ARTÍCULO ORIGINAL

Gac Méd Caracas 2023;131(4):908-920
DOI: 10.47307/GMC.2023.131.4.13

Surgical Treatment of Abdominal Aortic Aneurysms

Tratamiento Quirúrgico de los Aneurismas de Aorta Abdominal

Edmond Nuellari[1*], Saimir Kuci[2], Albana Kenga[3], Denis Kosovrasti[4], Alfred Ibrahimi[5]

SUMMARY

Introduction: *Surgical treatment of abdominal aortic aneurysms poses a significant challenge in the field of vascular surgery, with numerous factors influencing operative technique and surgical outcome.* **Objective:** *This study aimed to assess the outcomes of open surgical treatment for patients with abdominal aortic aneurysms at the Vascular Surgery Service of Mother Teresa University Hospital Centre in Tirana, and provide recommendations for improving outcomes.* **Methods***: A total of 206 patients who underwent transabdominal and retroperitoneal surgical access between January 2008 and December 2015 were included in the analysis. The study evaluated the incidence of abdominal aortic aneurysms, clinical and imaging findings of the disease (ultrasound, tomographic, and arteriographic), frequency of involvement of the iliac artery in the pathological process, and postoperative complications.* **Results:** *Transabdominal access was the most commonly utilized, while retroperitoneal access was deemed the safest. No significant differences in recurrence rates were noted between the two approaches. The findings from this study suggest that surgery is necessary for aneurysms greater than 4.5 cm with clinical symptoms. In contrast, regular monitoring every 3 to 6 months is recommended for aneurysms smaller than 4.5 cm in the absence of clinical symptoms. The study highlights the need for ultrasound screening of the abdomen in patients over the age of 55 years referred to a vascular center with arterial hypertension, diabetes mellitus, or appropriate complaints. Further development of abdominal aortic aneurysm screening for patients over 55 years of age is warranted.*

Keywords: *Aortic repair; open aortic surgery, operative surgical procedures, screening program, quality of care, treatment outcome.*

DOI: https://doi.org/10.47307/GMC.2023.131.4.13

ORCID: 0009-0009-7187-450X[1]
ORCID: 0000-0002-6869-4120[2]
ORCID: 0009-0009-2979-2631[3]
ORCID: 0009-0009-6657-0210[4]
ORCID: 0000-0001-6845-0137[5]

Mother Teresa University Hospital Centre in Tirana.1000, 372 Dibrës Str., Tirana, Albania

[1]Vascular Surgery Service. E-mail: edmondnuellari@aol.com
[2]Anesthesia-reanimation Service.
[3]Vascular Surgery Service.
[4]Vascular Surgery Service.
[5]Anesthesia-reanimation Service.

Recibido: 21 de julio 2023
Aceptado: 13 de septiembre 2023

RESUMEN

Introducción: *El tratamiento quirúrgico de los aneurismas de aorta abdominal plantea un desafío importante en el campo de la cirugía vascular, con numerosos factores que influyen en la técnica quirúrgica y el resultado quirúrgico.* **Objetivo***: El objetivo de este estudio fue evaluar los resultados del tratamiento quirúrgico abierto para pacientes*

con aneurismas aórticos abdominales en el Servicio de Cirugía Vascular del Centro Hospitalario Universitario Madre Teresa en Tirana, y brindar recomendaciones para mejorar los resultados. **Métodos***: Se incluyeron en el análisis un total de 206 pacientes que se sometieron a un acceso quirúrgico transabdominal y retroperitoneal entre enero de 2008 y diciembre de 2015. El estudio evaluó la incidencia de aneurismas de aorta abdominal, los hallazgos clínicos e imagenológicos de la enfermedad (ecografía, tomografía y arteriografía), la frecuencia de afectación de la arteria ilíaca en el proceso patológico y las complicaciones posoperatorias.* **Resultados***: El acceso transabdominal fue el más utilizado, mientras que el acceso retroperitoneal se consideró el más seguro. No se observaron diferencias significativas en las tasas de recurrencia entre los dos enfoques. Los hallazgos de este estudio sugieren que la cirugía es necesaria para los aneurismas mayores de 4,5 cm con síntomas clínicos. Por el contrario, se recomienda un control regular cada 3 a 6 meses para aneurismas menores de 4,5 cm en ausencia de síntomas clínicos. El estudio destaca la necesidad del cribado ecográfico del abdomen en pacientes mayores de 55 años derivados a un centro vascular con hipertensión arterial, diabetes mellitus o padecimientos propios. Se justifica un mayor desarrollo de la detección del aneurisma de la aorta abdominal en pacientes mayores de 55 años.*

Palabras clave: *Reparación aórtica, cirugía aórtica abierta, procedimientos quirúrgicos operativos, programa de detección, calidad de atención, resultado del tratamiento.*

INTRODUCTION

Abdominal aortic aneurysm (AAA) is a ticking time bomb in the abdominal cavity of over 1 % of adults worldwide (1,2). Open surgical repair of AAAs is a major procedure with its own risks, while endovascular aneurysm repair (EVAR) has lower perioperative mortality but higher long-term complications and reintervention rates. If left untreated, the ballooning weakness in the abdominal aorta can catastrophically rupture and rapidly lead to death (3,4). Despite advancements in screening and surgical techniques, AAA remains a prevalent and potentially fatal vascular disease. In the United States alone, over 15 000 deaths per year can be attributed to ruptured AAAs. Early detection and proactive surgical intervention are crucial for averting these tragic outcomes (5).

Recent studies have examined surgical outcomes and mortality rates for abdominal aortic aneurysm (AAA) repair, both open and endovascular. Despite the demonstrated prevalence of AAA, treatment outcomes vary. For instance, a nationwide prospective cohort study by Alberga et al. (6) analyzed the outcomes of endovascular treatment in 11 624 patients (74.8 %) and open intervention in 3 908 patients (25.2 %) from 2014 through 2019. They observed a decrease in total complications from 10.1 % to 7.0 %, postoperative mortality from 6.1 % to 4.6 %, and an increase in the proportion of patients with cardiac comorbidity since the creation of this nationwide initiative.

Meanwhile, Brown et al. (7) reported wide variability in risk-adjusted mortality rates (1.3 %-8.2 %) across 223 centers performing open repair from 2003-2019. The studies by Alberga et al. and Brown et al. both analyzed recent surgical trends and mortality rates, providing complementary multi-center perspectives on real-world outcomes. Meanwhile, Sharma et al. (8) and Tshomba et al. (9) drilled down on mortality and complications for specific patient subgroups. Sharma et al. reported a postoperative mortality rate of 4.1 % (n=126) in a Vascular Quality Initiative registry study of 3 078 patients who underwent elective open surgery for AAA. Tshomba et al. examined the long-term outcomes of open treatment of complex AAAs in 119 patients at a major vascular center from January 2010 to June 2016, with a mean follow-up of 76 months. They found that open repair of complex AAAs can be performed with acceptable surgical risk and consistent results, despite 37 % of deaths and 43.8 % of patients experiencing long-term chronic renal failure.

There are different views on AAA screening at both national and regional levels in many countries (10). Powell and Wanhainen (11) compared the recently published National Institute for Health and Care Services (United Kingdom) 2020 and European Society for Vascular Surgery (France) 2019 guidelines on the diagnosis and management of patients with abdominal aortic aneurysm, which contain conflicting recommendations in important areas (Table 1). The differences in the recommendable methods of treatment of juvenile aneurysms are

similarly explained by the authors as reflecting different perspectives, methodologies, and quality assurance. Despite strong evidence supporting the need for screening to reduce mortality (12-14), there are only a few national programs in the United States, Great Britain, Sweden, and Norway, and other countries are currently evaluating the economic effectiveness of screening programs before implementing them (4,15).

Table 1

Points of Divergence in AAA Guidelines from the UK and France

Guideline Aspect	NICE Guideline	ESVS Guideline
Screening women	Consider screening women aged ≥70 years with risk factors	Do not recommend population screening for women
Screening men	Recommend population screening for men aged 65-74 years	Same as NICE - recommend screening for men 65-74 years
Intervention threshold women	5.5 cm	Consider 5.0 cm
Intervention threshold men	5.5 cm	5.5 cm
Elective AAA repair women	No specific recommendation	Consider EVAR first if suitable anatomy
Elective AAA repair men	Recommend open repair first end open repair first	Recommend EVAR first for most patients
Ruptured AAA repair women	Consider EVAR first	Recommend EVAR first if suitable anatomy
Ruptured AAA repair men	Consider open repair first for men <71 years	Recommend EVAR first if suitable anatomy
Complex/juxtarenal AAA repair	Consider open repair first	Individualized approach based on patient factors

Main differences

1. NICE focuses on cost-effectiveness and uses rigorous methodology relying heavily on randomized controlled trials (RCTs).
2. ESVS considers a wider range of evidence including recent observational studies.
3. NICE takes a UK health system perspective, and ESVS aims for the best clinical practice across Europe.
4. NICE guideline development is lengthy but multidisciplinary, ESVS is faster paced but mainly vascular surgeons.

Therefore, the problem of surgical treatment of AAAs is urgent and important for practical tasks of vascular surgery. This study aimed to analyze the surgical treatment of patients who underwent open surgery for AAA to identify factors contributing to improved outcomes. Specifically, the task was to determine the place of AAA in the structure of vascular pathology, the frequency of concomitant obliterating pathology of the iliac and femoral segments, clinical characteristics of patients, their complaints and symptoms, imaging results of aneurysm signs using different methods, and to compare the results of transabdominal and retroperitoneal methods and their possible complications.

There is a gap in knowledge regarding the optimal surgical approach for AAA repair in terms of outcomes and complications. The purpose of this study was to compare outcomes and complications between transabdominal and retroperitoneal surgical approaches for abdominal aortic aneurysm repair in a single-center patient cohort.

MATERIALS AND METHODS

A single-center, non-randomized, retrospective study of the results of open surgical treatment of abdominal aortic aneurysms in 206 patients from January 2008 to December 2015 was performed at the Vascular Surgery Service of Mother Teresa University Hospital Centre in Tirana. The study only included patients with a histologically confirmed diagnosis of abdominal aortic aneurysm, while patients with ruptured abdominal aortic aneurysm were excluded.

Patient identification was based on the analysis of surgical logs, statistical data from medical records, and radiology imaging protocols. The data collected for each patient included demographics such as age and sex, timing of complaints before referral, comorbidities such as arterial hypertension, heart and lung diseases, diabetes mellitus, probable risk factors such as smoking, hypertension, positive family history, metabolic disorders, etc. Preoperative aneurysm imaging findings were divided into different categories based on the size of the aneurysm, which included 4 cm, 4.5 cm, 5 cm, 5.5 cm, 6 cm, 6.5 cm, 7 cm, and >7 cm. The localization of the aneurysm, involvement of iliac and femoral vessels, and aneurysm shape (sac-like, spindle-shaped, mixed) were also recorded.

The selection of the surgical intervention option for AAA was dependent on clinical features, surgery was performed using either a retroperitoneal or transabdominal approach, and the recommendations of the European Society for Vascular Surgery were followed. The surgical treatment strategy was determined and coordinated by a multidisciplinary team, which included vascular surgeons, interventional radiologists, and anesthesiologists. The date of surgery, type of surgery (transabdominal, retroperitoneal), type of first surgery and access in case of recurrence, results of the pathohistological examination, immediate and long-term results of surgery, postoperative laboratory data, postoperative complications, and their treatment were recorded. Short-term follow-up was defined as follow-up within the first year after surgery, while long-term follow-up was defined as follow-up over five years.

To analyze the data, the licensed version of the statistical program SPSS Statistics version 17 Chicago was used. Statistical analysis of indicators was carried out by studying the characteristics of the process under study, followed by the selection of indicators and their ranking by importance. The collected values of the indicators were grouped in the form of statistical tables. The results were processed by methods of descriptive statistics without testing the compared populations on the nature of the distribution. A two-sided Student's t-test was used to evaluate the statistical significance of differences between average values, followed by the comparison of the calculated value with the critical table value of the coefficient. To compare the relative frequency rates in the compared groups, we used the χ^2 (Chi-Square) goodness-of-fit test compared to the table value of the critical value.

A single-center retrospective study was chosen due to several advantages. First, it allowed access to detailed medical records and a sufficient sample size from a major vascular center. Second, it enabled analyzing real-world surgical outcomes over a 8-year period. Third, it avoided selection bias that could occur in a prospective study. Finally, it had lower costs and faster completion compared to a prospective study. However, there were also some disadvantages to this approach. First, there was potential for missing or incomplete data from the medical records. Second, findings had limited generalizability beyond this specific center. Third, there was an inability to control confounding factors or prove causation like an RCT could. Fourth, it was susceptible to biases like selection bias or reporting bias. In conclusion, a retrospective single-center study was an appropriate design to analyze surgical outcomes from this hospital's experience, although findings may not be fully generalizable. There were also limitations compared to what a prospective multicenter study could have provided.

Patients were not involved in the design, conduct, reporting, or dissemination plans of this research. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964

Helsinki Declaration and its later amendments or comparable ethical standards. A study was approved by the Ethics Commission of the Mother Teresa University Hospital Centre in Tirana on May 26, 2023, No 3021-A.

RESULTS

Patient characteristics

During the study period, a total of 206 patients underwent surgery for AAA and met the inclusion criteria. Of these, 188 (91.3 %) were male, and 18 (8.7 %) were female. The mean age of the patients was 67.8±5.7 years, with 67.7±5.9 years for men and 69±3.1 years for women. There were no statistically significant differences in age between genders ($p>0.05$). Following the detection of AAA, all patients were hospitalized for surgical treatment after a thorough clinical examination based on a standard protocol. In almost all patients, there was a delay in diagnosis from 2 to 25 weeks, resulting in a difference in time from the onset of symptoms to hospitalization. On average, this time was 2.3±6.4 weeks for men and 2.5±35.2 weeks for women, with a statistically significant difference between genders ($p<0.05$). Abdominal pain was reported by 12 male patients and 6 female patients, with a statistically significant difference in the frequency of abdominal pain between genders ($\chi^2=4$, df=1, $p=0.05$). Detailed clinical features are provided in Table 2.

Table 2

Distributions of clinical signs

	Men	Women	Total
Clinical signs	6	0	6
Abdominal pain + lumbar pain + intermittent claudication	6	6	12
Abdominal + lumbar + back pain	8	0	8
Intermittent claudication	9	0	8
Abdominal + lumbar + chest pain	4	0	4
Epigastric + lumbar + right hypogastric pain	6	2	8
Lumbar + gluteal pain + left lower extremity	8	0	8
Colic	4	6	10
Peri umbilical pain + pelvis	24	14	38
Periabdominal and umbilical pain	104	4	108
No symptoms	178	28	206

Source: created by the authors.

Before surgery, in addition to standard clinical tests, routine instrumental studies were conducted, and specialists were consulted as necessary. All patients exhibited concomitant pathology on admission. The most common comorbidities were chronic obstructive pulmonary disease (COPD) and chronic smoker's bronchitis (52.9 %), hypertensive disease (61.1 %), angina and postinfarct cardiosclerosis (20.4 %), vascular pathology including cerebral atherosclerosis (21.4 %), and diabetes mellitus (8.7 %, all male). This information will be considered when distributing patients according to the types of surgical interventions performed. Among the examined patients, the following risk factors were identified: active smoking in 6 cases (2.9 %) among women and in 96 cases (4.4 %) among men; coronary heart disease of varying severity was found in 54 patients (26.2 %); mild degree obstructive diseases were found in 60 patients (29.1 %), moderate degree in 32 patients (15.5 %), and severe obstructive changes in 18 patients (8.73 %), with obstructive phenomena absent in 96 patients (46.6 %).

Confirmation of the diagnosis and follow-up imaging was performed using color Doppler echography (CDE), contrast-enhanced computed tomography (CT), and arteriography. According to standard guidelines, patients with an AAA size of 3.0-4.4 cm underwent follow-up once a year, while those with a size of 4.5-5.4 cm underwent follow-up every 3 months. Follow-up observation of the patient and recording of the results were also performed using color CDE, CT with contrast, and arteriography. The average AAA diameter was 5.8 cm in men according to CDE and 4.6 cm in women, with a statistically significant difference (p=0.05). On CT scan AAA sizes were slightly different and were 6.34 cm and 5.5 cm in men and women, respectively (p=0.05). The frequency of involvement of the underlying vessels was also analyzed, and the results are shown in Table 3.

Table 3

Prevalence of AAA and involvement of the iliac and femoral arteries

	Women	Men	Total
Femoral arteries	0 %	2.92 %	2.92 %
Iliac arteries	2.92 %	42.73 %	45.64 %
Iliac-femoral arteries	2.92 %	5.82 %	8.74 %
Without involvement arteries	0 %	0 %	38.8 %
No data	0 %	0 %	2.92 %

Source: created by the authors.

In 3.88 % of cases, there was involvement of the iliac arteries on both the right and left sides. In 2.92 % of cases, there was involvement of just the right iliac and femoral arteries. In another 3.88 % of cases, there was involvement of just the left iliac and femoral arteries. In 2.92 % of cases, there was involvement of both femoral arteries.

Characteristics of operations

The selection of the surgical intervention option for AAA was dependent on clinical features, and the recommendations of the European Society for Vascular Surgery were followed. Surgical treatment was recommended for cases of detected or suspected aneurysm rupture, rapidly enlarging aneurysms irrespective of symptoms, aneurysms over 4.5 cm in diameter, signs of embolization, thrombosis, occlusion, and atypical aneurysm forms such as mycotic, stratifying, or circular. All these cases posed a high level of danger for the patient.

Surgery for AAA was performed using either a retroperitoneal or transabdominal approach. The transabdominal technique was performed by a median incision of the anterior abdominal wall from the xiphoid process to the symphysis, the Treitz ligament was dissected, and the retroperitoneal space was opened to the left of the aorta. If the aneurysm was infrarenal, the retroperitoneal space was dissected to expose the aorta to the level of the left renal vein, and the left renal vein was mobilized if suprarenal clamping was necessary. Distal clamping was performed below the level of the lesion. In the retroperitoneal method, the patient was laid on the right side, and access was made from the 10th intercostal space to the upper-anterior apex of the iliac bone through the lateral abdominal muscles. The left kidney was mobilized ventrally, the left ureter was visualized, and it was diverted anteriorly along with the kidney. Before aortic clamping, systemic heparin at a dose of 80–100 units/kg weight was administered, regardless of the approach. The clamping sequence was started from the distal portions of the aorta and then switched to the proximal portions to reduce the risk of distal embolization. The transabdominal route was used in 120 (58.3 %) cases, and the retroperitoneal route was used in 86 (41.7 %) cases. The use of each method depending on the clinical situation is shown in more detail in Table 4.

Anesthesia support for surgical interventions on the aorta and its branches in AAA was provided in a combined manner, including epidural anesthesia. This approach reduced the volume of narcotic analgesics used and allowed for prolonged anesthesia for several days after surgical intervention. The advantages of this approach included full protection of the patient from afferent impulses from the surgical area, adequate muscle relaxation, absence of respiratory and metabolic disorders, and reduction of surgical blood loss. The average values are shown in Table 5.

Table 4

Distribution of patients depending on comorbidities and method of intervention

	Transabdominal procedures	Retroperitoneal procedures	Validity of the difference
Smoking	70	33	0.5
Cardiac infarction	6	12	0.05
Diabetes mellitus	8	10	0.07
Hypertension	86	40	0.05
Stenocardia	14	10	0.01
COPD	66	40	0.01
Carotid artery disease	16	8	0.02
Total	120	86	

Source: created by the authors.

Table 5

Comparative values of the mean values in both groups

	Transabdominal procedures (n=120)	Retroperitoneal procedures (n=86)	Validity of the difference
Time of operation (hours)	3.18±0.19	3.55±0.18	0.006
Intravenous analgesics (mg)	49.5±28.5	36.6±21	0.004
Epidural analgesics (mg)	56.6±9.5	39.5±6.4	0.004
Time spent in hospital (days)	11.8±2.3	7.2±1.6	0.02
Effectiveness	82.7±5.46%	85.3±4.03%	0.05

Source: created by the authors.

The maintenance of anesthesia during AAA surgeries was tailored to the specific patient, taking into account various influencing factors, including indications for the particular case, the duration of the surgical intervention, the degree of hypothermia, the level of blood loss and hemodilution, and intraoperative homeostasis results.

The choice of the optimal aortic prosthesis was based on certain requirements for its physical characteristics, including elasticity, adaptability, flexibility, ease of stitching, resistance to material separation, smooth lumen surface, and resistance to infection and thrombogenicity. It should have no toxic or allergic side effects and should be consistently available in a full range of sizes and lengths in a moderate price range. The configuration of the aortal prosthesis was dependent on the extent of the aneurysm and the specific clinical data of the particular patient. Two types of aortic vascular prostheses were used in this study: "Dacron" – 167 (81 %) operations, and "PTFE" (polytetrafluoroethylene) – 39 (19 %) operations. No fundamental differences in the frequency or type of complications associated with the type of prosthesis used have been revealed.

The surgical procedures involved in the study included aorta-aortic lumen reconstruction in 12 cases (5.8 %), aorta-subiliac artery reconstruction in 120 cases (58.3 %), aorta-common femoral artery reconstruction in 18 cases (8.7 %), aorta-deep femoral artery reconstruction in 6 cases (2.9 %), aorta-anterior iliac artery reconstruction in 32 cases (15.5 %), aorta-both external iliac arteries reconstruction in 12 cases (5.8 %), and common iliac-external iliac artery reconstruction in 6 cases (2.9 %).

The present study utilized objective criteria derived from macroscopic CT and interventional data, as well as microscopic anatomic-pathological findings, to define aneurysms as inflammatory. The classification of inflammatory aneurysms was based on the presence of specific macroscopic features, such as thickening in the aneurysm wall, retroperitoneal fibrosis, and adhesions to neighboring organs, as well as microscopic features, including inflammatory infiltrates with plasma and lymphocytic walls, adventitial fibrosis, obliterating endarteritis, and fibrosis around nerves. These objective criteria allowed for a clear distinction between inflammatory and noninflammatory aneurysms. The inflammatory nature of AAA was observed in six patients (2.91 %) during the study, while mycotic aneurysms were encountered in two patients (0.97 %).

Characteristics of complications

Despite all the measures implemented, complications occurred during the study. Intraoperative complications were observed in 11 cases (5.3 %). Damage to the ureter occurred in 6 cases (2.6 %), requiring primary suture in 2 cases and stenting in 4 cases. Inferior vena cava damage occurred in 6 cases (2.9 %), all of which were treated with primary sutures. The duodenal injury occurred once (0.5 %) and was also sutured. These injuries were timely detected and eliminated, without affecting the further course of the operation and postoperative period in patients. Postoperative complications occurred more frequently, and their types and frequencies are presented in Table 6.

Table 6

Type and frequency of postoperative complications

	Complications
Pulmonary complications	20 (9.7%)
Cardiovascular complications	16 (7.8%)
Gastrointestinal complications	20 (9.7%)
Postoperative hernia	11 (5.3%)
Hemorrhagic complications	11 (5.3%)
Thromboembolia	11 (5.3%)
Bedsores	12 (5.8%)

Source: created by the authors.

As can be seen from the table, pulmonary complications were the most common, recorded in 8 patients (8.8 %) in the retroperitoneal group and 12 patients (9.2 %) in the transabdominal group. However, this difference was not statistically significant (p=0.07). Cardiovascular complications occurred in 6 patients (13.3 %) in the retroperitoneal group compared to 10 patients (15.8 %) in the transabdominal group, with a statistically significant difference (p=0.004). Gastrointestinal complications were observed in 5 patients (5.8 %) in the retroperitoneal group compared to 15 patients (12.5 %) in the transabdominal group, with a statistically significant difference (p=0.002). Postoperative hernia developed in 6 patients (6.9 %) in the retroperitoneal group compared to 5 patients (4.2 %) in the transabdominal group, without a statistically significant difference (p=0.5). Hypotension and drainage bleeding were observed in 6 cases (9.5 %) in the transabdominal group and 5 cases (11.1 %) in the retroperitoneal group, without a statistically significant difference. Bedsores and wounds of the sacrum and gluteal muscles were observed in 7 patients (11.1 %) in the transabdominal group and 4 patients (8.8 %) in the retroperitoneal group, without a statistically significant difference. Acute thromboembolism of the femoral artery was observed in 6 cases (9.5 %) in the transabdominal group and 3 cases (6.6 %) in the retroperitoneal group, without a statistically significant difference. The surgery time for retroperitoneal interventions averaged 3.55 hours, while for transabdominal interventions, it was 3.18 hours, with a statistically significant difference (p=0.06).

Thirty-one repeated interventions were performed to eliminate complications: nephrectomy (1 case, 0.5 %), colostomy (6 cases, 2.9 %), catheter thrombectomy (12 cases, 5.8 %), iliofemoral arterial shunt (4 cases, 1.9 %), femoral arterial shunt (6 cases, 2.9 %), relaparotomy and abdominal revision (2 cases, 0.9 %).

The transabdominal approach requires more extensive abdominal exposure and manipulation which can increase stress on the cardiovascular system, especially in patients with pre-existing cardiac conditions. The increased surgical

trauma may lead to greater hemodynamic instability intra-operatively and a higher risk of events like myocardial ischemia or infarction postoperatively.

Gastrointestinal complications occurred more often after transabdominal procedures (12.5 % *vs*. 5.8 % for retroperitoneal). The transabdominal technique requires more intestinal manipulation and retraction which can disrupt bowel function after surgery, increasing the risk of ileus, nausea/vomiting, etc. Dividing the posterior peritoneum also compromises the bowel blood supply.

The transabdominal incision and opening of the peritoneum breach two additional tissue planes compared to the retroperitoneal approach. This greater surgical trauma predisposes to increased pain, ileus, infection, and other wound-related complications that may prolong recovery. The transabdominal technique has greater potential for direct injury to intra-abdominal organs like the bowel, spleen, or liver which could lead to increased complications if unrecognized or not repaired appropriately.

DISCUSSION

The present study investigated the impact of various complications on the outcomes of surgical treatment for AAA. While some complications are difficult to prevent, particularly in high-risk cases with concomitant pathology, most can be significantly reduced by improving surgical technique. In the analysis of 214 patients who underwent open planned surgical treatment for AAA between January 2012 and December 2021 (16), in-hospital mortality within 30 days was 1.9 %. Using multivariate logistic regression was identified chronic obstructive pulmonary disease (COPD) was the only predictor significantly associated with mortality (p=0.015).

This study found a postoperative mortality rate of 4 %, which is within the range reported in the literature for planned open treatment of AAA (1-8 %). For example, a recent large comparative analysis (7) of 67 073 surgical procedures for AAA performed between 2003 and 2019 found mortality rates ranging from 1.3 % to 8.2 %. Only 4.9 % of the 223 hospitals performing surgical procedures during this period performed ≥15 of them per year. The authors of the analysis observed a trend of decreasing mortality with increasing annual volume of surgery, with each additional case associated with a 0.012 % decrease in mortality (p=0.05). To achieve acceptable outcomes, the minimum abdominal aortic aneurysm repair volume for a specific surgical team should be between 9 and 13 operations per year (8), and at least 18 operations per year for the hospital as a whole. Vascular Surgery Services of Mother Teresa University Hospital Centre in Tirana's average annual number of surgeries is 12.1. The mortality rates for centers with a low volume of surgeries should be treated with caution since much of the variability in these results will be statistical noise rather than true differences in the quality of treatment at the center level. These findings are consistent with a similar analysis of the centralization of surgical treatment for AAA in Catalonia, Spain (17) which found a significant reduction in overall mortality after complete centralization (4.7 % versus 2.0 %, p<0.001), particularly for open operations (8.7 % versus 3.6 %, p=0.005). To achieve the best long-term outcome, open surgical treatment of ABA should be performed in centers with a high volume of aortic surgery and tailored to the individual patient (9,18).

Endovascular aneurysm repair has become a priority in vascular surgery and the main method of AAA treatment due to its ability to reduce procedure time, surgical complications, and length of hospital stay (2,6). As a result, it has significantly replaced open intervention techniques in the treatment of AAA (3,14).

While EVAR has become the predominant method for elective AAA repair, open surgical repair still plays an important role in certain circumstances. EVAR offers benefits including shorter hospital stays, lower perioperative mortality, and quicker recovery times. However, EVAR also has drawbacks such as the need for long-term surveillance, higher re-intervention rates, and inferior long-term aneurysm-related mortality compared to open repair. Open surgery may be preferred for patients with hostile neck anatomy unsuitable for EVAR, those with large or complex AAAs, or young and healthy patients expected to outlive the durability of endograft. The choice between open and endovascular repair is made based on a detailed assessment of patient

risk factors, anatomy, and life expectancy. In general, authors aim to reserve open repair for younger, low-risk surgical candidates expected to benefit from the more durable results. For older or higher-risk patients with suitable anatomy, the main default strategy is EVAR to minimize perioperative morbidity and mortality.

A retrospective cohort study (19) compared perioperative data and complications of open operations for AAA performed at Ottawa Hospital from 2014 to 2017 (n=49) and from 2005 to 2007 (n=53). The study found that the number of open AAA surgeries decreased by 61 %, anesthesia time and time in the operating room increased, and complications in anatomically similar patients increased. These results suggest a decline in the level of preparedness of the specialized institution for the open treatment of AAA and the postoperative care of such patients as a result of a decrease in the number of surgeries performed.

Treatment of recurrent AAA is usually difficult, and perioperative mortality in such cases is significantly increased compared with primary treatment (1,4,20). This study found slightly higher postoperative complication rates (15.2 %) than reported in the literature, but they did not contribute to increased mortality. The 5-year survival rates at the Vascular Surgery Service of Mother Teresa University Hospital Centre in Tirana were high, ranging from 60 % to 75 %.

The issue of mycotic abdominal aortic aneurysm (AAA) has been discussed in the literature. However, due to its rarity, there are limited studies available to establish a consensus on its treatment and management (21-23). According to the 2016 Dutch Audit of Surgical Aneurysms, 26 cases of mycotic AAA were identified, representing 0.7 % of all reported AAA cases (21). Monthly mortality among these patients was 7.7 %, with one patient dying within the first day after surgery, representing 9.1 % of cases. Re-hospitalization within a year was observed in 36.4 % of the cases. In a retrospective review of treatment for patients with an infectious nature of AAA from 2002 to 2020, open surgical procedures were performed in 66 patients with a median follow-up of 26.5 months (13-66 months). The overall in-hospital mortality was 27.9 % (23). A retrospective analysis of case histories reported that 17 open surgeries for mycotic AAA were performed at a single tertiary vascular center from 2001 to 2018. The 1-year overall survival rate was 94.1 %, while the 3-year survival rate was 81.8 %, and the 5-year survival rate was 75.0 %. The curves of overall and recurrence-free survival showed no statistically significant differences depending on the type of intervention (22,24,25). Although the small number of patients in this study does not allow for significant statistical conclusions, it is evident that individually planned surgical treatment with adequate antibiotic therapy can achieve acceptable results in this group of patients.

Despite reliable data supporting the need for screening to prevent rupture and reduce mortality in patients with AAA, the condition continues to pose a serious risk (15,26-28). Screening is economically effective, even with an AAA prevalence as low as 0.5 % (4). However, Dansey et al. (14) analyzed the U.S. National Inpatient Sample from 2004 to 2015 and identified 46 191 patients scheduled for AAA surgery, of whom 59 % did not meet the screening criteria. Among these, 27 653 (63 %) were over 75 years old, 10 603 (24 %) were under 65 years old, and 16 103 (36 %) were women (29). The authors recommended that consideration be given to broadening the screening criteria to include individual women and a broader age range. Kapila et al. (15) recommend screening men and women aged 65-80 years and first-degree relatives, while Dansey et al. (14) recommend screening smoking men over 55 years of age and all patients with a family history of AAA.

Nayeemuddin et al. (30) reviewed imaging and management of complications from open surgical repair of AAA. They noted that while patients undergoing EVAR are routinely followed up with imaging to detect complications, those with open repair typically do not receive imaging follow-up. However, this study and others demonstrate that open repair can also lead to postoperative complications (31,32). Nayeemuddin et al. (30) highlighted how increased use of CT angiography has enabled better identification of complications after open AAA repair. Similar to their findings, this single-center study was able to characterize a range of complications through the utilization of

imaging modalities like CT and color Doppler ultrasound. Further research on larger scales can help provide more robust data on the rates of various complications following open AAA repair.

Swerdlow et al. (33) discussed the dramatic shift towards endovascular aneurysm repair (EVAR) and away from open repair over the past two decades. As they noted, EVAR has become the predominant technique for AAA treatment due to advantages like shorter hospital stays and lower perioperative mortality. The decrease in open repairs has correspondingly led to diminished technical proficiency and preparedness for managing complications (34,35), as evidenced by studies like Nayeemuddin et al. (30). However, Swerdlow et al. (33) caution against the overuse of EVAR, as younger, healthier patients may benefit more from the durability of open repair in the long run. They emphasize that open repair remains an essential treatment modality for certain patients and situations. Maintaining capabilities for both open and endovascular repair is important, as this study shows open AAA surgery still has a role despite the rise of EVAR. Individualized assessment of patient risk factors and anatomy can help determine the optimal approach (36).

Given the patient characteristics in the current study, it would be reasonable to consider the feasibility of screening those over 55 years of age. If modern surgical treatment of AAA can be performed in a safer manner, the benefits of screening and subsequent surgical intervention may be greater than traditionally thought.

CONCLUSIONS

Abdominal aortic aneurysms are more prevalent in men aged 55-75 years and account for 3 %-5 % of vascular surgery cases. This study found a delay in diagnosis after the onset of symptoms. The transabdominal surgical approach was more commonly used, but the retroperitoneal approach had lower complication rates. There was no significant difference in recurrence rates between the two techniques. For inflammatory and mycotic aneurysms, the transabdominal approach gave better outcomes. The retroperitoneal approach reduced pain severity, complications, hospital stay, and costs. Mortality rates within 1 month and 1 year were similar for both surgical techniques.

In addition, the study has a number of limitations. Key limitations of the study include:

1. Single-center retrospective study with a relatively small sample size (n=206). The results may not be generalizable to other hospitals/regions. A multi-center study could provide more robust results.
2. Lack of a control group for comparison. Having a group of patients who received alternative treatment or no treatment would allow stronger conclusions about the impact of the surgical interventions.
3. No data on long-term survival, quality of life, or aneurysm-related mortality after hospital discharge. This information would provide valuable insights into the long-term efficacy of interventions.

Based on these findings, surgical treatment may be recommended for abdominal aortic aneurysms larger than 4.5 cm and in the presence of clinical symptoms. Observation tactics with visual monitoring every 3 or 6 months may be considered if the aneurysm is smaller than 4.5 cm and there are no clinical complaints. Any physician in the area, whether general surgeon or urologist, cardiologist or pathologist, encountering a patient over 55 years of age with arterial hypertension, diabetes mellitus, a history of smoking, and unspecified abdominal pain of indefinite or stabbing nature, should recommend an abdominal ultrasound in addition to the appropriate investigations indicated by the treatment protocol. A strategy of continuous monitoring of the patient by improving functional vital signs is advisable only in cases where the risk of lethal outcomes after and during surgery is too high. In all other cases of abdominal aortic aneurysms, surgical treatment should be strongly recommended. Finally, given the clinical benefits of using surgical treatment of asymptomatic aneurysms to reduce mortality, it is necessary to conduct an economic assessment of the feasibility of abdominal aortic aneurysms screening in the population over 55 years of age of both sexes.

REFERENCES

1. Sakalihasan N, Michel JB, Katsargyris A, Kuivaniemi H, Defraigne JO. Abdominal aortic aneurysms. Nature Rev Dis Primers. 2008;4:34.
2. Blackstock CD, Jackson BM. Open surgical repair of abdominal aortic aneurysms maintains a pivotal role in the endovascular era. Semin Intervent Radiol. 2020;37(4),346-355.
3. Witheford M, Brandsma A, Mastracci TM, Prent A. Era of endovascular aortic aneurysm repair is linked to preoperative anatomic severity and perioperative patient outcomes. J Vasc Surg. 2022;75(1):126-135.
4. Kessler V, Klopf J, Eilenberg W, Neumayer C, Brostjan C. AAA revisited: A comprehensive review of risk factors, management, and hallmarks of pathogenesis. Biomedicines. 2022;10(1):94.
5. Castro-Ferreira R, Lachat M, Schneider PA, Freitas A, Leite-Moreira A, Sampaio SM. Disparities in contemporary treatment rates of abdominal aortic aneurysms across Western countries. Eu J Vasc Endovasc Surg. 2019;58(2):200-205.
6. Alberga AJ, Karthaus EG, Wilschut JA, de Bruin JL, Akkersdijk GP, Geelkerken RH. Dutch Society of Vascular Surgery, Steering Committee of the Dutch Surgical Aneurysm Audit, and the Dutch Institute for Clinical Auditing. Treatment outcome trends for non-ruptured abdominal aortic aneurysms: A nationwide prospective cohort study. Eur J Vasc Endovasc Surg. 2022;63(2):275-283.
7. Brown CS, Montgomery JR, Kim GY, Kemp MT, Osborne NH. Reliability of hospital-level mortality in abdominal aortic aneurysm repair. J Vasc Surg. 2022;75(2):535-542.
8. Sharma G, Madenci AL, Wanis KN, Comment LA, Lotto CE, Shah SK. Association and interplay of surgeon and hospital volume with mortality after open abdominal aortic aneurysm repair in the modern era. J Vasc Surg. 2021;73(5):1593-1602.
9. Tshomba Y, Sica S, Minelli F, Ferraresi M, de Waure C, Donati T. Long-term results of complex abdominal aortic aneurysm open repair. J Personalized Med. 2022;12(10):1630.
10. Pratesi C, Esposito D, Apostolou D, Attisani L, Bellosta R, Benedetto F. Italian Guidelines for Vascular Surgery Collaborators – AAA Group. Guidelines on the management of abdominal aortic aneurysms: Updates from the Italian Society of Vascular and Endovascular Surgery (SICVE). J Cardiovasc Surg. 2022;63(3):328-352.
11. Powell JT, Wanhainen A. Analysis of the differences between the ESVS 2019 and NICE 2020 guidelines for abdominal aortic aneurysm. Eur J Vasc Endovasc Surg. 2020;60(1):7-15.
12. Carnevale M.L, Koleilat I, Lipsitz EC, Friedmann P, Indes JE. Extended screening guidelines for the diagnosis of abdominal aortic aneurysm. J Vasc Surg. 2020;72(6) :1917-1926.
13. O'Donnell TFX, Schermerhorn ML. Abdominal aortic aneurysm screening guidelines: United States Preventative Services Task Force and Society for Vascular Surgery. J Vasc Surg. 2020;71(5):1457-1458.
14. Dansey KD, V arkevisser RRB, Swerdlow NJ, Li C, de Guerre LEVM, Liang P. Epidemiology of endovascular and open repair for abdominal aortic aneurysms in the United States from 2004 to 2015 and implications for screening. J Vasc Surg. 2021;74(2):414-424.
15. Kapila V, Jetty P, Wooster D, Vucemilo V, Dubois L. Canadian Society for Vascular Surgery. Screening for abdominal aortic aneurysms in Canada: 2020 review and position statement of the Canadian Society for Vascular Surgery. Canadian J Surg. 2021;64(5):461-466.
16. Ibrahim A, Yordanov MD, Hasso M, Heine B, Oberhuber A. Open treatment of abdominal aortic aneurysm in the endovascular era. J Clin Med. 2022;11(11):3050.
17. Tripodi P, Mestres G, Riambau V. Vascular Advisory Committee – Catalan Health Service. Impact of centralisation on abdominal aortic aneurysm repair outcomes: Early experience in Catalonia. Eur J Vasc Endovasc Surg. 2020;60(4):531-538.
18. Chaikof EL, Dalman RL, Eskandari MK, Jackson BM, Lee WA, Mansour MA. The Society for Vascular Surgery practices guidelines on the care of patients with an abdominal aortic aneurysm. J Vasc Surg. 2018;67(1):2-77.
19. Kinio A, Ramsay T, Jetty P, Nagpal S. Declining institutional memory of open abdominal aortic aneurysm repair. J Vasc Surg. 2021;73(3):889-895.
20. Park JK, Kang J, Kim YW, Kim DI, Heo SH, Gil E. Outcomes after elective open abdominal aortic aneurysm repair in octogenarians compared to younger patients in Korea. J Korean Med Science. 2021;36(47):e314.
21. Dang Q, Statius van Eps RG, Wever JJ, Veger HTC. Dutch Society of Vascular Surgery, the Steering Committee of the Dutch Surgical Aneurysm Audit, and the Dutch Institute for Clinical Auditing. Nationwide study of the treatment of mycotic abdominal aortic aneurysms comparing open and endovascular repair in The Netherlands. J Vasc Surg. 2020;72(2):531-540.
22. Premnath S, Zaver V, Hostalery A, Rowlands T, Quarmby J, Singh S. Mycotic abdominal aortic aneurysms – A tertiary center experience and

formulation of a management protocol. Ann Vasc Surg. 2021;74:246-257.

23. Touma J, Couture T, Davaine JM, de Boissieu P, Oubaya N, Michel C. Mycotic/infective native aortic aneurysms: Results after preferential use of open surgery and arterial allografts. Eur J Vasc Endovasc Surg. 2022;63(3):475-483.
24. Turgunov Y, Shakeyev K, Sharapatov Y, Lavrinenko A, Pronkin E. The Model of Acute Obstructive Pyelonephritis for Studying Bacterial Translocation of E. coli from Gastroenteric Tract. Open Access Macedon J Med Sci. 2022;10:232-235.
25. Tamm TI, Datsenko BM, Nepomniashchiĭ VV, Kramarenko KA, Zakharchuk AP, Mamontov IN, et al. Diagnostics and tactics of treatment in patients with acute pancreatitis complicated by jaundice syndrome. Klin Khirurh / Ministerstvo okhorony zdorov'ia Ukraïny, Naukove tovarystvo khirurhiv Ukraïny. 2009;(7-8):122-123.
26. Kamilova U, Ermekbaeva A, Nuritdinov N, Khamraev A, Zakirova G. Occurrence of comorbid diseases in patients after COVID-19. J Med Life. 2023;16(3):447-450.
27. Dobrovanov O, Králinský K. Sonographic screening of congenital kidney malformations in Slovakia. Lek Obz. 2018;67(12):426-429.
28. Semianiv M, Sydorchuk L, Fedonyuk L, Nebesna Z, Kamyshnyi O, Sydorchuk A, et al. Metabolic and hormonal prognostic markers of essential arterial hypertension considering the genes polymorphism AGTR1 (rs5186) and VDR (rs2228570). Roman J Diabet Nutrit Metabol Dis. 2021;28(3):284-291.
29. Sakibaev KS, Nikityuk DB, Atabaev IN, Sattarov AE, Nuruev MK. Somatotypological features of the physique of ethnic Kyrgyz women of different ages. Asia Life Sci. 2020;Suppl 22(2):S185-S200.
30. Nayeemuddin M, Pherwani AD, Asquith JR. Imaging and management of complications of open surgical repair of abdominal aortic aneurysms. Clin Radiol. 2012;67(8):802-814.
31. Phuangrach N, Sarakarn P. Using Multilevel Negative Binomial Modeling to Detect Active Smoking in Colorectal Cancer Screening. Asian Pacific J Cancer Prevent. 2023;24(8):2823-2827.
32. Lisnyy I, Zakalska O, Dmytriiev D, Dmytriiev K, Dobrovanov O. Pre-emptive analgesia with nonsteroidal anti-inflammatory drugs randomized, double-blind placebo-controlled study. Lek Obz. 2021;70(5):195-202.
33. Swerdlow NJ, Wu WW, Schermerhorn ML. Open and Endovascular Management of Aortic Aneurysms. Circ Res. 2019;124(4):647-661.
34. Zyuzkov GN, Miroshnichenko LA, Polykova TY, Simanina EV. Regulation of functions of regeneration-competent cells of nerve tissue in ethanol-induced neurodegeneration by erk1/2 and p38 inhibitors. Azerb Pharm Pharmacother J. 2022;22(1):42-46.
35. Imashev M, Fursov A, Imasheva B, Fursov R, Kuspaev Y, Kovalenko T, et al. Gastroduodenal bleeding and perforation in diabetic patients with metabolic syndrome (The results of a 15-year observation of city residents with intensive urbanization). Iran J Publ Health. 2019;48(10):1786-1793.
36. Arapbaevna KZ, Ardak A, Abzhanovna AG, Bahitkerevna DA, Uringalievna BA, Izbasarovna KE, et al. Modern diagnostic approaches for early detection of antiphospholipid syndrome. Arch Venez Farmacol Terapeut. 2021;40(2):178-186.