Iranian Heart Journal; 2024; 25 (3)

Original Article

Complications in Computed Tomography Angiography Following Thoracic Endovascular Aneurysm Repair and Endovascular Aortic Aneurysm Repair

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ABSTRACT

Background: This study aimed to investigate the frequency and types of complications observed in computed tomography angiography (CTA) following thoracic endovascular aortic repair (TEVAR) and endovascular aneurysm repair (EVAR).

Methods: This cross-sectional study included 96 patients who underwent TEVAR and EVAR for thoracic and abdominal aortic aneurysm treatment at the Rajaie Cardiovascular Medical and Research Center. Two experienced radiologists evaluated CTA results and recorded the types of complications following TEVAR and EVAR.

Results: The mean patient age was 17.82±56.56 years, with 86.46% male patients. Post-intervention complications occurred in 47.8% of cases, with the most common complications being endoleak (33.3%), occlusion (11.5%), pelvic ischemia (9.4%), hemothorax (3.1%), and hemopericardium (1%), respectively. Although complications were more frequent among women and elderly patients, no significant correlation was found between age, sex, and complication frequency.

Conclusions: Over one-third of our patients experienced complications following TEVAR and EVAR. Endoleak, occlusion, and ischemia were the most common complications. To ensure early detection of potential complications, performing at least 1 CTA within a month after the interventions is recommended. ***(Iranian Heart Journal 2024; 25(3): 51-57)***

KEYWORDS: Aneurysm, Computed tomography angiography, EVAR, TEVAR, Thoracic-abdominal aorta

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Received: November 4, 2023 **Accepted:** May 12, 2024

Several treatment options are available for disorders of the thoracic and abdominal aorta, such as aneurysms, aortic dissections, aortic intramural hematoma, penetrating aortic ulcer, traumatic aortic rupture (so-called "traumatic aortic disruption"), and others, including open surgery, thoracic endovascular aortic repair (TEVAR), and endovascular aneurysm repair (EVAR).[1-4] Open surgery was previously the standard treatment for descending thoracic aortic aneurysms. However, since its

introduction in 2005 by the United States Food and Drug Administration (FDA), TEVAR has quickly replaced open thoracic endovascular aortic surgery.[5-10]

Following TEVAR and EVAR, the prosthesis is placed via vascular access in a proper position at the site of thoracic or abdominal aortic injury to maintain the integrity of the aortic wall.[11] Over the last 2 decades, TEVAR and EVAR have become widely used on the strength of advancements in imaging knowledge and technology. Endovascular intervention techniques are safer treatment methods, particularly for elderly patients with cardiovascular, pulmonary, and renal disorders without anatomical and underlying problems.[12, 13] Compared with open surgery, endovascular procedures require shorter recovery periods, are less invasive, do not necessitate a thoracotomy or sternotomy, and are associated with less blood loss during treatment, fewer neurological complications, and lower mortality rates. The mortality rate in the first month following EVAR and open surgical interventions was 1.6% and 4.8%, respectively.[13] Nonetheless, complications such as endoleak, infection, dislocation, and stent migration can be associated with TEVAR and EVAR treatments.[11, 12] Therefore, early diagnosis, especially within the first month after treatment, helps prevent complication progression and ensures timely intervention.[14]

Diagnosis and treatment of complications after intervention require appropriate imaging methods such as ultrasonography, magnetic resonance angiography, and conventional angiography. Computed tomography angiography (CTA) is the gold-standard method used by most medical centers for diagnosing postprocedural complications and making appropriate treatment decisions.[12, 14, 15]

While TEVAR and EVAR are widely used, the diagnosis and treatment of their complications have not been extensively studied. This study aimed to determine the frequency and types of complications following TEVAR and EVAR using CTA.

METHODS

This cross-sectional study included 96 patients who underwent TEVAR and EVAR at a single center (the Rajaie Cardiovascular Medical and Research Center) in Tehran, Iran, from 2016 through 2021. Two experienced radiologists examined CTA data from patients' medical records in cardiovascular imaging, documenting complications following TEVAR and EVAR in a checklist.

Inclusion criteria were patients with TEVAR and EVAR who had at least 1 CTA after treatment. Exclusion criteria were contraindications to vascular intervention methods and surgical indications.

Data analysis was performed using SPSS version 26 and GraphPad Prism software. Descriptive data are reported as frequency tables, central indices, and dispersion measures. The χ^2 and *t* tests were used to compare the frequency of TEVAR and EVAR complications based on patient sex and age. Statistical significance was set at a *P* value of less than 0.05.

RESULTS

This study aimed to determine the types and frequencies of complications observed in CTA following TEVAR and EVAR. Ninety-six patients meeting the inclusion criteria were studied at a single center in Tehran, Iran. The mean patient age was 17.82±56.56 years, with the youngest patient being 16 years old and the oldest being 88 years old. Most patients were in the 60–69 and 70–79 age groups. Eighty-three patients (86.46%) were male, and 13 patients (13.54%) were female.

Of the 96 patients, 46 cases (47.8%) experienced complications after TEVAR and EVAR (Fig. 1).

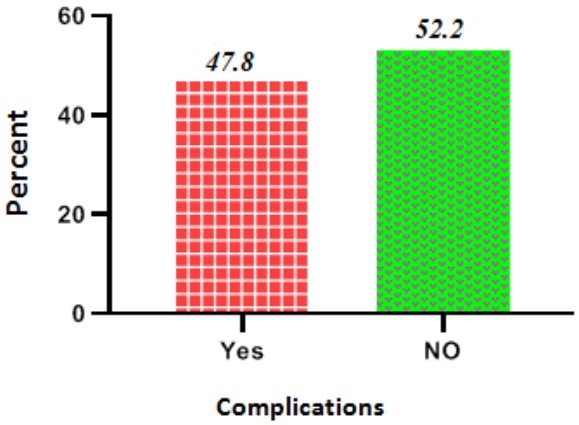
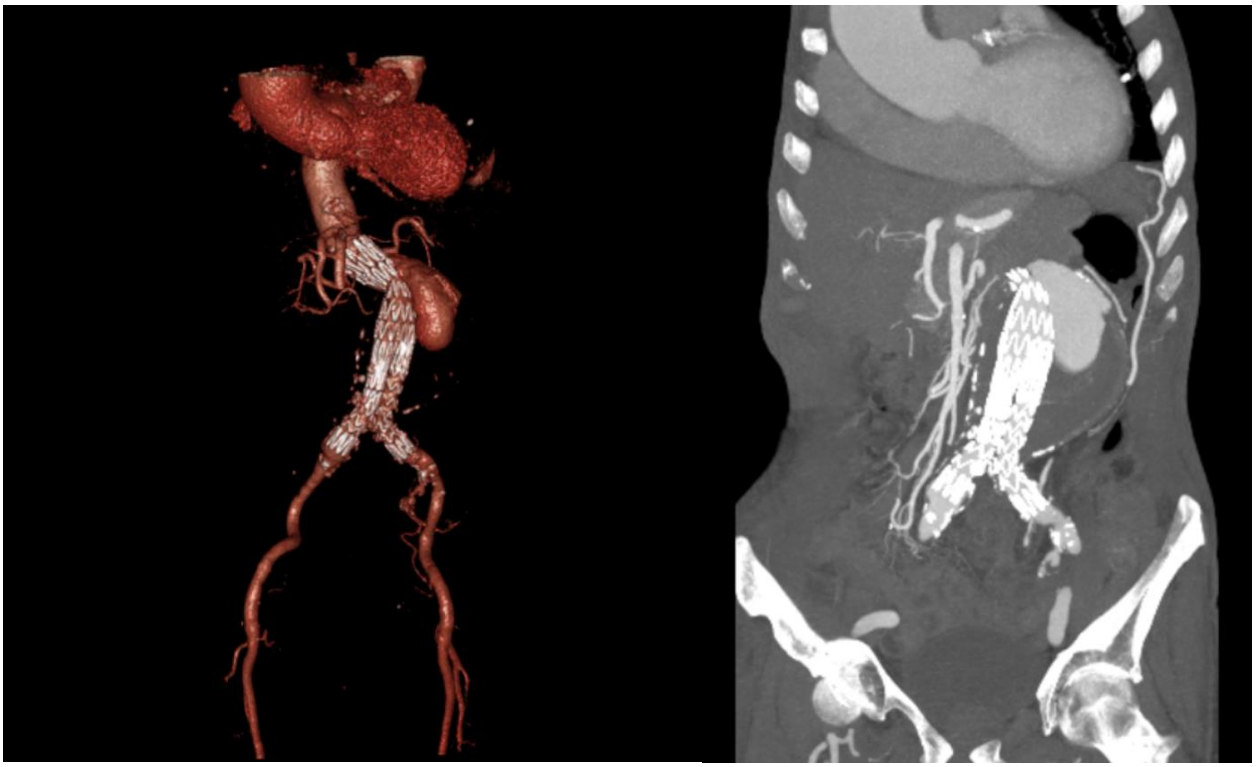


Figure 1: The image presents the frequencies of complications observed in computed tomography angiography following thoracic endovascular aortic repair and endovascular aneurysm repair.

The most common post-intervention complications were endoleak, occlusion, and pelvic ischemia, respectively (Table 1). No cases of hemomediastinum, hemoperitoneum, or retroperitoneal bleeding were observed. Of the 46 patients with complications, 36 experienced a single complication, while 10 had 2 simultaneous complications.

Table 1: The Frequency of the Complications of Thoracic Endovascular Aortic Repair and Endovascular Aneurysm Repair Observed in Computed Tomography Angiography

Complication	N	%
Endoleak	32	33.3
Occlusion	11	11.5
Pelvic ischemia	9	9.4
Hemothorax	3	3.1
Hemopericardium	1	1



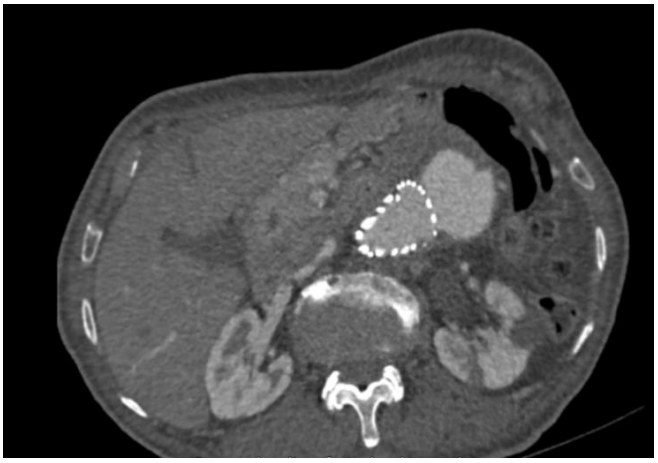


Figure 2: The image shows a notable Type IA endoleak in the proximal half of the aneurysm, with no vessels coming from or entering the aneurysmal sac, indicating the absence of a Type II endoleak.

Most endoleak cases following EVAR and TEVAR were Type II, Type I, and Type IB, respectively (Table 2).

The overall frequency of complications following EVAR and TEVAR was 45.7% and 61.5% (*P*=0.081) in men and women, respectively, while endoleak complications occurred at rates of 30.1% and 53.8% (*P*=0.117) among men and women, respectively.

Table 2: The Frequency of Endoleak Complications of Thoracic Endovascular Aortic Repair and Endovascular Aneurysm Repair Observed in Computed Tomography Angiography

Endoleak Type	N	%
I	7	21.9
II	12	37.5
I &II	2	6.3
IA	1	3.1
IB	6	18.8
IA & II	1	3.1
I & IB	1	3.1
B	1	3.1
II & IB	1	3.1
Total	32	100

The mean age of patients with and without complications following TEVAR and EVAR was 17.64±59.58 years and 17.72±53.90 years, respectively (*P*=0.120).

DISCUSSION

Based on CTA, 47.8% of patients with abdominal and thoracic aneurysms had complications following TEVAR and EVAR in this study. Additionally, endoleak (33.3%) was the most common complication observed in the CTA of patients with abdominal and thoracic aneurysms undergoing TEVAR and EVAR. These findings align with a study by Parmer et al,[15] which reported a 29% endoleak incidence following TEVAR in 105 patients in the United States.

According to the present study, all endoleak cases following EVAR and TEVAR were Type I or Type II, with about 10% having more than 1 endoleak type. Parmer et al[15] reported that 75% of endoleak cases were Type I or Type II, 20% were Type III, and 5% of patients had more than 1 type of endoleak. Nevertheless, no Type III endoleaks were observed in the present study. Since many types of endoleak can be successfully treated, close patient monitoring after surgery is essential.

In the present study, 9.4% of the patients experienced ischemia. In the United States, Maldonado et al[17] studied 331 patients who underwent EVAR for abdominal aortic aneurysm treatment, finding that 28 patients (9%) experienced ischemia, a result similar

to ours. However, we evaluated EVAR and TEVAR complications simultaneously, with a smaller sample size. Limb ischemia results from limb occlusion and can be successfully treated through intravascular interventions.[17]
In our study, 11.5% of complications involved occlusion. Carroccio et al[18] investigated the prediction of iliac occlusion following bicuspid aortic stent transplantation. Of 351 patients with abdominal aortic aneurysms and 702 grafts, 7.3% had occlusion during a 4-year follow-up period. This discrepancy in results might be due to differences in methodologies used across studies, such as open surgery vs EVAR.
A recent study identified male sex, aneurysm size, the length of the aorta treated with a stent graft, and the number of stents used as predictors of endoleak.[16] In this study, no significant differences were observed between men and women regarding endoleak incidence in patients with abdominal and thoracic aneurysms following TEVAR and EVAR.
No cases of stent migration were observed in the present study. Stent migration results from poor stent attachment to the aortic wall. On CTA, stent migration is best diagnosed by comparing the distance from the proximal stent margin to a fixed reference, such as the left subclavian artery. This distance is best evaluated in sagittal images.[15]
A study by Dreimann et al[19] involving 284 patients undergoing EVAR/TEVAR surgery in Germany reported only 2 cases of infection with positive blood cultures, indicating a relatively uncommon complication. No cases of infection following TEVAR were found in the present study.
Stent collapse is another complication of thoracic-abdominal aneurysm repair, which can be detected using CTA. Poor stent attachment or oversizing of the stent can cause this complication. On CTA, collapsed stents exhibit a thinning of the endoluminal diameter and lose lateral contact with the aorta. Stent graft collapse necessitates immediate intervention if the aortic lumen narrows significantly.[15]
A study by Murphy et al[20] examined the management of aortic endograft infection following endovascular repair of abdominal-thoracic aneurysms, reporting a 0.6% infection rate. Other studies have reported a 0.05% to 4% incidence of aortic endograft infection following EVAR and TEVAR for thoracic/abdominal aneurysms.[21, 22]

CONCLUSIONS

More than one-third of the patients in the present study experienced complications following TEVAR and EVAR for thoracic and abdominal aortic aneurysms. Endoleak, occlusion, and ischemia were the most common complications, respectively, after TEVAR and EVAR. Therefore, performing at least 1 CTA within a month after TEVAR and EVAR is essential for the early detection of potential complications.

Acknowledgments
This paper is based on a thesis for radiology assistant education, approved by the Vice-Chancellor of Iran University of Medical Sciences.

Funding
The authors received no financial support for the research, authorship, or publication of this article.
Our sincere appreciation goes to all those who have contributed to this research.

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