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**ORIGINAL ARTICLE**

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# Impact of the coronavirus disease 2019 (COVID-19) pandemic on the care of patients with acute and chronic aortic conditions

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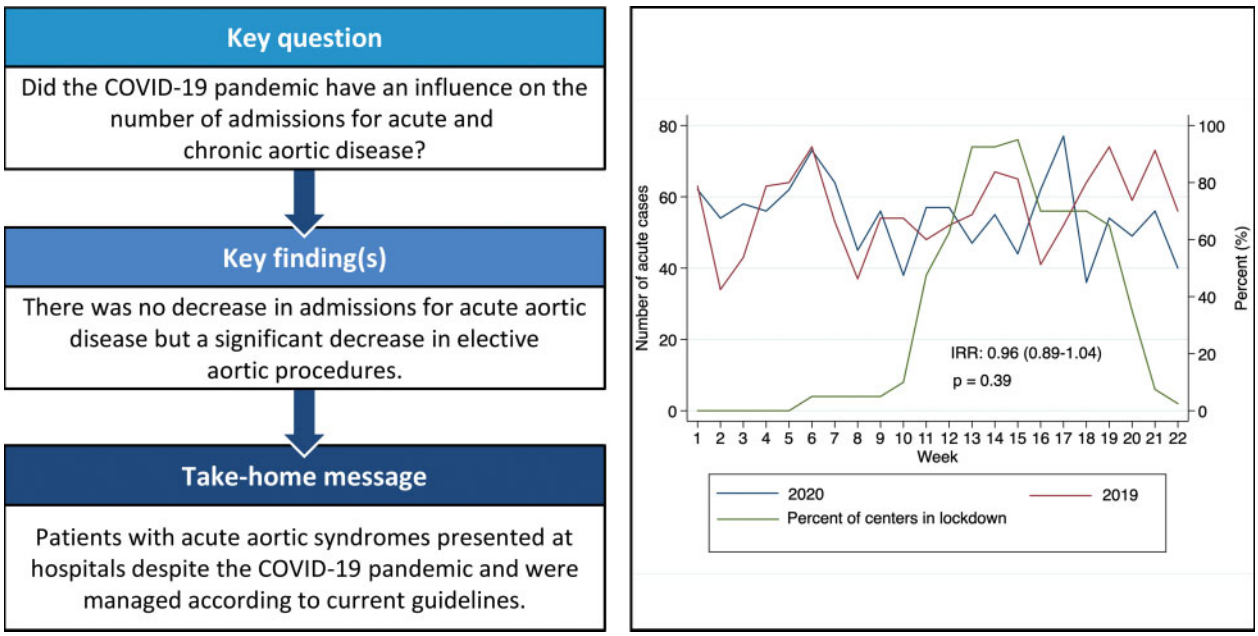


## Abstract

**OBJECTIVES:** To evaluate the impact of the coronavirus disease 2019 (COVID-19) pandemic on acute and elective thoracic and abdominal aortic procedures.

**METHODS:** Forty departments shared their data on acute and elective thoracic and abdominal aortic procedures between January and May 2020 and January and May 2019 in Europe, Asia and the USA. Admission rates as well as delay from onset of symptoms to referral were compared.

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**RESULTS:** No differences in the number of acute thoracic and abdominal aortic procedures were observed between 2020 and the reference period in 2019 [incidence rates ratio (IRR): 0.96, confidence interval (CI) 0.89–1.04; $P = 0.39$]. Also, no difference in the time interval from acute onset of symptoms to referral was recorded (<12 h 32% vs > 12 h 68% in 2020, < 12 h 34% vs > 12 h 66% in 2019 $P = 0.29$). Conversely, a decline of 35% in elective procedures was seen (IRR: 0.81, CI 0.76–0.87; $P < 0.001$) with substantial differences between countries and the most pronounced decline in Italy (-40%, $P < 0.001$). Interestingly, in Switzerland, an increase in the number of elective cases was observed (+35%, $P = 0.02$).

**CONCLUSIONS:** There was no change in the number of acute thoracic and abdominal aortic cases and procedures during the initial wave of the COVID-19 pandemic, whereas the case load of elective operations and procedures decreased significantly. Patients with acute aortic syndromes presented despite COVID-19 and were managed according to current guidelines. Further analysis is required to prove that deferral of elective cases had no impact on premature mortality.

**Keywords:** Acute and elective thoracic and abdominal aortic procedures • Coronavirus disease 2019 pandemic

**ABBREVIATIONS**

| | |
|---|---|
| ACS | Acute coronary syndromes |
| CI | Confidence interval |
| COVID-19 | Coronavirus disease 2019 |
| IRR | Incidence rates ratio |
| TIA | Transient ischaemic attack |

## INTRODUCTION

During the initial wave of the coronavirus disease 2019 (COVID-19) pandemic, a substantial decrease in the admission rates of patients with acute coronary syndromes (ACS) and consequently, a sharp decline in the number of emergency coronary procedures performed in Europe and the USA, were observed [1–3]. In several European countries, the nationwide lockdown severely restricted movement, which might have contributed to this phenomenon on top of the widespread fear of contracting COVID-19 when admitted into a hospital [4]. There is substantial concern that similar trends will be observed in the setting of acute aortic syndrome (aortic dissection) with a substantial death toll, if not managed swiftly.

The aim of this study was to evaluate the impact of the COVID-19 pandemic on acute and elective thoracic and abdominal aortic procedures and to compare the data with the same period in 2019 in participating institutions.

## PATIENTS AND METHODS

### Patients

The study was registered at the ethics committee—Albert-Ludwigs-University Freiburg under the reference ID: 20-1025. Forty departments from Europe, Asia and the USA that provided services for acute and chronic aortic conditions contributed and shared their data on the number of acute and elective thoracic and abdominal aortic procedures performed between January and May 2020 and between January and May 2019. Only the number of procedures for acute and chronic aortic conditions, further divided into thoracic and abdominal procedures, without any patient-related information was collected. Figure 1 shows the

**Figure 1:** Location of the participating departments (source: google maps).

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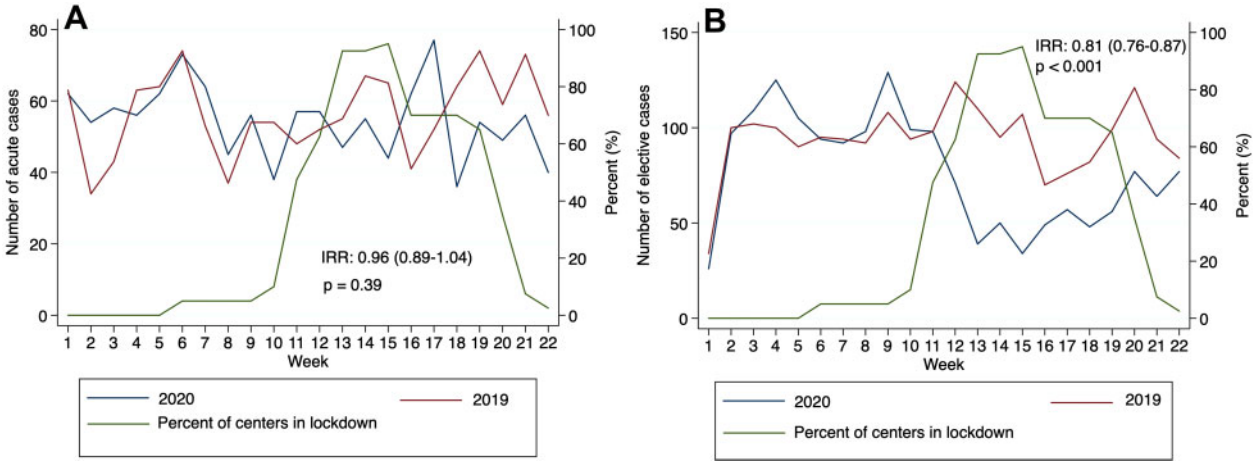


**Figure 2:** (**A**) Acute aortic cases—Europe, Asia, USA. (**B**) Elective aortic cases—Europe, Asia, USA.

**Table 1:** Acute and elective cases per week—2020

| Week | Total cases | Total acute cases | Acute >12 h | Acute <12 h | Total elective cases |
|---|---|---|---|---|---|
| 1 | 88 | 62 | 23 | 39 | 26 |
| 2 | 151 | 54 | 23 | 31 | 97 |
| 3 | 167 | 58 | 21 | 37 | 109 |
| 4 | 181 | 56 | 20 | 36 | 125 |
| 5 | 167 | 62 | 19 | 43 | 105 |
| 6 | 167 | 73 | 17 | 56 | 94 |
| 7 | 156 | 64 | 21 | 43 | 92 |
| 8 | 143 | 45 | 15 | 30 | 98 |
| 9 | 185 | 56 | 17 | 39 | 129 |
| 10 | 137 | 38 | 10 | 28 | 99 |
| 11 | 155 | 57 | 15 | 42 | 98 |
| 12 | 128 | 57 | 20 | 37 | 71 |
| 13 | 86 | 47 | 20 | 27 | 39 |
| 14 | 105 | 55 | 14 | 41 | 50 |
| 15 | 78 | 44 | 16 | 28 | 34 |
| 16 | 111 | 62 | 17 | 45 | 49 |
| 17 | 134 | 77 | 27 | 50 | 57 |
| 18 | 84 | 36 | 9 | 27 | 48 |
| 19 | 110 | 54 | 18 | 36 | 56 |
| 20 | 126 | 49 | 13 | 36 | 77 |
| 21 | 120 | 56 | 19 | 37 | 64 |
| 22 | 117 | 40 | 13 | 27 | 77 |

location of the participating departments. Figure 1 was generated with google maps.

## Definitions

Thoracic aortic pathology comprised any pathology beginning at the proximal thoracic aorta with treatment of the disease is usually limited to the thoracic aorta but also extending down to the abdominal aorta (e.g. type A, type non-A-non-B and type B aortic dissection). Abdominal aortic pathology refers to any pathology below the diaphragm and involving the abdominal aorta with or without the iliac arteries. Acute aortic pathology indicates any pathology requiring urgent or emergency treatment, whereas a chronic aortic pathology was present when treatment could be deferred to an elective setting.

## Data collection

A template excel file was sent to all participating aortic centres with the request to share their number of procedures partitioned in calendar weeks [1–22] in 2020 and 2019. In addition, in acute cases, we retrieved the time between onset of symptoms and referral for treatment. Data were systematically retrieved from institutional databases for cardiac and vascular care units.

## Statistical methods

The cases are presented as weekly recorded numbers in all centres. Incidence rates ratios (IRRs) were calculated by using Poisson regression analysis. The IRRs are presented with 95% confidence intervals (CIs). Statistical analysis was performed using R version 3.6.1 for macOS (The R Foundation for Statistical Computing, Vienna, Austria) with a level of significance set at *P*-value <0.05.

# RESULTS

## Acute and elective aortic cases in Europe, Asia, the USA

No difference in the number of acute aortic cases could be observed between 2020 and 2019 (IRR: 0.96, CI 0.89–1.04; $P = 0.39$), Fig. 2A. A significant decrease of 35% in elective cases was seen (IRR: 0.81, CI 0.76–0.87; $P < 0.001$), Fig. 2B. Table 1 shows the number of acute and elective cases per calendar week in 2020 and stratifies the acute cases in <12 and >12 h between onset of symptoms and referral for treatment. Table 2 shows the number of acute and elective cases per calendar week in 2019 and stratifies the acute cases in <12 and >12 h between onset of symptoms and referral for treatment.

## Acute and elective aortic cases—Europe

No difference in the number of acute aortic cases could be observed between 2020 and 2019 (IRR: 0.94, CI 0.86–1.03; $P = 0.25$), Fig. 3A. A decrease in elective cases was seen (IRR: 0.81,

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CI 0.75–0.87; $P < 0.001$) as shown in Fig. 3B. In Figs 2–3, we additionally added the percentage of the centres being affected by the lockdown per week by retrieving these data from https://en.wikipedia.org/wiki/COVID-19_pandemic_lockdowns where the exact time points and durations of lockdowns are documented. Figure 4 shows the changes in acute cases in Europe according to country, where no significant decrease could be observed in Italy (decrease by 11%, $P = 0.29$) and Austria (decrease by 9%, $P = 0.49$). In Switzerland (increase by 9%, $P = 0.36$) and Poland (increase by 20%, $P = 0.36$), a non-significant increase in acute cases could be observed. Germany was the only country where a significant decrease in acute cases was seen (decrease by 22%, $P = 0.006$). Figure 5 shows the changes in elective cases in Europe according to country, in which Italy (decrease by 40%, $P < 0.001$), Austria (decrease by 20%, $P = 0.03$) and Poland (decrease by 26%, $P = 0.02$) showed a significant decrease, whereas the decrease was non-significant in Germany (decrease by 6%, $P = 0.41$). On the other hand, Switzerland showed an increase in elective cases as compared to 2019 (increase by 35%, $P = 0.02$).

**Table 2:** Acute and elective cases per week—2019

| Week | Total cases | Total acute cases | Acute >12 h | Acute <12 h | Total elective cases |
|---|---|---|---|---|---|
| 1 | 97 | 63 | 26 | 37 | 34 |
| 2 | 134 | 34 | 10 | 24 | 100 |
| 3 | 145 | 43 | 14 | 29 | 102 |
| 4 | 163 | 63 | 20 | 43 | 100 |
| 5 | 154 | 64 | 23 | 41 | 90 |
| 6 | 169 | 74 | 20 | 54 | 95 |
| 7 | 147 | 53 | 23 | 30 | 94 |
| 8 | 129 | 37 | 16 | 21 | 92 |
| 9 | 162 | 54 | 17 | 37 | 108 |
| 10 | 148 | 54 | 15 | 39 | 94 |
| 11 | 146 | 48 | 16 | 32 | 98 |
| 12 | 176 | 52 | 20 | 32 | 124 |
| 13 | 165 | 55 | 19 | 36 | 110 |
| 14 | 162 | 67 | 23 | 44 | 95 |
| 15 | 172 | 65 | 22 | 43 | 107 |
| 16 | 111 | 41 | 13 | 28 | 70 |
| 17 | 128 | 52 | 15 | 37 | 76 |
| 18 | 146 | 64 | 25 | 39 | 82 |
| 19 | 173 | 74 | 19 | 55 | 99 |
| 20 | 180 | 59 | 19 | 40 | 121 |
| 21 | 167 | 73 | 29 | 44 | 94 |
| 22 | 140 | 56 | 14 | 42 | 84 |

## Time between onset of symptoms and referral

In acute cases, no difference regarding the time interval from acute onset of symptoms to referral was recorded (< 12 h 32% vs > 12 h 68% in 2020, < 12 h 34% vs > 12 h 66% in 2019) $P = 0.29$ (Fig. 6).

## DISCUSSION

There was no change in the number of procedures for acute thoracic and abdominal aortic pathologies during the initial phase of the COVID-19 pandemic whereas, due to the provision of intensive care capacity for potential COVID-19 patients, a decrease in elective thoracic and abdominal procedures was observed. The burden of aortic pain seems to outperform the reluctance to seek medical attention which is reflected in a similar time interval between onset of symptoms and referral, when compared with the pre-COVID-19 times.

In comparison to other cardiovascular pathologies, such as ACS, the incidence of acute aortic syndrome and the prevalence of chronic thoracic and abdominal aortic pathologies are low.

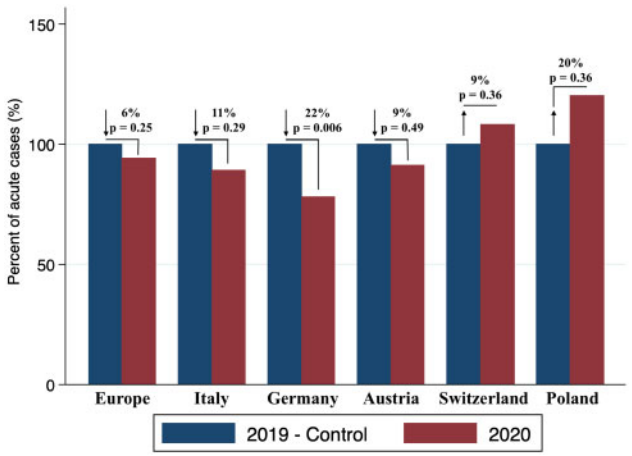


**Figure 4:** Changes in acute cases in Europe according to country.

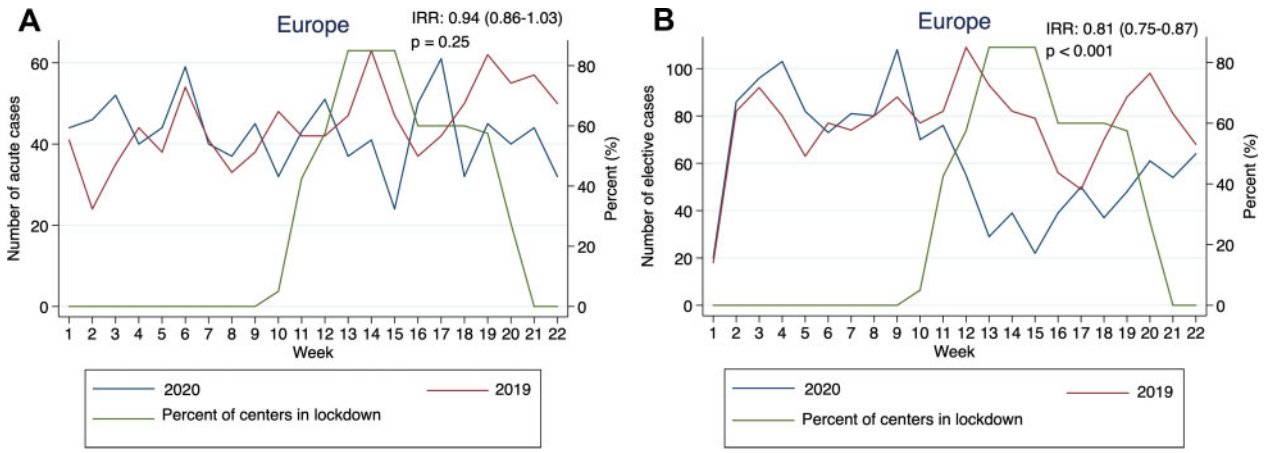


**Figure 3:** (**A**) Acute aortic cases—Europe. (**B**) Elective aortic cases—Europe.

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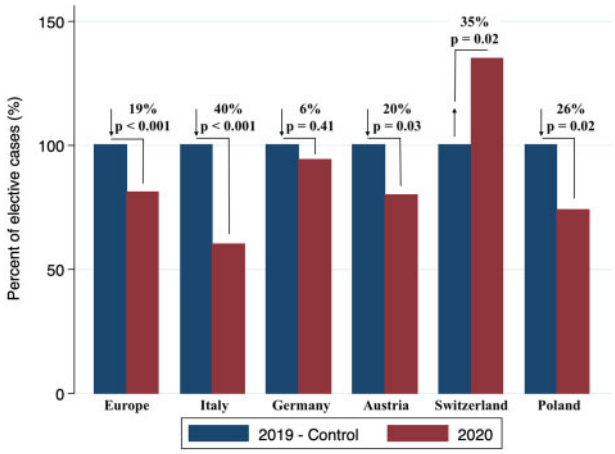


**Figure 5:** Changes in elective cases in Europe according to country.

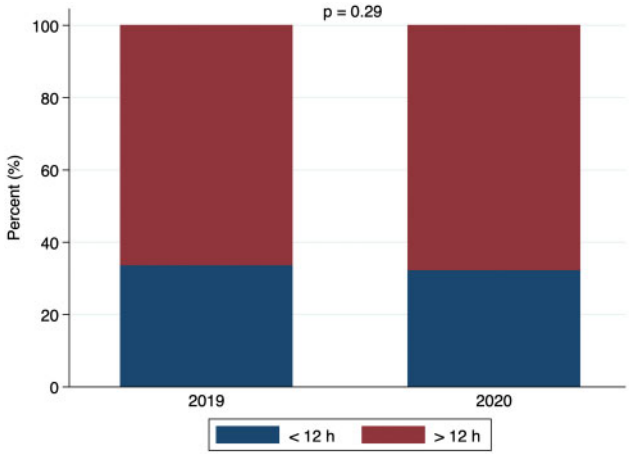


**Figure 6:** Time interval from acute onset of symptoms to referral.

However, pooling data from 40 institutions affected by the pandemic may enable a robust analysis on a representative cross-section of the current situation in 3 continents. Interestingly, even in 2020 (under pandemic conditions), the overall number of acute cases remained unchanged. This finding might well be attributed to the fact that symptoms from acute aortic syndromes are so striking, that the potential reluctance to seek medical advice, which has been reported in other types of cardiovascular disease such as ACS, is overridden by the urge to seek medical help [5]. This is also backed by a German analysis on admissions for acute myocardial infarction, acute limb ischaemia, aortic rupture, stroke or transient ischaemic attack (TIA) between 1 January 2019 and 31 May 2020 that found a decline in admissions between 9% and 15% for all other conditions but no decline in admissions for aortic rupture [6].

There was a substantial decrease in elective cases in particular between calendar Week 11 and 15 which can be clearly related to nationwide lockdown in most countries and a reduction in elective surgical procedures in order to be able to preserve intensive care capacity for potential COVID-19 patients [7]. As this expected increase in ICU admissions for COVID-19 patients did not occur in many settings, these measures were gradually eased, enabling the resumption of treatment for elective patients.

This exact same pattern could be observed when focusing on various European centres in this report. However, some differences were observed between European countries with regard to both acute and elective procedures. Regarding acute cases, stable conditions could be observed in Italy, Austria, Switzerland and Poland with little fluctuations. Germany was the only country where a significant decrease was observed, in particular between Calendar week 14 and 22. Currently, the reasons remain speculative but reluctance of patients to seek advice or a natural undulation in the incidence might be causative [8]. But in some epicentres of the COVID-19 pandemic a dramatic decrease in patients treated for acute aortic disease could also be seen [9, 10].

The decrease in elective cases in Europe was substantial with 2 exceptions, Germany where conditions were stable, and Switzerland where even an increase in elective cases was observed. The reason here might well represent the fact that one department of vascular surgery was recently newly established—which makes a difference in a small country and referrals were increasing there despite the COVID-19 pandemic. Another reason might well be the adherence to guidelines as well as the newly developed knowledge that even patients with diameters having just crossed the threshold to indication already have a substantial yearly risk of sustaining an acute aortic event, which justifies timely treatment [11]. Finally, the net numbers per country could well explain fluctuations in both directions which refer in particular to smaller countries. This is reasonable, as an acute aortic event on top of a chronic aortic condition will substantially impact immediate as well as long-term outcome [12]. Finally, hospital strategies play a decisive role in this rapidly changing environment. However, as national rules regarding the provision of care for potential COVID-19 patients—at least in the countries participating in this project—have been very similar, we would not expect an effect in this regard on our results.

Interestingly, the time between onset of symptoms and referral in acute cases showed no difference, which is in contrast to a very recent analysis on symptom-to-hospital analysis in ST-elevation myocardial infarction patients in the UK, where a decrease in number of procedures and an increase in the time interval to hospitalization were observed [13]. Here, it seems obvious that typical aortic syndrome is such a devastating clinical event that patients will seek medical advice regardless of circumstances (as long as hospitals provide acute aortic care) and that the need and provision of acute aortic care and emergency operations is independent of any pandemic and should always be an option.

## Limitations and strengths

This report lacks nationwide reporting but is the first of its kind to analyse referral pattern in the setting of the COVID-19 pandemic by data sharing of several high-volume cardiovascular referral centres from 3 continents, which provided a unique opportunity to obtain insight into this complex and dynamic topic. It has to be clearly stated that the low number of centres contributing from outside of Europe might therefore not reflect the actual situation in the respective regions or countries. Finally, conservative management of aortic diseases is expected to have increased during the pandemic. This may be related to restrictions on the resources or to a decreased use of health facilities by

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patients with symptoms, although these data cannot be mirrored by this analysis.

## CONCLUSION

In summary, there was no change in the number of procedures in acute thoracic and abdominal aortic pathologies during the initial phase of the COVID-19 pandemic whereas, due to the provision of intensive care capacity for potential COVID-19 patients, a decrease in elective thoracic and abdominal procedures has been observed. The burden of aortic pain seems to exceed the reluctance to seek medical advice which is additionally reflected in an unchanged time interval between onset of symptoms and referral. The need for acute aortic care is unchanged in a pandemic and resources are to be secured.

**Conflict of interest:** none declared.

## Author contributions

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