

Surgeries Performed Within 3 Months in the Neurosurgery Clinic of a Coronavirus Disease-2019 Hospital and Its Effects on Coronavirus Disease-2019 Transmission

Koronavirüs Hastalığı-2019 Pandemi Hastanesinin Nöroşirürji Kliniğinde 3 Ay Boyunca Yapılan Ameliyatlar ve Koronavirüs Hastalığı-2019 Bulaşı Açısından Etkileri

✉ Mert Şahinoğlu, ✉ Derya Karaoğlu Gündoğdu, ✉ Murat Ertaş, ✉ Fırat Yıldız, ✉ Ender Köktekir, ✉ Hakan Karabağlı

Selçuk University Faculty of Medicine, Department of Neurosurgery, Konya, Turkey

Cite this article as: Şahinoğlu M, Karaoğlu Gündoğdu D, Ertaş M, Yıldız F, Köktekir E, Karabağlı H. Surgeries Performed Within 3 Months in the Neurosurgery Clinic of a Coronavirus Disease-2019 Hospital and Its Effects on Coronavirus Disease-2019 Transmission. J Acad Res Med 2021;11(2):192-8

ABSTRACT

Objective: Health workers are on the frontlines in the fight against coronavirus disease-2019 (COVID-19) and are unfortunately the occupational group with the highest risk of infection. For this reason, as in all surgical branches, neurosurgery organisations have recommended postponing or limiting surgeries during the pandemic to reduce the risk of transmission. In our literature review, no study reported the number of neurosurgeons infected with COVID-19 following surgeries performed during the first 3 months of the pandemic. This study examined surgeries performed during the first 3 months of the pandemic in Turkey and COVID-19 transmission to neurosurgeons involved in these cases.

Methods: Records of 188 patients who underwent surgery in our neurosurgery clinic during the first wave of the pandemic in Turkey (March 11-31 May 2020) were examined retrospectively. Characteristics of the operations performed, COVID-19 tests performed and results, intraoperative measures taken and frequency of COVID-19 symptoms among neurosurgeons after the surgery were determined.

Results: Of the 188 patients included in the study, none had a definitive diagnosis of COVID-19 at the time of surgery. However, 25 patients (13.29%) had a history of unsafe contact or symptoms suggestive of COVID-19. Moreover, 9 (36%) patients had a positive result from the COVID-19 polymerase chain reaction test. A total of nine neurosurgeons who participated in surgeries were included in the study and none of them exhibited COVID-19 symptoms during the 3-month pandemic period.

Conclusion: Although many surgeries were performed during the first wave of the pandemic in Turkey, with some simple precautions, none of the neurosurgeons developed COVID-19. We think that this is a pioneering study since this quantitatively demonstrates the extent of COVID-19 transmission to neurosurgeons during surgery.

Keywords: COVID-19, neurosurgeon, pandemic, surgery, transmission

ÖZ

Amaç: Sağlık çalışanları koronavirüs hastalığı-2019 (COVID-19) ile mücadelede en ön safta bulunmaktadır ve ne yazık ki bulaş riski en yüksek olan meslek grubudur. Bu yüzden pandemi döneminde tüm cerrahi branşlarda olduğu gibi beyin ve sinir cerrahisi örgütleri de bulaş riskini azaltmak için çoğu olgunun ertelenmesini veya azaltılmasını önermişlerdir. Literatür taramalarımızda pandeminin ilk 3 ayında yapılan ameliyatlara beyin cerrahlarının ne kadarının COVID-19 ile enfekte olduğunu gösteren bir çalışma bulamadık. Biz de bu çalışma ile pandeminin ülkemizdeki ilk 3 ayında opere ettiğimiz olguları inceledik ve bu olgularda bulunan, beyin ve sinir cerrahlarına COVID-19 bulaşı durumunu değerlendirdik.

Yöntemler: Pandemi döneminde (11 Mart-31 Mayıs 2020) kliniğimizde opere ettiğimiz 188 hastanın dosyaları retrospektif olarak incelendi. Yapılan cerrahilerin özellikleri, bakılan COVID-19 testleri, sonuçları, cerrahi sırasında nöroşirürjikal açıdan alınan önlemler ve cerrahi sonrasında, beyin ve sinir cerrahlarında COVID-19 semptomlarının görülme oranları saptandı.

ORCID IDs of the authors: M.Ş. 0000-0003-0633-8304; D.K.G. 0000-0003-2345-8818; M.E. 0000-0001-5722-9832; F.Y. 0000-0003-0921-8658; E.K. 0000-0002-6442-6663; H.K. 0000-0002-1184-3965.

Corresponding Author/Sorumlu Yazar: Mert Şahinoğlu,

E-mail: msahinoglu09@gmail.com

Received Date/Geliş Tarihi: 19.01.2021 **Accepted Date/Kabul Tarihi:** 15.06.2021

©Copyright 2021 by University of Health Sciences Turkey, Gaziosmanpaşa Training and Research Hospital. Available on-line at www.jarem.org

©Telif Hakkı 2021 Sağlık Bilimleri Üniversitesi, Gaziosmanpaşa Eğitim ve Araştırma Hastanesi. Makale metnine www.jarem.org web sayfasından ulaşılabilir.



Bulgular: Çalışmaya dahil edilen 188 hastanın hiçbiri COVID-19 kesin tanısı ile operasyona alınmadı. Ancak 25'inin (%13,29) anamnezinde COVID-19 ile temas veya semptom açısından şüphe mevcuttu. 9 (%36) hastanın polimeraz zincirleme reaksiyonu testi COVID-19 pozitif olarak geldi. Çalışmaya dahil edilen hastaların cerrahisinde bulunan beyin ve sinir cerrahisi ekibindeki toplam doktor sayısı ise 9 idi. Çalışmanın yapıldığı 3 aylık pandemi döneminde cerrahlara katılan beyin ve sinir cerrahlarında COVID-19 semptomu saptanmadı.

Sonuç: Ülkemizdeki pandeminin ilk dalgasının yükselişinde birçok farklı ameliyat gerçekleştirmiş olsak da, bazı basit önlemlerle beyin ve sinir cerrahlarında COVID-19 semptomu oluşturacak bulaşın önüne geçildi. Bu çalışmanın, COVID-19'un nöroşirürjikal cerrahlara bağlı cerrahi ekibe bulaşma derecesini nicel olarak gösteren literatür açısından öncü bir çalışma olduğunu düşünmekteyiz.

Anahtar kelimeler: COVID-19, beyin cerrahi, pandemi, cerrahi, bulaşma

INTRODUCTION

The novel coronavirus disease-2019 (COVID-19) pandemic has been the most significant global event of 2020. This highly contagious and life-threatening viral disease was first officially reported in Turkey on 11 March 2020 (1). As in the rest of the world, it has adversely affected all aspects of life in Turkey, with the health sector receiving the greatest impact. The decision was to suspend elective surgeries and only perform emergency and urgent procedures in surgical departments of all hospitals, including neurosurgery.

Under the circumstances of this pandemic, which is new to the global health sector, neurosurgeons in Turkey have also taken preventive measures along with the rest of the world (1,2). However, owing to the many unknown aspects of the disease, neurosurgeons were still concerned about contracting COVID-19 despite all of the preventive measures (1). This is because initial publications reported distressingly high rates of transmission to health workers (2,3). Although the Turkish Neurosurgical Society (TNS) has issued risk-based recommendations of surgeries that can be performed during the pandemic to guide neurosurgeons, concerns still exist for emergency neurosurgeries (4). In fact, the initial 3-month pandemic period affected later elective cases, indirectly leading to disruption of neurosurgical health care services.

In our literature review, no find study has reported the number of neurosurgeons infected with COVID-19 following surgeries performed during the first 3 months of the pandemic. Therefore, this study aimed to evaluate the types of surgeries performed in our centre, precautions taken during surgery and rates of COVID-19 transmission among neurosurgeons following surgeries performed during the first 3 months of the COVID-19 pandemic in Turkey.

METHODS

Records of 188 patients who underwent surgery in our department during the first wave of the COVID-19 pandemic in Turkey (March 11-31 May 2020) were examined retrospectively. Patients' sex, mean age, diagnosis, surgery type, department from which the patient was referred for surgery and department to which the patient was admitted after surgery were noted. Patients who had a history of suspected COVID-19 and underwent polymerase chain reaction (PCR) analysis and/or rapid antibody test (RAT) were identified. If available, results of blood tests and thoracic

computed tomography (CT) were also examined. Information on whether the tests were performed before or after surgery was noted. Patients with test results and findings supporting a diagnosis of COVID-19 were recorded. Which neurosurgeons had participated in each operation was also determined. Emergence of COVID-19 symptoms, positive test results and/or thoracic CT findings in patients within 14 days after surgery were recorded. For patients who were followed in a ward or intensive care unit for 14 days post-operatively, these data were obtained by reviewing their follow-up charts. Patients who were discharged before the end of 14 days were contacted by phone. Appearance of COVID-19 symptoms in the operating neurosurgeons and results of their COVID-19 tests were evaluated.

The study was approved by the Medical Faculty of Selçuk University, Local Ethics Committee (decision no: 2020/452, date: 14.10.2020).

Statistical Analysis

Statistical analysis was performed using SPSS 18.0 programme. Compliance with normal distribution was tested with Shapiro-Wilk test. Statistical analysis between two percentages was tested with Pearson chi-square and likelihood ratio test due to the lack of normal distribution. Multi-group median values were also analysed with Kruskal-Wallis test. A value of $p < 0.05$ was considered significant.

RESULTS

This study included 188 patients who underwent emergency or urgent surgeries, all of which were performed under general anaesthesia. The patient group was composed of 103 male (54.78%) and 85 female (45.22%) patients. The mean age was 42.08 (range, 1 day-83) years. Moreover, 88 patients were referred to surgery from the emergency department, 39 from other wards and 61 from the neurosurgery outpatient clinic.

Thirty-six patients underwent surgery due to lumbar disc herniation. These patients developed cauda equina syndrome or had severe pain that severely impaired their quality of life despite analgesic treatment. Ten patients with cervical disc herniation and one patient with lumbosacral listhesis underwent surgery due to uncontrolled pain. In addition, six patients with spinal mass, two with spinal infection, two with cervical stenosis and three with lumbar stenosis underwent surgical treatment due to newly emerging or worsening neurodeficits. Thirty-five

patients underwent surgery because of intracranial mass, and four of these patients had pituitary macroadenoma that caused apoplexy and/or increased vision loss. Other intracranial masses were malignant glial mass in 12 patients, intracerebral metastasis in seven, meningioma in four and pilocytic astrocytoma in two. These patients underwent early surgical treatment due to clinical signs of herniation, diffuse cerebral oedema or progressive deterioration in neurological examinations. Another four patients (one with ependymoma, two with medulloblastoma and one with colloid cyst) underwent surgery because of acute hydrocephalus caused by the mass. Surgery was performed due to cranial nerve palsy in one patient with an epidermoid tumour in the posterior fossa and due to uncontrolled pain in one patient with trigeminal neuralgia. During this period, the third most common surgery was surgical treatment of hydrocephalus, which was performed in 31 patients. Six of these patients underwent endoscopic third ventriculostomy, seven underwent shunt removal and 16 patients underwent shunt insertion. Emergency surgery was performed in 12 patients with unstable vertebral fracture, nine with epidural haemorrhage, eight with subdural haemorrhage, four with intracerebral haemorrhage, three with calvarial collapse fracture, four with myelomeningocele, six with intracerebral abscess and two with ruptured cerebral aneurysm. In addition, nine patients who developed malignant oedema due to cerebrovascular disease underwent decompressive craniectomy, one patient with Chiari malformation and symptoms of cranial nerve compression underwent decompression surgery and two patients with iatrogenic or traumatic cerebrospinal fluid leak underwent duraplasty. One patient with tethered cord syndrome underwent surgery for urinary incontinence (Table 1).

Table 1. Distribution of patients in terms of diagnosis

Disease	Number of patients who underwent surgery (%)
Lumbar degenerative disease	40 (21.27%)
Cervical degenerative disease	12 (6.38%)
Spinal infection	2 (1.06%)
Intracranial infection	6 (3.19%)
Spinal tumours	6 (3.19%)
Intracranial tumours	35 (18.61%)
Cranial trauma	24 (12.76%)
Spinal trauma	12 (6.38%)
Hydrocephalus	31 (16.48%)
CSF fistula	2 (1.06%)
Malign cerebral oedema (associated with CVD)	9 (4.78%)
Ruptured cerebral aneurysm	2 (1.06%)
Trigeminal neuralgia	1 (0.53%)
Myelomeningocele	4 (2.12%)
Chiari malformation	1 (0.53%)
Tethered cord syndrome	1 (0.53%)

CSF: cerebrospinal fluid, CVD: cerebrovascular disease

None of the patients had a definitive diagnosis of COVID-19 at the time of surgery. However, 25 (13.29%) patients had history of unsafe contact or symptoms suggestive of COVID-19. No significance was found between the diagnosis of the patients who underwent surgery and suspicion of COVID-19 (likelihood ratio test, $p=0.811$) (Table 2). No significance was found between patients diagnosed with COVID-19 and the operation diagnosis (likelihood ratio test, $p=0.973$) (Table 3). At the same time, no significance was found between the department where the patient was hospitalised and the suspicion of COVID-19 (Pearson chi-square test, $p=0.179$) (Table 4). All patients underwent RAT, PCR analysis and thoracic CT. Nine (36%) patients had a positive result from the COVID-19 PCR test. Three of these patients had a lumbar degenerative disease, two had hydrocephalus, one had intracranial tumour, one had epidural haematoma, one had lumbar vertebral fracture and one had cervical degenerative disease (Table 2). PCR analysis was repeated for only five of these patients during post-operative follow-up; all results were positive. Forty patients who were discharged before completing 14 days of follow-up could not be contacted. Therefore, it was not possible to ascertain whether they had tested positive for COVID-19 after discharge. Moreover,

Table 2. Distribution of patients suspected with coronavirus disease-2019 according to the diagnosis during surgery

		Not suspected	Suspected	Total
Cerebrospinal fluid fistula	n	1	1	2
	%	50.0%	50.0%	100.0%
Cervical degenerative disease	n	11	2	13
	%	84.6%	15.4%	100.0%
Cranial trauma	n	19	3	22
	%	86.4%	13.6%	100.0%
Hydrocephalus	n	27	4	31
	%	87.1%	12.9%	100.0%
Intracranial tumour	n	32	3	35
	%	91.4%	8.6%	100.0%
Lumbar degenerative disease	n	33	7	40
	%	82.5%	17.5%	100.0%
Malign cerebral oedema	n	7	2	9
	%	77.8%	22.2%	100.0%
Others	n	18	1	19
	%	94.7%	5.3%	100.0%
Spinal trauma	n	11	1	12
	%	91.7%	8.3%	100.0%
Spinal tumour	n	4	1	5
	%	80.0%	20.0%	100.0%
Total	n	163	25	188
	%	86.7%	13.3%	100.0%

*Analysed by likelihood ratio test, $p=0.811$

3 (1.59%) patients died in the early post-operative period. Autopsy reports indicated that no signs of COVID-19 were detected in these patients.

No significance was found between the department (emergency, outpatient and other wards) and COVID-19 diagnosis (likelihood ratio test, $p=0.115$) (Table 5).

A total of nine neurosurgeons who participated in surgeries were included in the study. The average number of surgeries performed

by these neurosurgeons was 39 (23-58). The average number of surgeries received from the emergency clinic was 15.8 (3-36), the number of operations received from the outpatient clinic was 15.3 (9-30) and the number of operations received from the other ward clinic was 7.7 (2-13) (Table 6). No significant difference was found between the number of patients who underwent surgery performed by the nine neurosurgeons and the median of the number of patients they received from clinics (Kruskal-Wallis test, $p=0.433$) (Table 7).

During this period, RAT was performed by six neurosurgeons who participated in the surgery of patients who became positive of COVID-19 post-operatively. The results of the tests were negative. During the 3-month study period, none of the nine neurosurgeons experienced COVID-19 symptoms. Therefore, except for the six neurosurgeons mentioned, blood test (haemogram, C-reactive protein, D-dimer), thoracic CT scan, RAT and PCR analysis were not needed.

DISCUSSION

There were several reasons for limiting or halting elective surgeries during the COVID-19 pandemic. The first reason was to increase bed capacity by decreasing patient density and to assign health workers to COVID-19 cases. The second reason was to reduce the risk of COVID transmission to patients who presented to hospitals due to diseases other than COVID-19. The implementation of curfews also caused a decrease or halt in elective procedures. Another important aim was to protect health workers, who are the frontline fighters against the pandemic, to reduce workforce loss (3,5).

Because this study was performed during the first 3 months of the pandemic, the virus transmission rate was high and the number of tests was inadequate. For this reason, the COVID-19 status of patients scheduled for elective surgery was unknown, which placed all surgical teams at great risk. Therefore, in our centre and unit, surgeries were only performed in emergency and urgent cases. Under normal pre-pandemic circumstances, approximately 450 surgeries were performed in our clinic during a 3-month period, including elective and emergency cases. However, within

Table 3. Distribution of patients diagnosed with coronavirus disease-2019 according to the diagnosis for the operation

		Diagnosed	No diagnosis	Total
Cerebrospinal fluid fistula	n	0	2	2
	%	0.0%	100.0%	100.0%
Cervical degenerative disease	n	1	12	13
	%	7.7%	92.3%	100.0%
Cranial trauma	n	1	21	22
	%	4.5%	95.5%	100.0%
Hydrocephalus	n	2	29	31
	%	6.5%	93.5%	100.0%
Intracranial tumour	n	1	34	35
	%	2.9%	97.1%	100.0%
Lumbar degenerative disease	n	3	37	40
	%	7.5%	92.5%	100.0%
Malign cerebral oedema	n	0	9	9
	%	0.0%	100.0%	100.0%
Others	n	0	9	9
	%	0.0%	100.0%	100.0%
Spinal trauma	n	1	11	12
	%	8.3%	91.7%	100.0%
Spinal tumour	n	0	5	5
	%	0.0%	100.0%	100.0%
Total	n	9	169	178
	%	5.1%	94.9%	100.0%

*Analysed by likelihood ratio test, $p=0.973$

Table 4. Number and percentage of coronavirus disease-2019 suspicion in the clinic where the patient was admitted

		Not suspected	Suspected	Total
Emergency	n	72	15	87
	%	82.8%	17.2%	100.0%
Other ward	n	37	2	39
	%	94.9%	5.1%	100.0%
Outpatient	n	54	8	62
	%	87.1%	12.9%	100.0%
Total	n	163	25	188
	%	86.7%	13.3%	100.0%

*Analysed by Pearson chi-square test, $p=0.179$

Table 5. Number and percentage of coronavirus disease-2019 diagnosis in the clinic where the patient was admitted

		With diagnosis	Without diagnosis	Total
Emergency	n	5	82	87
	%	5.7%	94.3%	100.0%
Other ward	n	0	39	39
	%	0.0%	100.0%	100.0%
Outpatient	n	4	58	62
	%	6.5%	93.5%	100.0%
Total	n	9	179	188
	%	4.8%	95.2%	100.0%

*Analysed by likelihood ratio test, $p=0.115$

Table 6. Total number of surgeries in which neurosurgeons were involved and the total number of surgeries performed according to the department the patients were admitted to

Number of neurosurgeons	Number of surgeries	Outpatient surgeries	Emergency surgeries	Other ward surgeries
1	39 (11.1%)	24 (17.3%)	8 (5.6%)	7 (10%)
2	42 (12%)	30 (21.7%)	3(2.1%)	9 (12.9%)
3	44 (12.5%)	17 (12.3%)	14 (9.8%)	13 (18.5%)
4	35 (10%)	12 (8.7%)	16 (11.2%)	7 (10%)
5	44 (12.5%)	12 (8.7%)	26 (18.2%)	6 (8.6%)
6	53 (15.1%)	10 (7.2%)	36 (25.1%)	7 (10%)
7	29 (8.3%)	11 (8%)	16 (11.2%)	2 (2.8%)
8	37 (10.5%)	13 (9.5%)	14 (9.8%)	10 (14.3%)
9	28 (8%)	9 (6.6%)	10 (7%)	9 (12.9%)

Table 7. Median, minimum and maximum number of surgeries performed by neurosurgeons according to the clinics where their patients were hospitalised

Neurosurgeon	1	2	3	4	5	6	7	8	9	p value
Number of operations	8 (7-24)	9 (3-30)	14 (13-17)	12 (7-16)	12 (6-26)	10 (7-36)	11 (2-16)	13 (10-14)	9 (9-10)	0.433*

*Analysed by Kruskal-Wallis test

this 3-month period during the pandemic, a total of 188 surgeries were performed, all of which were emergency or urgent cases. In accordance with the recommendations of the TNS, other than emergency neurosurgery cases, patients with progressive neurological deficit or those with cranial and spinal conditions with very low survival potential were regarded as urgent cases (e.g., intracranial masses without neurodeficit but with brain oedema that does not regress substantially with medical treatment or spinal degenerative diseases with severe, medically refractory pain) (4).

The TNS, Society of British Neurosurgical Surgeons and many other organisations specifically advised against performing endonasal surgery (3,6). Owing to the presence of the virus in the mucus of the respiratory tract and paranasal sinuses, procedures in these areas were determined to be high risk. Therefore, performing COVID-19 tests for each patient before the operation was recommended (7). During the study period, four endoscopic pituitary surgeries were performed in our clinic. Three were performed by a microscopic endonasal transsphenoidal approach and one via an endonasal transsphenoidal approach. These patients were not suspected of having COVID-19 and were not tested pre- or post-operatively. As tests were performed for only 25 patients with suspected COVID-19, the incubation time of the virus was 5 days while symptoms could appear up to 14 days after infection, test reliability was not above 90% and the COVID-19 status of patients was unknown. Since the transmission rate was high in the initial 3-month period, it is also highly likely that some asymptomatic or untested patients were carrying COVID-19. In our study, only 25 patients who were found suspicious were analysed for PCR and 36% of them were COVID-19 positive. Considering this high percentage, it is likely that other patients

were not tested because there was no suspicion, so the number of people carrying COVID-19 will not be low. Thus, although different procedures were performed in our clinic, many of which were high risk of COVID-19 transmission; thus, it is important that none of the neurosurgeons who participated in these operations developed COVID-19 symptoms.

We attribute this to the protective measures we took in the clinic. We would like to underline that these precautions were not complex and did not include various categorisations described in the literature (3,5). Considering the incubation time of the virus and the time required for symptoms to emerge, it is impossible to determine which patient may be carrying COVID-19; therefore, personal protective measures should always be kept in mind (3,8). Other than endonasal procedures and patients with suspected or confirmed COVID-19, we did not use N95 masks [filtering face piece-2 (FFP2)] or protective shields. We continued to use standard surgical masks, disposable gloves, hair restraints, reusable scrubs and personal surgical clogs as in the pre-pandemic period, and there was no limitation on the number of surgeons involved in surgeries. For endonasal cases and patients with suspected or confirmed COVID-19, we used N95 masks (FFP2), protective shields, disposable gloves and hair restraints, reusable scrubs and personal surgical clogs (Figure 1). Unless absolutely necessary, a maximum of two neurosurgeons were involved in these surgeries. During intubation, a single neurosurgeon waited in the operating room.

In our clinic, RAT, PCR analysis and thoracic CT were not performed routinely before and after each operation. Consistent with other studies, thoracic CT, RAT and/or PCR analysis were performed only if the patient had a history suggestive of COVID-19, suspicious blood test results, or suspicious chest X-ray findings. Patients who required emergency surgery were assessed by

RAT preoperatively and PCR analysis post-operatively. For patients who did not require emergency surgery, PCR analysis was performed preoperatively instead of RAT. However, thoracic CT, RAT and PCR analysis were not performed for patients who had no history suggesting COVID-19 and no suspicious blood test or chest x-ray findings. Another important matter was the evaluation of thoracic CT in patients with trauma. COVID-19 involvement was particularly difficult to distinguish in patients with lung contusion. If the radiologist had any suspicion, the same algorithm was used.

Neurosurgeons involved in the operations included in our study only underwent blood tests, thoracic CT, RAT and PCR analysis in case of risky contact or if the surgeon exhibited typical COVID-19 symptoms (Figure 2).

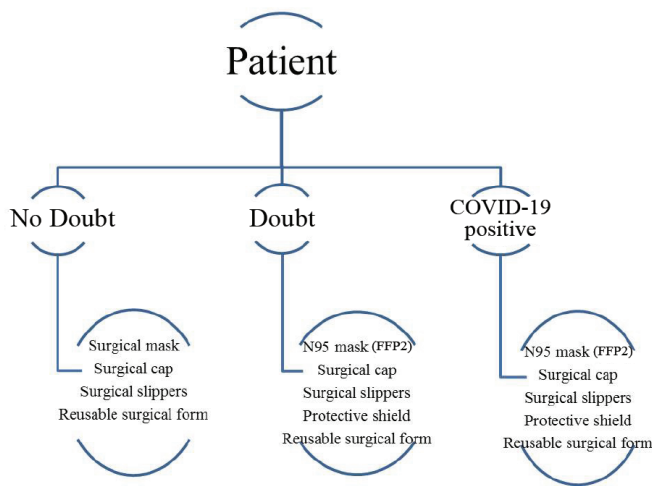


Figure 1. Our personal protection measures in surgery according to patients suspected with COVID-19 or with COVID-19 diagnosis
COVID-19: coronavirus disease-2019, FFP2: filtering face piece-2

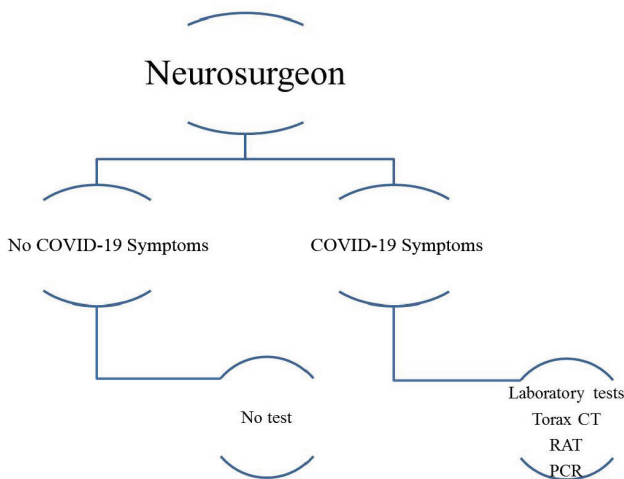


Figure 2. Our approach for the diagnosis of COVID-19 according to the presence of symptoms in the neurosurgeon
COVID-19: coronavirus disease-2019, RAT: rapid antibody test, CT: computed tomography, PCR: polymerase chain reaction

Study Limitations

We were not able to show the rates of COVID-19 transmission in asymptomatic cases, because the study was carried out during the first wave of the pandemic and thoracic CT, RAT and PCR analysis could not be performed routinely or periodically on asymptomatic neurosurgeons or each patient. Moreover, these evaluation tools will be performed with more cases in a longer time. Prospective studies are needed to examine this topic in the future.

CONCLUSION

To the best of our knowledge, this is a pioneering study that quantitatively demonstrates the extent of COVID-19 transmission to neurosurgeons who performed surgeries to patients with COVID-19. Although different procedures were performed during the first wave of the pandemic in Turkey, none of the neurosurgeons participating in procedures developed COVID-19 despite following only simple precautions implemented in our clinic. Our knowledge and experience during the first wave of the pandemic was practically low; however, recently, we have gained more information and experience to wield in future waves. These results should serve as a guide for performing all operations, including neurosurgical elective procedures and endonasal surgeries in particular, with minimal concern. The ability to minimise transmission with uncomplicated diagnostic algorithms and simple but necessary precautions is important in terms of assuaging concerns of neurosurgeons.

Ethics Committee Approval: The study was approved by the Medical Faculty of Selçuk University, Local Ethics Committee (decision no: 2020/452, date: 14.10.2020).

Informed Consent: Retrospective study.

Peer-review: Externally and internally peer-reviewed.

Author Contributions: Surgical and Medical Practices - M.Ş., D.K.G., M.E., F.Y., E.K., H.K.; Concept - M.Ş., E.K., H.K.; Design - H.K.; Data Collection and/or Processing - M.E., F.Y.; Analysis and/or Interpretation - M.Ş.; Literature Search - D.K.G.; Writing - H.K.

Conflict of Interest: The authors have no conflict of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Etik Komite Onayı: Çalışma Selçuk Üniversitesi Tıp Fakültesi Yerel Etik Kurulu tarafından onaylandı (karar no: 2020/452, tarih: 14.10.2020).

Hasta Onamı: Retrospektif çalışma.

Hakem Değerlendirmesi: Editörler kurulu ve editörler kurulu dışında olan kişiler tarafından değerlendirilmiştir.

Yazar Katkıları: Cerrahi ve Medikal Uygulama - M.Ş., D.K.G., M.E., F.Y., E.K., H.K.; Konsept - M.Ş., E.K., H.K.; Dizayn - H.K.; Veri Toplama veya İşleme - M.E., F.Y.; Analiz veya Yorumlama - M.Ş.; Literatür Arama - D.K.G.; Yazan - H.K.

Çıkar Çatışması: Yazarlar tarafından çıkar çatışması bildirilmemiştir.

Finansal Destek: Yazarlar tarafından finansal destek almadıkları bildirilmiştir.

REFERENCES

1. Yılmaz A, Karakoyun DO, Isik HS, Bostan S. The effect of the COVID-19 pandemic on functioning of neurosurgery clinics and the anxiety levels of neurosurgeons in Turkey. *Turk Neurosurg* 2020; 30: 944-51.
2. Sheng L, Chen Y, Li H, Wang Z, Bie B, You H, et al. Experience in Neurosurgery During the Prevalence of COVID-19. *J Craniofac Surg* 2020; 31: e622-4.
3. Ozoner B, Gungor A, Hasanov T, Toktas ZO, Kilic T. Neurosurgical practice during coronavirus disease 2019 (COVID-19) Pandemic. *World Neurosurg* 2020; 140: 198-207.
4. Turkish Neurosurgery Society. Egitim gruplarımızın acil önerileri. Available from: <https://www.turknorsirurji.org.tr/1/haberler/894/duyuru-egitim-gruplarimizin-acil-onerileri>; 2020.
5. Iorio-Morin C, Hodaie M, Sarica C, Dea N, Westwick HJ, Christie SD, et al. Letter: The risk of COVID-19 infection during neurosurgical procedures: a review of Severe Acute Respiratory Distress Syndrome Coronavirus 2 (SARS-CoV-2) modes of transmission and proposed neurosurgery-specific measures for mitigation. *Neurosurgery* 2020; 87: E178-85.
6. Jenkins A. Letter: Transmission of COVID-19 during neurosurgical procedures-some thoughts from the United Kingdom. *Neurosurgery* 2020; 87: E68.
7. Ahluwalia R, Rocque BG, Shannon CN, Blount JP. The impact of imposed delay in elective pediatric neurosurgery: an informed hierarchy of need in the time of mass casualty crisis. *Childs Nerv Syst* 2020; 36: 1347-55.
8. Manusubroto W, Wicaksono AS, Tamba DA, Sudiharto P, Pramusinto H, Hartanto RA, et al. Neurosurgery services in Dr. Sardjito General Hospital, Yogyakarta, Indonesia, During the COVID-19 pandemic: experience from a developing country. *World Neurosurg* 2020; 140: e360-6.