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Research Article

Chronic hypertension in infrarenal abdominal aortic aneurysm repair surgery. Multivariate analysis

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Abstract

Background and objectives: Chronic hypertension has a higher incidence in the perioperative setting. It increases the risk of complications like acute hypertension, bleeding, myocardial ischemia, and stroke. Perioperative management of these patients during vascular surgery could be challenging because of the additional co-morbidities like diabetes mellitus, vasculopathy, and cardiac disease. For these reasons, we conducted a retrospective study to observe the complications and mortality associated with chronic hypertension during vascular surgery.

Materials and methods: After ethical committee approval we retrospectively review medical records of patients undergone abdominal aortic aneurysm repair surgery. Age, sex, ASA physical status, chronic hypertension (controlled or uncontrolled), type of surgery (open or endovascular; scheduled or urgent), anesthesia type, postoperative complications (acute hypertension, bleeding, acute renal failure, heart failure, stroke, and cardiac arrest) and mortality were recorded. A multivariate analysis of chronic hypertension, postoperative complications, and mortality was conducted using SPSS Software. A p - value < 0.05 was considered statistically significant.

Results: Our study included 544 patients undergoing abdominal aortic aneurysm repair surgery. Ninety-four percent of patients were men, mean age of 72 years old, and 67% were ASA III and IV. Seventy-three percent of patients presented chronic hypertension with appropriate control defined as the lack of target organ damage and previous complications related to hypertension in 83% of these patients. Endovascular surgery was performed in 44% and open procedure in 56% of patients. Elective surgery was carried out in 83% and urgent surgery in 17% of patients. General anesthesia was performed in 73% (combined general anesthesia with epidural analgesia in 36%) and regional anesthesia in 27% of cases. Controlled chronic hypertension was not associated with postoperative complications (CI 95% 0,581-2,982 p 0,510) and mortality (1-year mortality CI 95% 0,786-5,240 p 0,144; 2-year mortality CI 95% 0,655-3,845 p 0,306).

Discussion: Chronic hypertension is largely considered a risk factor for perioperative complications of AAA repair. Conversely, our results suggest that adequate control of chronic hypertension before AAA repair leads to a low incidence of postoperative complications as well as 1 and 2-year mortality rates.

Introduction

Arterial hypertension (HTN) is one of the most prevalent risk factors in the world since it is related to the incidence of cardiovascular events. According to WHO (2013), chronic hypertension affects one billion people worldwide and it is the cause of death of nine million people annually. In Spain, according to the Di@bet.es study, the prevalence of HTN is 42.6%, being slightly higher in males especially at younger ages, while 36.3% of patients have no prior knowledge of their hypertension, which means that up to 6 million people could be undiagnosed [1]. The management of hypertensive patients who require a surgical procedure is of great clinical importance because it has been observed that they have a higher risk of perioperative morbidity and mortality. Perioperative arterial hypertension occurs in 25% of patients with chronic

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hypertension undergoing non-cardiac surgery and may affect up to 80% of patients undergoing cardiac surgery [2]. Perioperative hypertension has been identified as one of the main risk factors for myocardial ischemia, heart failure, stroke, cognitive dysfunction, renal failure, and hemorrhage [2].

Perioperative hypertension can happen at any phase of the perioperative period: before and during anesthetic induction associated with the patient's anxiety related to the surgical process; intraoperatively due to vasoconstriction resulting from sympathetic stimulation associated with surgical stress; and in the postoperative period to pain, hypothermia, and volume overload [3,4]. A higher incidence of perioperative hypertension requiring control with pharmacological treatment has been observed in the perioperative period of carotid vascular surgery, abdominal aorta, peripheral vascular, intraperitoneal, and intrathoracic surgery. In the case of abdominal aortic aneurysm surgery, strict control of blood pressure through intravenous pharmacological treatment will probably reduce complications associated with high morbidity and mortality such as hemorrhage, renal failure, arrhythmias, and embolic complications, among others.

Pathophysiology of perioperative hypertension is complex, and among the proposed mechanisms are: a) vascular damage with endothelial dysfunction and failure of the L-arginine Nitric Acid (NO) pathway with reduced NO levels, which is a potent vasodilator, b) the activation of stress hormones and the renin-angiotensin system contribute to the loss of vascular relaxation capacity, platelet aggregation, inflammation, remodeling, and c) increase peripheral vascular resistance, which can alter cardiac output in patients with heart dysfunction unable to compensate for the increase in afterload, leading to hypoperfusion and organs target damage [3]. Effective management of perioperative blood pressure is especially important in surgeries such as peripheral vascular, carotid, abdominal aortic, and neurosurgical procedures to reduce complications.

For this reason, we have designed a retrospective, observational study to analyze the incidence of complications and mortality in patients with a history of hypertension undergoing abdominal aortic aneurysm repair surgery.

Hypothesis

We established a hypothesis that the control of chronic arterial hypertension is associated with lower mortality and perioperative complications in patients undergoing repair of infrarenal abdominal aortic aneurysm in the Vascular Surgery and Emergency operating rooms of the Hospital Universitario de Cruces. The definition of controlled chronic arterial hypertension is recognized as the maintenance of Systolic Blood Pressure (SBP) ≤ 160 mmHg and Diastolic Blood Pressure (DBP) ≤ 90 mmHg according to the most recent clinical management guidelines by the American Heart Association (AHA) [5].

Objectives

The primary objective is to determine the relationship between mortality at 1 and 2 years and controlled arterial hypertension in patients undergoing abdominal infrarenal aortic aneurysm repair surgery. The secondary objective is to determine the relationship between the incidence of perioperative complications and controlled arterial hypertension in patients undergoing infrarenal abdominal aortic aneurysm repair surgery.

Materials and methods

After obtaining approval from the Clinical Research Ethics Committee of the Hospital Universitario de Cruces in Baracaldo (Spain), a retrospective, observational, single-center study was conducted by reviewing the medical records of patients undergoing infrarenal abdominal aortic aneurysm repair surgery in the Vascular Surgery and Emergency operating rooms of the Cruces University Hospital between January 1, 2012, and January 1, 2019. We decided to follow these patients during their hospital stay and 2 years after because this length of time should allow us to properly observe mortality since aneurysm aortic repair surgery could increase mortality in the long term as previously published evidence had shown.

We included patients of both genders with cardiovascular risk factors (chronic arterial hypertension, diabetes mellitus, hypercholesterolemia, smoking, obesity) and specific comorbidities such as heart disease (ischemic heart disease, heart failure), lung disease (chronic obstructive pulmonary disease COPD, bronchial asthma, pulmonary fibrosis), cerebrovascular disease (acute cerebrovascular accident ACVA: stroke, transient ischemic attack), chronic kidney disease and peripheral vascular disease undergoing infrarenal abdominal aortic aneurysm repair surgery. Patients without comorbidities or cardiovascular risk factors were excluded.

The sample size was determined by the number of consecutive infrarenal abdominal aortic aneurysm repair surgeries in the period between January 2012 and 2019.

The data collection included the following variables

- **Age:** Years of life (discrete quantitative variable).
- **Sex:** Gender (dichotomous nominal qualitative variable).
- **ASA score (American Society of Anesthesiologists):** Perioperative risk classification with values between 1 and 4 (discrete quantitative variable).
- **Pulmonary disease:** COPD, bronchial asthma, or pulmonary fibrosis (qualitative nominal dichotomous variable).
- **Cerebrovascular disease:** ACVA such as stroke or transient ischemic attack (qualitative nominal dichotomous variable).
- **Chronic kidney disease:** Presence of kidney disease defined as the presence for at least 3 months of glomerular filtration below 60 ml/min/1.73m2 or kidney damage determined by the presence of structural or functional abnormalities of the kidney that can potentially cause a decrease in glomerular filtration rate (dichotomous nominal qualitative variable) [6].

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Peripheral vascular disease is defined as the presence of occlusive arterial disease, which conditions insufficient blood flow to the extremities (dichotomous nominal qualitative variable) [7].

- **Cardiovascular risk factors:** Controlled chronic arterial hypertension defined as SBP ≤ 160 mmHg and DBP ≤ 90 mmHg [8], diabetes mellitus (defined as the group of metabolic disorders characterized by hyperglycemia due to defects in insulin secretion or action [9]), hypercholesterolemia (cholesterol levels above 240 mg/dL[10]), smoking (defined as habitual smoker [11]) and obesity (defined as a Body Mass Index, BMI, greater than 30 Kg/m [12]) (dichotomous nominal qualitative variables).

- **Type of surgery:** Open or endovascular; scheduled or urgent (dichotomous nominal qualitative variables).

- **Type of anesthesia:** General, regional, or combined. The type of general anesthesia was recorded as balanced (using volatile inhaled anesthetics), total intravenous general anesthesia (with remifentanil and propofol), and regional (epidural or intradural). Likewise, the use of combined anesthesia (general with epidural or epidural with intradural) is recorded (non-dichotomous nominal qualitative variable).

- **Intraoperative hemorrhage:** Amount of blood in milliliters lost during the surgical intervention (discrete quantitative variable).

- **Surgical time:** From the induction of anesthesia to the time the patient leaves the operating room in minutes (discrete quantitative variable).

- **Clamping time:** Time in minutes from the beginning of the occlusion of the aortic blood flow necessary for the exclusion of the aneurysm until blood flow restoration (discrete quantitative variable).

- **Perioperative complications:**

a) **Acute hypertension:** Elevation of systolic and diastolic blood pressure figures above 20% of baseline values (qualitative nominal dichotomous variable).

b) **Acute renal failure:** Increased creatinine levels and decreased diuresis according to the Acute Kidney Injury Network classification [13] (qualitative nominal dichotomous variable).

c) **Acute heart failure:** Clinical evidence of 2 major criteria such as dyspnea, orthopnea, jugular disgorgement, crackles, third heart sound, radiological cardiomegaly, and radiological pulmonary edema or 1 major and 2 minor criteria such as edema in the lower limbs, nocturnal cough, dyspnea of effort, hepatomegaly, pleural effusion, tachycardia greater than 120 beats per minute (bpm) or loss of 4.5 kg in 5 days after diuretic treatment associated with echocardiographic evidence of systolic and/or diastolic dysfunction (qualitative nominal dichotomous variable).

a) **Stroke:** Clinical neurological deterioration of sudden onset associated with a radiological image compatible with cerebral perfusion defect or cerebral hemorrhage [14] (qualitative nominal dichotomous variable).

b) **Cardiorespiratory arrest:** Pulseless electrical activity, asystole, ventricular fibrillation, or ventricular tachycardia (qualitative nominal dichotomous variable).

c) Hypovolemic shock due to intraoperative hemorrhage: hemodynamic instability associated with peripheral hypoperfusion data requiring vasoactive support and transfusion of blood products after acute intraoperative hemorrhage greater than 1000 ml (qualitative nominal dichotomous variable).

d) **Rebleeding:** Evidence of blood loss greater than 500 ml through abdominal drains associated with hemodynamic instability and peripheral hypoperfusion data in the the immediate postoperative period that requires surgical reintervention or coagulopathy correction for management (qualitative nominal dichotomous variable).

e) **Ischemia-reperfusion syndrome:** Hemodynamic instability associated with peripheral hypoperfusion data that occur during the unclamping period (qualitative nominal dichotomous variable).

f) **Multiple organ dysfunction syndrome:** Dysfunction of two or more organ systems according to the SOFA (Sequential Organ Failure Assessment) definition [15] (qualitative nominal dichotomous variable).

g) **Thrombosis or ischemia of the lower extremities:** Clinical and radiological evidence of peripheral arterial occlusion (iliofemoral) in the immediate postoperative period of abdominal aortic aneurysm repair surgery (qualitative nominal dichotomous variable).

h) **Atrial fibrillation with rapid ventricular response:** Supraventricular tachycardia compatible with atrial fibrillation (previously known or not) with ventricular response greater than 110 bpm associated or not with hemodynamic instability in the perioperative period (qualitative nominal dichotomous variable).

i) **Infectious complications:** Surgical wound infection (microbiological evidence of bacterial growth in culture obtained from secretions from the surgical wound; dichotomous nominal qualitative variable), urinary tract infection (microbiological evidence of bacterial growth in urine culture obtained after at least 3 days of admission in the hospital, dichotomous nominal qualitative variable); bacteremia (evidence of bacterial growth in at least 2 peripheral blood cultures; dichotomous nominal qualitative variable), respiratory infection (evidence of at least 2 of the following criteria hypoxemia, fever,

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increased respiratory secretions or their purulence, leukocytosis or radiological image of pneumonia at least 3 days after admission (dichotomous nominal qualitative variable), periprosthetic infection (evidence of aortoenteric fistula associated with bacterial growth in cultures taken from Gore-Tex prostheses used to exclude aortic aneurysm or periprosthetic abscesses in patients with symptoms of fever without evidence of another source of infection (dichotomous nominal qualitative variable); and septic shock according to the definition of sepsis 2 (sepsis defined as 2 or more of the following Systemic Inflammatory Response Syndrome (SIRS) criteria: temperature > 38 ºC or < 36 ºC, heart rate > 90 bpm, respiratory rate > 20 breaths per minute or PaC02 < 32 mmHg and leukocytes > 12,000 or <4000/mm3 or >10% immature forms (falls) produced by an infection associated with organ dysfunction and persistent hypotension after fluid resuscitation [16] (qualitative nominal (dichotomous variable).

j) **ST-elevation acute coronary syndrome:** Chest pain associated with compatible electrocardiographic changes such as ST elevation or new onset left bundle branch block and troponin elevation (99th percentile of the upper reference value or increase ≥ 20% of the initial value) [17] (qualitative nominal dichotomous variable).

k) Acute Respiratory Distress Syndrome (ARDS) according to the presence of all Berlin criteria: time of acute onset and within the first week of injury or new or worsening respiratory symptoms, presence of bilateral opacities consistent with pulmonary edema on chest x-ray or computed tomography (CT) scan (these opacities should not be fully explained by pleural effusion, atelectasis, or pulmonary nodules), respiratory failure is not fully explained by heart failure or fluid overload (maybe requires objective evaluation with echocardiography to exclude hydrostatic pulmonary edema if there are no risk factors for ARDS), impaired oxygenation defined by the PaO_2/FiO_2 ratio or by the ratio of peripheral O_2 saturation (pulse oximetry) to FiO_2 (SpO_2/FiO_2) [18] (qualitative dichotomous variable).

l) Brain hematoma: impaired level of consciousness associated with a radiological image compatible with intraparenchymal brain hematoma or basal ganglia (dichotomous nominal qualitative variable).

- **Mortality at 1 and 2 years:** Percentage of patients who died 1 and 2 years after the date of abdominal aortic aneurysm repair surgery (discrete quantitative variable).

- **Hospital length of stay:** Days of hospital stay from the day of admission to the day of discharge after abdominal aortic aneurysm surgery (discrete quantitative variable).

These data were collected in a data management program that allows their confidentiality to be protected (using a password and the inclusion of a patient identification code), and filters and controls were established for inconsistencies and data entry errors.

Each variable was characterized using frequency distributions for qualitative variables and central tendency statistics such as mean and standard deviation, or median and Interquartile Range (IQR) for quantitative continuous variables (normal or non-normal, respectively). A bivariate comparative regression analysis was performed, with mortality being the explanatory variable. A logistic regression was performed to predict the relationship of controlled chronic arterial hypertension with mortality and perioperative complications. The level of statistical significance in the contrasts (alpha) is 5% with bilateral contrasts. The analysis was performed by personnel from the Clinical Epidemiology Unit of the Hospital Universitario de Cruces using the SPSS ® 22.0 program for Windows.

The development of the study complies with the standards of international Good Clinical Practices, the Declaration of Helsinki in its last active amendment, and international and national standards and regulations.

In this study, patient data was collected anonymously and we did not collect data that could identify the patient. In the data collection sheet, the patient is identified only by an alphanumeric assignment code in the study. The patient's name will not appear in any publication or communication of the study results. A list containing the names of the patients participating in the study, their inclusion number, and their clinical history is completed. Only the investigators and the personnel in charge of guaranteeing the quality of the data and the analysis of the same have access to the clinical documentation of the participant. Personal information is not available to the public, complying with the provisions of the Organic Law 15/1999, of December 13, on the Protection of Personal Data.

Results

544 patients undergoing infrarenal abdominal aortic aneurysm repair surgery in the period between January 2012 and 2019 in the Vascular Surgery and Emergency operating rooms of Cruces University Hospital were included. The patients were mainly men (94%) with a mean age of 73 years old, ASA III (47%) and II (32%). Seventy-three percent of patients (73%) had controlled hypertension, while 27% were non-hypertensive or had non-treated hypertension. Medical history of ischemic heart disease (27%), COPD (26%), peripheral vascular disease (21%), previous acute stroke (17%), and chronic kidney disease (19%) were seen in our patients. Cardiovascular risk factors were present in a higher number of patients (81%). Hypertension (73%) and hypercholesterolemia (54%) were the most frequent cardiovascular risk factors and almost half of patients (49%) had 2 or more of these factors simultaneously (Table 1).

Surgery was elective in a higher number of patients (84%) using an endovascular approach or an open procedure in almost half of patients, 43% and 57% respectively. General anesthesia was performed in a higher number of cases (87%) combined with epidural analgesia in almost half of the patients (43%). Balanced general anesthesia with sevoflurane and

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total intravenous anesthesia with remifentanil were used in almost half of patients respectively (data not shown). Neuroaxial anesthesia was used only in 14% of patients. Median surgical time was 256 minutes and median clamping time was 76 minutes. Median intraoperative bleeding was 956 mL with almost half of patients bleeding less than 500 mL but 50% of cases requiring blood products transfusion with a polytransfusion in 15% of cases (data not shown) (Table 2).

Perioperative complications were seen in 50% of patients. The most frequent complications were ischemia-reperfusion syndrome (15%), acute kidney failure (10%), hypovolemic shock due to intraoperative hemorrhage (9%), and multiorgan dysfunction syndrome (9%). Other less frequent complications were atrial fibrillation with tachyarrhythmia (7%), thrombosis-ischemia of lower limbs (5%), rebleeding (4%), bacteremia (4%), pneumonia (4%), congestive heart failure (3%), periprosthetic infection (3%), stroke (2%), surgical wound infection (2%), septic shock (2%), respiratory failure (1%), acute coronary syndrome (1%), acute respiratory distress syndrome (1%), urinary tract infection (1%) and brain hematoma (1%). The median length of stay was 11 days. Mortality at 1 and 2 years were lower in our sample (16% and 21%, respectively) (Table 2).

In Table 3, the bivariate analysis results showed that controlled chronic hypertension is not associated with perioperative complications (95% CI 0.581-2.982 p 0.510) or mortality (1-year mortality 95% CI 0.786-5.240 p 0.144; 2-year mortality CI 95% 0.655-3.845 p 0.306).

Discussion

This retrospective observational study conducted in patients undergoing infrarenal abdominal aortic aneurysm repair surgery is based on the initial hypothesis that adequate control of chronic arterial hypertension before surgery will entail clinically important benefits such as decreased mortality and perioperative complications.

The most important characteristics of our sample for the study are the presence of severe systemic disease according to the ASA classification and the high prevalence of risk factors (81%), being controlled chronic hypertension (defined as SBP <160. and TAD <90 mmHg) without severe complications, the most frequent (73%). Therefore, our sample included patients with a high risk of perioperative complications and mortality, combined with a high prevalence of controlled chronic

Table 1: Baseline characteristics.

Gender	
Male (%)	94
Female (%)	6
Age (Mean ± SD)	73 (55-90)
ASA	
III (%)	47
II (%)	32
IV (%)	21
Hypertension history	73
Controlled hypertension (%)	
No Hypertension/ Uncontrolled hypertension (%)	27
Medical history	
Ischemic heart disease (%)	27
Chronic Pulmonary Obstructive Disease (COPD) (%)	26
Peripheral Vascular disease (%)	21
Previous stroke (%)	17
Chronic Kidney disease (%)	19
Cardiovascular risk factors (%)	81
Hypertension (%)	73
Hypercholesterolemia (%)	54
Diabetes Mellitus (%)	11
2 or more cardiovascular risk factors (%)	49

Table 2: Perioperative variables in infrarenal abdominal aortic aneurysm repair surgery.

Surgical Approach	
Endovascular surgery (%)	43
Open surgery (%)	57
Time of Surgical Indication	
Elective (%)	84
Urgent (%)	16
Type of Anesthesia	
General (%)	87
Combined (%)	43
Regional (%)	14
Surgical time (Median ± IQR)	256 (45-480)
Intraoperative bleeding (Median ± IQR)	956 (200-10000)
< 500 ml	45
500-1000 ml	30
1000-2000 ml	18
2000-4000 ml	7
Clamping time (Median ± IQR)	76 (35-208)
Perioperative complications (%)	50
Ischemia-reperfusion (%)	15
Acute Kidney Failure (%)	10
Hypovolemic shock due to intraoperative hemorrhage (%)	9
Multiorgan Dysfunction Syndrome (%)	9
Atrial Fibrillation with tachyarritmia (%)	7
Thrombosis-ischemia of lower extremities (%)	5
Rebleeding (%)	4
Bacteriemia (%)	4
Pneumonia (%)	4
Congestive Heart Failure (%)	3
Periprosthetic infection (%)	3
Stroke (%)	2
Surgical wound infection (%)	2
Septic shock (%)	2
Respiratory failure (%)	1
Acute coronary syndrome (%)	1
Acute Respiratory Distress Syndrome (%)	1
Urinary tract infection (%)	1
Brain hematoma (%)	1
Hospital length of stay (Median ± IQR)	11 (1-63)
1-year mortality (%)	16
2-year mortality (%)	21

Table 3: Bivariate comparative regression analysis results.

Controlled hypertension and perioperative complications (CI 95%)	0.581-2.982 p 0.510
Controlled hypertension and 1-year mortality (CI 95%)	0.786-5.240 p 0.144
Controlled hypertension and 2-year mortality (CI 95%)	0.655-3.845 p 0.306

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hypertension, which allows us to observe the interrelationship between them.

In our study, we included surgeries performed on elective as well as on urgent bases using open or endovascular techniques to accumulate as many patients as possible and to be able to observe the more frequent perioperative complications and mortality that occur after aneurysmal rupture. The results obtained in this study after a strict annual follow-up of patients diagnosed with abdominal aortic aneurysm support our preference for performing this type of surgery preferably electively (84%). However, we also included surgeries performed urgently in our analysis (18%), which correspond mostly to aneurysms with radiological criteria of contained or uncontained rupture. Although the use of endovascular techniques is becoming more frequent, the prevalence of significant cardiopulmonary comorbidities in these patients, the anatomical characteristics of the aneurysm, and the intraoperative hemorrhagic complications are determinant factors supporting the decision to carry out open procedures in some cases. The high incidence of severe cardiopulmonary comorbidities (ischemic heart disease 27%, COPD 26%) in 43% of our patients is probably why they were operated using an endovascular technique, while 57% underwent open procedures. According to the most recently published evidence comparing the results of open versus endovascular procedures for aortic aneurysm repair, there are not enough randomized controlled clinical trials to assess the advantages of one technique over another, in terms of mortality, immediate, intermediate, and long-term frequency of complications [19]. Consequently, the decision fundamentally depends on the type of repair, the patient's characteristics, the anatomy of the aneurysm, and the technical skills of the vascular surgeon.

In this study, we observed that most cases were performed under general anesthesia (87%), and the combined technique of general anesthesia with the epidural was used in 43% of cases, which contributed to the implementation of multimodal analgesia strategies for postoperative pain management, especially in open abdominal aortic aneurysm repair technique. Although half of the patients in our study were operated using an endovascular technique, only 14% of our patients underwent endovascular repair with loco-regional anesthesia. We speculate that most patients were operated under general anesthesia due to the high prevalence of cardiopulmonary comorbidities and the prolonged surgical time (256 mean surgical time), intraoperative hemorrhage requiring transfusion (mean 956 milliliters); in these cases, regional anesthesia does not provide advantages over general anesthesia in terms of morbidity and mortality, although, patients receiving regional anesthesia showed a reduced intraoperative time, faster admission to an Intensive Care Unit, and shorter postoperative hospital stay [20].

The results of our study showed that mean intraoperative bleeding was moderately significant, with 55% having a blood loss between 500- and 4000 ml and requiring transfusion support by the standard clinical practice of our hospital in which the hemoglobin levels must be maintained over 8 to 10g/dL. This could explain why half of the patients underwent open surgery under anesthesia general. Only in 15% of cases did patients require multiple blood transfusions, mainly due to intraoperative hemorrhagic, hypovolemic shock, and rebleeding. The most frequently observed perioperative complications in infrarenal abdominal aortic aneurysm repair surgery are ischemia-reperfusion syndrome, hemorrhage, rebleeding, arrhythmias, coronary ischemia, congestive heart failure, acute renal failure, respiratory failure, thrombosis with limb ischemia inferior, cerebral ischemia, ischemic colitis, intestinal ischemia, and paralytic ileus. In our study, we observed that 50% of our patients presented some perioperative complications, explained by the fact that the majority of our patients underwent elective surgery (84%), which allowed sufficient time for preoperative optimization and consequently, reduced the incidence of complications. A higher percentage of our cases presented significant cardiopulmonary comorbidities, moderately high intraoperative bleeding (between 500 and 4000 ml) requiring transfusion support, as well as relatively long mean surgical and clamping times (256 and 76 minutes, respectively), which predispose to more adverse events. The most common complications in our cohort were ischemia-reperfusion syndrome (15%), acute renal failure (10%), hypovolemic shock due to intraoperative hemorrhage (9%), multi-organ dysfunction syndrome (9%), atrial fibrillation with rapid ventricular response (7%), lower extremity thrombosis-ischemia (5%), rebleeding (4%), congestive heart failure (3%), stroke (2%), respiratory failure (1%), acute coronary syndrome (1%), acute respiratory distress syndrome (1%) and cerebral hematoma (1 %).

Infectious complications, although not described as frequent in infrarenal abdominal aortic aneurysm repair surgery, are common with those observed in the perioperative period of major abdominal surgery. Evidence has recently been published that shows that postoperative infections are the result of the activation of pro- and anti-inflammatory responses associated with cardiovascular, neuronal, autonomic, hormonal, metabolic, and hemostatic changes that ultimately lead to cell damage. The severity of the infection depends upon factors like age, comorbidities, surgical stress, and the source of infection [21]. In this study, we observed that the most frequent infectious complications were pneumonia (4%), periprosthetic infection (3%), surgical wound infection (2%), septic shock (2%) and urinary tract infection (1%). The mean hospital length of stay in this study was 11 days, with a mortality rate of 1 and 2 years of 16% and 21%, respectively. This is probably favored by the high incidence of perioperative complications determined by the prevalence of serious preoperative comorbidities in half of the patients, significant intraoperative bleeding requiring transfusion, long surgical and clamping times, even in patients operated on an elective basis in whom some measures before surgery allowed a better level of optimization, especially in those with chronic arterial hypertension (73%).

In this study, we observed that controlled chronic arterial hypertension is not associated with mortality at 1 and 2 years or with the incidence of perioperative complications, which were our primary and secondary objectives, respectively. Our

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results are in line with a study conducted in 2009, in which they concluded that controlled chronic arterial hypertension is not related to the statistical increase in morbidity and mortality in patients undergoing carotid endarterectomy [22]. Hereafter, adequate preoperative control of chronic hypertension is likely to provide benefits in reducing morbidity and mortality in patients undergoing infrarenal abdominal aortic aneurysm repair surgery [22]. Other authors also recommend that the main target should be sustained control of hypertension in the weeks or months before surgery, allowing the body time to prepare for perioperative changes in arterial pressure [23]. However, it is important to consider that there are other factors whose combination probably contributes to mortality and perioperative complications, as we have observed in this study, like the presence of cardiopulmonary comorbidities with systemic repercussion corresponding to grade III of the ASA classification, which is the most frequent among our patients, moderately significant intraoperative bleeding requiring transfusion, as well as relatively long surgical and clamping times.

Our results showed that controlled chronic arterial hypertension is not associated with mortality at 1 and 2 years or with the incidence of perioperative complications, which are our primary and secondary objectives, respectively. This coincides with a study conducted by Kahn et al., which also concluded that controlled chronic arterial hypertension is not related to the statistical increase in morbidity and mortality in patients undergoing carotid endarterectomy [23]. Therefore, adequate preoperative control of chronic hypertension is likely to provide benefits in reducing morbidity and mortality in patients undergoing infrarenal abdominal aortic aneurysm repair surgery. Other authors recommended adequate control of HTN in the weeks or months before elective surgery, allowing the body time to prepare for perioperative changes in arterial pressure [24]. However, it is important to consider that the combination of other factors probably contributes to increased mortality and perioperative complications, as we have observed in this study, like the presence of cardiopulmonary comorbidities with systemic effects corresponding to grade III of the ASA classification, which is the most frequent among our patients; moderately significant intraoperative bleeding requiring transfusion; as well as relatively long surgical and clamping times.

The retrospective and observational design of our study are its main limitations. Nevertheless, sufficient published evidence and guidelines support that chronic arterial hypertension control in the perioperative setting is an effective strategy to reduce morbidity and mortality [8,25,26]. Our results may serve as a basis for future prospective studies that will allow us to establish the role of controlling preoperative chronic arterial hypertension in patients undergoing infrarenal abdominal aortic aneurysm repair surgery.

Conclusion

According to the present study, controlled chronic arterial hypertension is not associated with an increased incidence of perioperative mortality or perioperative complications. Likely, factors such as previous cardiopulmonary pathology with systemic repercussions, moderately significant intraoperative bleeding requiring transfusion, as well as prolonged surgical and clamping times contribute to a greater extent to morbidity and mortality. Our results emphasize the importance of adequate control of arterial hypertension in the preoperative setting as a measure to reduce complications and mortality in patients undergoing infrarenal abdominal aortic aneurysm repair surgery. However, the design of our retrospective and observational study determines that the results of this study may lead to long-range prospective trials to determine the true impact of adequate control of chronic arterial hypertension in the preoperative setting.

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