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Original Research

Our Center's Experience With Open Surgical Repair Of Ruptured Infrarenal Abdominal Aortic Aneurysm

Runing title: Open Surgical Repair Of Ruptured Infrarenal AAA

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Abstract:

Objective: Infrarenal abdominal aortic aneurysms are life-threatening vascular disorders that carry the risk of rupture and death. Interventional endovascular management with stent replacement has become a viable alternative to open surgery because to its decreased mortality and morbidity rates. In this research. we want to report the outcomes of emergency abdominal aortic aneurysm repair with open surgery.

Material and Methods: We collected data on all patients who had open surgical repair for a ruptured infrarenal abdominal aorta between February 2010 and February 2022. The research involved 43 participants. Co-morbidities. revision. and death were examined statistically with the other variables and values.

Results: There were forty males and three females in the group. The average age of all patients was 68.8 years. and the average abdominal aorta size was 7.45 cm. The bulk of the patients had hypertension. with diabetes. Thirty percent underwent revision surgery. while twelve (24%) died. Thirty Dacron 'Y' grafts (16–8 mm) were employed. In 11 patients. straight-tube Dacron grafts were employed. In two patients. abdominal aorta was ligated at the infrarenal level. and an axillo-bi-iliac graft was bypassed.

Conclusion: The most prevalent blood transfusion products are erythrocytes. followed by fresh frozen plasma. More than half of the patients had hypertension on antihypertensive drugs and ASA. This was strongly linked to mortality. There is a strong correlation between revision. mortality. and blood transfusion. Open surgical repair is still the choice of treatment. when endovascular interventional management is not possible. with a high mortality rate and blood transfusion.

Keywords: Abdominal aortic aneurysm rupture. open surgical repair. enovascular repair. Dacron graft.

Introductıon:

Abdominal aortic aneurysm (AAA) is a serious vascular disease affecting the portion of the aorta from the level of the diaphragm to the bifurcation that. if ruptured. may be fatal in 65% of patients

(1). The abdominal aorta is deemed aneurysmal if its diameter exceeds 1.5 times the predicted normal diameter. or if it is bigger than 30 mm. with a frequency of 6.1% in males and 1.8% in women (2.3). AAAs are often asymptomatic and identified incidentally; however. if they exhibit symptoms or have a diameter more than 55mm or a fusiform shape. they should be treated surgically or interventionally (4). The global prevalence rate of developing AAA is around 6.0% for males and 1.6% for women (5). Approximately 80% of AAA ruptures occur retroperitoneally on the posterolateral side and 20% occur anteriorly (6).

A physical examination of the abdomen may reveal a pulsating abdominal mass. Abdominal ultrasonography (USG). computed tomography angiography (CTA). or magnetic resonance angiography (MRA) may offer a good understanding of the location. diameter. and morphology of a mass that may be AAA. as well as its localization (7).

The care of non-ruptured AAA varies from center to center. however. in the past two decades. interventional endovascular management with stent replacement (EVAR) has become an option to open surgical repair owing to its safety and lower morbidity and mortality when compared to open surgery (8.9). On the other hand. the matter remains contentious. Numerous studies have been undertaken on the efficacy of EVAR in patients with a high surgical risk. but none have conclusively shown its long-term efficacy and durability (9).

In hospitals located in the periphery. the ability to execute EVAR is hindered by a number of obstacles. such as the time required to get a suitable graft from the closest center and the lack of a hybrid operating room. in addition to the lack of skilled surgeons who can perform both forms of repair.

In elective cases (non-ruptured AAA). our institution can execute EVAR. even though the nearest center that can supply us with the stent is four hours distant; but. in urgent cases. we must perform an open surgical repair immediately.

To disseminate knowledge that may be of use to a wide audience. we are seeking to publish our results from this study on urgent cases of ruptured AAA and how we address them.

Material and Methods:

From February 2010 through February 2022. we collected information on all patients with ruptured abdominal aorta who had an open surgical repair. The research involved 43 patients.

Patients who were transferred to our hospital from other facilities with no data on file were excluded from this research. Patients diagnosed with ruptured abdominal aortic aneurysms who died before surgery were also excluded.

Co-morbidities such as hypertension. diabetes. coronary artery disease. and chronic obstructive pulmonary disease. as well as the risk factors for developing AAA. were researched and assessed.

In our facility. all patients were treated as emergent cases and observed by the surgical team. Revision and mortality have been statistically examined with the other variables and values. Preoperatively and postoperatively. HB. Htc. PLT. WBC. creatinine. calcium. AST. and ALT data were collected and analyzed.

The preoperative medications. particularly those that might alter our findings. such as ASA. clopidogrel. warfarin sodium. and antihypertensive drugs were also analyzed.

The kind and volume of intraoperative and postoperative blood transfusions were collected and examined. Erythrocytes. fresh frozen plasma. platelets. and whole blood are the most often transfused blood products at our clinic. Blood transfusion products and their transfusion quantities were associated with the other parameters investigated.

Surgical Procedure:

a) General anesthesia is administered in a supine posture with endotracheal intubation. After painting and toiling. midline laparotomy is performed from about 2 cm below the xiphoid bone to the upper level of the pubic symphysis. The abdominal wall has been gradually opened.

The peritoneum is exposed. In the instance of an anteriorly ruptured AAA. massive amounts of blood loss may occur. however in the majority of retroperitoneal rupture cases. the amount of blood loss is minimal. Wet sterile compresses were used to draw the left transverse colon upward. while the small intestine was moved to the right side.

In situations of self-limited retroperitoneal hemorrhage. the abdominal aorta was gently dissected and released up to the renal arteries and downward to the distal common iliac arteries. An anticoagulant (heparin) dosage of 1 mg/kg was administered to keep the activated clotting time (ACT) between 250 and 350 seconds. Cross-clamping was performed on the proximal abdominal aorta. just below the renal arteries. and on both common iliac arteries.

Using 4.0 polypropylene sutures. the proximal section of the 'Y' graft is anastomosed to the healthy distal segment of the infrarenal abdominal aorta. and the two graft legs are end-to-end anastomosed to the two iliac arteries.

b) In the case of a ruptured AAA with active bleeding. we insert an Intra aortic balloon through the common femoral artery up to the level of the renal arteries. If we couldn't find a good place to cross-clamp. the assistant doctor sometimes had to use a compress to press on the proximal abdominal aorta. In the same way. the graft interposition is done.

When there is a healthy backflow from the inferior mesenteric artery. we choose to re-implant it into the graft. When lumbar arteries are found after the mural thrombus has been removed. they are usually sewn. Then. the sac of the aneurysm is wrapped around the graft.

Results:

There are 43 patients enrolled in this trial. There were forty male patients (93%) and three female patients (7%). (Figure 1)a. The average age of all patients was 68.8 years. with men averaging 68.5 years and females 86 years. The average diameter of the abdominal aorta at the moment of rupture was determined to be 7.45 cm (minimal 4.0 – maximal 12.0 cm).

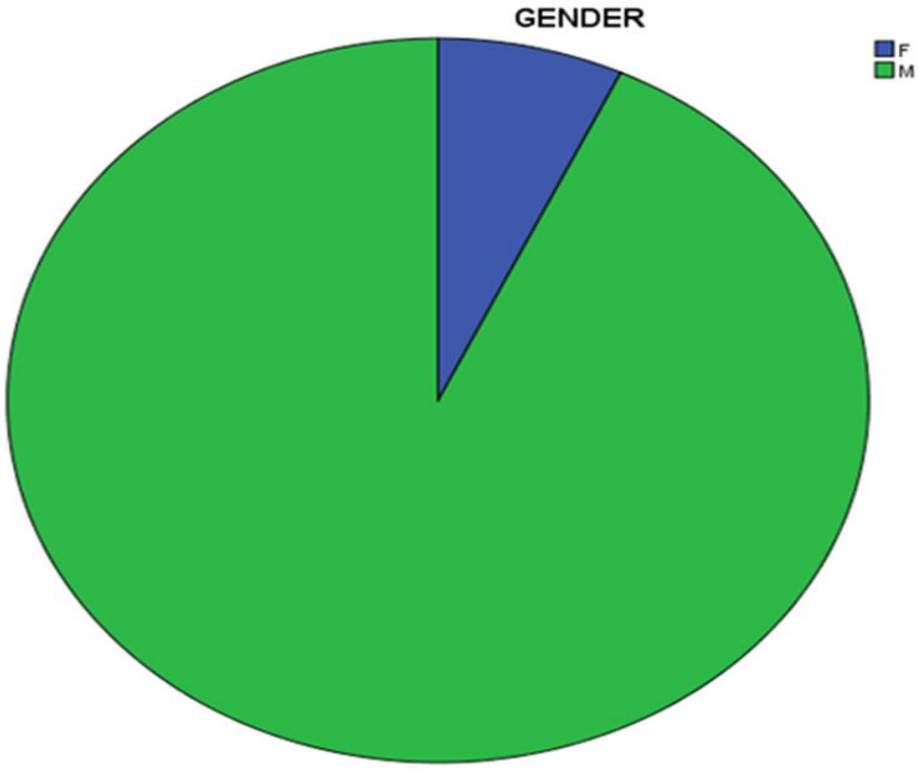

Figure 1: Pie chart of the gender distribution.

The patient's laboratory levels were also evaluated and analyzed. Preoperative hemoglobin (Hg). hematocrit (Htc). white blood cells (WBC). platelets (PLT). creatinine. calcium. alanine aminotransferase (ALT). and aspartate aminotransferase (AST) levels were (10.24. 31.72. 13.26. 187.35. 1.34. 8.07. 24.28. 31.42). respectively (Table 1).

The data obtained on the kinds and volumes of blood transfusions intra and postoperatively revealed that the average erythrocyte blood transfusion was 7.65 units. fresh frozen plasma was 14.14 units. platelets were 1.14 units. and total blood transfusion was 0.81 units.

The survivors were followed for an average of 14.16 months (0–144 months) (Table 1).

Table 1: Characteristics and descriptive data of the patients.

	Minimum	Maximum	Mean	Std. Deviation
Mean Age (years)	55.0	95.0	68.814	8.6665
Mean male age (years)			67.5	
Female mean age (years)			86.0	
Abdominal aortic diameter (cm)	4.0	12.0	7.45	1.886
Hg (gr/dL)	4.6	14.0	10.244	2.2821
Htc (%)	14.6	44.0	31.714	7.1815
WBC (K/uL)	6.0	30.0	13.260	4.6246
PLT (K/uL)	34	414	187.35	82.734
Creatinine (mg/dL)	.52	2.42	1.3367	.53032
Calcium (mg/dL)	5.20	9.60	8.0728	.85269
ALT (IU/L)	4	462	24.28	68.692
AST (IU/L)	6	365	31.42	52.943
Erythrocyte blood transfusion (unit)	.0	32.0	7.651	7.2173
Fresh frozen plazma transfion(unit)	.0	16.0	4.140	4.0917
Platelets blood tansfusion (unit)	.0	23.0	1.140	3.5763
Fresh blood transfusion (unit)	.0	8.0	.814	1.8029
Follow up period (month)	.0	144.0	14.163	30.9869

Hg: Hemoglobin. Htc: Hematocrit. WBC: White blood cell. PLT: Platelates. AST: Aspartate aminotransferase. ALT: Alanine aminotransferase

According to the morbidity of the patients and the medications taken preoperatively. the majority of them had hypertension (n=24. 55.8%). followed by diabetes (n=9. 21%). coronary artery disease (n=8. 18.6%). chronic obstructive pulmonary disease (n=6. 14%). and chronic renal failure (n=4. 9.3%). Antihypertensive medications (n=25. 50%). and acetylsalicylic acid (ASA) (n=25. 50%) were the most often found pharmaceuticals. followed by clopidogrel (n=4. 8%). and warfarin sodium (n=3. 6%). The revision was performed on 12 patients (24%). whereas the mortality rate was 30% (n=15 patients) (Table 2).

Table 2: The descriptive data of the co-morbidities. drugs on use. revision and mortality.

	Frequency	Percent%
Hypertension (HTN)	24	55.8
Diabetes mellitus (DM)	9	21
Coronary artery disease (CAD)	8	18.6
Chronic renal failure (CRF)	4	9.3
Chronic obstructive pulmonary disease (COPD)	6	14.0
Acetylsalicylic acid (ASA)	25	50.0
Clopidogrel	4	8.0
Warfarin sodium	3	6.0
Anti hypertansive	25	50.0
Revision	12	24.0
Mortality	15	30.0

All patients were promptly operated on after being diagnosed with ruptured AAA. The patients were sent to surgery. where the ruptured AAA was repaired with Dacron grafts. Table 3 illustrates the anastomosis locations and the kind of Dacron grafts employed. Thirty 'Y' Dacron grafts (16-8 mm) were used. One (2.3%) of them anastomosed as aorto-Rt-iliac and aorto-Lt-femoral and the other 29 'Y' grafts (67.4%) were anastomosed as aorto-bi-iliac (Figure 2).

Figure 2: Aorto-bi-iliac 'Y' graft bypass with inferior mesenteric artery re-implantation.

There were eleven (25.5%) straight tube graft (16mm) insertions and two (4.8%) instances of infra-renal aortic ligation with Rt. axillo-bi-femoral Polytetrafluoroethylene (PTFE) (8mm) graft bypass (Table 3).

Table 3: Descriptive data on the surgical technique and used grafts.

Operation Type		**Frequency**	**Percent%**
Y-Graft interpositioning	**Aorto-bil-iliac**	29	67.4%
Y-Graft interpositioning	**Aorto-Rt.iliac + Aorto-Lt.femoral**	1	2.3%
Straight tube graft interpositioning		11	25.5%
Infra-renal Abdominal Aorta ligation and axillo-bifemoral graft bypass		2	4.8%

We identified a correlation between Hg. Htc. and calcium when we reviewed the patient data. but creatinine exhibited a correlation with PLT. In contrast. PLT was correlated with a mortality rate (Table 4).

Table 4: The relationship between blood test findings. revision. and mortality rate.

		WBC	**Hg**	**Htc**	**PLT**	**Creatin.**	**Calcium**	**ALT**	**AST**	**Revision**	**EX**
WBC	**p**		.568	.477	.383	.650	.277	.376	.514	.509	.544
Hg	**p**	.568		.000	.031	.226	.002	.118	.124	.945	.165
Htc	**p**	.477	.000		.023	.340	.009	.165	.169	.910	.098
PLT	**p**	.383	.031	.023		.006	.236	.136	.112	.678	.003
Creatin.	**p**	.650	.226	.340	.006		.254	.413	.532	.729	.280
Calcium	**p**	.277	.002	.009	.236	.254		.258	.274	.673	.799
ALT	**p**	.376	.118	.165	.136	.413	.258		.000	.522	.168
AST	**p**	.514	.124	.169	.112	.532	.274	.000		.429	.187
Revision	**p**	.509	.945	.910	.678	.729	.673	.522	.429		.572
EX	**p**	.544	.165	.098	.003	.280	.799	.168	.187	.572	

Hg: Hemoglobin. Htc: Hematocrit. WBC: White blood cell. PLT: Platelates. AST: Aspartate aminotransferase. ALT: Alanine aminotransferase

When we compared blood transfusion types with age. revision. and mortality. we discovered a significant correlation between revision and mortality with erythrocytes and fresh frozen plasma transfusion. in addition to the correlation between all kinds of blood products (Table 5).

Table 5: The relationship between transfused blood products. revision. and mortality.

		Age	Blood Eryth.	Blood FFP	Blood PLT	Whole Blood	Revesion	EX
Age	**P**		.657	.915	.415	.187	.962	.738
Blood Eryth.	**P**	.657		.000	.001	.001	.144	.001
Blood FFP	**P**	.915	.000		.000	.000	.091	.005
Blood PLT	**P**	.415	.001	.000		.000	.976	.091
Whole Blood	**P**	.187	.001	.000	.000		.122	.120
Revesion	**P**	.962	.144	.091	.976	.122		.572
EX	**P**	.738	.001	.005	.091	.120	.572	

Our most recent correlation was between the use of preoperative medications with revision and mortality. We observed that ASA has a significant relationship with age and mortality rate. Mortality also has a strong relationship with antihypertensive medicines (Table 6).

Table 6: The relationship between drug use, age, revision, and mortality.

		Age	Anti-HTN	ASA	Clopidogrel	Warfarin Na	Revision	EX
Age	**P**		,091	,047	,181	,809	,962	,738
Anti-HTN	**P**	,091		,000	,485	,134	,181	,002
ASA	**P**	,047	,000		,078	,379	,988	,002
Clopidogrl	**P**	,181	,485	,078		,576	,895	,672
Warfarin Na	**P**	,809	,134	,379	,576		,275	,955
Revision	**P**	,962	,181	,988	,895	,275		,572
EX	**P**	,738	,002	,002	,672	,955	,572	

Statistical Analysis: For analysis. the IBM SPSS Statistics 25 Windows Multilingual Assembly Editions application was used. Categorical variables are presented as numbers and percentages. whereas continuous variables are represented as mean standard deviation. Using Chi-square analysis. the differences between the categorical variables were examined. Moreover. Pearson Correlation analyses were performed on the correlations between continuous variables. A two-tailed P-value of 0.05 or less signified statistical significance.

Dıscussıon:

Untreated abdominal aortic aneurysms present a significant risk of rupture and a high mortality rate. When the mechanical stress of the entire aortic wall exceeds the tensile strength. according to the Low of Laplace. the aorta may rupture (10).

Numerous factors influence the development of AAA. with hereditary risk factors and smoking playing a significant role. Additionally. male gender and high diastolic blood pressure were identified as risk variables (11.12).

In a 2016 research. 282 individuals with ruptured AAA were included. The average age of all patients at the time of rupture was 73.6 years. with males being 72.2 and women being 80.7 years old. In terms of gender. male patients made up 83.1% of all patients. while females made up 16.9%. (13). The outcomes of our research were younger than those of this study. and gender disturbance was greater with men and lower with females. The study's tiny population might explain the results. Another research found that the average age of patients with ruptured AAA was 739 years old. with males accounting for 76% of the patients. (14).

In general. the majority of patients in our research were male and older than in the other studies; moreover. the mean age of our male patients was younger than the other studies. while female patients were equivalent. This might be connected to our population's natural condition of eating and minimal daily activity.

We observed that the diameter of the abdominal aorta at the moment of rupture was 7.75 cm. with a range of 4.0 to 12.0 cm. The mean abdominal aortic diameter at the time of rupture in prior research was 8.30 cm (15). 7.6 cm (13). and 6.6 cm (16). therefore our result was similar to earlier studies.

Blood tests performed before to surgery revealed a mean Hg concentration of 10.24 (minimum 4.60. maximum 14.0) gr/dl. This significant difference between the minimum and maximum values was related to the clinical presentation of the patients. with some having substantial blood loss and others having self-limited blood loss. The average creatinine level was higher than usual. although PLT. AST. ALT. and calcium were all within the normal range.

According to the blood transfusion intra and postoperatively. erythrocytes were the most transfused blood product with a mean transfusion rate of 7.65 units. while fresh frozen plasma and whole blood were the second and third most transfused blood products. respectively.

The average time of follow-up for our patients was around 14 months. Many of our patients are from nearby villages with poor socioeconomic status. which they are unable to regulate after discharge.

In terms of co-morbidity; hypertension was present in around 55.7 percent of patients. This is comparable to a 2016 research which found that HTN was present in 52.7% of a total of 585 patients whereas DM was present in 13.7%. CAD was present in 50.9%. and COPD was present in 27.1% (13). Also. another research revealed that the prevalence of hypertension. diabetes. coronary artery disease. and chronic obstructive pulmonary disease (COPD) among patients with ruptured AAA was 66.2%. 22.3%. 70.7%. and 57.6%. respectively (16). Diabetes mellitus. coronary artery disease. and chronic obstructive pulmonary disease have been seen at greater rates than in our research. CRF was detected in 4 (9.3%) individuals; in a recent research conducted in 2022. CRF prevalence was comparable to ours but somewhat higher at 8.2%. (17).

The data on drugs taken prior to procedures was collected and analyzed in the same table (Table 3). with almost half of the patients on ASA and antihypertensive medications.

Revision was performed in 12 patients (24%) owing to postoperative excessive bloody drainage or examination of the viability of the visseral organs. Ten of the early-revision procedures were for bleeding. which was usually from the site of proximal anastomisi. and two instances were for checking the bowls variability. which were found to be ischemic but not necrotic during the surgery. Re-interventions were often conducted during the first few hours after surgery or on the second or third day.

In a 2022 research (18). re-intervention after open surgical repiar of non-ruptured big AAA was found at a rate of 16%. while it was about 13.9% in ruptured AAA in another study (19) in the first 5 years. When compared to previous studies. our revision rate was considerable. but it was confined to revisions in the same admission. This high incidence might be attributed to late diagnosis. which is often performed at a peripheral hospital prior to transfer to our hospital. as well as the

patients' serious co-morbidities. Those reasons seem to be the same for the high mortality rate of about 30%. The mortality rate for general urgent open surgical repair of ruptured AAA is significant. In one research. the mortality rate after endovascular and open surgical repair of similar instances was 44.2% in open surgery and 24.2% in endovascular operations (20).

The causes of death in our research varied; we had 5 patients die on the table owing to hypotension from extensive bleeding from the ruptured aorta. and one patient had acute heart failure that resulted in a cardiovascular arrest after the end of the procedure. The remaining ten patients died from post-operative bleeding and disseminated intravascular coagulation. as well as complications from severe COPD. ACS. and CRF. On the fifth day of the procedure. one of our patients died from ischemic bowls illness. After the initial look in the first operation. general surgeons conducted bowel resection on the second day of the ruptured abdominal aortic repair. Unfortunately. the patient died.

The majority of surgeries (n=29. 67.4%) were performed using 'Y'-shaped Dacron grafts. The typical graft-iliac anastomosis was performed on the common iliac artery at its bifurcation site. On the other hand. aorto-Rt.iliac. and aorto-Lt.femoral anastomosis was performed in one patient. In this instance. the patient had an aneurysm of the left iliac artery. which was ligated and plicated down to the bifurcation.

The straight tube Dacron grafts were used in 11 patients. Two patients were treated with infrarenal abdominal aortic ligation and axillo-bi-femoral graft bypass. One of them had a prior aorto-bi-iliac graft bypass that got infected. so the old graft was removed. debridement was done. and since there was no healthy portion of the aorta for graft bypass. The other patient had previous abdominal surgery and extensive adhesions. so it was impossible to perform an aortoiliac graft bypass.

There was a significant correlation between Hg. Htc. and calcium in the preoperative blood test readings. Similar correlational significance was seen between PLT and Hg. Htc. creatinine. and mortality. In general. a significant correlation was seen between mortality and platelets.

The use of erythrocytes and fresh frozen plasma blood transfusions during and after surgery was associated with a statistically significant increase in mortality. Patients who required more erythrocytes and fresh frozen plasma died at a higher rate than those who did not. This discovery might be attributed to the ongoing bleeding that required so many blood transfusions. Research done in 2010 looked at the efficacy of transfusing patients with a ruptured abdominal aorta with fresh frozen plasma and the risk of mortality. According to the authors. early plasma transfusion may have other advantages. one of which is a reduction in mortality (21). Another study published in 2016 revealed equivalent results to ours. indicating that FFP and PLT transfusions may be associated with an increased risk of postoperative morbidity and mortality (22).

Patients with a history of taking ASA and antihypertensive medications had a higher mortality risk. As seen above. more than half of the patients are using antihypertensive medications. and ASA. In reality. several studies have demonstrated a relationship between hypertension and the development of abdominal aortic aneurysms. particularly uncontrolled high diastolic hypertension (23.24).

We observed that the usage of ASA had a significant correlation with mortality. This result was similar to the results of a 2017 research that examined the effectiveness of low-dose ASA and rupture of abdominal aortic aneurysm in 2010 individuals (25).

Conclusıon:

A ruptured abdominal aortic aneurysm is one of the most life-threatening surgical emergency that requires prompt diagnosis and management. When feasible. EVAR is the most often done endovascular repair. When it is not feasible to do EVAR owing to the time required for preparation and transporting the stent to a distant location. or due to the high cost of the patient's condition. open surgical repair remains the primary surgical

treatment option. Even if conducted under ideal settings. this is a complex operation with a substantial mortality and morbidity risk. In the research. we examined our experience in open surgical repair for this form of acute vascular disease over the last twelve years.

The majority of patients were male. and the average age at the time of rupture was 68.8 years. The majority of abdominal aortic aneurysms ruptured with a mean diameter of 7.45 cm. but a few ruptured with a diameter of less than 5cm. The most prevalent blood transfusion product is erythrocyte. followed by fresh frozen plasma. platelets. and whole blood. Prior to surgery. more than half of the patients were hypertensive and using antihypertensive drugs. which had a strong correlation with the intra- or post-operative mortality rate. A significant mortality rate is also connected with ASA usage. One-fourth of the opertade patients required revision. mostly due to hemorrhage. According to the pathological site and position of the abdominal aorta and iliac arteries. the ruptured abdominal aortic aneurysms were repaired by replacing 'Y'-shaped Dacron grafts or by utilizing straining tube grafts. Ligation and axillo-bi-iliac graft bypass surgery was conducted in two instances. demonstrating that it is achievable under certain circumstances.

Limitation of the study: Our research has a limited sample size. which may have an effect on the outcomes. but it does provide a decent notion and shed light on the topic. For definitive conclusions. more research with bigger populations are required. Due to the absence of EVAR procedures in such situations. we were unable to compare the two surgical methods.

Ethics Committee Approval: The research was authorized by the institution's ethical committee and performed according to the Helsinki Declaration's standards. The permission was taken from our center ethics committee.

Patients Inform Consent: Inform consent had been written and signed by the patients themselves or their relatives.

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