



AKADÉMIAI KIADÓ

IMAGING

ORIGINAL ARTICLE



Vascular procedures during the COVID-19 pandemic in a high volume Eastern European interventional radiology department

ÁKOS BÉRCZI^{1,2}, PÁL NOVÁK KAPOS³, HUNOR SARKADI¹, CSONGOR PÉTER^{1,2}, VIKTOR BÉRCZI³ and EDIT DÓSA^{1,2*} 

¹ Heart and Vascular Center, Semmelweis University, Budapest, Hungary

² Hungarian Vascular Radiology Research Group, Budapest, Hungary

³ Medical Imaging Center, Semmelweis University, Budapest, Hungary

Received: December 23, 2020 • Accepted: June 7, 2021

ABSTRACT

Aim: To assess the impact of the COVID-19 outbreak on trends in hospital admissions and number of diagnostic and therapeutic procedures in the largest tertiary vascular center in Hungary.

Patients and Methods: A retrospective analysis was carried out. The first wave of the COVID-19 pandemic occurred approximately from March 15 until June 1 in Hungary. We have compared the same period of 2020 to 2019. Electronic medical records were reviewed for the clinical status of the patients and treatment-related information.

Results: The total number of diagnostic angiographies and therapeutic interventions in 2020 ($N = 233$) decreased significantly ($P = 0.046$) compared to 2019 ($N = 373$). The ratio of Fontaine stage I–II cases to Fontaine stage III–IV cases for both diagnostic angiographies and therapeutic interventions was significantly lower (OR, 2.11; 95% CI, 1.26–3.59; $P = 0.007$ and OR, 3.22; 95% CI, 1.67–6.52; $P < 0.001$) in 2020 (0.36 and 0.27) than in 2019 (0.77 and 0.89). There was also a negative but not significant change in the number of supra-aortic (including internal carotid artery stenting) ($P = 0.128$) and other vascular therapeutic interventions (superior vena caval stenting, hemodialysis access percutaneous transluminal angioplasty [PTA], visceral artery/vein PTA/stenting, embolization) ($P = 0.452$) in 2020 ($N = 16$ and $N = 21$) compared to 2019 ($N = 39$ and $N = 37$).

Conclusion: The first wave of the COVID-19 pandemic had a negative effect on the total number of endovascular procedures in the largest tertiary vascular center in Hungary.

KEYWORDS

COVID-19 pandemic, interventional radiology, vascular procedures, peripheral artery disease, Fontaine stages

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has had an unprecedented impact on the healthcare system worldwide [1]. Prevention of hospital-acquired infections is a critical and necessary task, especially during a pandemic. Compared to open vascular surgery procedures, the duration of hospitalization for endovascular interventions is generally shorter, resulting in reduced exposure to nosocomial severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission [2]. However, like other specialties, interventional radiology had to adapt to the new situation rapidly [2].

There are concerns that the COVID-19 pandemic negatively affects the quality of care for patients with acute vascular disorders [3]. For example, while assessment of patients with intermittent claudication (Fontaine stage II) may be delayed for 2–3 months, Fontaine stages III and IV are urgent medical conditions [4]. We aimed to investigate the influence of the

IMAGING 13 (2021) 2, 138–141

DOI: [10.1556/1647.2021.00032](https://doi.org/10.1556/1647.2021.00032)

© 2021 The Author(s)

*Corresponding author. Heart and Vascular Center, Semmelweis University, Városmajor Street 68, 1122 Budapest, Hungary. Tel.: +36 20 825 8108; fax: +36 458 6746. E-mail: drdosaeedit@gmail.com



COVID-19 outbreak on trends in hospital admissions and number of diagnostic and therapeutic interventional procedures in the largest tertiary vascular center in Hungary.

Patients and methods

A retrospective analysis from a single institution of all diagnostic and therapeutic vascular interventional procedures was carried out. The first wave of the COVID-19 pandemic occurred approximately from March 15 until June 1 in Hungary. We have compared the same period (between March 15 and June 1) of 2020 to 2019.

Institutional Review Board approval was granted (Approval No: 177/2020). Due to the retrospective nature of this study, patient informed consent for analysis of data was not obtained. Electronic medical records were reviewed for the clinical status of the patients (Fontaine stages) [4] and procedural information.

Statistical analysis

We used the Wilcoxon signed-rank test to identify the types of vascular interventional procedures of which significantly less were performed in 2020 than in 2019. We used the Chi-square test to compare distributions of the vascular interventional procedures between the 2020 and the 2019 time frames. Alternatively, when the number of procedures in a category was less than five, the Fisher's exact test was used. We adjusted the level of significance (P) in case of multiple comparisons with the Bonferroni correction. We calculated the odds ratio (OR) from a two-by-two contingency table to determine the size of the effect of the time frame on the probability of a vascular procedure. The OR was presented together with its 95% confidence interval (CI). Statistical calculations were completed with the R.3.5.2. software (www.r-project.org).

Results

In 2020, 233 vascular interventional procedures (diagnostic, $N = 126$; therapeutic, $N = 107$), while in 2019, 373

(diagnostic, $N = 178$; therapeutic, $N = 195$) were performed. The number of all vascular procedures (diagnostic angiographies and therapeutic interventions) was significantly lower ($P = 0.046$) in 2020 ($N = 233$) than in 2019 ($N = 373$).

Among the diagnostic angiographies, in 2020, 113 were lower extremity related (Fontaine stage I, $N = 1$; Fontaine stage II, $N = 29$; Fontaine stage III–IV, $N = 83$), while in 2019, 159 (Fontaine stage I, $N = 3$; Fontaine stage II, $N = 66$; Fontaine stage III–IV, $N = 90$). The number of lower extremity diagnostic angiographies carried out in 2020 was non-significantly lower (OR, 1.27; 95% CI, 0.91–1.76; $P = 0.184$) than that in 2019. The ratio of Fontaine stage I–II cases to Fontaine stage III–IV cases decreased significantly (OR, 2.11; 95% CI, 1.26–3.59; $P = 0.007$) in 2020 compared to 2019 (Table 1).

Among the therapeutic interventions, in 2020, 70 were lower extremity related (Fontaine stage I, $N = 2$; Fontaine stage II, $N = 13$; Fontaine stage III–IV, $N = 55$), while in 2019, 119 (Fontaine stage I, $N = 0$; Fontaine stage II, $N = 56$; Fontaine stage III–IV, $N = 63$). The number of lower extremity therapeutic interventions carried out in 2020 was non-significantly lower (OR, 0.92; 95% CI, 0.64–1.31; $P = 0.696$) than that in 2019. The ratio of Fontaine stage I–II cases to Fontaine stage III–IV cases decreased significantly (OR, 3.22; 95% CI, 1.67–6.52; $P < 0.001$) in 2020 compared to 2019 (Table 1).

The number of supra-aortic diagnostic angiographies and therapeutic interventions was significantly lower ($P = 0.049$) in 2020 ($N = 18$) than in 2019 ($N = 51$). As there were few cases in each diagnostic and therapeutic subgroup, no subgroup analysis was performed. The number of internal carotid artery (ICA) percutaneous transluminal angioplasty (PTA)/stenting/covered stent implantation, common carotid artery (CCA; proximal or middle) PTA/stenting/covered stent implantation, subclavian artery PTA/stenting, and innominate artery stenting in 2020 were five, four, two, and four, whereas those for 2019 were 28, five, four, and two, respectively (Table 2). PTA was performed only in patients with restenosis. In one patient, stent fracture with displacement was identified as the cause of ICA restenosis. The patient underwent surgical stent removal and the

Table 1. Lower extremity procedures performed between March 15 and June 1 in 2019 and 2020

Procedures	2019	2020	Significance
<i>Diagnostic angiographies</i>			
All	$N = 159$	$N = 113$	OR, 1.27; 95% CI, 0.91–1.76; $P = 0.184$
Fontaine stage I	$N = 3$	$N = 1$	–
Fontaine stage II	$N = 66$	$N = 29$	–
Fontaine stage III–IV	$N = 90$	$N = 83$	–
Fontaine stage I–II/Fontaine stage III–IV	$69/90 = 0.77$	$30/83 = 0.36$	OR, 2.11; 95% CI, 1.26–3.59; $P = 0.007$
<i>Therapeutic interventions</i>			
All	$N = 119$	$N = 70$	OR, 0.92; 95% CI, 0.64–1.31; $P = 0.696$
Fontaine stage I	$N = 0$	$N = 2$	–
Fontaine stage II	$N = 56$	$N = 13$	–
Fontaine stage III–IV	$N = 63$	$N = 55$	–
Fontaine stage I–II/Fontaine stage III–IV	$56/63 = 0.89$	$15/55 = 0.27$	OR, 3.22; 95% CI, 1.67–6.52; $P < 0.001$

CI, Confidence interval; OR, odds ratio.



Table 2. Supra-aortic procedures performed between March 15 and June 1 in 2019 and 2020

Procedures	2019	2020
All supra-aortic procedures (diagnostic + therapeutic), N	51	18
Diagnostic angiographies, N	12	2
Bilateral carotid angiography, N	7	2
Four-vessel angiography, N	5	0
Therapeutic interventions, N	39	16
ICA PTA, N	1	0
ICA stenting, N	26	5
ICA covered stent implantation, N	1	0
CCA PTA, N	1	0
CCA stenting, N	4	1
CCA covered stent implantation, N	0	1
Subclavian artery PTA, N	1	1
Subclavian artery stenting, N	3	4
Innominate artery stenting, N	2	4

CCA, Common carotid artery, ICA, internal carotid artery, PTA, percutaneous transluminal angioplasty.

damaged carotid segment was replaced with a polytetrafluoroethylene interpositum (with end-to-end anastomosis of the ICA and CCA). Due to prolonged awakening, the patient had cranial computed tomography (CT) and carotid CT angiography (CTA) in the postoperative period. CTA showed significant stenosis at the distal anastomosis, which was treated with covered stent deployment. The other covered stent was implanted in a patient with iatrogenic CCA injury during a dialysis cannula insertion attempt.

Other procedures include numerous types of diagnostic angiographies and therapeutic interventions (Table 3). The total number of these procedures was non-significantly lower ($P = 0.487$) in 2020 ($N = 32$) than in 2019 ($N = 44$). Due to the small number of cases in each diagnostic and therapeutic subgroup, no subgroup analysis was performed.

As in 2019, during the first wave of the COVID-19 pandemic in 2020, those who had a diagnostic angiography were sent home or to the referring site after a short observation period, while those who underwent an intervention spent 24 hours in our institution.

Discussion

Our institution is a tertiary center for vascular and endovascular surgery with 50 beds. The referring territory is approximately 1.7 million. This is the largest such institution in Hungary having approximately 1,000 open surgical and 1,800 endosurgical procedures per year.

We have shown that the number of all lower extremity vascular procedures was lower during the first wave of the COVID-19 pandemic in 2020 than in the same period of 2019. However, there was no significant change in the number of emergency cases (Fontaine stages III and IV). Interventional procedures for those with intermittent claudication (Fontaine stage II) were postponed several weeks; in

Table 3. Other procedures performed between March 15 and June 1 in 2019 and 2020

Procedures	2019	2020
All other procedures (diagnostic + therapeutic), N	44	32
Diagnostic angiographies, N	7	11
Cavography, N	2	0
Hemodialysis access fistulography, N	1	2
Upper extremity angiography, N	1	3
Visceral angiography, N	1	3
Renovasography, N	2	3
Therapeutic interventions, N	37	21
Superior vena caval stenting, N	11	1
Hemodialysis access PTA, N	6	4
Renal vein stenting, N	1	0
Celiac trunk stenting, N	2	0
Superior mesenteric artery stenting, N	2	2
Inferior mesenteric artery PTA, N	0	1
Inferior mesenteric artery stenting, N	1	0
Renal artery PTA, N	0	1
Renal artery stenting, N	7	1
Renal artery covered stent implantation, N	0	1
Embolization, N	7	10

PTA, Percutaneous transluminal angioplasty.

these cases, the delay did not risk the patients' long-term health condition. So, the referral physicians were able to triage the patients in an adequate manner. A recent study revealed that the number of amputations is more than two-fold higher and the number of revascularizations is close to half in Hungary than that reported internationally; these numbers indicate the need to improve amputation prevention [5]. We have demonstrated that even in the COVID-19 era the number of patients with Fontaine stages III and IV has not decreased in our center. It should be noted that in patients with Fontaine stage I, diagnostic angiography or therapeutic intervention is normally not necessary. In our cohort, these were due to arterial aneurysms.

An online survey regarding the effect of the COVID-19 pandemic was sent to 365 vascular surgeons across the United States in April 2020 [6]. The COVID-19 pandemic has resulted in performing primarily emergency and urgent cases, and the number of elective operations was substantially reduced [6]. Moreover, a minority of vascular surgeons have been redeployed outside of their specialty; this was more common among states with high case numbers [6]. Similar results were observed in the United Kingdom in a survey for interventional radiologists: the COVID-19 outbreak has dramatically changed their practice in favor of mostly urgent endovascular care [7]. Comparable outcome was found in a tertiary academic center in Madrid; however, this study has not compared data of COVID-19 era to data of any pre-COVID-19 era [8].

In 2020, there were also far fewer therapeutic carotid interventions in our institution than in 2019. This is because stenting is mainly executed in the presence of asymptomatic stenosis, so these procedures could be postponed. Those treated invasively during the COVID-19 pandemic were



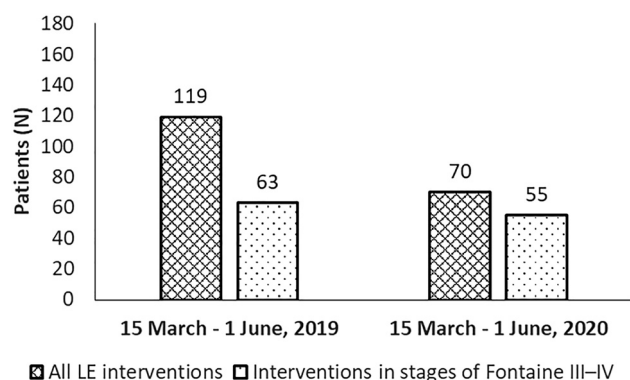


Fig. 1. Central Illustration. Lower extremity therapeutic interventions. The number of lower extremity therapeutic interventions for all patients (bars with crosslines) and for patients with Fontaine stage III–IV (dotted bars) in 2019 (left bars) and 2020 (right bars). The ratio of Fontaine stage I–II cases to Fontaine stage III–IV cases decreased significantly (OR, 3.22; 95% CI, 1.67–6.52; $P < 0.001$) in 2020 compared to 2019.

LE, Lower extremity

symptomatic patients for whom surgery was contraindicated. Ultrasound-determined carotid stenosis is usually verified by CTA or by magnetic resonance angiography. Bilateral carotid digital subtraction angiography (DSA) was done with the intention of a therapeutic procedure; however, the therapeutic intervention was either unnecessary (the baseline DSA showed carotid artery occlusion or non-significant luminal narrowing in contrast to the CTA) or was not feasible for any unforeseen cause. Four-vessel cerebral angiographies were performed only to confirm brain death.

The number of embolization for acute bleeding also remained stable (10 in 2020, seven in 2019; Table 3), showing another field of patient group where emergency situations were well managed.

Patients, who underwent a therapeutic intervention were discharged from our institution only after 24 hours, regardless of the pandemic. In the Vascular and Endovascular Research Network (VERN) COVID-19 Vascular Service (COVER) Tier 2 Study, 1,103 procedures were analyzed and in 2% of the cases, a change in the choice of post-operative destination was reported. However, no further details on the change can be found in the article [9].

In conclusion, the first wave of the COVID-19 pandemic had a negative effect on the total number of endovascular procedures in the largest tertiary vascular center in Hungary.

Authors' contribution: All authors contributed to the study conception and design. Material preparation, data collection

and analysis were performed by Á.B., P.N.K., H.S., C.P., and E.D. The first draft of the manuscript was written by Á.B., V.B., and E.D., and all authors commented on previous versions of the manuscript. All authors read and approved the final version of the manuscript, and agreed to submit it to IMAGING for publication.

Funding sources: This article was funded by the EFOP-3.6.3-VEKOP-16-2017-00009 project (Ákos Bérczi).

Conflict of interests: The authors declared no potential conflict of interests with respect to the research, authorship, and/or publication of this article.

REFERENCES

- [1] Palmer K, Monaco A, Kivipelto M, Onder G, Maggi S, Michel J-P, et al.: The potential long-term impact of the COVID-19 outbreak on patients with non-communicable diseases in Europe: consequences for healthy ageing. *Aging Clin Exp Res* 2020; 32: 1189–94.
- [2] Chandy PE, Nasir MU, Srinivasan S, Klass D, Nicolaou S, Babu SB: Interventional radiology and COVID-19: evidence-based measures to limit transmission. *Diagn Interv Radiol* 2020; 26: 236–40.
- [3] Quek LHH, Tan GWL, Pua U: Managing endovascular workload during COVID-19 outbreak-the Singapore experience. *Ann Vasc Surg* 2020; 66: 3–5.
- [4] Norgren L, Hiatt WR, Dormandy JA, Nehler MR, Harris KA, Fowkes FGR, et al.: Inter-society consensus for the management of peripheral arterial disease (TASC II). *J Vasc Surg* 2007; 45 Suppl S: S5–67.
- [5] Kolossváry E, Ferenci T, Kovács T, Kovács L, Szeberin Z, Sótonyi P, et al.: Lower limb amputations and revascularisation procedures in the Hungarian population: a 14 year retrospective cohort study. *Eur J Vasc Endovasc Surg* 2020; 59: 447–56.
- [6] Latz CA, Boitano LT, Png CYM, Tanious A, Kibrik P, Conrad M, et al.: Early vascular surgery response to the COVID-19 pandemic: results of a nationwide survey. *J Vasc Surg* 2021; 73(2): 372–80.
- [7] Rostampour S, Cleveland T, White H, Haslam P, McCafferty I, Hamady M: Response of UK interventional radiologists to the COVID-19 pandemic - survey findings. *CVIR Endovasc* 2020; 3: 41.
- [8] Reyes Valdivia A, Aracil Sanus E, Duque Santos Á, Gómez Olmos C, Gordillo Alguacil S, El Amrani M, et al.: Adapting vascular surgery practice to the current COVID-19 era at a tertiary academic center in Madrid. *Ann Vasc Surg* 2020; 67: 1–5.
- [9] Benson RA, Nandhra S: Outcomes of vascular and endovascular interventions performed during the coronavirus disease 2019 (COVID-19) pandemic. *Ann Surg* 2021; 273: 630–5.