Outcomes after open repair of aortic aneurysms and dissections in cannabis consumers

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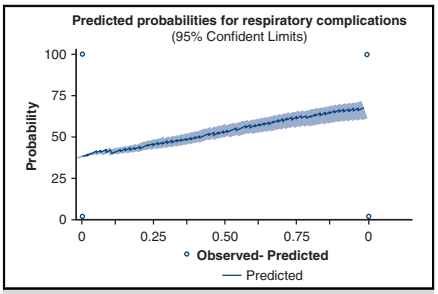
ABSTRACT

Objective: To investigate the influence of cannabis consumption on the mid- and long-term surgical outcomes of patients with aortic aneurysms or dissections.

Methods: All individuals aged 18 years and older with more than 6 months of cannabis use at the time of surgical repair for cardiovascular disease (aortic aneurysms or aortic dissection) between 2007 and 2023 were eligible. Patients were stratified into 2 groups based on their preoperative history of cannabis use: cannabis users and noncannabis users. The primary end point was complications or death within 30 days of intervention. Secondary outcomes included late complications and reinterventions. Data were combined from our institution and inpatient hospital records.

Results: We identified 134 patients who met the inclusion criteria out of 1543 treated patients (9%). Compared with the nonusing cannabis group, individuals in the cannabis group were significantly younger (cannabis: 48.3 ± 11.8 years vs noncannabis: 58.5 ± 14.9 years; $P < .001$). The cannabis group included significantly higher patients with Marfan syndrome (cannabis: 11.2% vs noncannabis: 4.4%; $P < .001$). Furthermore, the cannabis group showed significantly higher history of recreational drug use, including cocaine (25.4% vs 1.6%; $P < .001$), amphetamines (3.7% vs 0.6%; $P < .001$), opioids (8.2% vs 0.5%; $P < .001$), and intravenous drugs (6.7% vs 0.6%; $P < .001$). Emergency surgeries were significantly more frequent in the cannabis group (cannabis: 56.7% vs noncannabis: 36.2%; $P < .001$). Surgical mortality was comparable between both groups (cannabis: 9.7% vs noncannabis: 8.6%; $P = .662$). Postoperative stroke was significantly higher in the cannabis group (cannabis: 14.9% vs noncannabis: 8.2%; $P = .009$), and the rate of postoperative respiratory complications was also significantly higher in the cannabis group (cannabis: 32.1% vs noncannabis: 19.0%; $P < .001$).

Conclusions: The increased rates of postoperative cerebrovascular accidents and respiratory complications suggest that cannabis use is a significant risk factor in aortic surgery. Our study showed that young, healthy patients with prolonged cannabis use might be at a higher risk of requiring more emergency surgeries due to their background. (JTCVS Open 2024;22:107-13)



Predicted probabilities for respiratory complications among cannabis consumers.

CENTRAL MESSAGE

Young, healthy patients with prolonged cannabis use might be at higher risk of requiring more emergency surgeries.

PERSPECTIVE

We investigated the influence of cannabis consumption on the mid- and long-term surgical outcomes of patients with aortic aneurysms or dissections. We found increased rates of postoperative cerebrovascular accidents and respiratory complications that suggest cannabis use is a significant risk factor in aortic surgery.

Although there is scarce precise information about the incidence and prevalence of thoracic aortic aneurysms, previous studies have found an incidence of 5 per 100,000 individuals/year, with a prevalence of thoracic aortic aneurysms of 0.16%. On the other hand, the incidence of aortic dissection (AD) has been reported to be much more uncommon, with rates between 5 and 30 cases per million people per year.[1-3] Predisposing high-risk factors for the development of AD encompass hypertension (present in 75% of patients with Stanford type B AD), atherosclerosis, age exceeding 70 years, strenuous weightlifting, and the utilization of sympathomimetic agents such as cocaine, ecstasy, or energy drinks. Additionally, genetic conditions are recognized as a significant cause, including Marfan syndrome, Turner syndrome, Ehlers-Danlos syndrome, bicuspid aortic valve, and coarctation of the aorta. Within the cohort of patients with Marfan syndrome, an International Registry of Acute Aortic Dissection review revealed that this condition

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Abbreviations and Acronyms
AD = aortic dissection
aSAH = aneurysmal subarachnoid hemorrhage
MSA = metropolitan statistical area
RSF = respiratory failure
THC = tetrahydrocannabinol

was observed in 50% of individuals younger than age 40 years, in stark contrast to 2% among the older patient population.[1,2,4,5]

MORTALITY

Prior research has documented the connection between specific substances, such as cocaine and methamphetamines, and the occurrence of AD.[6,7] Nonetheless, a thorough investigation into the potential relationship between cannabis and aortic aneurysms and dissections remains lacking in the literature. We hypothesized that cannabis use might be associated with aortic aneurysms and acute AD. Additionally, we conducted a secondary analysis to explore whether cannabis use could be associated with cardiac, renal, and respiratory complications, as well as hospital length of stay, intensive care unit duration, and other perioperative outcomes. Another aspect we investigated is whether symptomatic or ruptured aneurysms or dissections would demonstrate elevated mortality rates among individuals with cannabis abuse.

METHODS

All individuals older than age 18 years with more than 6 months of cannabis use at the time of surgical repair for cardiovascular disease (aortic aneurysms or AD) between 2007 and 2023 were eligible. Patients were stratified into 2 groups based on their preoperative history of cannabis use: cannabis users and noncannabis users. The primary end point was complications or death within 30 days of intervention. Secondary outcomes included late complications and reinterventions. Data were combined from our institution (University of Texas Health Science) and inpatient records from Memorial Hermann Hospital (Houston, Tex). Data were analyzed by univariate and multivariable methods, including contingency tables and logistic regression. Substance use was documented from patient interview or urine drug screen. The indications and outcomes were analyzed, including elective surgical repairs, emergency procedures, or urgent procedures. Complications analyzed included gastrointestinal, stroke, renal, respiratory and 30-day death. Respiratory complications included prolonged ventilation, reintubation, acute respiratory distress, and pneumonia. All our cases were retrospectively reviewed from a prospectively maintained database. The Society for Vascular Surgery and Society for Thoracic Surgery reporting standards were used for defining the postoperative complications, the classification systems for thoracic aortic aneurysms and dissections, as well as the grade severity of patients' comorbidities.[8,9]

Statistical Analysis

Primary end points were morbidity and mortality. Other study end points included freedom from aneurysm rupture and aortic graft-related complications. Cerebrovascular complications included transient ischemic attack, stroke, postoperative cognitive dysfunction, or syncope. Gastrointestinal complications included all intraabdominal complications, including ileus, cholecystitis, gastritis, peptic ulcer disease, and bowel ischemia. Data were analyzed using definitions proposed by the Society for Vascular Surgery and Society for Thoracic Surgery reporting standards for open aortic aneurysm and dissection repair. Time-to-event outcomes were analyzed using Kaplan-Meier methods. Results were reported as percentage, hazard ratio for Cox proportional hazard ratios, or odds ratio (OR) for logistic regressions, all reported with 95% CI. The Pearson χ^2 or Fisher exact test was used for analysis of categorical variables. Differences between means were tested with a 2-sided t test or the Wilcoxon rank-sum test. A value of $P < .05$ was used to determine statistical significance.

RESULTS

During the study period, we identified 134 patients who met the inclusion criteria out of 1543 treated patients (9%). Comorbidity data and clinical characteristics can be found in Table 1. Compared with the noncannabis group, individuals in the cannabis group were significantly younger (cannabis: 48.3 ± 11.8 years vs noncannabis: 58.5 ± 14.9 years; $P < .001$). The cannabis group included significantly higher patients with Marfan syndrome (cannabis: 11.2% vs noncannabis: 4.4%; $P < .001$). Furthermore, the cannabis group showed significantly higher history of recreational drug use, including cocaine (25.4% vs 1.6%; $P < .001$), amphetamines (3.7% vs 0.6%; $P < .001$), opioids (8.2% vs 0.5%; $P < .001$), and intravenous drugs (6.7% vs 0.6%; $P < .001$).

Emergency surgeries were significantly more frequent in the cannabis group (cannabis: 56.7% vs noncannabis: 36.2%; $P < .001$). Surgical mortality was comparable between both groups (cannabis: 9.7% vs noncannabis: 8.6%; $P = .662$). Postoperative stroke was significantly higher in the cannabis group (cannabis: 14.9% vs noncannabis: 8.2%; $P = .009$), and the rate of postoperative respiratory complications was also significantly higher in the cannabis group (cannabis: 32.1% vs noncannabis: 19.0%; $P < .001$). Respiratory failure (RSF) was more common among cannabis users (cannabis: 32% vs 19% in noncannabis; $P = .0003$). The predicted probabilities for respiratory complications among cannabis users is seen in Figure 1. Total arch repair was significantly more common in the cannabis group (20.15% vs 12.14%; $P = .008$). Individuals in the cannabis group had significantly higher rate of hypertension (cannabis: 56.7% vs noncannabis: 40.95%; $P < .001$). Ascending aortic aneurysms were more commonly found in the cannabis group (82.09% vs 72.82%; $P = .0199$). Substance users were younger by a decade than nonusers (47 vs 57 years; $P < .0001$), and were more likely to be hypertensive (74% vs 59%; $P < .04$) and have a current smoking history (65% vs 25%; $P < .0001$).

Substance use did not influence intraoperative events. However, respiratory complications after type A dissection repair were strongly associated with cannabis use (OR, 2.4; $P < .004$), independent of age (1.02/year; $P < .01$), and not explained by tobacco smoking history ($P = .58$) in

TABLE 1. Patient characteristics

Characteristic	Open surgery on aortic aneurysms and dissections (n = 134)		
	Cannabis consumers	Noncannabis consumers	*P* value
Age, (IQR), y	48 (36-60)	58 (43-73)	.001
Sex			
Male	73.88	67.99	
Female	26.12	32.01	.160
Hypertension	56.7	40.95	.001
Smoking	49.25	14.62	.001
Coronary artery disease	14.9	14.6	.920
Diabetes	8.96	8.8	.974
Previous cerebrovascular accident	8.21	8.52	.900
Previous stroke	6.72	5.54	.571
Peripheral artery disease	1.49	3.97	.148
Respiratory disease			
Congestive heart failure	27.6	22.92	.220
COPD	20.9	17.53	.330
Kidney impairment	8.21	8.09	.961
CTDs	18.66	19.66	.779
Marfan syndrome	11.2	4.4	.001
Emergency	56.72	36.20	.001
Rupture	2.99	2.56	.764
Circulatory arrest	85.82	76.30	.012
Recreational drug use			
Cocaine	25.4	1.6	.001
Alcohol abuse	18.66	1.7	.001
Opioids	8.2	0.5	.001
Intravenous drugs	6.7	0.6	.001
Amphetamine	3.7	0.6	.001

Values are presented as %. *COPD*, Chronic obstructive pulmonary disease; *CTDs*, connective tissue disorders.

multivariable analysis. Renal failure was also found to be significantly higher in the cannabis group (cannabis: 27.6% vs noncannabis: 17.53%; $P < .004$). No significant differences were found between women and men in the cannabis group (women: 26% vs men: 32%; $P = .16$). No significant differences were found between the cannabis group and noncannabis in regard to diabetes (8.96% vs 8.8%; $P = .9740$), coronary artery disease (14.93% vs 14.62%; $P = .92$), chronic heart failure (27.6% vs 22.92%; $P = .2202$), chronic obstructive pulmonary disease (20.90% vs 17.53%; $P = .3307$), or postoperative infection (5.97% vs 4.1%; $P = .3109$). Last, no significant differences were found in regard to prior surgeries, including prior aortic valve repair, mitral valve repair, percutaneous coronary intervention, coronary artery bypass graft, or surgery for abdominal aortic aneurysms (Table 2).

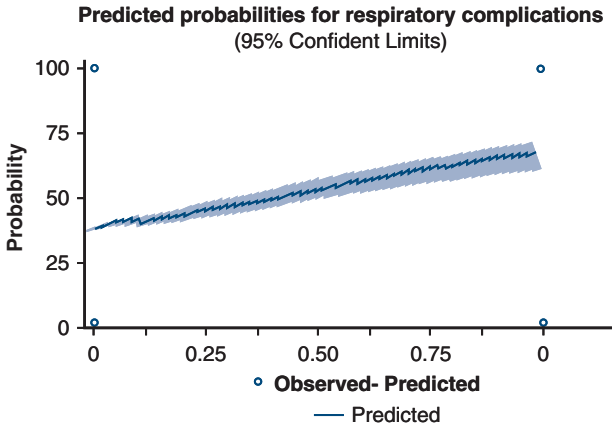

FIGURE 1. Predicted probabilities for respiratory complications among cannabis consumers.

On univariate analysis, we found that the mean age in the cannabis group was 48 years (range, 37-59 years). The mean body mass index in the cannabis group was 27.7 (range, 20.6-35), and the mean intensive care unit, length of stay was 8.5 ± 8 days (range, 0-16 days). The main outcomes regarding morbidity and mortality may be found in Table 3.

DISCUSSION

Stimulants, such as cocaine and amphetamines, are well-established risk factors for AD. Although cannabis is the most commonly used illicit drug in the United States, its relationship to AD and aneurysms has not been well studied.[6,10]

Within the Houston-Sugar Land-Baytown metropolitan statistical area (MSA), an annual average of 490,000 individuals, aged 12 years or older, used any illicit drugs within the preceding year. This figure corresponds to approximately 11.8% of the total MSA population, and is similar to the rate observed across the state of Texas (12.6%). Furthermore, the prevalence of cannabis use within the MSA over the same period was calculated at 7.9%, a statistic that also closely aligns with the corresponding rate within the entire state of Texas.[11,12]

Tetrahydrocannabinol (THC) is the main psychoactive component of cannabis, and 1 of at least 113 total cannabinoids identified on the plant. The chemical formula for THC ($C_{21}H_{30}O_2$) encompasses multiple isomers. Typically, the term *THC* refers specifically to the Delta-9-THC isomer.[7,13] Acute cannabis use has been associated with an increase in systolic blood pressure. Acute and chronic cannabis may increase heart rate, blood pressure, pulse pressure, and it may place an acute stress on the aortic wall, increasing the risk of AD.[14] Spontaneous coronary artery dissection has also been described directly associated to cannabis use but has been rarely reported. Only 10 cases have been reported to

TABLE 2. Prior and current aortic surgery

Characteristic	Open surgery on aortic aneurysms and dissections (n = 134)		
	Cannabis consumers	Noncannabis consumers	*P* value
Prior cardiovascular surgery	13.43	14.27	.791
AVR	9.70	7.88	.458
PCI	4.48	2.91	.312
TEVAR	2.99	1.28	.111
CABG	2.24	3.76	.367
DTA	2.24	1.71	.651
MVR	0.75	0.78	.965
AAA	0.75	0.78	.965
Type of aortic surgery			
Ascending/arch	76.87	67.49	.025
Proximal arch	76.12	66.08	.018
Total arch	20.15	12.14	.008
Aortic root	18.66	16.11	.446
Bentall procedure	10.45	8.30	.394
AVR	8.96	18.10	.007
David procedure	5.97	5.96	.996
DTA	2.24	1.70	.651
Circulatory arrest	85.82	76.30	.012

Values are presented as %. *AVR*, Aortic valve replacement; *PCI*, percutaneous coronary intervention; *TEVAR*, thoracic endovascular aortic repair; *CABG*, coronary artery bypass graft; *DTA*, descending thoracic aorta; *MVR*, mitral valve repair; *AAA*, abdominal aortic aneurysm.

date.[14-18] Very few articles have reported the use of cannabis and its association with AD or aneurysms. The first case of cannabis use and AD was published in 2019. Since then, only 3 publications have reported this association.[19-21] Long-term cannabis may increase the levels of carboxyhemoglobin, leading to a reduced systemic level of oxygenated hemoglobin. This may represent one of the mechanisms causing a misbalance between oxygen requirement and oxygen tissue delivery, and may be a cause of cannabis-associated cardiovascular injury.[20,22-28] Another study disclosed that cannabis smoking increased systolic blood pressure and heart rate, as well as decreasing the exercise angina threshold by 48% compared with noncannabis cigarettes.[29]

A nationwide inpatient sample study, encompassing 379,843 patients, evaluated acute myocardial infarction and revealed that admissions for acute myocardial infarction among cannabis users increased by 32%, resulting in a 60% rise in hospital mortality over a span of 4 years.[30]

An analysis of a statewide registry, which included more than 113,000 patients undergoing percutaneous coronary intervention at 48 hospitals in Michigan, revealed that cannabis users, in comparison to nonusers, exhibited a significantly heightened risk of experiencing bleeding and stroke.[31] A study involving 1014 patients diagnosed with aneurysmal subarachnoid hemorrhage (aSAH) demonstrated that cannabis use was independently associated with a heightened likelihood of experiencing delayed cerebral ischemia (OR, 2.7; 95% CI, 1.4-5.2; $P = .003$). Additionally, the study revealed that radiographic vasospasm was significantly more prevalent among cannabis users compared to nonusers.[32]

Another study from 2020 analyzed a cohort of 1,247,035 pregnant women and examined their exposure to both current and previous cannabis usage. They found that women with cannabis use had a higher incidence of cardiovascular hospitalization compared to unexposed women (58.4 vs 33.6 per 10,000 person years). Cannabis use was associated with 1.48 times the risk of cardiovascular hospitalization.[33]

A 2022 study evaluated the effect of cannabis on hospitalized patients with aneurysmal aSAH. They concluded that cannabis was associated with an 18% increased rate of developing aSAH. Further studies are being performed related to cannabis and intracranial aneurysms.[34] Various studies have deepened into the physiologic effects of cannabis and potential mechanisms of action that may influence on complications with cannabis use. With higher doses of cannabinoids, significant complications may be observed. Cardiovascular complications may include malignant arrhythmias, coronary spasm, sudden death, and stroke. Altered thermoregulation, bronchial hyperreactivity, upper airway obstruction and coagulopathy (increased clotting time and decreased platelet count) are also common.[35]

In the existing literature, it has been previously documented that ruptured type A AD exhibit lower long-term survival rates compared with their nonruptured counterparts.[2,36] Another aspect we investigated is whether symptomatic or ruptured aneurysms or dissections would demonstrate elevated mortality rates among individuals with cannabis abuse.

Summary of Key Findings

Our findings highlight the significance of respiratory complications after aortic surgery in patients who are cannabis users. This is the first study that has analyzed the effects of cannabis on aortic aneurysms and dissections. Among the most crucial findings of our study was the significant number of patients with cannabis use who presented with stroke after aortic surgery repair and how our study found that, compared with the noncannabis smokers, postoperative stroke was significantly higher in the cannabis group.

A limited number of studies have investigated the correlation between cannabis use and postoperative complications within a substantial patient cohort. Potnuro and colleagues[37] recently investigated perioperative complications following surgery on patients with cannabis use disorder. Among 12,422 hospitalizations, a cohort comprising 6211 patients who were cannabis users was matched with an equivalent number of patients who did not exhibit

TABLE 3. Patient outcomes

Characteristic	Open surgery on aortic aneurysms and aortic dissections (n = 134)		
	Cannabis consumers	Noncannabis consumers	*P* value
30-d mortality	9.70	8.59	.661
Intraoperative complications	26.87	18.88	.020
Intraoperative cardiac arrest	1.49	2.34	.527
Myocardial infarction	3.21	1.33	.026
Ventricular fibrillation	5.22	1.56	.002
Pneumonia			
Respiratory complications	46.27	27.54	.001
Respiratory failure	32.09	19.02	.001
Pneumothorax	11.94	6.74	.026
Pleural effusion	8.21	7.03	.611
Tracheostomy	6.72	7.38	.777
Coagulation complications	32.84	23.70	.018
CNS complications	26.87	17.81	.010
Coagulopathy	19.40	12.92	.035
Gastrointestinal complications	17.91	10.29	.007
Stroke	14.93	8.23	.009
TIA	2.24	0.35	.004
Acute kidney injury	27.6	17.53	.004
Dialysis	11.19	7.59	.140
Infection	5.97	4.12	.311
Vessel access complications	2.99	2.56	.764
ICU stay (d)			
Hospital length of stay (d)	85.82	76.30	.012
Discharge home	65.67	59.26	.148

Values are presented as %. *CNS*, Central nervous system; *TIA*, transient ischemia attack; *ICU*, intensive care unit.

cannabis use disorder.[37] The analysis revealed a notable association between cannabis use and an elevated risk of perioperative morbidity and mortality when compared with individuals without cannabis use disorder. Moreover, the study identified a higher rate of myocardial ischemia (96% vs 89%), acute kidney injury (79% vs 57%), and respiratory complications (96% vs 81%) in cannabis smokers. However, statistical significance was not observed in these differences.[37] Our study also found that respiratory complications after type A dissection repair were strongly associated with cannabis use.

Cardiovascular and Aortic Involvement in Marijuana Smokers—How Our Study Differs

This study has provided information that was not previously analyzed or published in the literature. First, our research indicates a higher frequency of emergency operations among cannabis users. This occurrence might be linked to the concurrent use of other recreational drugs in some cases or be a specific factor directly associated with acute or chronic cannabis consumption. Additionally, the increased prevalence of emergency cases within the cannabis group compared with the noncannabis group might be correlated with the higher presence of Marfan patients in the cannabis group.

Second, our findings revealed a significantly higher incidence of hypertension in the cannabis user group. Some previous studies have suggested a potential relationship between cannabis use and hypertension, as well as angina. Cannabis has been posited to potentially induce vascular symptoms due to the vasoconstrictive influence of THC. Furthermore, vasospasm has been proposed as a potential pathophysiological mechanism contributing to vessel ischemia and hypertension.[18,38,39]

Third, our research revealed a considerably higher incidence of stroke among cannabis users (14.93% vs 8.23%; $P = .009$). This finding holds great significance and warrants careful consideration by physicians. It should also be strongly taken into account for patient information and counseling purposes.

Several prior studies have provided data supporting the assertion that THC triggers vasoconstriction and may lead to cerebral ischemia.[32,40] Cannabis has also been linked to increased occurrences of aSAH and cerebral ischemia, alongside higher incidences of angiographic spasms in cannabis users.[32]

Fourth, respiratory complications and RSF were observed to be more prevalent among cannabis users (RSF: 32.09% vs 19.02% in noncannabis users; $P = .0003$). Whether respiratory complications are more likely in patients with acute cannabis use or chronic use necessitates further research. Our findings suggest that preoperative pulmonary function tests, along with scheduled lung physical therapy and the use of an incentive spirometer, may be crucial for this cohort of cannabis users before aortic surgery.

Although this presentation may be relatively uncommon, physicians should remain vigilant and consider the possibility of an acute AD in younger patients presenting with chest pain and having a recent or long-term history of cannabis consumption.

To the best of our knowledge, this article represents the first study delving into the correlation between cannabis use and aortic aneurysms and dissections. It specifically examines the postoperative complications, exclusive to this demographic, and compares outcomes in cannabis users versus nonusers. Notably, our investigation stands as the most extensive study to date to include patients who engage in cannabis consumption and have undergone open aortic surgery for thoracoabdominal aortic aneurysms and AD.

We consider that further studies with larger populations and more detailed data about preoperative and postoperative variables are required to help to determine the association between cannabis use and aortic disease. Our study suggests that young, otherwise healthy patients who engage in prolonged cannabis use may be at a heightened risk of developing AD or aortic aneurysms. We found that respiratory complications after type A AD repair were strongly associated with cannabis use.

Limitations

There are inherent limitations related to data abstraction from electronic health records. This retrospective study may also be subject to inherent biases that are associated with the study design. Furthermore, another limitation is the absence of long-term follow-up. Although our department holds extensive experience with thoracoabdominal aortic aneurysms and dissections, the electronic medical records were only completely available as far back as 2007.

CONCLUSIONS

The increased rates of postoperative cerebrovascular accidents and respiratory complications suggest that cannabis use is a significant risk factor in aortic surgery. These individuals may derive advantages from rigorous monitoring of their respiratory condition during the postoperative period. Our study showed that young, healthy patients with prolonged cannabis use might be at higher risk of requiring more emergency surgeries due to their background.

Conflict of Interest Statement

Dr Estrera is on the advisory board of Artivion and a consultant for WL Gore and Terumo Aortic. All other authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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