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Clinical Research

Progression of Changes in Vascular Surgery Practices during the Novel Corona Virus SARS-CoV-2 Pandemic

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Abstract: Introduction: The novel coronavirus SARS-CoV-2 (COVID-19) has spread rapidly since it was identified. We sought to understand its effects on vascular surgery practices stratified by VASCON surgical readiness level and determine how these effects have changed during the course of the pandemic.
Methods: All members of the Vascular and Endovascular Surgery Society were sent electronic surveys questioning the effects of COVID-19 on their practices in the early pandemic in April (EP) and four months later in the pandemic in August (LP) 2020.
Results: Response rates were 206/731 (28%) in the EP group and 108/731 (15%) in the LP group ($P < 0.0001$). Most EP respondents reported VASCON levels less than 3 (168/206,82%), indicating increased hospital limitations while 6/108 (6%) in the LP group reported this level ($P < 0.0001$). The EP group was more likely to report a lower VASCON level (increased resource limitations), and decreased clinic, hospital and emergency room consults. Despite an increase of average cases/week to pre-COVID-19 levels, 46/108 (43%) of LP report continued decreased compensation, with 57% reporting more than 10% decrease. Respondents in the decreased compensation group were more likely to have reported a VASCON level 3 or lower earlier in the pandemic ($P = 0.018$). 91/108(84%) of LP group have treated COVID-19 patients for thromboembolic events, most commonly acute limb ischemia (76/108) and acute DVT (76/108). While the majority of respondents are no longer delaying the vascular surgery cases, 76/108 (70%) feel that vascular patient care has suffered due to earlier delays, and 36/108 (33%) report a backlog of cases caused by the pandemic.
Conclusions: COVID-19 had a profound effect on vascular surgery practices earlier in the pandemic, resulting in continued detrimental effects on the provision of vascular care as well as compensation received by vascular surgeons.

INTRODUCTION

The effects of the COVID-19 pandemic upon clinical care, workforce environments and clinically generated revenue and compensation have been ubiquitous and with deep consequence for nearly all vascular surgeons within the United States[1–3] as well as those around the world[4–6]. Threat responses from COVID-19 upon healthcare resources and health systems have been varied as different regions of the United States have experienced surging in differing numbers of cases, and therefore different strains upon resources. This healthcare system response has been described by Dr. Thomas Forbes using the Vascular Activity Condition (VASCON)[7]

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Table 1.

Type of surgical activity	VASCON Level
Evidence based surgical practice	5
Limitations on nonemergency surgery	4
Severe limitations on nonemergency surgery	3
Emergency surgery only	2
No surgical activity	1

scale and has been utilized widely to describe local COVID-19 surge responses, providing an objective and standardized frame of reference and surrogate for COVID-19 cases. Although numerous reports regarding initial COVID-19 readiness were published in the early stages and during the initial peak of the pandemic[8–10], not much has been studied on the lingering effects and response from healthcare organizations and vascular surgeons in the mid- and late portions of the pandemic. We sought to understand how the responses to the COVID-19 pandemic, as well as the effects on practice and compensation for vascular surgeons and healthcare organization, have changed from a timepoint early in the pandemic (April 2020) to a timepoint later in the pandemic (August 2020) by surveying the members of the Vascular and Endovascular Surgery Society (VESS).

METHODS

All active and senior members of the VESS were sent an email requesting their participation in a survey detailing the effects the COVID-19 pandemic was having on their vascular surgery practices. This survey was sent at the beginning of August 2020 via the Qualtrics^{XM} Survey Software (Provo, Utah), and data were collected for a total of three weeks with reminder emails sent at the halfway point of data collection. Survey questions were identical to a survey sent to this same group in April 2020, and included self-reported VASCON levels of the respondent's health care system. In addition to the questions from the April Survey, the August survey had the addition of several questions pertaining to compensation and changes in workplace environments due to COVID-19.

Vascular Activity Condition (VASCON) Scale

The Vascular Activity Condition (VASCON) scale was first proposed by Dr. Thomas Forbes during the early part of the COVID-19 pandemic via social media and subsequently in an editorial in the Journal of Vascular Surgery as a way to describe the capability of hospitals/healthcare systems to provide surgical activity when resources become limited (Table 1).[7] Similar to the Defense Readiness Condition (DEFCON) status used by the United States military to describe the levels of military readiness to world threats, the VASCON reports graduated levels of surgical activity from VASCON 5 (normal practice) to VASCON 1 (no surgical activity). It is self-reported, either by a practitioner or a health care system, and may reflect not only the current activity level of a practice, but also may be useful in predicting and measuring the effects of a catastrophe on these practices.

Statistical Analysis

Responses were placed into groups based on the date of data collection. Survey responses from the April 2020 survey were placed in the early pandemic (EP) group, while the responses in the August 2020 survey were placed in the later pandemic (LP) group. Descriptive statistics were obtained from the LP group examining the current state of vascular surgery practices at that time and comparisons were made between the two groups in regard to the VASCON level, average caseload, changes in vascular surgery practices, compensation, COVID-19 patients treated, and use of personal protection equipment (PPE) and other protective changes in the workplace. Categorical data between these groups were analyzed using a contingency table with Fisher exact test. A *t*-test was used for analyzing continuous data. A *P*-value of <0.05 was considered statistically significant. All data analysis was performed using Microsoft Excel (Redmond, Washington, USA) and Graphpad (LaJolla, California, USA).

The VESS executive committee approved the distribution of the survey to its membership, and the Saint Louis University Institutional Review Board reviewed and approved the protocol and questionnaire for this study prior to collection of data.

Table 2.

Demographic	Early pandemic ($n = 206$)	Late pandemic ($n = 108$)	P-value
Gender			
Male	156 (76%)	81 (75%)	0.4679
Female	48 (23%)	24 (22%)	
Prefer not answering	2 (1%)	2 (3%)	
Age			
<35	8 (4%)	3 (3%)	0.1256
35–40	56 (27%)	28 (26%)	
40–45	48 (23%)	17 (16%)	
45–50	29 (14%)	26 (24%)	
50–55	31 (15%)	12 (11%)	
55–60	18 (9%)	8 (7%)	
>60	14 (7%)	14 (13%)	
Prefer not answering	2 (1%)	0 (0%)	
Academic affiliation	174 (84%)	92 (85%)	1.0

RESULTS

Demographics

Email addresses were current and available for 731 (91%) of the 805 active and senior members of the VESS. Of these, 108/731 members (15%) completed the August survey. This compared to 206/731 (28%), who completed the early survey ($P = 0.0001$). There were no significant differences between the groups in regard to baseline demographics. Most respondents in both groups were male, over the age of 40 and worked in a vascular surgery practice with an academic affiliation (Table 2). Most respondents in both groups reported COVID-19 had affected their practice, although less participants in LP reported current effects of COVID-19 on their practices (21/108 vs. 205/206, $P = 0.0001$).

VASCON Levels

Respondents in the EP group were asked what their current VASCON level was while those in the LP were asked about current and lowest VASCON level since the onset of the pandemic (Fig. 1). Those in the EP group reported a statistically significant lower VASCON level than those in the LP group (indicting higher surgical acuity), however when comparing the VASCON level in the EP group with the lowest VASCON level experienced by participants, there was no difference in responses.

Effect of COVID-19 on Overall Clinical Practice

Most respondents in both time periods felt their institutions were handling the COVID-19 pandemic well (Table 3). The EP group was more likely to report difficulties in accessing personal protective equipment/N95 masks, and a significant portion of both groups felt they would wear masks for patient encounters even post-COVID-19. While those respondents in the EP group reported significant decreases in clinic referrals and consults as well as limiting of cases performed, those in LP reported significantly less effects on decreased number of vascular patients seen and treated. When asked how many cases per week they were currently performing, those in the EP group reported significantly fewer cases, and when comparing the LP group with their pre-COVID case numbers, there was no difference, implying a return to pre-COVID practice levels. Despite this return to pre-COVID levels of cases, those in the LP group were more likely to be receiving decreased compensation as compared to pre-COVID levels. Of the LP respondents with decreased compensation, 33/58 (57%) reported greater than 10% decrease (Fig. **2**). A significant number of respondents reported protective changes to their practice due to COVID-19, including increased social distancing, mask wearing, and decreasing staff and guest presence in the workplace (Table 4). Additionally, over 30% have continued to experience furloughing of nonessential support staff in their work environments.

Effect of COVID-19 on Management of Specific Vascular Disorders

Those in the EP group were more likely to delay nonurgent/critical vascular issues (Table 5), which had mostly resolved by the LP time period. However, 29% of respondents in the LP group reported delaying peripheral arterial disease patients with only claudication and 20% reported

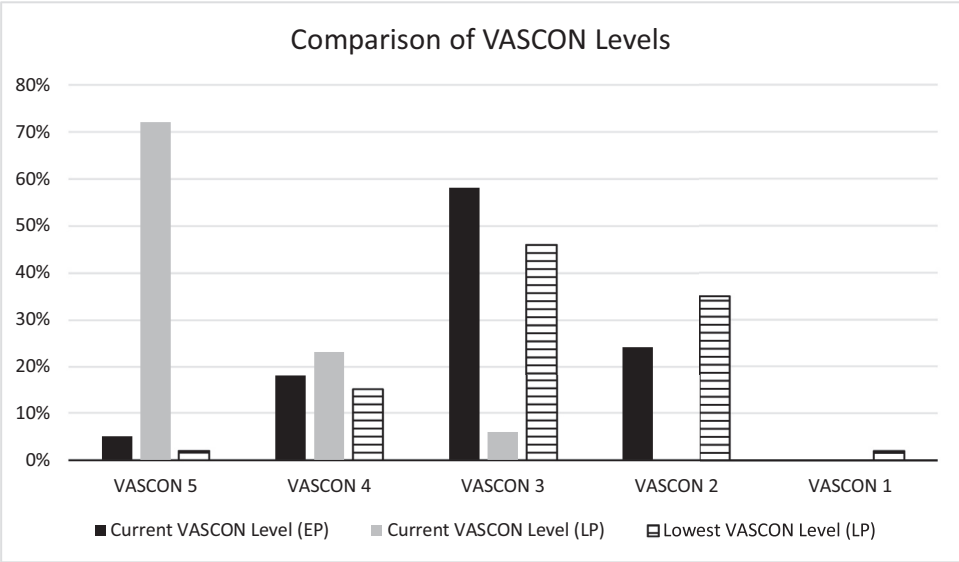

Fig. 1. Comparison of VASCON levels between EP and LP timepoints as well as the lowest VASCON level the LP group a

Table 3.

Practice characteristics	Early pandemic ($n = 206$)	Late pandemic ($n = 108$)	*P*-value
Institution specific questions			
My institution has handled the pandemic well	148 (72%)	86 (80%)	0.1725
Vascular patients with emergent issues are not being handled in a safe/quick manner	21 (10%)	9 (8%)	0.6887
I feel pressure to capture delayed cases	148 (72%)	86 (80%)	0.1725
Personal protective equipment (PPE) usage			
At work, i have easy access to PPE	163 (79%)	102 (94%)	**0.0003**
At work, i have easy access to N95 masks	130 (63%)	90 (83%)	**0.0002**
Once the covid19 pandemic is over, I will wear a mask for all patient care encounters	36 (18%)	25 (23%)	0.2332
Once the covid19 pandemic is over, I will wear a mask for all patients with cough/fever	123 (60%)	74 (69%)	0.1411
Practice changes			
Limiting of elective cases	201 (98%)	21 (19%)	**<0.0001**
Limiting of urgent cases	65 (32%)	6 (6%)	**<0.0001**
Limiting of emergent cases	10 (5%)	4 (4%)	0.778
Increased telehealth visits	186 (90%)	70 (65%)	**<0.0001**
Lengthening of call periods	90 (44%)	5 (5%)	**<0.0001**
Staying at home if no clinical duties	176 (85%)	33 (31%)	**<0.0001**
Providing surgical care you otherwise wouldn't	23 (11%)	1 (1%)	**0.0005**
Providing critical care you otherwise wouldn't	25 (12%)	4 (4%)	**0.0136**
Providing nonsurgical/non-ICU care for COVID positive patients	23 (11%)	2 (2%)	**0.0035**
Decrease in referrals			
Clinic referrals	175 (85%)	46 (43%)	**<0.0001**
Inpatient hospital consults (acute)	134 (65%)	21 (19%)	**<0.0001**
Emergency room consults (acute)	127 (62%)	18 (17%)	**<0.0001**
Inpatient hospital consults (chronic)	148 (72%)	20 (19%)	**<0.0001**
Emergency room consults (chronic)	162 (79%)	21 (19%)	**<0.0001**

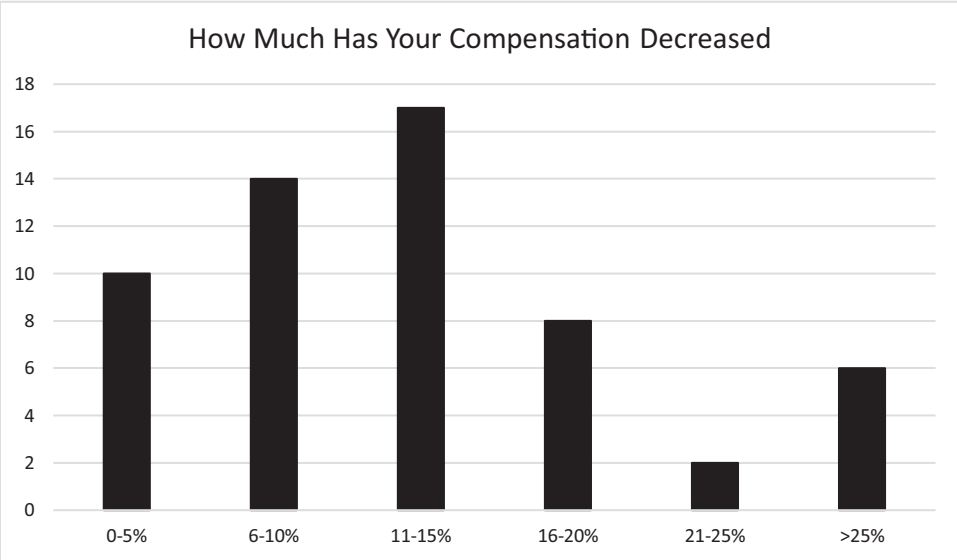

Fig. 2.

Table 4.

Practice effects	Currently affecting	Previously affecting	Total affected
Allowing NO patient guests	33 (31%)	73 (68%)	106 (98%)
Limiting patient guests	88 (81%)	15 (14%)	103 (95%)
Temperature screening of employees	79 (73%)	11 (10%)	90 (83%)
Requiring facemasks for all patient care	103 (95%)	2 (2%)	105 (97%)
Requiring facemasks for all in-person encounters	99 (92%)	4 (4%)	103 (95%)
Non-essential staff working from home intermittently	83 (77%)	20 (19%)	103 (95%)
Furloughing of staff	35 (32%)	37 (34%)	72 (67%)
Social distancing – plexiglass separators	93 (86%)	1 (1%)	94 (87%)
Social distancing – chair/seating configurations	107 (99%)	0 (0%)	107 (99%)

Table 5.

Delaying of cases due to COVID-19	Early pandemic ($n = 206$)	Late pandemic ($n = 108$)	*P*-value
Peripheral arterial disease			
Claudication	204 (99%)	31 (29%)	**<0.0001**
Rest pain	105 (51%)	4 (4%)	**<0.0001**
Tissue loss	26 (13%)	1 (1%)	**0.0002**
Carotid artery disease			
Severe stenosis (asymptomatic)	199 (97%)	22 (20%)	**<0.0001**
Severe stenosis with TIA/stroke	10 (5%)	2 (1%)	0.2303
Aneurysmal disease			
Asymptomatic AAA 5.5–6.5 cm	179 (87%)	14 (13%)	**<0.0001**
Asymptomatic AAA > 6.5%	68 (33%)	3 (3%)	**<0.0001**
Asymptomatic thoracic aortic aneurysm 6–7 cm	141 (68%)	8 (7%)	**<0.0001**
Asymptomatic thoracic aortic aneurysm > 7 cm	55 (27%)	5 (5%)	**<0.0001**
Thoracic outlet syndrome with DVT	88 (43%)	10 (9%)	**<0.0001**
Chronic mesenteric ischemia	139 (67%)	9 (8%)	**<0.0001**
Dialysis access/ESRD			
In need of access (>3 months)	187 (91%)	11 (10%)	**<0.0001**
In need of access (<3 months)	127 (62%)	6 (6%)	**<0.0001**
In need of access with functioning catheter	157 (76%)	5 (5%)	**<0.0001**
Malfunctioning access	27 (13%)	4 (4%)	**0.0087**

Table 6.

COVID-19 patients with thromboembolic events treated	Respondents who treated		Number of cases treated
Acute mesenteric ischemia	28 (26%)	1–5 cases	24
		>5 cases	4
Acute carotid occlusion/stroke	34 (31%)	1–5 cases	27
		>5 cases	7
Pulmonary embolism	47 (44%)	1–5 cases	21
		>5 cases	26
Dialysis related thrombus	55 (51%)	1–5 cases	25
		>5 cases	30
Acute limb ischemia	76 (70%)	1–5 cases	45
		>5 cases	31
Acute deep venous thrombosis (DVT)	76 (70%)	1–5 cases	28
		>5 cases	47

continuing to delay asymptomatic carotid artery stenosis. When asked about treatment of COVID-19 patients with thromboembolic events, the majority of respondents had treated at least one patient with these issues, with the most common pathology treated being acute limb ischemia or acute deep venous thrombosis (Table 6).

DISCUSSION

Since it was first identified in late 2019, COVID-19 has had a profound effect on society. As of the writing of this manuscript, nearly one hundred million patients worldwide have been diagnosed, and over two million people have died[11]. Current numbers in the United States reflect a "second wave" has begun, and potentially will result in even higher casualties than what was brought by the initial wave of the pandemic. A previous survey of VESS membership conducted in April of 2020 demonstrated that the pandemic had affected nearly all vascular surgeons across the US with decreased clinical and operative volumes, along with diminished educational opportunities for trainees[1]. This new survey was conducted of the VESS membership four months after this previous survey to determine the continued impact of the pandemic on vascular surgery practices as well as to ascertain the changes to practices that have ensued, including cases being performed and delayed, safety changes to limit exposure, and issues relating to compensation.

Overall, the survey response rate for the late pandemic survey was lower than the early pandemic survey (15% vs. 28%). This may represent survey fatigue, as all physicians across the US have been receiving multiple surveys during the COVID-19 pandemic, and it is quite possible that users at the receiving end may be losing interest in participating in these assessments. Additionally, surgeons who are more (or less) affected by COVID in their particular practices may be more (or less) likely to fill out these surveys, which may be skewing results one way or the other. While COVID-19 has had a profound effect on society, physicians have been particularly hard hit with increasing levels of anxiety and depression[12]. A recent survey of vascular surgeons found that over 50% of respondents had some level of anxiety, with 23% exhibiting signs of severe anxiety related to COVID-19[5]. Many of these respondents reported using an avoidant strategy for coping, and as such, not participating in studies such as ours may be a reflection of this desire to not be consumed by COVID-19 in their personal time. An overwhelming majority of the survey respondents in both the surveys identified themselves to be academic surgeons, likely reflective of the membership of the VESS at large.

Thomas Forbes developed the VASCON model to simplify priorities for vascular surgeons during the pandemic, based on the diagnosis and the urgency of treatment required[7]. In our earlier study, we confirmed its utility as a tool to both prioritize procedures during times of practice turmoil, but also as an instrument that could be used to predict and measure the impact of catastrophic events on vascular surgery practices. In the early pandemic, a majority of vascular surgeons across the country identified their practices to be at VASCON-3 level, indicating severe limitations on nonemergency vascular procedures. This was reflected by a significant reduction in the number of cases being performed at that time, including on patients with severe disease. Early on in the pandemic, the American College of Surgeons

created a tiering system to help healthcare systems focus resources on patients who would benefit the most[13]. Those in tier 3 are considered to have life or limb-threatening issues and no delay was recommended while those in tier 1 were considered elective cases that should be delayed. Our study confirmed that most practitioners early in the pandemic seemed to be following these recommendations. At that time, patients with elective cases (claudication, asymptomatic carotid disease, smaller aneurysms, etc.) were delayed, while urgent/emergent cases, other than in the direst situations, continued. As resources became more available, and the management strategies for COVID-19 patients became more refined, surgeons have begun a resumption of normal practice. In fact, the majority of vascular surgeons in the late pandemic group have reported their practices to be at VASCON-5 level, and they are performing similar numbers of cases as compared to prepandemic levels. These findings signal a return to prepandemic evidence-based care in both the types of procedures and number of cases being performed. When asked about the lowest VASCON level achieved thus far in the pandemic, there was no statistical difference between the late pandemic and early pandemic groups indicating these groups were similar in regard to their experiences of COVID-19 at its worst.

Congruent with the decrease in clinical activity in the early pandemic time period, nearly a third of vascular surgeons reported decreased compensation during that time. However, despite a return to more normal practice by the late pandemic time period, the number of surgeons experiencing decreased compensation persisted, with 43% affected. A survey done of medical groups in April of 2020 revealed 97% of respondents reported a negative impact on their practice due to COVID-19 with a 33% decrease in office visits and a 70% decrease in surgical procedures[14]. Vascular practices were likewise affected, with one study demonstrating reduction in vascular clinic volume by more than 96%, and a reduction in surgical volume by more than 70%[15]. In March, the U.S. Government enacted the Coronavirus Aid, Relief, and Economic Security Act, which expanded telemedicine visit reimbursement, increased Medicare payments to hospitals related to treatment of COVID-19, suspended Medicare sequestration, and provided loans and direct payment to healthcare providers, with over 40 billion dollars distributed[14,16]. Our study suggests that despite this governmental economic stimulus, the financial repercussions of COVID-19 continue to plague vascular surgeons, and likely reflect the ongoing financial crisis affecting healthcare systems as a whole.

The jury is out on what affect the reduction on surgical practice early in the pandemic will have on vascular surgery patients suffering with disease at that time that were delayed. Early reports suggest that patients presenting during the early pandemic tended to present with more severe disease and often in a delayed fashion, and in some centers, there were lower rates of limb salvage and higher rates of amputation.[17,18] In another study looking at data from a single state, the projected backlog of vascular cases from COVID-19 will take nearly 8 months to reconcile if practices continue to operate at pre-COVID standards[19]. While our study indicates that vascular surgeons are currently seeing patients and performing procedures at pre-COVID levels, our survey did not specify whether these patients were new patients or those that had been delayed. However, more than 30% of respondents reported backlogs of patients that needed to be treated. Further study will be needed to determine the ultimate long-term effects of the delay of care on our vascular patients.

One of the major concerns for physicians in the initial stages of the pandemic was access to personal protective equipment (PPE). The Centers for Disease Control and Prevention (CDC) recommends healthcare providers wear NIOSH-approved N95 or equivalent or higher-level respirators/masks while treating patients with suspected or confirmed SARS-CoV-2 infection[20]. However, due to the sudden rise in demand, low initial supplies on hand, panic buying by the population and healthcare centers, decreased supply from suppliers, and a lack of an effective distribution plan by the federal government to maintain domestic inventory, many healthcare practices found themselves lacking nearly all forms of PPE[21–22]. These issues with U.S. supply chains of PPE have been known when similar, albeit less profound, shortages occurred following the 2009 H1N1 influenza pandemic and the 2014 Ebola virus pandemic[23], and a world-wide survey done in April of 2020 revealed that over 50% of healthcare providers caring for COVID-19 patients lacked at least one piece of normal PPE and more than 30% were recycling facemasks[24]. It was no surprise, then that in our initial survey in the early pandemic, 79% of the vascular surgeons across the country stated that they had easy access to PPE while only 63% had easy access to N95 masks. These numbers were similar to other surveys performed during the pandemic that showed about 80% of surgeons reported having adequate access to PPE

at that time[3]. With changes in resource utilization, increasing supplies, and practice pattern changes, access to PPE has improved by the late pandemic time point to 94% having easy access to PPE and 83% having access to N95 masks, despite there being more patients being treated in many hospital settings for COVID-19 as compared to earlier in the pandemic.

In addition to universal mask wearing, recommendations exist to control transmission of the COVID-19 virus. This includes staying at home if infected or exposed to infected individuals, avoiding nonessential travel, and social distancing to allow at least two meters in between people in public areas[25]. The respondents in our survey report significant use of social distancing strategies such as limiting patient guests, chair/seating configurations, and increased working from home or furloughing of nonessential employees. Multiple studies confirm social distancing works in diminishing the transmission of COVID-19, with one study showing a 29% reduction in COVID-19 incidence and a 35% reduction in mortality when higher social distancing is practiced.[26,27] Despite this data, however, there has been significant misinformation given and believed by the U.S. population, which has been found to have negative influences on behavior with those individuals who believe this misinformation being less likely to practice social distancing[28]. Additionally, those people who live in areas that have higher "civic capital", are more likely to embrace socially responsible distancing[29]. We did not survey participants in their beliefs regarding these practices, but as of the late pandemic time point, it appears that most of the health care systems of our respondents still embrace these tenants of disease prevention.

LIMITATIONS

The limitations for our study include a reduced survey response, as compared to previous survey, likely to survey fatigue. As with any survey, selection bias plays a significant role: those affected the least and the most by the pandemic were more likely to respond to the surveys. Similarly, recall bias is an important limiting factor in this analysis. It is also possible that the VESS members who filled the survey during the early pandemic phase are different than those who filled the survey during late pandemic, hence the changes reflected in the comparisons between the two groups do not reflect true changes in practice patterns. The majority of respondents were involved in an academic practice. This may be a reflection of the VESS membership or a reflection of people who fill out surveys. As such, these results may be more applicable to those in academic practices and not private practice. While respondents were asked about compensation, they were not specifically asked about payments, total income, or how they received this compensation (salary vs. fee for services). As such, the decrease in compensation being seen may have been a reflection of a lag in payments after procedures were performed. Finally, we did not obtain information pertaining to the geographical location of the respondents in the later survey, and as such variation in the effects of COVID-19 stratified by region or environment (urban vs. rural) were not obtained. Despite these limitations, this survey reflects a comparison of vascular surgery practices during early and late pandemic phases throughout the country. It includes vascular surgeons from both academic and community practices, and hence provides a real-life picture of how the COVID-19 pandemic has affected vascular surgeons across the country and how these affects have changed from the early to late phases.

CONCLUSIONS

In conclusion, the COVID-19 pandemic has had a significant effect on vascular surgery practices across the United States. With the passage of time, limitations on elective cases have been lifted, however, the majority of vascular surgeons face a continued significant decrease in compensation. The availability of PPE has improved, and most workplaces continue to practice socially responsible distancing behaviors. While surgical practices appear to be back at prepandemic levels, time will tell if the backlog of procedures acquired during this time period will have a detrimental effect on the long-term outcome of vascular surgery patients.

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