



Effects of COVID-19 on the admissions of aneurysmal subarachnoid hemorrhage: the West Greece experience

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Abstract

Background Acute subarachnoid hemorrhage (SAH) due to aneurysmal rupture is a devastating vascular disease accounting for 5% of strokes. COVID-19 pandemic resulted in a decrease in elective and emergency admissions in the majority of neurosurgical centers. The main hypothesis was that fear of COVID-19 may have prevented patients with critical medical or surgical emergencies from actively presenting in emergency departments and outpatient clinics.

Methods We conducted a single-center, retrospective, observational study searching our institutional data regarding the incidence of spontaneous subarachnoid hemorrhage (SAH) and compare the admissions in two different periods: the pre COVID-19 with the COVID-19 period.

Results The study cohort was comprised of a total of 99 patients. The mean (SD) weekly case rate of patients with SAH was 1.1 (1.1) during the pre-COVID-19 period, compared to 1.7 (1.4) during the COVID-19 period. Analysis revealed that the volume of admitted patients with SAH was 1.5-fold higher during the COVID period compared to the pre-COVID period and this was statistically significant (ExpB = 1.5, CI 95% 1–2.3, $p = 0.044$). Difference in mortality did not reach any statistical significance between the two periods ($p = 0.097$), as well as patients' length of stay ($p = 0.193$).

Conclusions The presented data cover a more extended time period than so far published reports; it is reasonable that our recent experience may well be demonstrating a general realistic trend of overall increase in aneurysmal rupture rates during lockdown. Hospitalization of patients with SAH cannot afford any reductions in facilities, equipment, or personnel if optimum outcomes are desirable.

Keywords Subarachnoid hemorrhage (SAH) · Coronavirus disease 19 (COVID-19) · aneurysm · admission rate

Introduction

Acute subarachnoid hemorrhage (SAH) due to aneurysmal rupture is a severe vascular disease accounting for 5% of strokes approximately and carries a high mortality and morbidity burden [1]. One-third of patients die before reaching hospital or within the first days after rupture, one-third faces long-term neurological deficits and complications, and the last

third returns to normal life [2, 3]. The incidence of acute SAH has been estimated at approximately 10 cases per 100 000 persons annually, and mostly affects young people around 40–60 years old [4]. The two leading risk factors of aneurysm rupture are cigarette smoking and uncontrolled hypertension, following familial predisposition and heritable connective tissue diseases [4, 5]. Gender and region seem to influence the incidence of SAH, as women have higher predisposition than men, and black people have a two-fold greater risk than whites [2, 6]. The main symptom of acute SAH is a severe occipital headache of sudden onset (described as “the worst of the patient’s life), followed by seizures, neurologic deficits, or faint.

Since the declaration of COVID-19 pandemic on March 2020, studies in the field of cardiology and neurology present a decline in acute coronary syndromes and neuro-emergencies, respectively [7, 8]. The main hypothesis was

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that fear of COVID-19 may have prevented patients with critical medical or surgical emergencies from actively presenting in emergency departments and outpatient clinics [8].

This speculation led us to search our institutional data regarding the incidence of spontaneous subarachnoid hemorrhage (SAH) and compare two different periods: the pre-COVID-19 with the COVID-19 period.

Methods

Data collection

We performed a single-center, retrospective, observational study including patients with a principal diagnosis of non-traumatic SAH who were admitted between 31 December 2018 and 26 June 2020 at the University Hospital of Patras (single neurosurgical referral center of west Greece and Ionian Islands region). International Statistical Classification of Diseases and Related Health Problems codes on discharge were used to identify the study population. Epidemiological and clinical data of patients included were anonymously extracted from the hospital's electronic database and checked for accuracy by study investigators. The study was conducted in accordance with the Declaration of Helsinki.

Study periods and outcomes

The volume of admitted patients was measured as cases of SAH per week. To perform comparative analysis, we defined two different control periods. The first was the COVID-19 period (26 February to 26 June 2020 covering a period from the first COVID-19 case until the end of first lockdown in Greece), and the second was the pre-COVID-19 period (previous year until first COVID-19 case in 2020). To adjust for a possible seasonable variance, a 3rd comparison was performed, and an equal to COVID-19 period during 2019 was compared to the rest of 2019.

The COVID-19 defined period corresponds to the “first wave” of the pandemic, during which a strict nationwide lockdown was implemented in Greece. The University Hospital of Patras represents the main referral center for COVID-related emergencies, while non-COVID-related emergency plans, including referral pathways for SAH, were not moderated throughout the pandemic period.

The primary outcome was the weekly case rate of SAH hospitalizations during the control periods. This was corrected by the 3rd period group. The secondary outcomes were patient characteristics and in-hospital outcomes (length of stay and mortality).

Statistical analysis

Patient demographics and in-hospital outcomes were summarized as descriptive statistics. Trends among the 2 periods were compared using *t* test, χ^2 , or Fisher exact test as appropriate, and Mann-Whitney test as non-parametric equivalent. Poisson regression model was used to determine volume changes over time. Analyses were produced using IBM SPSS v.25.0 statistical package, and the level of statistical significance was set at $p \leq 0.05$.

Results

The study cohort was comprised of a total of 99 Greek patients, with a mean (SD) age of 59.4 (15). Of those 52 (52.5%) were women, and 47 (47.5 %) were men. The mean (SD) weekly case rate of patient with SAH was 1.1 (1.1) during the pre-COVID-19 period, compared to 1.7 (1.4) during the COVID-19 period. Poisson analysis revealed that the volume of admitted patients with SAH was 1.5-fold higher during the COVID period compared to the pre-COVID period, and this was statistically significant (ExpB = 1.5, CI 95% 1–2.3, $p = 0.044$) (Fig. 1).

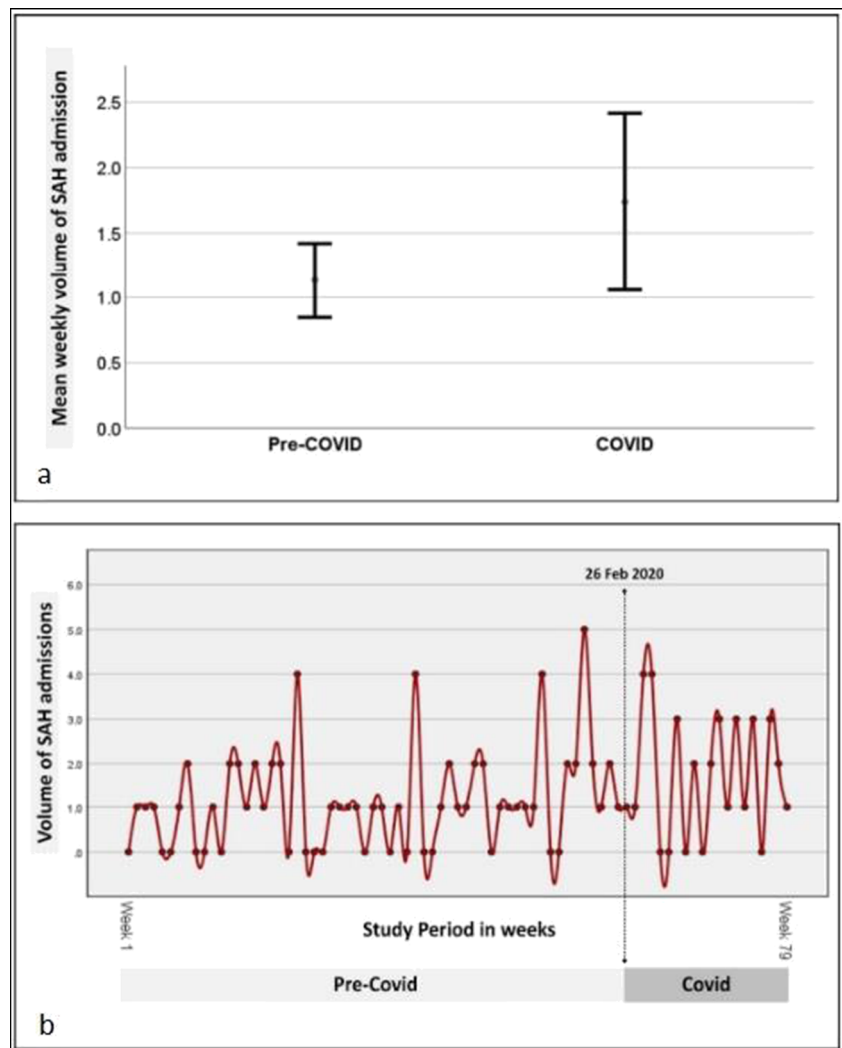
There was no statistically significant difference when seasonal adjustment comparison was made ($p = 0.8$). The mean age (SD) of patients during the COVID era was 54.1 years (14.8), remarkably younger compared to the pre-COVID period with a mean age of 61.8 years (15). There was no statistically significant difference in gender distribution between the two periods. A total of 12 deaths occurred during the study period, of which 1 during the COVID period. Difference in mortality did not reach any statistical significance between the two periods ($p = 0.097$), as well as patients' length of stay ($p = 0.193$) (Table 1).

Discussion

In this study, we investigated the case rate of hospitalizations due to SAH during the first wave of COVID-19 pandemic, compared with previous year until first COVID-19 case in 2020. The main finding of this study is a significant increase in the number of patients admitted to our hospital due to SAH during the COVID-19 period compared to the pre-COVID period, even when adjusting for a possible season-related increase.

Our institution is the only referral care hospital in Western Greece providing complete emergent neurosurgical coverage for neurovascular pathology offering surgical or interventional neuroradiology procedures on a 24/7 basis for a population of approximately 2 million inhabitants, and remains the single hub for SAH in this wide healthcare geographical area

Fig. 1 Comparison of weekly volume of SAH admissions between COVID and pre-COVID periods



throughout the pandemic. According to our findings, there was a significant increase of 1.5 times in the number of patients with spontaneous SAH admitted to our hospital during the COVID-19 pandemic (26 February to 26 June 2020 covering a period from the first COVID-19 case until end of first lockdown in Greece) when compared to the pre-COVID-19 period (previous year until first COVID-19 case in 2020). The mean (SD) weekly case rate of patient with SAH was 1.1 (1.1) during the pre-COVID-19 period, compared to 1.7 (1.4) during the COVID-19 period. Combined with the fact that the presented data cover a more extended time period than so far published reports, it is reasonable that our recent experience may well be demonstrating a general realistic trend of overall increase in aneurysmal rupture rates.

The most probable explanation to this special epidemiological configuration may be accredited to early, very strict and synchronously applied, confinement measures obtained in Greece during the first wave of COVID-19 pandemic. This led to less infected patients, intubated cases, and deaths due to COVID-19 virus even when compared to countries with

similar population. Consequently, pressure on Greek healthcare system was not excessive compared to other European countries, avoiding in this way misdiagnosis especially for SAH patients.

While all the referral centers for COVID-19 in our country, including our hospital, significantly restricted any elective function, there has been no official change regarding management of emergencies in our district. As there was no policy change in referral pathways compared to the pre-COVID period, this could not serve as a possible explanation for the observed increase in SAH admissions in our hospital. Given the strict travel ban, it is unlikely that tourism has influenced the demographics in our area. However, socioeconomic repercussions of the pandemic may have contributed to a temporary population relocation and possible increase of patient input in our healthcare geographical region.

Furthermore, the statistically significant increase of 1.5-fold in the number of patients with spontaneous SAH admitted to our hospital during the COVID-19 pandemic may be explained on the basis of extremely increased average civilian's overall

Table 1 Primary and secondary outcomes of COVID versus pre-COVID period

	Total	Pre-COVID period	COVID period	COVID vs Pre-COVID
<i>N</i> of patients	99	68	31	
Primary outcome				
Weekly volume of SAH				
Mean (SD)	1.3 (1.2)	1.1 (1.1)	1.7 (1.4)	
Median (min–max)	1 (0–5)	1 (0–5)	2 (0–4)	
Exp B (95% CI); <i>p</i> value				1.5 (1.01–2.32); <i>p</i> = 0.044
Secondary outcomes				
Sex				
Male	47.5%	45.6%	51.5%	<i>p</i> = 0.578
Female	52.5%	54.4%	48.8%	
Age–yrs				
Mean (SD)	59.4 (15.0)	61.8 (15.0)	54.2 (14.8)	<i>p</i> = 0.019
Median (min–max)	58 (17–87)	62 (17–87)	54 (21–78)	
Hospitalization—days				
Mean (SD)	16.9 (16.8)	14.7 (10.7)	20.9 (24.1)	<i>p</i> = 0.193
Median (min–max)	14 (1–103)	14 (1–60)	15 (1–103)	
<i>N</i> of deaths	12	11	1	<i>p</i> = 0.097

stress levels during the pandemic, not only due to social isolation but also compounded by lockdown-driven economic recession and resultant financial strain and job insecurity. The aforementioned psychological factors' physical manifestations could trigger activation of inflammatory cascades, as well as elevate systolic and mean arterial pressure, both potentially increasing the chance of aneurysmal rupture and SAH.

Hecht et al. from Charité University Hospital in Berlin investigated how the COVID-19 pandemic and social distancing affected the neurosurgical admissions, non-elective emergency care, and how neuro-emergencies occurred regarding the neurological spectrum of symptoms and the severity of disease. They found that, in the period between February 1st and April 15th of 2020, compared with the same of 2019, the number of overall admissions to their neurosurgical department was 46% lower, but that the number of patients specifically suffering from SAH had not changed during the pandemic [9]. This fact reflected that patients with acute SAH continued to seek emergency medical care regardless of COVID-19, which stands in contrast to previous concerns and needs to be considered when developing strategies for resource reallocation [9, 10].

Similarly, Luostarinen et al. from the Helsinki University Hospital published that there were no notable differences in diagnoses (e.g., traumatic brain injury—TBI vs. SAH), interval (early vs. late), age, sex, GCS score, pupillary light reaction, ICU length-of-stay, and standardized mortality rates between the 2019 and the 2020 admissions [11]. They argued that the symptoms of aneurysmal SAH are often so severe that delaying contact with healthcare seems unlikely, and they wondered why the aneurysmal SAH incidence did not decrease due to the collapse in incidence of

the normal seasonal influenza epidemic as it has been speculated that respiratory infections might predispose aneurysm rupture [11, 12].

On the other hand, a European study which included 34 neurosurgical departments in Europe comparing neurosurgical activity, resources, and indications during 1 week with usual activity in December 2019, and 1 week during SARS-CoV-2 pandemic in March 2020, showed that the resources for neurosurgical patients decreased dramatically. In particular, fewer intermediate and regular neurosurgical beds were available, the number of neuro-ICU beds was lower, and most centers treated fewer ICU-treated SAH patients during the pandemic. The mean numbers were 2.7 vs 1.8 SAH patients/1,000,000 population in December 2019 and March 2020, respectively. Only four out of the 34 centers referred increased number of SAH patients [13]. In addition, an Australian study showed a reduction in vascular emergencies (SAH) which was attributed to public's fear of presenting to the emergency department during the COVID-19 pandemic [14].

In contrast to other reports, a study from the Lariboisière Hospital in Paris, France [15], and another by St. Michael's Hospital, Toronto, Canada [16], both report a significantly reduced census of SAH admissions during the start of the pandemic. The aforementioned reports' proposed explanations of their corresponding findings share a common theme in hypothesizing possible reluctance in seeking medical care upon warning signs of SAH, due to a perceived risk of contracting COVID-19 by the general public. Similar results and explanations have been reported with regards to hospital admissions due to myocardial infarction and stroke in the COVID-19 era [17–19].

It is worth noting that there are certain limitations relative to study design. This is a single-center study covering the first wave of COVID-19 pandemic in our country, and therefore, generalization of our results should be cautious. Longer term analyses and comparisons with data regarding admissions for other emergencies in our hospital as well as with records from different SAH referral centers are essential to further elucidate the impact of COVID-19 pandemic on emergency admissions in our country. Moreover, being observational in nature, the present study cannot provide a demonstration of causality. However, due to the life-threatening nature of SAH and the apparent extended duration of the COVID-19 pandemic, an attempt at providing possible reasonable explanations seems justified, albeit partial and speculative in nature. As there are no signs that the COVID-19 pandemic will be coming to an end in the near future, the widespread use of socioeconomic restrictions is probably here to stay for a significant amount of time, although several vaccines have been recently developed, and mass production is on the way. Given the heavy burden of the pandemic for the healthcare system, resource allocation will likely still continue to be shifted to tracking, diagnosing, and dealing with COVID-19 infections.

However, we advocate that the hereby presented observation of concurrently increased SAH cases during the first wave of the pandemic should prompt further studies to validate our findings and investigate for similar trends in other conditions of emergent nature. We firmly believe that due consideration by the healthcare authorities should be given to securing sufficient resources—both human and material—for continuing care of SAH patients in these precarious times [20]. Aneurysmal subarachnoid hemorrhage is a relatively frequent emergency that carries a high rate of mortality and neurologic morbidity while its treatment requires highly specialized care; therefore, its victims cannot afford any reductions in facilities, equipment, or personnel if optimum outcomes are desirable.

Abbreviations SAH, Subarachnoid hemorrhage
 COVID-19
 Coronavirus disease 19
 SD
 Standard deviation
 TBI
 Traumatic brain injury

Data availability The data provided are available from the corresponding author.

Declarations

Conflict of interest The authors declare no competing interests.

Ethical approval For this type of study, formal consent is not required.

Informed consent This is a retrospective study of data analysis. Due to the retrospective nature of the study, this project was waived from the written informed consent requirement.

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