to get the COVID-19 vaccine among the participants was high (81.7%) with significantly less hesitant individuals among healthcare workers ($P = 0.001$). This successful vaccine rollout helped resuming gradually elective surgeries in our department.

Conclusion: Our study found a high acceptance rate of COVID-19 vaccines among Moroccans, which gives a glimmer of hope of restoring all our neurosurgical services. However, despite the high acceptance rate, the authorities must address concerns among hesitant individuals and raise awareness on the importance of COVID-19 immunization.

Keywords: Acceptance, Coronavirus disease 2019, Impact, Neurosurgery, Vaccine

INTRODUCTION

In December 2019, coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) emerged in Wuhan, China.^[33] Since then, the virus has

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spread in an enormous way to over 200 countries worldwide and officially declared as a pandemic by the World Health Organization (WHO) in March 2020.^[10] The whole world has been facing the unprecedented coronavirus health crisis over a year now.

In Morocco, the first case of COVID-19 was reported on March 2 in Casablanca, 2020.^[17] Although the Moroccan authorities made radical decisions to overcome the health-care system weaknesses, the virus has continued to spread across the country, increasing pressure on Moroccan hospitals. To cope with the high numbers of COVID-19 patients and the increased demand for intensive care beds, certain hospitals were prepared to manage COVID-19 cases. As a result, all surgical departments were forced to reduce elective and postponable surgeries, guaranteeing only emergency or high-priority operations. Surgeons were confronted with the challenging triage of patients into emergency, urgent and elective, which had real impact on disease progression and patient health outcomes.

To overcome this pandemic and recover from its devastating human, social and economic impact, all countries around the world try to get enough COVID-19 vaccines to immunize their communities. Morocco was no exception in this regard. Despite its limited resources, the North African kingdom has one of the most advanced vaccination programs. The country launched a nationwide vaccination campaign on January 28, aiming to vaccinate 80% of its citizens.^[21] However, Morocco, like other low- and middle-income countries, is facing difficulties in gaining access to the vaccines, as wealthier countries make bilateral deals and drive up the prices. Consequently, this inequality increases the risk of the spread of the virus in our country, given its current status of health-care system and its limited resources.^[8]

However, utility of vaccine campaigns is not merely dependent on vaccine availability and affordability. In fact, vaccine hesitancy remains a global challenge even among healthcare workers and appears to have a decisive role in the successful control of the pandemic.^[20] This could delay the restoration of elective surgeries and hospital activities. Identifying factors associated with vaccine acceptance is crucial to address COVID-19 vaccine hesitancy and guide interventional measures aimed at increasing this awareness in the general population. To the best of our knowledge, there is currently no study that highlights COVID-19 vaccine acceptance in Morocco. Therefore, the purpose of our study was first to assess the effect of COVID-19 outbreak on neurosurgical services of our hospital compared to the pre-COVID-19 period. And secondarily, we aimed to evaluate current vaccination compliance rates among healthcare workers as well as patients admitted to our hospital, and to evaluate the early impact of the national vaccination campaign on neurosurgical practice in our university hospital.

MATERIALS AND METHODS

Study design and data collection

To assess the impact of the COVID-19 pandemic on neurosurgical practice in Morocco, a single-center retrospective epidemiological study was conducted in our hospital, which is one of the major hospitals in our city, based in an urban area of 1.3 million inhabitants.

First of all, we described the global epidemiology of COVID-19 in our city based on the COVID-19 online database created by the Moroccan Ministry of Health.^[17] At the beginning, the government selected the Pasteur Institute of Morocco as COVID-19 national referral laboratory. Then, to increase the screening rate for the COVID-19 virus, the Ministry of Health selected other laboratories from the beginning of April 2020 between March 2, 2020, and June 28, 2021. 6,273,223 tests were carried out, for a rate of approximately 10,000 tests per day.^[3] However, Morocco's testing capacity for COVID-19 is 10 times lower than high-income countries, which hardly gives a clear picture of the real situation of the pandemic in the country.^[15]

To examine how COVID-19 challenged the neurosurgical delivery of care in our unit, we compared emergency and elective admissions during COVID-19 and pre-COVID-19 period using the registry of neurosurgery department. All neurosurgical procedures performed in our department between March 2, 2020, and June 28, 2020, were enrolled in our study. Data collected were: the surgery date, the number, and the types of surgical procedures performed during the study period. We also classified patients according to surgical urgency. Urgent cases included:

1. Brain tumor with cerebral herniation on MRI or worsening symptoms or acute hydrocephalus
2. Skull base tumors with worsening symptoms or visual disturbances
3. Acute hydrocephalus, shunt malfunction, and ruptured spina bifida
4. Aneurysm rupture or other acute vascular diseases
5. Neurotrauma, vertebro-medullary trauma, cauda equina syndrome, acute spinal cord compression, and paralyzing disk herniation.

Apart from these emergencies, the rest of the patients were included in elective surgery group. These data were then compared to those obtained in the "pre-COVID-19 period" (from March 2, 2019, to June 28, 2019), to assess the impact of the pandemic.

Second, to evaluate vaccine acceptance rates among Moroccan population, we distributed an anonymous questionnaire from January 1, 2021, to January 31, 2021, just before the beginning of the mass vaccination program in Morocco to healthcare workers and patients admitted to our

hospital within the study period. The questions were related to socio-demographic characteristics (age, gender, area of residence, marital status, and parenthood status), education level, employment status, financial status, underlying diseases, perceptions, risk factors for COVID-19, and willingness to get COVID-19 vaccination. With reference to previous studies,^[26] five response options were provided: very unlikely, somewhat unlikely, somewhat likely, very likely, and unsure. Then, participants who responded “very unlikely” or “somewhat unlikely” or “unsure” were presented with specific questions regarding the reasons for vaccine hesitancy. In total, responses from 243 healthcare workers and 1220 patients were collected. All participants provided informed consent before their participation.

Finally, to assess the early impact of the national vaccination program on neurosurgical activity in our hospital, we compared elective and urgent procedures performed in our department before (from March 2, 2020, to June 28, 2020) and after implementation of a mass vaccination campaign against COVID-19 in Morocco (from March 2, 2021, to June 28, 2021).

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences version 25. Mean and standard deviation was calculated to describe continuous variables while numbers and percentages were used for categorical variables. Descriptive analysis and Chi-square tests were used to evaluate the data and assess the statistical significance of observed differences between cohorts before and during the COVID-19 pandemic. $P < 0.05$ was considered significant.

RESULTS

COVID-19 in Morocco

Since the report of the first case on March 2, 2020, and until June 28, 2021, the cumulative number of confirmed cases reached 529,895 cases with 9,283 deaths and a cumulative incidence of 1456, 3 per 100,000 inhabitants.^[3] Morocco's quick and strict response to the pandemic was relatively effective at the beginning in containing the spread of the virus. However, after easing the containment measures, the situation in Morocco has deteriorated. In fact, the numbers of new cases and deaths have reached the highest levels ever recorded since the start of the pandemic, mainly related to professional and familial clusters. In fear of a new wave of COVID-19 infections that could threaten months of progress, and especially with the emergence of the Indian coronavirus variant, the Moroccan authorities banned flights with most countries and kept a night curfew in place to counter the spread of new variants.

Marrakech is the fourth largest city in the Kingdom with 1329,850 inhabitants. The Red City was ranked 9th best global destination in 2019 by TripAdvisor.^[5] On March 10, the health authorities announced the first case in Marrakesh. It was a French tourist who arrived in Morocco on March 7. Early during the outbreak of the pandemic, Marrakech-Safi region turned out to be one of the most affected regions with an average of over 100 daily new cases. This is why the city is classified as zone 2. In fact, the Moroccan provinces are categorized into two zones depending on the level of COVID-19 risk present in the region, and these categories are updated on a weekly basis.^[9]

Hospital organization and the phases of the pandemic at our Hospital

After announcing the country's first case of COVID-19 on March 2, a full reorganization of the health system was initiated countrywide to overcome the chronic weakness of medical infrastructure and the lack of resources. We divided our experience during this period into two phases: phase 1 (March 2-27, 2020) in which the activity remained almost normal and phase 2 (March 28 – June 28, 2020) during which Mohammed VI university hospital was completely devoted to COVID-19 admissions, while our hospital was assigned to manage all non-COVID patients with urgent neurosurgical pathology. At the beginning of phase 2, our hospital, which became the only hospital in the region admitting neurosurgery patients, had to be on high alert to contain the influx of patients and to ensure safety of health-care providers and neurosurgical patients.

Emergency and elective neurosurgical operations performed before and during COVID-19 at our hospital

We divided our patients into two groups: those requiring immediate surgical procedure and those waiting for scheduled surgery before and during COVID-19 pandemic. The total number of procedures dropped from $n = 197$ (pre-COVID-19) to $n = 150$ during COVID-19. Conversely, the number of emergency operations increased during COVID-19 ($n = 95$) compared to pre-COVID-19 period ($n = 58$). Before the pandemic, an average of 3.4 emergency operations was performed each week compared to 5.6 per week during COVID-19 [Table 1].

Concerning elective surgery, the overall number of operations declined from an average of 10.5 elective operations per week before COVID-19 to 7, 25 per week during phase 1 and 2, 9 per week during phase 2 [Table 1]. Regarding the distribution of operations per neurosurgical subspecialty, there was a statistically significant decrease during COVID-19 compared to the pre-COVID-19 period in tumor surgery (pre-COVID-19 $n = 64$, COVID-19 $n = 34$, $P = 0.04$) and

Table 1: Number of urgent and elective surgeries and diagnosis category pre- and during COVID-19 pandemic.

Variable	Pre-COVID-19 pandemic (n=197)	During COVID-19 pandemic (n=150)	P-value
Procedures per week, median			
Urgent surgeries	3.4	5.6	0.0001*
Elective surgeries	10.5	4	0.0001*
Diagnosis category, n (%)			
Trauma	29 (14.7)	38 (25.3)	0.01*
Tumor	64(32.4)	34 (22.7)	0.04*
Vascular	10 (5.07)	8 (5.3)	0.31
Endoscopic	47 (23.8)	22 (14.7)	0.034*
Spine	21 (10.6)	30 (20)	0.01*
Hydrocephalus	17 (8.6)	12 (8)	0.83
Congenital	7 (3.5)	5(3.3)	0.91
Infection	2 (1.01)	1 (0.6)	0.72

*Statistically significant difference

endoscopic surgery (pre-COVID-19 $n = 47$, COVID-19 $n = 22$, $P = 0.034$). In contrast, there was a statistically significant increase in spine surgery (pre-COVID-19 $n = 21$, COVID-19 $n = 30$, $P = 0.01$) and trauma surgery (pre-COVID-19 $n = 29$, COVID-19 $n = 38$, $P = 0.021$). No differences were reported in other neurosurgical categories between the COVID-19 period and the reference [Table 1].

Vaccine acceptance

The analysis set consisted of 1463 participants. Among the participants, 98 (6.7%) were medical doctors, 145 (9.9%) were nurses or paramedics, and 1220 (83.4%) were patients admitted to our hospital during the study period. The main characteristics of the participants are summarized in [Table 2]. Among study participants, 321 (21.9%) had been previously infected with COVID-19 and 86 (5.9%) had lost a relative or close friend due to COVID-19. Regarding perception toward COVID-19 pandemic, only 125 (8.5%) patients believed that the severity of COVID-19 infection was low and approximately a third of the participants agreed that the media coverage of the pandemic was exaggerated [Table 3].

Overall, willingness to get the COVID-19 vaccine was high, 45.9% of the participants were very likely and 35.8% were likely to be vaccinated, while 5.8% were undecided. Further analysis revealed that vaccine acceptance rates were significantly higher among healthcare workers (90.6%) than patients (80%; $P = 0.001$). Furthermore, the main reasons for vaccine hesitancy were fears of the vaccine's safety and concerns over efficacy and future unknown effects of the vaccine [Table 4].

The early impact of COVID-19 vaccination campaign on neurosurgical practice

Our findings showed that the total number of procedures increased from $n = 150$ (before vaccination) to $n = 179$

after starting a mass vaccination campaign in our country. However, the number of urgent operations decreased after implementation of the vaccination campaign to approach the average number found in the pre-COVID 19 period. Concerning elective surgery, the number of procedures increased from an average of 4 elective operations per week to 7.5 per week after starting the vaccination [Table 5].

The analysis of the distribution of operations per neurosurgical subspecialty revealed a statistically significant increase after implementation of the national vaccination campaign in tumor surgery ($P = 0.049$) and endoscopic surgery ($P = 0.019$). In contrast, we noted a statistically significant decrease in trauma surgeries ($P = 0.001$) and spine surgery ($P = 0.04$) after starting COVID-19 vaccination ($P = 0.001$) [Table 5].

DISCUSSION

COVID-19: A global health crisis

The coronavirus COVID-19 pandemic is the defining global health crisis of our time and the greatest challenge we have faced since World War Two. Since its emergence in Asia in December 2019, the virus has spread to every continent and nearly every country on earth. In the absence of effective treatments, many countries have responded by implementing several non-pharmaceutical interventions to halt the spread of the virus and limit the number of fatalities: social distancing, cancellation of public events, school closures, workplace closures, isolation and quarantine for infected people, and internal and international travel restrictions. The effectiveness of these containment measures remains unclear, but the number of reported cases in many countries increased rapidly after the release of lockdown measures. As of Monday May 31, 2021, over 170 million coronavirus cases have been reported and over 3.6 million people have died of COVID-19

Table 2: Characteristics of the participants.

	Total (n=1463)	Healthcare workers (n=243)	Patients (n=1220)	P-value
Gender, n (%)				
Male	625 (42.7)	105 (43.2)	520 (42.6)	0.8
Female	838 (57.3)	138 (56.8)	700 (57.4)	
Age, mean±SD, years	46.5±13.7	39.2±10.5	47.9±13.7	<0.001
Marital status, n (%)				
Married	676 (46.2)	130 (53.5)	546 (44.8)	0.01
Not married	787 (53.8)	113 (46.5)	674 (55.2)	
Parenthood status, n (%)				
Parent	680 (46.5)	104 (42.8)	576 (47.2)	0.2
Childless	783 (53.5)	139 (57.2)	644 (52.8)	
Education level, n (%)				
Illiterate	210 (14.3)	0 (0)	210 (17.2)	<0.001
Elementary and middle school	361 (24.7)	0 (0)	361 (29.6)	
High school	424 (29)	0 (0)	424 (34.8)	
Post secondary studies	468 (32)	243 (100)	225 (18.4)	
Geographical origin, n (%)				
Urban	758 (51.8)	243 (100)	515 (42.2)	<0.001
Rural	705 (48.2)	0 (0)	705 (57.8)	
Underlying diseases, n (%)				
Yes	812 (55.5)	50 (20.6)	762 (62.5)	<0.001
No	651 (44.5)	193 (79.4)	458 (37.5)	
Financial difficulties, n (%)				
Yes	886 (60.6)	32 (13.2)	854 (70)	<0.001
No	577 (39.4)	211 (86.8)	366 (30)	
Fixed monthly income, n (%)				
Yes	555 (37.9)	235 (96.7)	320 (26.2)	<0.001
No	908 (62.1)	8 (3.3)	900 (73.8)	

Table 3: Risk factors and perceptions of the COVID-19 pandemic.

	Total (n=1463)	Healthcare workers (n=243)	Patients (n=1220)	P-value
Need to leave the house quite often for work, n (%)				
Yes	801 (54.8)	243 (100)	558 (45.7)	<0.001
No	662 (45.2)	0 (0)	662 (54.3)	
Previously infected with COVID-19, n (%)				
Yes	321 (21.9)	76 (31.3)	245 (20.1)	<0.001
No	1142 (78.1)	167 (68.7)	975 (79.9)	
Relative or close friend died from COVID-19, n (%)				
Yes	86 (5.9)	14 (5.8)	72 (5.9)	0.9
No	1377 (94.1)	229 (94.2)	1148 (94.1)	
Perceived severity of COVID-19 infection, n (%)				
Low	125 (8.5)	0 (0)	125 (10.2)	<0.001
Middle	462 (31.6)	61 (25.1)	401 (32.9)	
High	876 (59.9)	182 (74.9)	694 (56.9)	
Is media coverage of the pandemic exaggerated? n (%)				
Yes	507 (34.7)	85 (35)	422 (34.6)	0.9
No	956 (65.3)	158 (65)	798 (65.4)	
Source of information related to the COVID-19 pandemic, n (%)				
I have no information	180 (12.3)	0 (0)	180 (14.8)	<0.001
Newspaper	53 (3.6)	0 (0)	53 (4.3)	
TV	506 (34.6)	0 (0)	506 (41.5)	
Internet and Social media	304 (20.8)	30 (12.3)	274 (22.4)	
World health organization	33 (2.3)	33 (13.6)	0 (0)	
More than one source	387 (26.4)	180 (74.1)	207 (17)	

Table 4: Willingness to get the COVID-19 vaccine and reasons for vaccine hesitancy.

	Total (n=1463)	Healthcare workers (n=243)	Patients (n=1220)	P-value
Willingness to get vaccination, n (%)				
Very unlikely	82	9	73	0.001
Somewhat unlikely	101	3	98	
Somewhat likely	524	93	431	
Very likely	672	127	545	
Unsure	84	11	73	
Concerns regarding COVID-19 vaccine, n (%)				
Doubted efficacy	256 (88.3)	21 (91.3)	235 (88)	<0.001
Safety	261 (90)	19 (82.6)	242(90.6)	
Accessibility	88 (30.3)	0 (0)	88 (32.9)	
Quality control	51 (17.6)	11 (47.8)	40 (15)	
Future effects	194 (66.9)	8 (34.8)	186(69.7)	
Pregnancy	19 (6.5)	5(21.7)	14 (5.2)	
Lack of trust in vaccines	97 (33.4)	2 (8.7)	95 (35.6)	

Table 5: Number of urgent and elective surgeries and diagnosis category before and after implementation of the national COVID-19 vaccination campaign.

Variable	Before vaccination (n=150)	After vaccination (n=179)	P-value
Procedures per week, median			
Urgent surgeries	5.6	3.5	0.004*
Elective surgeries	4	7.5	0.0001*
Diagnosis category, n (%)			
Trauma	38 (25.3)	21 (11.7)	0.001*
Tumor	34 (22.7)	58 (32.4)	0.049*
Vascular	8 (5.3)	8 (4.5)	0.71
Endoscopic	22 (14.7)	45 (25.1)	0.02*
Spine	30 (20)	21 (11.7)	0.04*
Hydrocephalus	12 (8)	14 (7.8)	0.95
Congenital	5 (3.3)	10 (5.6)	0.32
Infection	1 (0.6)	2 (1.1)	0.66

*Statistically significant difference

worldwide. The USA, India, and Brazil have recorded the highest number of confirmed cases, followed by France, Turkey, Russia, and the United Kingdom (UK). Moreover, the number of cases and deaths in Africa has increased at a faster rate in the last weeks compared to the other waves. This is driven by several factors including public fatigue, social mixing, ineffective use of public health and social measures, vaccine inequity, and the spread of new variants.^[25]

On the other hand, several coronavirus vaccines have been approved for use, either by individual countries or groups of countries, such as the European Union and the WHO.^[4] With an aim to give doses to nearly every adult around the world, this is the largest vaccination program in history. However, while countries in Europe and America are progressing well with their vaccination campaigns, many states in Africa are experiencing supply issues. This inequality gap is being addressed by strong multilateral cooperation involving the African Vaccine Acquisition Task Team of the African

Union and the COVAX consortium.^[22] In addition to vaccine inequities, vaccine acceptance appears to be the next challenge in the fight against COVID-19.

Neurosurgical impact of COVID-19 outbreak

The COVID-19 pandemic is a health crisis of unprecedented proportions that has taken a heavy toll on various aspects of the society. Health systems are facing the most serious global pandemic crisis in a century. To contain the spread of novel coronavirus COVID-19 and reduce the pressure on health systems, numerous guidelines were published by international surgical societies including neurosurgical societies.^[14,30] In developing countries including Morocco, where there is a chronic shortage of neurosurgeons, nurses or other skilled health workers, any additional pressure on health-care systems arising from the looming pandemic becomes almost unmanageable.^[11,23,29] Many of

the recommendations published by other neurosurgical centers could not be achieved given the local limitations and resources.^[16] According to a survey about how Africa's neurosurgical community has been affected by COVID-19, only 52 (16.5%) of the respondents stated they had a specific COVID-19 neurosurgery policy and only 49% felt that their response plans were satisfactory for their neurosurgical services.^[19]

To manage vital health-care resources during this public health emergency, national and international societies suggested stopping all elective activity and maintaining only emergent and urgent procedures.^[2,6] According to an international survey, neurosurgical activity was significantly reduced in most centers (79%).^[13] In our department, we did not postpone all elective neurosurgeries during phase 1, because we have a long list of patients waiting for surgery. However, during phase 2, we reduced the number of elective surgeries to handle the influx of emergency cases. The decrease in elective surgeries can also be explained by the shortage of intensive care unit (ICU) beds for neurosurgery patients, since most beds were reserved for COVID-19 patients and the poor availability of personal protective equipment (PPE) in the early phase of the pandemic. Moreover, the unprecedented increase in the demand for intensive care services due to the COVID-19 pandemic involved a rapid redeployment of healthcare staff, including neurosurgeons, to these units.

On the other hand, our findings showed that the number of urgent surgeries performed in our department increased during the pandemic, compared to the pre-COVID 19 period. This can be explained by the fact that our department became the only hospital in the region admitting neurosurgery patients, since the other hospitals were devoted to COVID-19 cases. We also noticed that during the pandemic the number of neurotrauma cases increased by approximately 10% compared to the pre-COVID-19 period, although road traffic accidents declined during lockdown. This can be explained by the significant increase of interpersonal violence documented by many reports, the increased unstructured time and the socioeconomic impact of the pandemic resulting in higher unemployment.^[1,24]

Neurosurgical training and education have also been significantly affected by this pandemic. In fact, neurosurgery departments worldwide have been forced to restructure their training programs to handle this healthcare emergency. According to a continental survey on the impact of COVID-19 on neurosurgical training in Africa, only 41% of the respondents had received training in COVID-19, although many African countries do not have formal neurosurgery training schemes or fellowship opportunities.^[7] Similar findings were reported

by Wittayanakorn *et al.* in Southeast Asia^[31] and Zoia *et al.* in Italy.^[34] In our department, we adopted a new shift scheduling system to decrease transmission among colleagues and to preserve the workforce. This also helped in optimizing PPE supplies in health-care settings. We divided the team into three groups that switch coverage each week, Group 1 for emergency cases (faculty, senior resident, and junior resident), Group 2 for elective surgeries (faculty, senior resident, and junior resident), and Group 3 forward activities. The rest of the team stay at home remotely providing telesupervision, consultation, and arrange different virtual teaching programs. They also replace those who show COVID-19 symptoms to ensure continuity of care.

In light of the above, successful control of COVID-19 infections and deaths at the international level seems to be important in ensuring continuation of neurosurgical training and provision of neurosurgical services. This objective can only be achieved through mass vaccination campaigns to reach herd immunity. However, despite the huge efforts made by health authorities, a major hindrance can be related to vaccine hesitancy.

Vaccine hesitancy

Based on the Strategic Advisory Group of Experts on Immunization, vaccine hesitancy is the term used to describe: "delay in acceptance or refusal of vaccination despite availability of vaccination services."^[18] It remains a barrier to full population inoculation against highly infectious diseases. Even before the emergence of SARS-CoV-2, the WHO had already highlighted vaccine hesitancy as one of the ten leading threats to global health.^[32] Factors that affect the attitude toward acceptance of vaccination are complex and can vary geographically. They include complacency, convenience, and confidence.^[27]

Our survey results found high vaccine acceptance rates among our healthcare workers and our patients. In fact, the vast majority of the participants (81.7%) are willing to take up a COVID-19 vaccine if offered. While only 18.3% are still hesitant or refusing to get vaccinated. The previous studies have also studied this global phenomenon and revealed the existence of regional variability in COVID-19 vaccine acceptance rates. According to a systematic review assessing the acceptances rates in different countries worldwide, the highest vaccine acceptance rates (>90%) among the general population were reported by four studies from Ecuador (97.0%), Malaysia (94.3%), Indonesia (93.3%), and China (91.3%). On the opposite, the lowest vaccine acceptance rates (<60%) among the general public were found in seven studies from Kuwait (23.6%), Jordan (28.4%), Italy (53.7), Russia (54.9%), Poland (56.3%), US (56.9%), and France (58.9%). However, this topic has not been explored to a large degree in Africa. Therefore, more studies are needed to address COVID-19 vaccine hesitancy in this continent.^[28]

Finally, the main reasons for vaccine hesitancy in our study were fears of the vaccine's safety and concerns over efficacy and future unknown effects of the vaccine. The same concerns were reported by Dror *et al.* in Israel^[12] and Robertson *et al.* in the UK.^[26]

The early impact of the COVID-19 vaccination campaign: Signals of hope

Morocco launched its ambitious COVID-19 vaccination campaign on January 28, 2021, seeking to vaccinate 80% of its adults. The king of Morocco, as the spiritual leader of the nation, was the first Moroccan to be vaccinated, giving an essential boost to the vaccination campaign. Despite monumental challenges, the African country is among the world's pioneers in vaccinating its population against COVID-19. On June 28, 2021, the total number of people fully vaccinated against COVID-19 in Morocco reached 8954030 (about 25.6% of Moroccan population), while a total of 9908882 first doses of COVID-19 vaccines have been administered.^[3] The Moroccan vaccination campaign has clearly been rapid and effective compared to other African countries, where the rates of vaccination did not exceed 1%. However, is it possible to already assess the positive effects of the COVID-19 vaccination while the country is facing a new wave?

In fact, it is too early to evaluate the real impact of the vaccination campaign. However, the ministry of health has carried out a comparative analysis on the epidemiological situation in Morocco and the UK based on the number of cases, the vaccination rate and the number of deaths. This study, which covered the period from January to August 2021, showed that, despite rising COVID-19 cases, the infection fatality rate of the disease is less than in the early stages of the pandemic thanks to vaccination. As of August 6, 2021, the case fatality rate was 0.6% in Morocco for a vaccination rate of 29.4% versus 0.2% in the UK for a vaccination rate of 57.9%.^[17]

Concerning the early impact of the COVID-19 vaccination campaign on neurosurgical activities in our country, our findings showed that the number of elective surgeries performed in our department increased after the start of the vaccination campaign. This can be explained by several factors. First of all, the number of COVID-19 patients admitted to hospital ICUs decreased after the implementation of the vaccination campaign. Furthermore, the relative stability of the epidemiological situation in Morocco allowed surgeons to go back to their departments and to resume their professional activities. As mentioned above, to minimize the risk of acquiring COVID-19 infection while managing patients, we reorganized our surgical team into three groups. However, we resumed the traditional staff scheduling after all the team members got fully vaccinated. Therefore, our hospital was given the green light to gradually begin

ramping-up elective surgeries and procedures. Nevertheless, vaccination alone is not enough to contain the pandemic. The healthcare workers should respect safety measures to avoid exposure to nosocomial infection for both patients and surgical teams.

Strengths and limitations of our study

Our study has several strengths. First, our study provided answers to two topics. On one hand, it revealed the neurosurgical impact of COVID-19 pandemic in Morocco. Moreover, on the other hand, it highlighted the high acceptance rate of COVID-19 vaccine among our participants, which can help controlling the pandemic, to restore all neurosurgical services. Second, to the best of our knowledge, this is the first study in Morocco to assess the acceptance regarding COVID-19 vaccines and the reasons why a COVID-19 vaccine would be refused. It also did so just before the launch of the vaccination campaign in Morocco on January 28, 2021. The country is now rolling out a successful vaccination program starting with the oldest and most vulnerable population groups. Finally, our survey covered healthcare workers as well as patients and compared responses to identify differences.

There are also limitations of our study which should be noted. First of all, concerning neurosurgical impact of the pandemic, the number of patients included was small due to the relatively short study period. A larger period could have been investigated but would not have been more relevant to evaluate the impact of the pandemic on neurosurgical activities. Moreover, the study was retrospectively performed in a single center and may therefore involve selection bias. We further did not analyze the impact of COVID-19 on patient outcomes because we could not exclude the possibility of unmeasured confounding factors. Another limitation is Morocco's infection rates during the early phase of the COVID-19 pandemic which were low compared with those of other countries.

CONCLUSION

The whole world is experiencing an unprecedented health crisis that has profoundly impacted all aspects of society, including neurosurgical activities. Our results highlighted how difficult is managing neurosurgical services during this pandemic in developing countries which cannot support any additional pressure on their health care systems. However, our study also found a high rate of acceptance of COVID-19 vaccines among Moroccans, which gives a glimmer of hope. Despite the high acceptance rate, the Moroccan authorities must address concerns among hesitant individuals and raise awareness on the importance of COVID-19 immunization, so that we can return soon to our normal life.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

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