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Hellenic Society of Vascular and Endovascular Surgery

Hellenic Journal of Vascular and Endovascular Surgery

OBITUARY

to Professor Hans - Henning Eckstein (1955 - 2024)

HOT TOPICS

A contemporary series on the endovascular management of visceral aneurysms and pseudoaneurysm
Birmingham, UK and Egypt

Early outcomes of t-Branch off-the-shelf multibranched stent graft for Pararenal and Thoraco-Abdominal Aortic Aneurysms: A Prospective, single centre study
Ioannina, Greece

Preservation of internal iliac artery by using it as target vessel for distal anastomosis of bifurcated aortic grafts during surgical repair of aorto-iliac aneurysms
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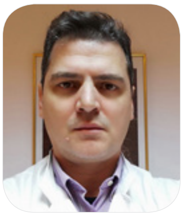

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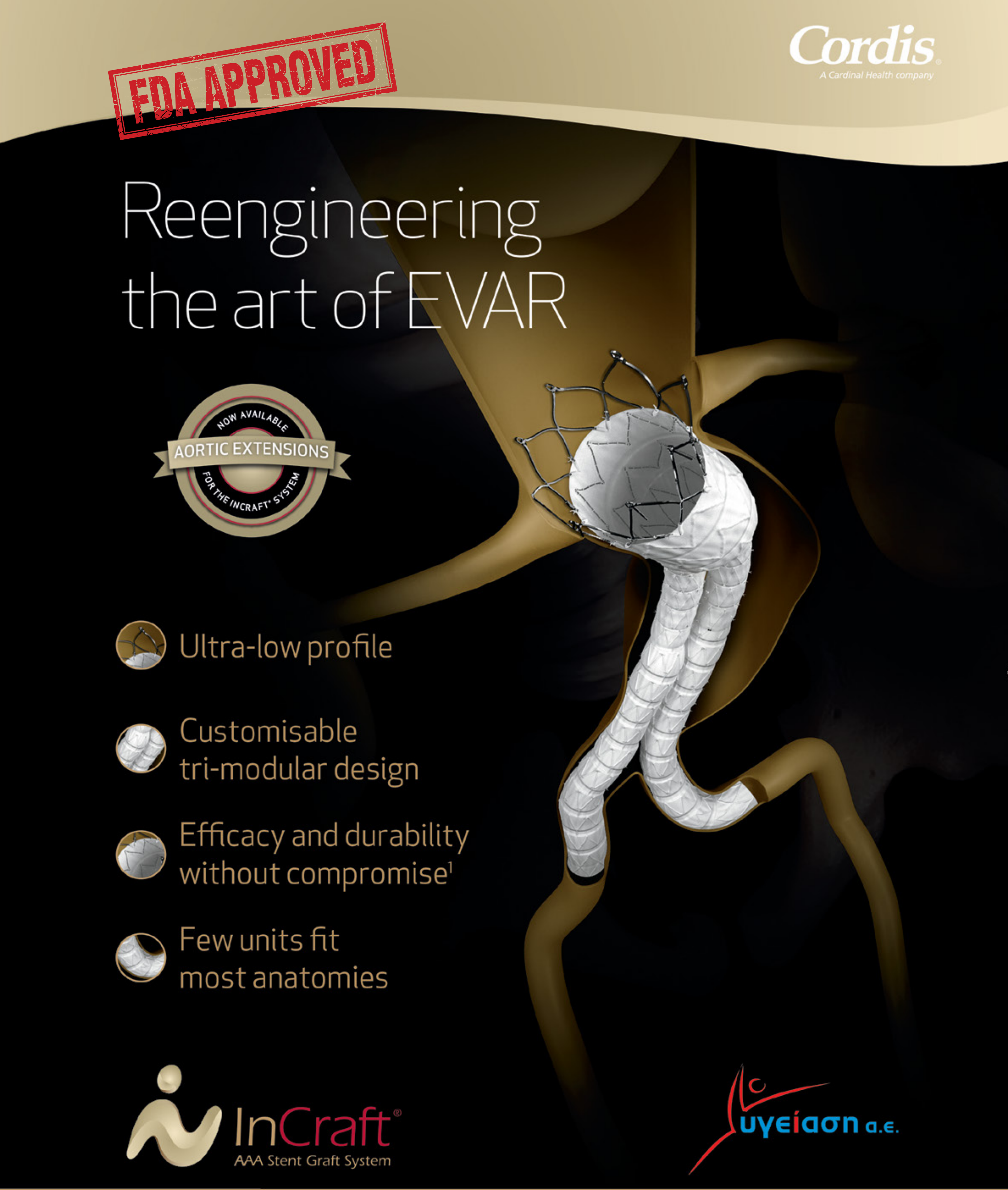

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Obituary to Professor Hans - Henning Eckstein (1955 - 2024)

Christos D. Liapis[1], George Geroulakos[2], Athanasios Giannoukas[3]

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Hans - Henning Eckstein, 19/09/1955 to 24/02/2024

On February 24th after a long and brave battle, Prof. Hans - Henning Eckstein passed away.

Prof. Eckstein was born in 1955. Completed his education (German, History and Medicine) at the University Ruprecht-Karls in Heidelberg in 1985 and received his Ph Degree in 1995. He was trained in General Surgery until 1993, following by Vascular Surgery training 1996-1999. He then served as a Medical Director for Vascular Surgery of the Klinikum Ludwigsburg 1999-2003. During this time, he received the "Forschungspreis der Deutschen Gesellschaft für Gefäßchirurgie" (1997) and "Alexis-Carrel-Preis der Deutschen Gesellschaft für Gefäßchirurgie" (1999) awards.

In 2004, he was elected Director of the Section of Vascular Surgery at the Klinik und Poliklinik für Vaskuläre und Endovaskuläre Chirurgie am Universitätsklinikum rechts der Isar der Technischen Universität München (TUM) after the retirement of Prof. Peter Maurer. In 2009, he was elected Professor of the newly established Chair of Vascular and Endovascular surgery at the TUM. Under his Directorship and his moto "Knowledge promotes healing" his department became one of the most prominent vascular centers in Germany with an international recognition, with renown faculty like Dr. A. Zimmermann, Dr. G. Biro, Dr. U. Werthern, Dr. T. Stadlbauer, Dr. F. Meisner, Dr. H. Wendorff and Dr. M. Kallmayer and areas of expertise including aortic pathology, carotid artery disease, PAOD, end stage renal disease, vein problems and angiology. In addition, he developed a very successful research program of vascular biology, the Munich Vascular Biobank and Biological Imaging with the collaboration of prominent scientists like Profs. L. Maegdefessel, J. Pelisek and V. Ntziachristos.

He has served as Editor of the "GEFÄSSCHIRURGIE" in 2006 and President of the Deutsche Gesellschaft für Gefäßchirurgie (2009-2010) where he was instrumental in establishing the SPACE 1 & 2 studies and the mandatory registration for carotid operations.

In 2011 he was elected President of the Section and Board of Vascular Surgery of the UEMS. True to his passion for training and education, he became one of the co-founders of Vascular International and promoted the use of models and simulators in vascular training.

In 2010, he established the Munich Vascular Conference (MAC) "where doctors meet science" as was his vision. This conference became a leading scientific meeting in Europe, providing an invaluable experience to the participants, especially the young doctors in training, giving them the opportu-

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nity to interact with the most prominent figures in the field of vascular diseases worldwide.

In April of 2017 he was awarded an Honorary Doctorate of the National and Kapodistrian University of Athens, Greece and at the same year of the University of Thessaly, Greece. In 2019, he became Visiting Professor at the Pittsburgh University, USA. Also, he had contributed in a fruitful collaboration between the annually organized Munich Vascular Conference (MAC) and the Leading Innovative Vascular Education (LIVE) Symposium by the Institute of Vascular Diseases, Greece holding joint sessions in both conferences with important participation of German and Greek vascular surgeons.

Prof. Eckstein was a prolific writer with more than 23.000 citations, an h-factor of 70 and numerous chapters in vascular textbooks.

He was fond of Greece, which he visited several times and a great friend for many of us who had the opportunity to collaborate with him, benefit from his wisdom, his free spirit, his immense knowledge of history, philosophy, politics and particularly music.

Overall, the best term to describe Prof. Hans-Henning Eckstein is a Renaissance Man: A polymath, a person whose expertise spans a significant number of different subject areas, a Homo Universalis.

He survived by his beloved wife Dr. Jutta Eckstein, his three children, his grandchildren. He would be greatly missed by his family, his friends and the world’s vascular community who lost a Crown Prince.

A contemporary series on the endovascular management of visceral aneurysms and pseudoaneurysm

Ahmed Elshiekh[1], **Amro Elboushi**[1,2], **Arunagiri Viruthagiri**[1], **Haren Wijesinghe**[1], **Jonathan Hopkins**[1], **Maciej Juszczak**[1], **Alok Tiwari**[1]

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Abstract:

Introduction: Visceral artery aneurysms (VAAs) and pseudoaneurysms are uncommon. Endovascular management is now the treatment of choice with either exclusion or occlusion. We report on our experience in a tertiary referral centre of elective and emergency VAAs and pseudoaneurysm treatment.

Patients and methods: A retrospective review of all VAAs and pseudoaneurysms cases treated using endovascular means over 8 years period. Follow up included clinic reviews as well as data on the system from admissions to other specialities including emergency department presentations.

Results: 53 visceral aneurysms in 50 patients were treated with endovascular techniques. 29 (58%) of the patients were males. The mean age was 62 years (range: 20-88). 26 (49%) were true aneurysm. 40% presented with rupture at the time of diagnosis. Technical success was achieved in 48 of the patients (96%). 78% of the cases had occlusion treatments coils or glue. The mean follow-up period was 3.3 years (range: 1 month to 10 years). The 30 days mortality was 8%. Two patients (4%) had clinical symptoms secondary to organ mal-perfusion. Five patients (10%) required subsequent re-intervention.

Conclusion: VAA and pseudo aneurysms can be treated successfully with endovascular means both in the elective and emergency settings. In our experience, the majority of patients are suitable for occlusion therapy without any risks of clinically significant organ ischemia.

Key words: Visceral aneurysm, Visceral pseudo aneurysm, Endovascular surgery, Mesenteric aneurysm

INTRODUCTION

Visceral artery aneurysms (VAAs) and pseudoaneurysms are uncommon with an incidence rate of 0.01% to 0.2%[1]. However, their detection rates are increasing due to the widespread advancement and availability of cross sectional imaging. The VAAs and pseudoaneurysms occur mainly in the splenic and hepatic vessels but are also recognised in renal, gastroepiploic, pancreaticoduodenal, gastroduodenal, celiac, superior mesenteric, or inferior mesenteric arteries. The vast majority of the cases are incidentally found and are essentially asymptomatic whilst few cases present with symptoms of rupture.

Pseudoaneurysms are treated irrespective of their size due to the high risk of rupture and bleeding while true aneurysms are treated once they reach the size threshold or if they become symptomatic[2, 3].

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Over the last decade the endovascular management of these pathologies has gained popularity given the reduced mortality, complications rate, and hospital stay in comparison to the open procedures[4]. The endovascular treatment techniques involves either exclusion or occlusion of the pathological segment which can be achieved by using stent grafts, coils, vascular plugs, occlusion devices or liquid embolics[5] when size exceeds 5cm visceral aneurysms are considered as "giant" (giant visceral artery aneurysms or GVAAs[4, 6, 7].

We report on our experience in a tertiary referral centre management of elective and emergency VAAs and pseudoaneurysms.

PATIENTS AND METHODS

A retrospective review of all VAAs and pseudoaneurysms cases presented to our unit from the year 2008 till 2015 were identified from hospital electronic records. Cases after 2015 were not included to allow a long follow up period and the subsequent covid pandemic. Both elective and emergency cases were included. Only cases treated endovascularly were included. Preoperative diagnosis was based on imaging mainly by computed tomography scans. There was no uniform protocol for post operative imaging as this was variable depending on the physician in charge.

Follow up included clinic reviews as well as data on the system from admissions to other specialities including emergency department presentations and scans done for other reasons.

The statistical analysis was performed in R environment (R version 4.0.3, The R Foundation for Statistical Computing, Vienna, Austria; https://www.r-project.org) using pre-specified data analysis plan. Data characteristics were assessed using dplyr package and data missingness was assessed using naniar package. Missing data were treated by pairwise deletion. Continuous variables were presented as median [interquartile range; IQR] unless stipulated otherwise; categorical data were presented as frequencies (%) with 95% confidence intervals (95%CI) if required. Student's t-test and Wilcoxon rank-sum test were used to compare continuous data. Pearson's chi-squared test and Fisher's exact test with continuity correction were used to analyse categorical data. Logistic regression was used to calculate the dichotomous data.

The project was approved by the hospital audit department. A formal ethics approval was not required as the project only included retrospective data collection.

RESULTS

53 visceral aneurysms were treated by endovascular techniques in 50 patients during the study period. 29 (58%) of the patients were males. The mean age was 62 years (range: 20-88). Three of the patients had connective tissue disorder, one with Marfan syndrome and two with Poly-Arteritis Nodosa (PAN). 26 (49%) of the identified cases were true aneurysm. 50% of the patients were asymptomatic, 10% symptomatic but not ruptured while 40% presented with rupture at the time of diagnosis.

61% of symptomatic cases presenting with rupture and bleeding were attributed to pseudoaneurysms. Among the true aneurysms presenting with rupture, three were hepatic with sizes measuring 37mm, 16mm, and 25mm, one splenic aneurysm measuring 33mm and one coeliac aneurysm measuring 24mm.

The mean sac size was 30.8 mm (range: 12-112). Common vessels affected with VAA and pseudoaneurysms were in the hepatic artery (70%), splenic (23%), coeliac, superior mesenteric and two cases in the gastroduodenal and transplant renal arteries (1.8% in each). The aetiology of these VAA/VAPA were variable including postoperative (28%), degenerative (28%), traumatic (20%), inflammatory causes (18%) as well as other causes (6%) including congenital causes, malignancy and post procedures like liver biopsy or Transjugular intrahepatic portosystemic shunt (TIPS).

Technical success was achieved in 48 of the patients (96%). The single case in which technical success was not achieved presented with bleeding post liver biopsy and was haemodynamically unstable at presentation. Unfortunately, this patient suffered a cardiac arrest before the attainment of endovascular access and successful sealing could be accomplished. 78% of the cases had occlusion treatments in the form of coils or glue. 22% had exclusion treatment with stent grafts with or without coils. The figure below (figure 1) shows pre operative CT scans and post operative angiography of treated aneurysms.

A significant proportion of cases requiring open surgical intervention were iatrogenic in nature, stemming from complications secondary to recent surgical procedures such as hepatic surgery. These cases often necessitate re-exploration in a surgical setting, by the initial operating team with help from the vascular surgeons.

The mean follow-up period was 3.3 years (range: 1 month to 10 years). The 30 days mortality was 8% as four patients died during this period all of which presented with acute postoperative or post intervention bleeding that has initially lead to the pseudoaneurysm or aneurysmal bleeding (3 post-abdominal surgery, one post liver biopsy). Technical success with control of bleeding was achieved in three of these four patients with failure to stop the bleeding in the fourth patient. One patient died of post-operative sepsis; another patient died secondary to cardiac arrhythmias. The cause of death was not recorded in the last patient.

Figure 1. showing hepatic artery aneurysm on 3D reconstructed CT (left image), pre-coiling angiography (middle image), and post coiling final angiogram (right image).

During the post operative 30 days period 7 patients (14%) had radiologic signs of organ ischaemia with no clinical consequences (6 in the spleen and one in the liver). Of those seven patients, 6 had occlusion therapy and one had an exclusion procedure. Two patients (4%) had clinical symptoms secondary to organ mal-perfusion as one patient developed an abscess that required radiologic drainage and the other patient suffered loss of the transplant kidney. These two patients had exclusion procedures.

The three cases of connective tissue diseases manifested as symptomatic emergency cases, with two cases presenting with rupture and the third case exhibiting a mycotic aneurysm who was deemed unsuitable for open surgery due to the prior occurrence of heart valve replacement and concurrent full anticoagulation at the time of presentation. Despite these complexities, all three cases achieved technical success, leading to subsequent discharge. Follow-up assessments revealed favourable outcomes with survival till the end of follow up in two cases. The third case died three years later due to unrelated cause.

Five patients (10%) required subsequent re-intervention which were all endovascular reinterventions (coil/ glue/ restent). During the subsequent follow up period 8 patients died. The causes of death were identified in three of these cases and were unrelated to the intervention (pneumonia in two cases and decompensated liver disease in one case). The cause of death was not available in the rest of these cases.

There was an association between the acute presentation with rupture and post-operative mortality (20%, P< 0.013). This is highlighted in the Kaplan Mayer curve for survival shown in figure 2.

There was also an association between aneurysm size and developing end organ ischemia (Odds Ratio: 1.10, 95%C.I.: 1.03-1.17, P <0.004918).

DISCUSSION

The risk of rupture of visceral pseudoaneurysms is up to 76.3 % irrespective of the size whilst the risks of VAA rupture is less than that of the pseudoaneurysms but remains high at about 25-40% once it is greater than 25mm in diameter. Hepatic artery aneurysms are more susceptible to rupture (up to 80%) followed by pancreaticoduodenal artery aneurysms with rupture rates up to 75%[8, 9]. Thus, the treatment of these cases in the asymptomatic phase before rupture is recommended by the European and American guidelines[2, 10]. The European guidelines advice repair in asymptomatic true aneurysms if

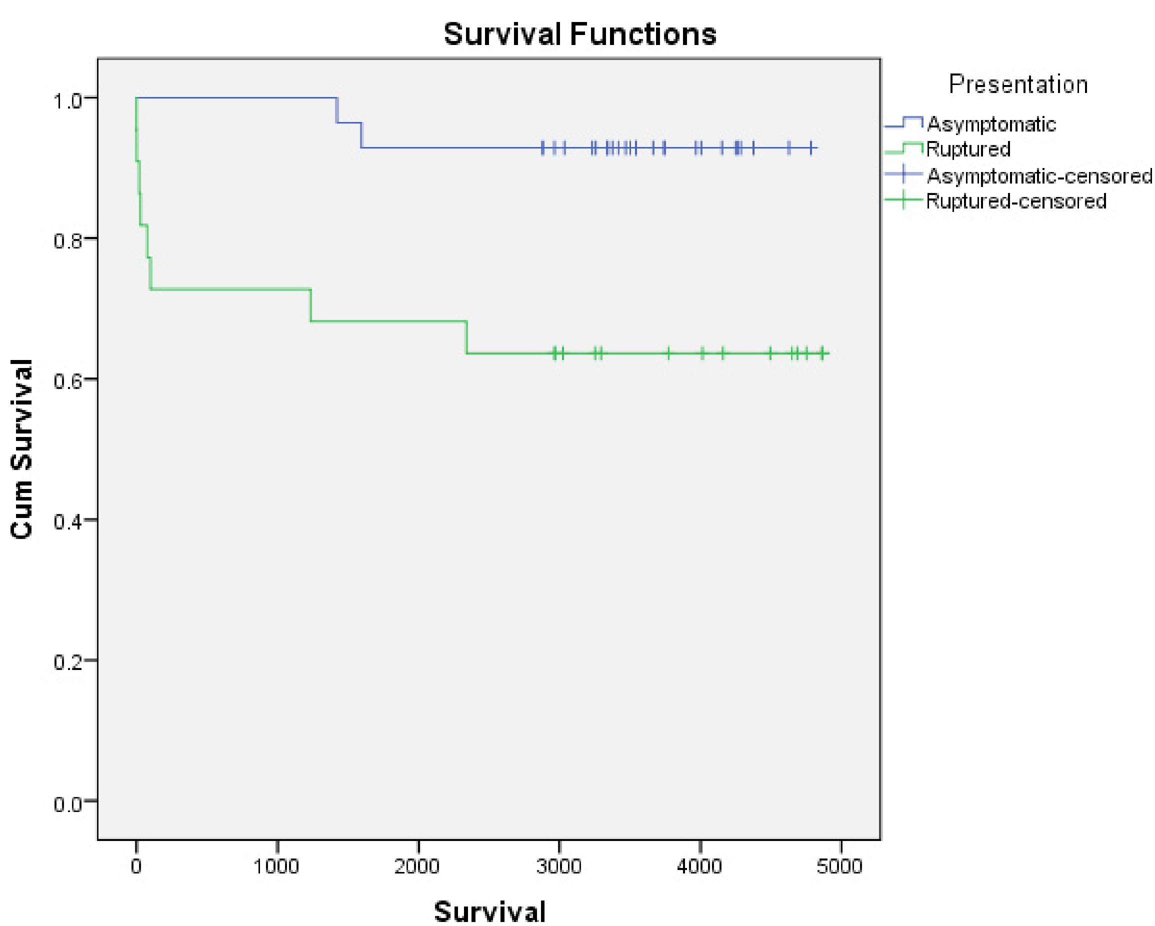

Figure 2. showing Kaplan Mayer survival curve

the size is above 25mm and consideration of intervention at any size for pancreaticoduodenal and gastroduodenal arcades as well as of the intra-parenchymatous hepatic arteries. The American guidelines recommend a size threshold of 20 mm for the hepatic and coeliac true arteries and a 30 mm threshold for the splenic artery true aneurysms. Pseudoaneurysm should be treated at any size due to the high risk of rupture.

In our series, we had 53 aneurysms in 50 patients. Previously published data have reported between 41 to 45 treated cases per series with follow up to ten years. We had a mean follow up of three years which was similar to the mean follow up in other published series[6, 9]. 40% of cases in our series presented with rupture which was similar to that of 46% reported in literature[6]. In our series VAA and pseudoaneurysms were most commonly found in the hepatic, splenic arteries with minimal numbers in the renal arteries. In contrast other studies found highest incidence in the splenic artery followed by the coeliac trunk, the renal and hepatic arteries[9]. A systematic review found the highest number of reported cases to be in the renal artery followed by the splenic then the hepatic arteries[11].

In our series, all the post interventions deaths occurred in patients who presented with symptoms of rupture with no mortality in patients who were asymptomatic. We also found that presentation with rupture carries a statistically significant risk of post intervention mortality (20%, P< 0.013). This is similar to the reported high mortality rates in the cases presenting with ruptures in the literature which is around 25%[12] but when they present as a rupture, a high mortality is associated. Material and Methods: We review our experience of 18 cases between 1988 and 2006. Results: 9 males and 9 females with a mean age of 66,5 years are analyzed. Aneurysms were located in splenic artery[9, 8]. Other cases series reported no mortality in asymptomatic cases treated with endovascular modalities which was the same as our experience[9]. This may be explained by the fact that these patients are often unstable with deranged physiology as a result of the initial shock cause by the acute bleeding. We also found that increase in sac size is associated with development of end organ ischemia with intervention.

Technical success in our series was high at 96% which was similar to that reported in literature[6]. The feasibility of the use of stent grafts for excluding visceral aneurysms/pseudoaneurysms is dependent on the arterial anatomy, location of , sac size and the ability to navigate the stent graft into the target vessel. It is also more technically demanding than occlusion therapy. Our data has demonstrated that occlusion therapy is safe with no risks of clinically significant organ ischaemia happening as a consequence of the occlusion. Interestingly the two cases in our series that had clinical consequences of organ malperfusion were treated with exclusion rather than occlusion therapy. An association was found between the aneurysm size and the risk of developing end organ ischemia (odd ratio 1.10 C.I. 1.03-1.17 P <0.004918). An association between the aneurysm size and the risk of developing end organ ischaemia has not been demonstrated in other series although an association with preoperative splenomegaly as well as the more distal aneurysm site has been suggested[13].

We had an acceptable reintervention rate of ten percent in our endovascular series. In a large systematic review, the reintervention rate following endovascular repair of the splenic artery aneurysms was 7% and was much higher at 40% for the hepatic artery[11]. The systematic review also showed much lower reintervention rates after open repair as expected.

Some of the limitations of this study include that fact that is a retrospective review and the lack of uniformity of the post-operative imaging or follow up protocols. Furthermore, our study did not delve into a detailed analysis of the open cases or the criteria guiding the decision-making process regarding the choice between open and endovascular treatment approaches. However, the data presented demonstrates the safety and efficacy of occlusion techniques for endovascular management of VAAs and pseudoaneurysms in the majority of patients. We have also not looked at patients undergoing open interventions.

CONCLUSION

Visceral artery aneurysms and pseudo aneurysms can be treated successfully with endovascular means both in the elective and emergency settings. In our experience, the majority of patients are suitable for occlusion therapy without any risks of clinically significant organ ischemia.

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Early outcomes of t-Branch off-the-shelf multibranched stent graft for Pararenal and Thoraco-Abdominal Aortic Aneurysms: A Prospective, single centre study

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Abstract:

Objective: To investigate outcomes of the off-the shelf t-Branch device (Cook Medical, Bloomington, Ind) for the treatment of thoraco-abdominal and pararenal aortic aneurysms

Methods: All the data from the patients who underwent thoracoabdominal or pararenal aortic aneurysm repair were retrospectively collected in an electronic database and analyzed. Primary outcome was the technical success of the procedure while secondary outcomes were the mortality rate, all cause morbidity, primary branch patency, endoleak, aneurysm sac change, and access related complications after the index procedure. Follow up assessments were scheduled before discharge and at 30 days, six and 12 months after the index procedure.

Results: Between February 2022 and January 2024, 11 patients (mean age 73.4±10.7 years; 10 men; [90%]) underwent endovascular repair using the off-the shelf t-Branch endograft. Most of the patients were treated electively (9/11;81%) while 2 (19%) were emergent cases; The technical success was 100%. In the early period (<30 days), one patient (9%) experienced immediate spinal cord ischemia (grade 3) that has not been restored. During follow-up, one patient had thrombosis in both renal arteries and the flow has been restored with percutaneous angioplasty. The primary branch patency was 95%. No other major events have been reported. Shrinkage of the aneurysm's sac has been detected in 2 patients (18%).

Conclusion: The off-the shelf t-Branch device yielded high technical success with good early and midterm outcomes for the treatment of TAAA and PAAs.

Keywords: Endovascular aortic repair, multibranched stent graft, Off the self, aortic aneurysm, pararenal aortic aneurysm, thoracoabdominal aortic aneurysm

INTRODUCTION

Endovascular repair of thoraco-abdominal (TAAA) and pararenal aortic aneurysms (PAAs) has achieved remarkable success over the last decade, offering low peri-operative morbidity and mortality, especially in patients unfit for open surgical repair.[1,2] Custom-made devices have played a primary role in this success, with manufactures working side by side with the physicians to design grafts tailored to the patient's anatomy, allowing optimal alignment between graft and target vessels.[3]

However, the manufacturing time, which can take up to three months represents the "Achilles heel" of these devices, limiting their applicability in emergency cases.[4] More specifically, patients with large in diameter aneurysms, symptomatic or ruptured cannot resist for this delay and necessitate alternative solutions. In this context, other alternatives such parallel aortic grafts have been proposed, yet gutter endoleak and compromise of the sealing zone remain serious concerns of this technique.[5,6]

The t-Branch (Cook Medical, Bloomington, Ind) introduced in 2009, represents an off-the shelf stent graft that includes four branches for visceral target vessel. This endograft yields encouraging results comparable with those of custom-made devices, and constitutes an appealing option, especially in emergency situations.[7,8]

The aim of this study is to report the early and midterm outcomes of the t-Branch off the shelf device for TAAA and PAAA at a single centre.

MATERIAL AND METHODS

Data from patients with thoracoabdominal aortic aneurysms and pararenal aortic aneurysms who were treated with t-Branch graft at our institution from February 2022 to January 2024 were retrospectively collected and analyzed. All the patients provided written informed consent for clinical research. Owing to the retrospective analysis of the anonymized data,

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the requirement for approval by the local ethics committee was waived.

Treatment indications were elective or symptomatic TAAA or pararenal aortic aneurysms. Patients who had previously undergone endovascular aortic aneurysm repair (EVAR) and subsequently experienced aortic dilatation were also included. The criteria for elective treatment included a maximum aortic diameter of ≥55 mm or rapid growth of an aneurysm (≥10 mm during 12 months). Symptomatic cases were defined as the presence of aneurysm-related pain, peripheral embolization, or contained rupture.

Follow-up

All the patients were followed-up clinically and with computed tomography angiography scan at 1, 6 and 12 months and annually thereafter. In cases where there was a suspicion of endoleak or branch vessel malperfusion, a digital substraction angiography was performed for further evaluation.

Endovascular technique

Computed Tomography angiography was performed in every patient before the endovascular procedure. All post-CT angiography images were transferred to a dedicated software workstation (Osirix MD (Pixmeo SARL, Geneva) or_3mensio Vascular Workstation (Pie Medical Imaging, BV, Maastricht, the Netherlands) to obtain preoperative measurements. All interventions were performed in a conventional for open repair operational theatre, equipped with a digital mobile C-arm (BV Pulsera, Koninklijke Phillips N.V., up to December 2022 and Ziehm Imaging GmbH, since January 2023).

Each patient was placed in the supine position. Both groins were prepared and draped. All the procedures were performed with the patient under general anesthesia. A broad-spectrum antibiotic was administered, a femoral artery cutdown or a percutaneous approach was performed in both groins, and the patient received 100U/kg units of heparin with a target activated clotting time of >250 seconds. The technique of the t-Branch implantation has been described before.[9] For catheterization of the branch vessels, the left axillary artery was the most common. Our strategy for reducing the cerebrovascular events was the insertion of a 12x45cm Flexor Check-Flo introducer (Cook Medical, Bloomington, Ind) and through it an Arrow sheath 8x90cm (Teleflex Medical Europe Ltd) to join the branches. Each branch with its corresponding artery was catheterized, wire and stented with balloon expandable Be-Graft [Bentley, Innomed GmbH, Germany], or VBX [W. L. Gore & Associates]) covered stents. In cases of severely angulated or tortuous visceral arteries (commonly the renal arteries) or long distances between the visceral branch and the target vessel ostium, relining of the bridging stents was performed with balloon-expandable or self- expanding stents.

Definitions and outcomes

The primary objective of the present study was technical success. Secondary objective was to assess the early (<30days) and late mortality rate, all cause morbidity, primary branch patency, endoleak, aneurysm sac change, and access related complications after the index procedure.

Technical success was defined as successfully completed treatment with exclusion of the aneurysm without type I or type III endoleak (EL), target vessel (TV) occlusion or injury, conversion to open repair, or intraoperative mortality. Morbidity was defined as a severe adverse event such as spinal cord ischemia, stroke, myocardial infraction, respiratory decline, mesenteric ischemia, and any unplanned reintervention.[10] Spinal cord ischemia (SCI) was defined any new neurological deficit of the lower limbs that leads to paraplegia (complete inability to move the lower limbs) or paraparesis (lower limb weakness; required assistance to stand or to walk) after the index procedure. Its appearance could be immediate (up to the first 12 hours postoperatively) or late (after 12 hours postoperatively) while further could be subdivided in temporary or permanent.[11] The TAAA classification by Crawford was presented by Safi in revised version.[12] PAAs were defined as aneurysms, degenerative in aetiology, that had no sufficient length of normal aorta between the upper extent of the aneurysm and the renal arteries to allow a conventional EVAR or necessitating suprarenal aortic clamping for open repair. They are further classified into 3 types; short neck infrarenal (<10 and >4mm infrarenal neck), juxtarenal (0-4 mm infrarenal neck) and suprarenal which involve at least one renal artery sparing the orifice of the superior mesenteric artery.[10]

Data analysis

Continuous data were reported as mean ± standard deviation (SD) and median (range) respectively. Categorical data were expressed as absolute numbers and percentage prevalence in the study cohort. P value was considered significant when it was <.05. Statistical analysis was performed by SPSS 26.0 for Windows software (IBM Corp, Armonk, NY).

RESULTS

Patient characteristics

Between February 2022 and January 2024, 11 patients (mean age 73.4±10.7 years; 10 men; [90%]) underwent endovascular repair using t-Branch endograft. Most of the patients were treated electively (9/11;81%) while 2 (19%) were emergent cases; Patient characteristics are illustrated in Table 1. The American Society of Anaesthesiologists classification for assessment of the patients' status was class II (8;73%), III (3;27%) (Table 2). The aneurysm classification was pararenal aortic aneurysms in 8 (73%) patients, Crawford extend type II in 2 (18%) patients (figure 1) and one (9%) patient who had undergone EVAR a few years ago and presented with a type Ia endoleak. The mean maximum aneurysm diameter was 73.7±15.8mm.

Procedure details

The median operation time was 240 minutes (range, 180-310) while the mean fluoroscopy time was 72 minutes (range, 51-271) (Table 2). Two patients suffered from Crawford type II TAAA, and they underwent a staged procedure at 6 weeks and

Table 1: Demographics, comorbidities, and pre-operative aneurysm features of 11 patients with thoraco-abdominal or pararenal abdominal aortic aneurysm included in the study

Characteristic	Patients (n)
Demographics	n/(SD)
Age (years)	73.4 ± 10.7
Male (sex)	10 (90%)
Comorbidities	
Hypertension	11
CAD	2
Hyperlipidaemia	9
Chronic kidney disease	2
COPD	1
Smoking	11
Diabetes	6
Stroke	1
PCI	2
ASA score	
1	0
2	8
3	3
Aneurysm Features	
Pararenal	8
Extent II TAAA	2
Failed previous EVAR	1
Type of presentation	
Elective	9
Emergent	2
Maximum aneurysm diameter (mm)	73.7 ± 15.8
Diameter of renovisceral artery (mm)	
Celiac Trunk	8.1 ± 0.7
SMA	7.8 ± 0.5
Left renal artery	6.0 ± 0.7
Right renal artery	5.6 ± 0.6
Length of renovisceral artery (cm)	
Celiac Trunk	2.7 ± 0.6
SMA	3.0 ± 0.8
Left renal artery	2.5 ± 0.9
Right renal artery	3.3 ± 1.6

Data are presented as mean ± standard deviation (SD) or as n (%).
CAD: coronary artery disease; **COPD:** chronic obstructive pulmonary disease; **PCI:** percutaneous coronary intervention; **ASA** =American Society of Anesthesiologists; **EVAR:** Endovascular aortic repair; **TAAA:** Thoracoabdominal aortic aneurysm

Table 2: Procedural details in 11 patients with thoraco-abdominal or pararenal abdominal aortic aneurysm

Characteristic	Patients (n)
CSF drainage	0 (0)
Operation time (min)	240 minutes (range, 180-310)
Fluoroscopy time (min)	72 minutes (range, 51-271)
Contrast volume (ml)	160 (60-210)
ICU stay (days)	0 (0)
Renovisceral arteries	44
Balloon expandable covered stents (Begraft/Bentley)	44
Self-expandable bare metal stent (Lifestent, Bard)	4
Relining	4

Data are presented as median (range), and as n (%). **ICU**= intensive care unit; **ASA** =American Society of Anesthesiologists **CSF=** Cerebrospinal fluid Drainage

Figure 1. a) Preoperative 3-D reconstruction b) First stage (TEVAR) c) Second stage (off-the shelf multibranched stent graft

4 months respectively. One of them, had history of stroke with left hemiplegia few years ago and he decided after the first Thoracic endovascular aortic repair (TEVAR) procedure to postpone the second stage. A total of 44 renovisceral arteries were reconstructed with overall 48 visceral stents. Due to the abrupt upward angulation of 4 renal arteries, relining has been performed using self-expandable bare metal stent (Table 2).

30-day Outcomes

The technical success was achieved in all 11 patients (100%). No death occurred during this period. One patient (9%) with TAAA Crawford type II, experienced spinal cord ischemia within 24 hours of the index procedure's second stage. Cerebrospinal fluid drainage was immediately implemented in this patient and strict monitoring was maintained including measurement of median arterial pressure (MAP≥80mmHg), drainage of cerebrospinal fluid, the haemoglobin level ≥8 g/dl, and strict hydration. Despite these efforts, the patient was discharged after 7 days without any neurological improvement. Two (18%) patients experienced a slight deterioration of renal function which resolved by discharge. There were no other severe complications such as respiratory failure, myocardial infarction, stroke, mesenteric ischemia, or the need for re-intervention within 30 days post-operatively. Three (27%) patients developed groin haematoma without bleeding. Table 3 reports the 30-day outcomes of the 11 enrolled patients.

Outcomes beyond 30-day postoperatively

The median follow-up period was 6 months (range, 1-22 months). There were no deaths in this period. One patient suddenly appeared pulmonary oedema due to deterioration of the kidney function. He underwent immediately in haemodialysis and in CTA scan that revealed thrombosis of both renal arteries. He underwent in percutaneous transluminal angioplasty in both renal arteries and relining with self-expandable stenting with successful restoration of the arterial flow. Slowly, the patient was weaned from the dialysis, and remained asymptomatic up to date. The primary branch patency was 95%. During the follow up period, 4 type II endoleak were detected with stable aneurysm sac and remained in surveillance. No other type of endoleak has been detected. Nine (82%) patients presented stable aneurysm sac and two patients (18%) shrinkage. No dilatation of aneurysm sac has been detected (Table 3).

DISCUSSION

In the present study we report the early and mid-term results of the t-Branch for TAAAs and PAAs in both elective and emergent situations. The technical success rate was high, with no mortality events. The main reason of these acceptable outcomes was that the patients had been treated within the instructions for use for t-Branch stent graft. Another factor was that most of the patients (81%) were operated on in elective situations rather than emergently. Cases in emergent situations and outside the instructions for use might be more technically demanding, requiring longer operation and fluoroscopy times. Silingardi et al[13] attempted to compare the elective and emergent/urgent treatment for patients with TAAAs. Their findings indicated a higher mortality rate and adverse events rate in emergent/urgent situations as well as longer

Table 3: 30-day and one year outcomes of the enrolled 11 patients with thoraco-abdominal or pararenal abdominal aortic aneurysm

Outcome	0-30 days	>30 days
Clinical outcomes	n/(%)	**n/(%)**
Patients (n)	11	11
Technical success	15 (100)	-
Mortality	0 (0)	0 (0)
Spinal cord ishemia		
Grade 0	10 (90%)	10 (90%)
Grade 1	0 (0)	0 (0)
Grade 2 (paraparesis)	0 (0)	0 (0)
Grade 3 (paraplegia)	1 (10%)	0 (0)
Renal function decline	2 (18%)	0 (0)
Dialysis	0 (0)	1(10%)
Respiratory failure	0 (0)	0 (0)
Myocardial infraction	0 (0)	0 (0)
Stroke	0 (0)	0 (0)
Mesenteric ischemia	0 (0)	0 (0)
Access related complcations		
Hematoma	3 (27%)	0 (0)
Pseudoaneurysm	0 (0)	0 (0)
Arteriovenous fistula	0 (0)	0 (0)
Thrombosis or dissection	0 (0)	0 (0)
Reintervention	0 (0)	1(10%)
Imaging outcomes		
Patients (n)	11(100%)	11(100%)
Primary branch patency	100%	90%
Endoleak		
Type I	0 (0)	0 (0)
Type II	0 (0)	4 (36%)
Type III	0 (0)	0 (0)
Aneurysm Diameter change		
Stabilisation	-	9 (82%)
Shrinkage	-	2 (18%)
Increase	-	0 (0)

Data are presented as n (%)

operation and fluoroscopy times compared with the elective group. Unfortunately, in the present study we cannot confirm these findings due to the lack of a robust sample in elective and emergent situations.

Regarding the postoperative morbidities, spinal cord ischemia represents the most dreadful event. In open surgical repair the rate of permanent neurological deficit ranges from 3% to 8%.[14,15] In a recent systematic review and meta-analysis on endovascular treatment with the t-Branch device, the rate of SCI was 12.2% (range, 4.1%-23.2%), with the rate of permanent paraplegia ranging from 0% to 8.7%.[16] In our series, one Crawford type II patient (9%) experienced immediate paraplegia. A possible explanation might be the prolonged coverage of the aorta within a short timeframe between the two stages. During preoperative planning and discussion of the case, we agreed to leave a side branch or an iliac extension open and complete the repair a few days later. However, intraoperatively, the patient had a heavily calcified aorta and presented hemodynamic instability despite continuous anesthesiological support. Consequently, we decided to complete the repair and to evaluate him upon awakening. Another weak point contributing to this result, is the avoidance of using CSF drains. The role of spinal drainage in preventing SCI is debatable today. Recent studies have demonstrated that although the incidence of SCI after F/B-EVAR with selective spinal drainage was low, major spinal drainage-related complications may exceed the SCI rate and undermine the benefits of using spinal drainage.[11]

The primary branch patency in the present study was also high (95%). Only one case of bilateral thrombosis of the renal arteries have been reported. This rate is similar to other recent publications in the literature which, range from 96% to 99%.[16] One possible explanation of this failure might be the emergent nature of the case and the severely upward angulated renal arteries. Unfortunately, we did not perform the relining technique and the use of balloon expandable covered stent graft, which, is less flexible, led to this unforeseen event. However, a successful reintervention has been performed using PTA and relining, achieving patency of both renal arteries. The present reintervention rate (5%) was comparable to the previously reported data of 14% to 36%.[13,17]

Last but not least, access related complications (27%) were noted in the present study. One possible explanation might be that we selected the cut-down for femoral arteries exposure instead of percutaneous technique. This situation was exacerbated after the administration of iv Heparin intraoperatively to achieve an ACT value >250 sec. Unfortunately, there is lack of standardization regarding the strategy of heparin administration in these procedures. Initially, due to the lack of experience, we attempted to maintain an ACT > 250sec throughout the entire procedure. However, this strategy was later revised, and now we aim to maintain an ACT≥200sec during the catheterization of the last branch. This adjustment significantly reduced the appearance of hematomas in subsequent operations.

The present study presents some limitations. Firstly, it was conducted at a single centre with limited sample size. A larger number of patients, both in elective and emergent/urgent situations, is needed to compare the performance of the technique in these scenarios. Secondly, it is retrospective in nature and has a short follow-up period. A longer follow-up timeframe is needed to better understand the requirements of the t-Branch device and the technique. Thirdly, these outcomes were influenced by the management and the decisions of three different physicians. Unfortunately, there was not a single master orchestrating the procedure, as might be happen in high-volume centres.

CONCLUSION

The off the shelf t-Branch endograft was designed to address difficult anatomies and situations either for TAAAs or PAAs. The high technical success and the good early and midterm outcomes of the t-Branch in this study support continued clinical investigation.

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Preservation of internal iliac artery by using it as target vessel for distal anastomosis of bifurcated aortic grafts during surgical repair of aorto-iliac aneurysms

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Abstract:

Common iliac artery aneurysms coexist with abdominal aortic aneurysms in 20-30% of cases and may present technical challenges during surgical reconstruction. Rarely, wide iliac bifurcations may be encountered which may render construction of the distal anastomosis in the iliac bifurcation not feasible. In this instance several techniques may be used, but our preferred approach is the anastomosis of the graft in the internal iliac with subsequent transposition of the external iliac artery in the graft limb. We describe this technique in 3 patients. Postoperative course was uneventful with no signs of pelvic or lower limb ischemia and 100% primary patency during 15 months. In conclusion, the anastomosis of the limb of a bifurcated graft with the internal and transposition of the external iliac artery onto the graft limb may simplify aorto-iliac reconstruction in case of wide iliac bifurcations and safely preserve flow in both internal and external iliac arteries.

INTRODUCTION

Open abdominal aortic aneurysm (AAA) repair is a major surgical procedure, which presents specific technical challenges when common iliac arteries (CIA) are involved (20-30% of cases).[1] Preservation of blood flow to at least one internal iliac artery (IIA) is crucial, since bilateral occlusion is related to a high complication rate, such as buttock claudication, intestinal ischemia and erectile dysfunction.[2,3] Typically, in the presence of a CIA aneurysm the distal anastomosis is performed on the iliac bifurcation, including both the orifices of IIA and external iliac artery (EIA). Rarely, this is not technically feasible, either because of the distance between the two orifices or the existence of an aneurysmal IIA orifice. In these cases the technique that has been mainly reported is constructing the distal anastomosis with the EIA and performing a jump graft to the IIA, although data are scarce.[4,5] An alternative technique that may be used and simplify the procedure is to anastomose the graft limb with the IIA and then transpose the EIA onto the graft. We present three cases in which this approach was used.

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CASE REPORT/TECHNIQUE

First case regards a 55-year old male patient presenting an aorto-iliac aneurysm with maximum aortic diameter of 87mm, right CIA of 56mm and left CIA of 86 mm. On the left side the origins of EIA and IIA were apart (Figure 1). The patient was treated with open repair, anastomosing the right graft limb with the iliac bifurcation whereas on the left side it was anastomosed with the left IIA and the EIA was transpositioned on the graft limb.

Second case regards a 67-year-old man suffering from a small 40mm AAA, and bilateral CIAs aneurysms with a maximum diameter of 70mm. Figure 2 present the pre-operative CT angiography indicating the long distance between the origins of EIA and IIA in both sides. Figure 2 also displays the postoperative CT angiography indicating ligation of left IIA and anastomosis of the graft to the left EIA while the right IIA was preserved by anastomosing the right graft limb to IIA followed by transposition of right EIA on the graft.

Third case is a patient with a 40mm AAA and bilateral 60mm CIA aneurysms and wide iliac bifurcations bilaterally. Figure 3 presents the pre-operative CT. Figure 3 also displays the 3-Dimensional reconstruction of the postoperative CT angiography with ligation of the right IIA and graft anastomosis to left IIA, and left EIA transposition.

All patients had an uneventful postoperative course. No signs of pelvic or lower limbs ischemic complications were noted. Furthermore, patients presented a free walking ability with no buttock claudication. During a mean follow-up of 15months primary patency of grafts and iliac vessels was 100%.

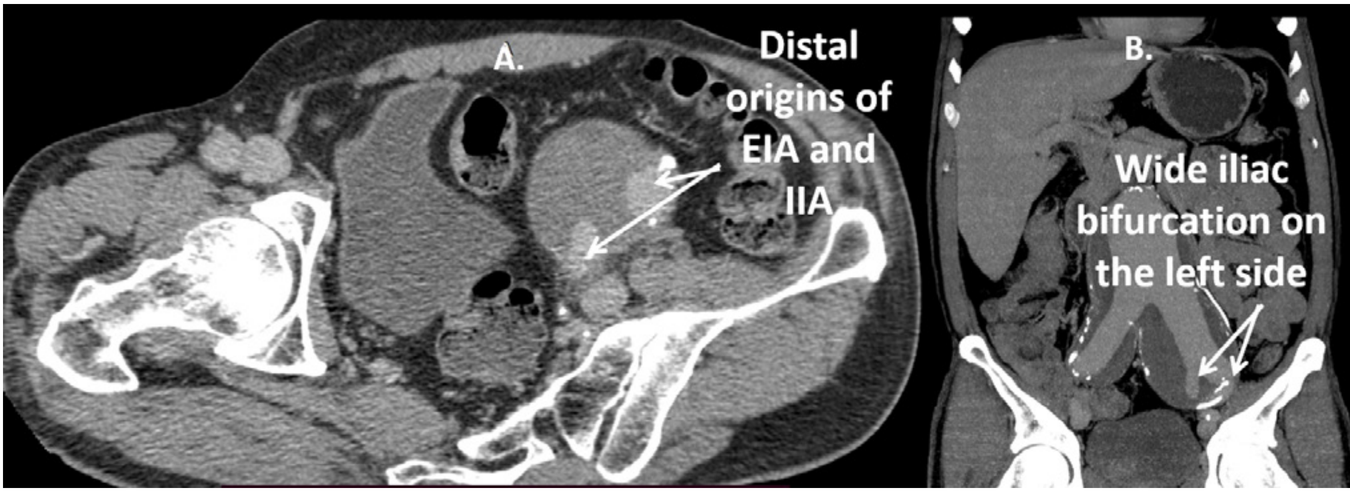

Figure 1: Axial (1A) and coronal (1B) views of the 1st patient, showing the wide left iliac bifurcation.

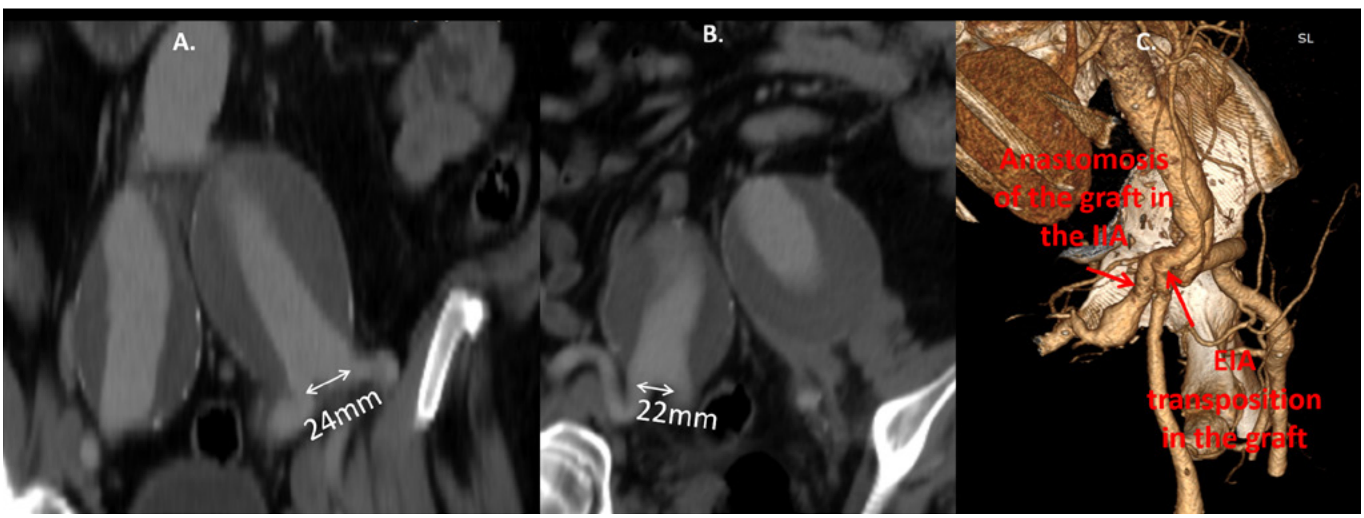

Figure 2: Coronal views indicating wide left (2A) and right (2B) iliac bifurcations and 3-Dimensional reconstruction of the post-operative CT angiography (2C), of 2nd patient.

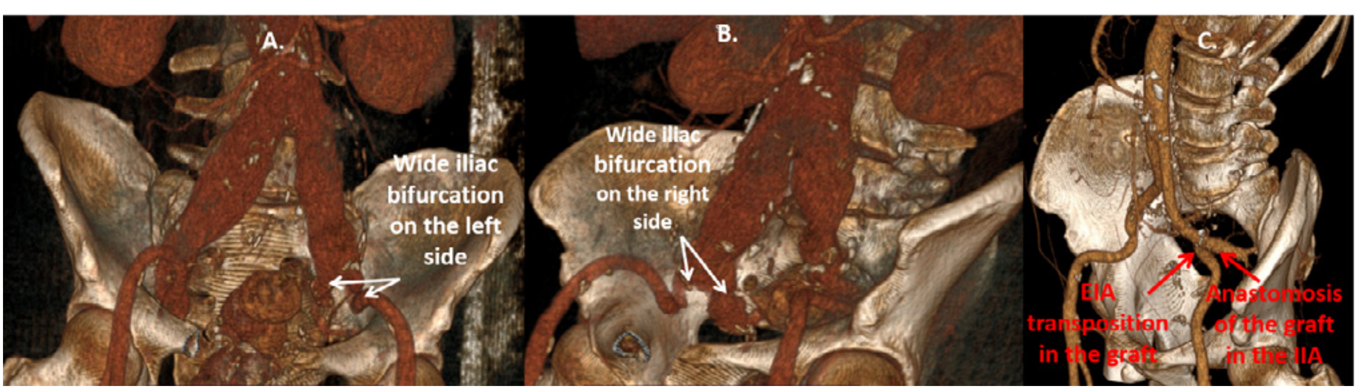

Figure 3: 3-Dimensional reconstruction indicating wide iliac bifurcations on left (3A) and right (3B) side and the postoperative CT scan (3C) of the 3rd case.

DISCUSSION

In this report our preferred treatment strategy during open surgical reconstruction of aorto-iliac aneurysms with wide iliac bifurcations is presented. This involves construction of the distal anastomosis in the IIA and subsequent transposition of the EIA onto the graft limb. This approach facilitates the preservation of both IIA and EIA without adding specific technical difficulties in the procedure. In our opinion, the opposite sequence (i.e. construction of the distal anastomosis in the EIA and transposition of the IIA) would be more far more demanding, especially in cases that the IIA lies deep in the pelvis and in a posterior position relative to the EIA. For example, in all three cases reported in the current study (Figures 1A, 2C, 3C) it can be seen that the anastomosis of the IIA origin would be required to be constructed in the posterior side of the graft limb. Therefore, our proposed technique to make the anastomosis of the graft in the IIA and transpose the EIA, may be particularly useful in patients with a deep and posterior IIA location.

Notably, we were not able to identify previous reports on this technique although it is possible that vascular surgeons might use this approach at an empirical fashion. Moreover, we could not retrieve any data on the frequency of an aorto-iliac anatomy that does not allow the inclusion of the EIA and IIA orifices in one anastomosis. According to our experience, this is a rare occasion which was encountered in only 3 cases, among 51 elective aortoiliac reconstructions for AAAs, during a 3-year period. As expected, no specific thresholds to define wide iliac bifurcations exist, but in the current series a distance >2cm between the origins of the division branches was recorded in all 3 cases.

An alternative technique which would be suitable for these cases is external to internal iliac bypass which again has only been scarcely reported in the literature, with most data regarding endovascular treatment of AAAs that need extension of the endograft in the EIA due to wide CIAs.[6,7] For these cases, an excellent patency of these grafts has been reported but data are available for a short follow-up of a few months. In our cases during a mean follow-up of 15 months primary patency of grafts and native iliac arteries was universal and no symptoms of pelvic or limb ischemia were reported. Notably, in these patients ligation of the CIA and femoro-femoral bypass in order to ensure reverse flow in the IIA was not feasible due to the distance between the origins of the IIA and EIA. Moreover, it should be underlined that endovascular repair was not preferred in these patients because of their young age and good general health status which made them suitable candidates for open surgery.

In conclusion, the anastomosis of the limb of a bifurcated graft with the IIA and transposition of EIA onto the graft limb is a safe technique to facilitate the preservation of the IIA when anastomosis with the iliac bifurcation is not feasible.

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Rupture of a Juxtarenal Abdominal Aortic Aneurysm after Segmental Artery Embolization before Fenestrated Endovascular Aortic Repair: Review of Literature and a Word of Caution

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Abstract:

Aim: To highlight the impact of wire and catheter manipulation on aortic wall integrity in minimally invasive segmental artery coil embolization (MISACE) before fenestrated endovascular aortic repair (FEVAR).

Case: An 80-year-old male with a juxtarenal abdominal aortic aneurysm opted for FEVAR due to comorbidities. MISACE was done to prevent spinal cord ischemia (SCI) and type II endoleak before deploying a custom-made fenestrated endograft. Tragically, the patient succumbed to rupture three days post-MISACE.

Conclusion: Although MISACE offers proven and unproven protection against SCI and type II endoleaks respectively, the risks associated with wire and catheter manipulation during the procedure on the integrity of aortic walls remain understudied. Further studies are needed to highlight the impact of such manipulation in complex aortic aneurysms.

Keywords: Juxtarenal aortic aneurysm; Spinal cord ischemia; Endoleak; Aortic Rupture; Case Report.

ABBREVIATIONS

CMD = Custom-Made Device; CT = Computed Tomography; EVAR = Endovascular Aneurysm Repair; FEVAR = Fenestrated EVAR; F/B-EVAR = Fenestrated/Branched-EVAR; JRAAA = Juxtarenal Abdominal Aortic Aneurysm; MISACE = Minimally invasive segmental artery coil embolization; SCI = Spinal Cord Ischemia; T2EL = Type II Endoleak.

INTRODUCTION

Fenestrated/branched endovascular aortic repair (F/B-EVAR) is now a valid treatment for juxtarenal abdominal aortic aneurysms (JRAAA), demonstrating outcomes comparable to open surgical repair.[1] However, extended proximal aortic coverage poses a risk of spinal cord ischemia (SCI) due to the coverage of spinal segmental arteries, with SCI rates reaching up to 17.7% post-endovascular repair.[2]

A study by Branzan and colleagues involving 54 patients with thoracoabdominal aortic aneurysms highlighted the success of Minimally Invasive Segmental Artery Coil Embolization (MISACE) in preventing SCI, with none of the subjects experiencing it during follow-up.[3] MISACE not only protects against SCI but also has a potential role in eliminating type II endoleaks (T2EL), the common presenting endoleaks after F/B-EVAR.[4, 5]

Despite these potential benefits, we present a case of a JRAAA that ruptured following a MISACE procedure.

CASE REPORT

An 80-year-old male with a history of diverticulitis and colonic resection was referred for a growing asymptomatic JRAAA that was first discovered accidentally a few years ago during a computed tomography (CT) scan. CT scan revealed a 59 mm aneurysm with an infrarenal aortic neck length of < 10 mm. Figures 1 A and B show the CT scan of the presented aortic aneurysm.

Open surgical repair was not considered suitable due to cardiovascular comorbidities, and history of previous abdominal surgery. Aortic anatomy was carefully assessed using a dedicated 3D workstation (Aquarius intuition viewer, TeraRecon) and measurements were sent to Cook Medical (Bloomington, IN, USA) to manufacture a custom-made four-fenestrated device.

The endograft would require proximal thoracoabdominal coverage of at least three levels of segmental arteries, each with diameter > 3mm. The patient deemed at risk of suffering spinal cord ischemia during endovascular aneurysm exclusion.

Minimally invasive segmental artery coil embolization (MI-

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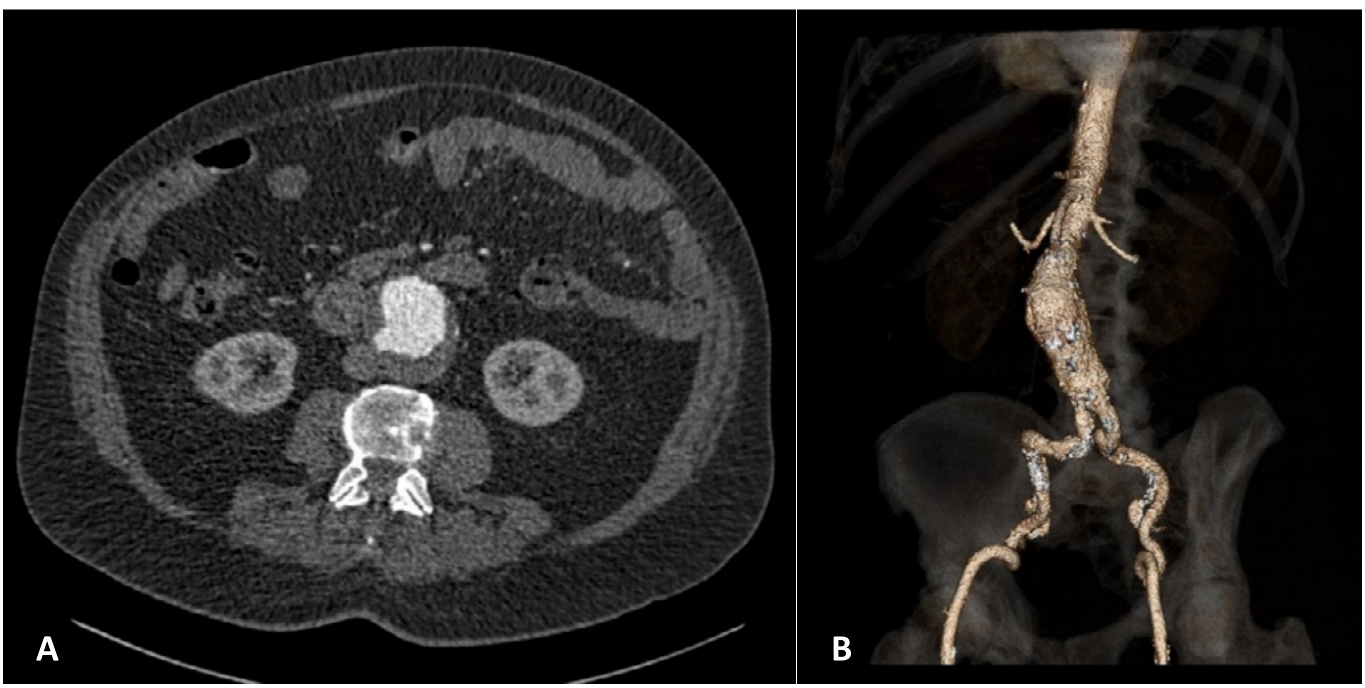
SACE) is a technique well acquainted at our institution performed by colleagues from interventional radiology for patients considered at risk of SCI before F/B-EVAR. Segmental arteries are usually selected during preoperative planning and intraoperatively according to their diameters. Consequently, it was proposed as a protective measure against SCI before definitive endovascular repair with the added benefit of possible protection against T2EL. The patient's consent was taken for the MISACE, the proposed aortic endovascular treatment, and the use of data for future studies and publication. The CMD was to be ready in about 8 - 12 weeks.

Two months later, the patient was readmitted and referred to the colleagues of the Interventional Radiology Department for MISACE. Using micro coils, the thoracic T12, and lumbar L1 segmental arteries were embolized on both sides. Figures 2 demonstrate the successful embolization steps of some of the segmental arteries.

The patient was transferred to the intensive care for monitoring. On the third post-operative day, he experienced sudden severe abdominal and back pain. Because of his known history, he underwent immediately a CT scan. Figures 3 A and B reveal a ruptured juxtarenal abdominal aortic aneurysm at the proximal aortic aneurysm segment.

An aortic rupture was visualized, and the patient was immediately transferred to the operative theatre. The patient was quickly intubated while mechanically and medically resuscitated. The femoral artery was punctured using duplex sonography and a guide wire was inserted. Attempts to advance different guidewires and catheters into the proximal healthy aortic segment failed. Despite the maximum efforts of the resuscitation process, adequate circulation was not restored and conversion to open surgery was aborted. Sadly, the medical team documented the patient's demise.

Postmortem examination was refused by the patient's rel-



Figures 1 (A, B): CT scan at the first visit to the clinic.

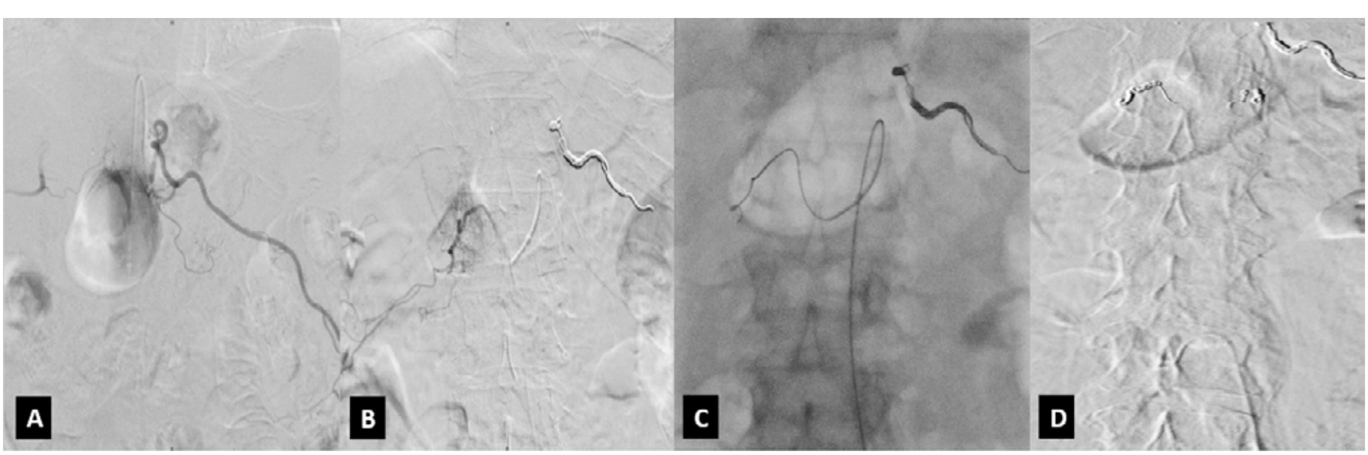
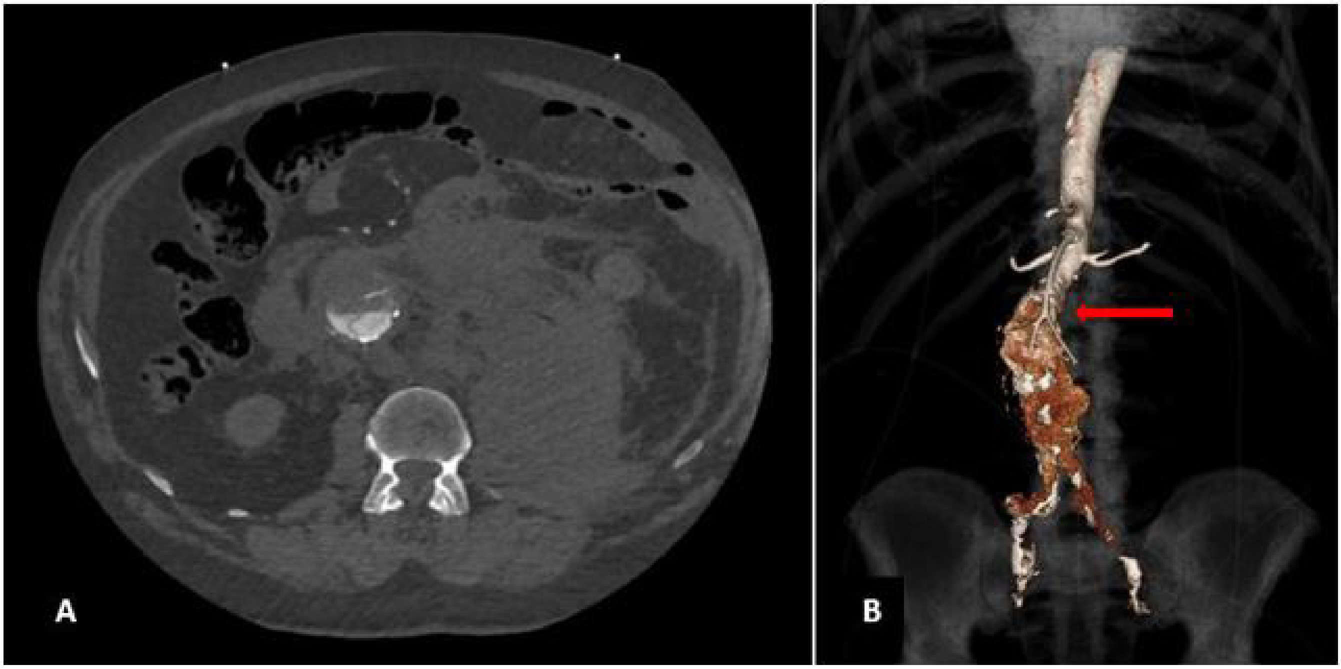


Figure 2: Successful embolization of segmental arteries.



Figures 3 (A, B): Ruptured juxtarenal abdominal aortic aneurysm (arrow points at the point of rupture).

atives, which went in line with the legal and medical authorities at our institution.

DISCUSSION

Juxtarenal abdominal aortic aneurysms, historically managed through open surgical repair, are now often treated with endovascular interventions due to advancements in techniques and experiences. These interventions are particularly beneficial for patients who were previously unsuitable for open surgery or had a high mortality risk.[1, 6, 7] In this case, a custom-made FEVAR device was chosen for the patient considering their age, cardiopulmonary status, and abdominal surgical history. These devices typically take 8-12 weeks to manufacture.

Endovascular treatment of juxtarenal aneurysms usually necessitates extended proximal coverage to higher aortic zones for a safe proximal landing zone.[7] Hence an increased risk of spinal cord ischemia and possible paraplegia or paralysis. Reports of SCI after endovascular aortic repair have varied and reached as high as approximately 18%[2]. To avoid such adverse outcomes, many solutions have been proposed including permissive hypertension, CSF drainage, temporary sac perfusion, staging the procedure(s), revascularization, or minimally invasive embolization of segmental arteries before definitive stent graft placement. The main rationale behind occluding these arteries is to precondition the spinal circulation for the forthcoming extensive occlusion, thereby inducing the formation of sufficient collateral arterial circulation to safeguard against SCI.[4]

Adjunctive measures to protect against SCI involve maintaining higher mean arterial blood pressure, optimizing oxygen saturation, and having adequate hemoglobin levels. Factors that would increase the risk of SCI include elevated international normalized ratio, bilateral iliac artery occlusion, and non-elective procedures.[8] In addition, a lumbar drain could be placed, if not already done before, by which the cerebrospinal fluid (CSF) is aspirated to reduce the CSF pressure and therefore, increase the cerebral and spinal perfusion pressure. However, this increases the risk of complications during drain placement and probable longer periods of stay in the intensive care unit.[8]

Endoleaks are the most common reported complication following EVAR procedures with T2EL accounting for up to 40 % of them.[9] Half of those reported endoleaks are usually self-limiting and require no treatment while the remainder are either persistent or late-onset. Mechanical occlusion of the segmental arteries aims to occlude major thoracic and lumbar arteries to prevent back bleeding after endograft deployment, thereby reducing the chances of having an endoleak type II. It also helps avoid the possible steal phenomenon from the collateral network of the spinal circulation. Therefore, MISACE presents a golden chance to resolve dual objectives simultaneously: SCI and T2EL.

According to the recent ESVS guidelines[10], for patients undergoing endovascular abdominal aortic aneurysm repair, routine pre-emptive embolisation of the inferior mesenteric artery and lumbar arteries, and non-selective aneurysm sac embolisation is not indicated. While MISACE is generally considered safe, with no reported mortality up to date, it still carries a similar risk of endovascular iatrogenic perforation and rupture.[11] In 2018, a study was published addressing the role of MISACE and SCI protection among patients with thoracoabdominal aortic aneurysms. MISACE was performed before definitive endovascular treatment. Two patients died in the interval period after MISACE completion and before definitive EVAR.[3] The dangers of mechanical manipulation on aortic walls leading to serious deterioration are understudied. Although several documented reports and case series have highlighted the association of vessel perforation with guidewires and catheters, such occurrences have not been demonstrated in the aorta.[11]

Despite the intended protection against spinal cord ischemia and T2EL; guidewire and catheter manipulation in patients with complex abdominal aortic aneurysms might result in serious adverse outcomes. CMD also has a significant long duration period of manufacture that might have seen the aneurysm grow more rapidly and fragile than expected. Despite the absence of a postmortem study confirming the connection between aortic rupture and mechanical manipulation, recent maneuvers make it challenging to dismiss such a causal link. Perhaps, a perforation was induced by the mechanical manipulation that remained indolent before transforming into a frank rupture. The use of upper extremity access could be used in the future for safe manipulation away from the abdominal aortic pathology and minimizing the risks of aortic wall engagement with potential adverse events. Hence, it was imperative to underscore this potential association and issue a cautionary message.

CONCLUSION

Although MISACE offers proven and unproven protection against SCI and type II endoleaks respectively, the risks associated with wire and catheter manipulation during the procedure on the integrity of aortic walls remain understudied. Further studies are needed to highlight the impact of such manipulation in complex aortic aneurysms.

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Reverse U stent graft technique for the treatment of a type IIIa endoleak with common and internal iliac aneurysms, preserving pelvic flow

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Abstract:
Type III endoleak is a severe complication after endovascular aneurysm repair (EVAR) and can result in aneurysm rupture. In the presence of common (CIA) and internal iliac artery (IIA) aneurysm the preservation of at least one IIA is mandatory to avoid pelvic ischemia. A 88-year old man with EVAR extending to the right external iliac artery, presented with a type IIIa endoleak from disconnection between the main body and the contralateral limb. He also had an aneurysm of the left CIA, with subsequent loss of left limb fixation, and an aneurysm of the left IIA, the only one maintaining pelvic flow. A hybrid procedure was performed including placement of an aorto-uni-iliac graft, crossover femoro-femoral bypass and placement of an external to the aneurysmal IIA reverse U stent-graft. Post-operative CT scan demonstrated complete sealing of the endoleak with preservation of pelvic flow through the left IIA.

Keywords: Type III endoleak, Iliac aneurysm, U graft, hybrid treatment.

INTRODUCTION

Type III endoleak is a late complication following endovascular repair of aortic aneurysm (EVAR), with incidence ranging from 0.9%-3%[1]. Although rare, type III endoleak is the second most common cause of late aneurysm rupture, following behind type I endoleaks[2]. Therefore, it is critical to proceed immediately to treatment upon identification of the problem. An endovascular approach has been the primary choice for treatment of type III endoleaks.[3] We present the case of a type IIIa endoleak, in the presence of common (CIA) and internal iliac artery (IIA) aneurysms, in which a standard endovascular technique would present a threat to the patient, as it would jeopardize his pelvic circulation. A consent regarding publication was obtained from the patient.

CASE PRESENTATION

This case refers to an 88-year-old Caucasian male who underwent EVAR in 2010, eleven years prior to the current presentation. His past medical history included hypertension, dyslipidemia, hyperuricemia, and hypothyroidism. He did not comply with his annual post-EVAR follow up for an unknown number of years. A routine abdominal ultrasound revealed an 11 cm aneurysm, and the patient was referred to our department. At presentation, the patient was asymptomatic and his routine laboratory values were within normal ranges. An urgent contrast-enhanced computed tomographic angiography (CTA) scan confirmed the 11cm abdominal aortic aneurysm. The CTA also demonstrated disconnection of the left limb from the main graft body, with loss of distal fixation and aneurysms of both the left CIA artery and the left IIA (3.2cm and 2.4cm respectively). Also, the right limb of the previous endograft was extended to the right EIA (Fig 1).

During multidisciplinary discussion among interventional radiologists and vascular surgeons, the option of a bridging stent graft between disconnected components was rejected, as it would require the graft to land on the left EIA, posing the threat of pelvic ischemia. Instead, an urgent hybrid procedure was planned.

The procedure was performed under general anesthesia with bilateral surgical cut-down for arterial access. Initially, a 36mm TREO aorto-uni-iliac (AUI) endograft (Terumo, Somerset, NJ) was deployed through the right limb of the previous graft (Fig 2). The second step was the construction of a femoro-femoral bypass from right to left using an 8mm PTFE ringed graft. The last planned step would be the placement of a reverse U-stent graft via ipsilateral left CFA access. The initial attempts to advance the stent graft within the IIA failed due to the steep angulation of the IIA origin and ~~the~~ insufficient support due to the largely aneurysmal CIA. A molding balloon, which temporarily sealed the left CIA, facilitated insertion of a 0.035’ stiff hydrophilic guidewire (Terumo, Japan) deep within the left aneurysmal IIA before the deployment of the reverse U-stent (Viabahn 8X100 mm and 10x50 mm) (Fig 3). Completion angiography demonstrated the complete exclusion of all

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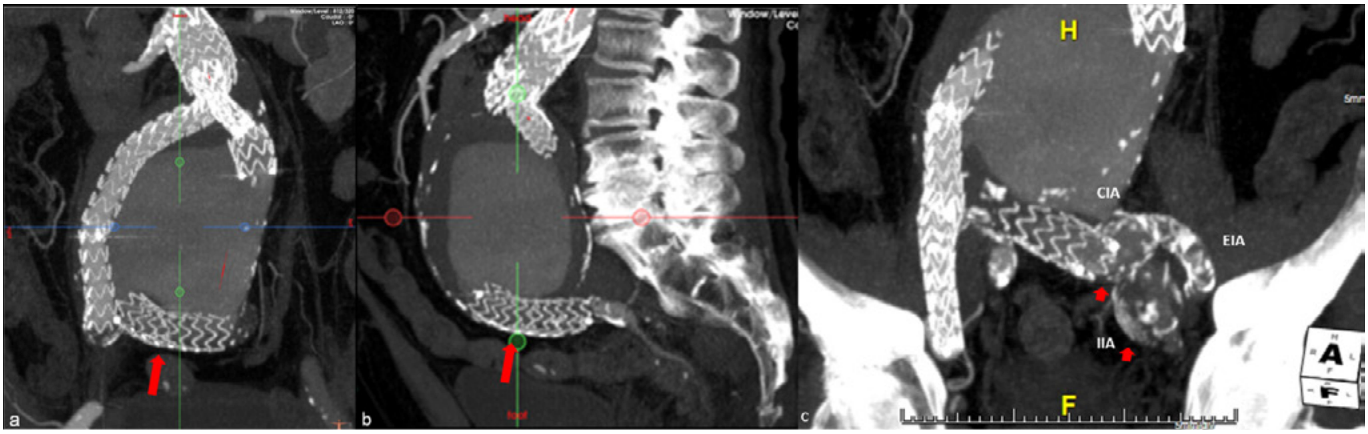

Figure 1 (a,b). Pre-op CT scan demonstrating the IIIa endoleak. The disconnected left limb of the endograft is within the sac of the aneurysm. 1c. Left CIA and IIA aneurysms. Loss of distal fixation of the left limb of the endograft. CIA: Common Iliac Artery, EIA: External Iliac Artery, IIA: Internal Iliac Artery

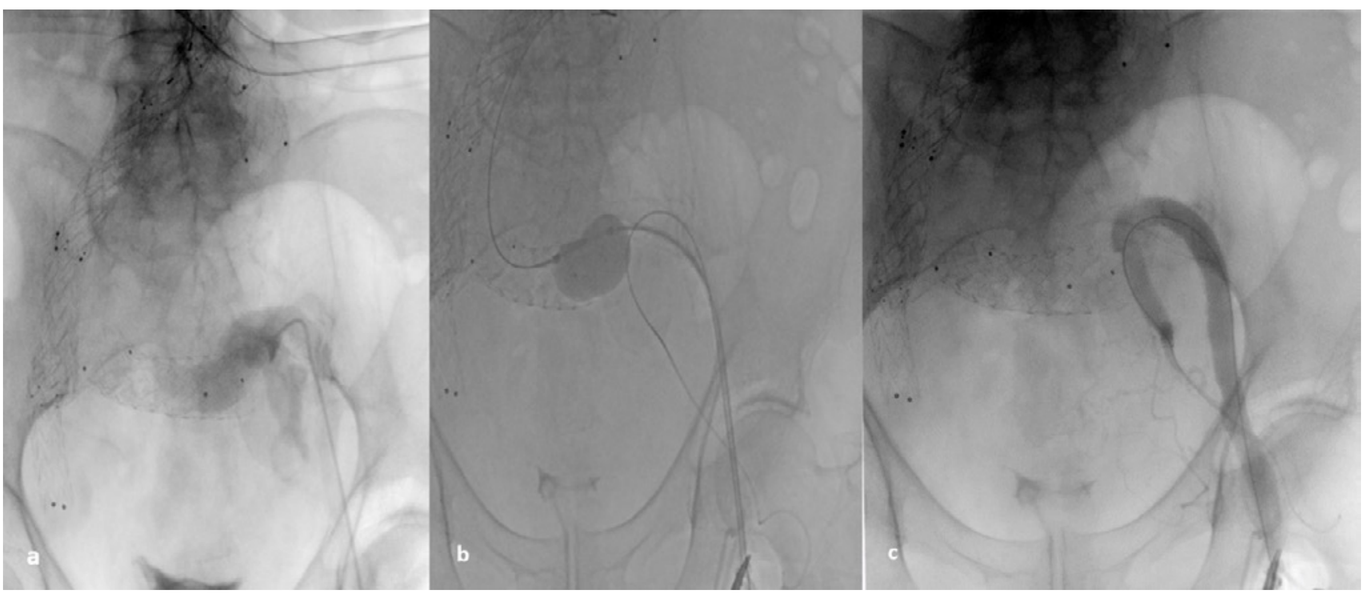

Figure 2. (a) Intaprocedural DSA depicting the aneurysms of the left CIA and the left IIA. (b)A molding balloon temporarily sealing the left CIA and (c) deployment of the reverse U-stent graft from the left EIA to the left IIA.

Figure 3 (a,b,c). Post-op CT scan image demonstrating sealing of the endoleak and patent reverse- U stent graft three aneurysms without any signs of endoleak. Aneurysms' exclusion without endoleak was also confirmed at 1-month follow up CT angiography.

DISCUSSION

This is the first report of a type IIIa endoleak and a IIA aneurysm treated using a hybrid surgical and endovascular AUI and reverse U stent technique.

Type III endoleaks include the IIIa and IIIb subtypes.[4] Subtype IIIa is the result of disconnection between one limb and the main body of the stent graft, while subtype IIIb is the consequence of a fabric defect. In this case, the existence of aneurysms in the left common and internal iliac artery likely contributed to the loss of left limb fixation, whilst making the treatment approach more complex.

Treatment of type IIIa endoleaks includes the vastly favorable minimal invasive endovascular treatment, as well as open surgery, which is more dangerous, especially in patients of advanced age with various comorbidities, as in this case.[5]

The usual endovascular treatment for type IIIa endoleak is an actual reconnection of the disconnected components using a stent graft. However, as the newly inserted stent should land on a healthy artery, the option for our patient would be to land the stent graft at the left EIA, completely excluding the left IIA and posing the patient to the risk of pelvic ischemia.

The proposed use of an AUI stent graft and femoro-femoral bypass is a well-established procedure[7] and the placement of a reverse U-stent graft from the EIA to the IIA has been used in the past in certain occasions to prevent retrograde flow into the aneurysmal sac.[7,8]

In the herein presented case the challenge was to treat simultaneously both the type IIIa endoleak and the IIA aneurysm, as the IIA was the only vessel providing perfusion to the pelvis. Due to the acute angulation of the IIA origin, the advancement of the stent graft within the IIA was not possible even with the use of a super stiff 0.035' guide wire. Therefore, after placing a stiff hydrophilic guide wire deep within the IIA, a CIA occlusion technique with a molding balloon was used to occlude the aneurysmal CIA and provide support for the advancement of stent graft across the IIA origin, and distal to the aneurysm, ~~as~~ to achieve efficient exclusion.

A valid alternative endovascular treatment option would be the use of an iliac branched stent graft. However, bridging of the disconnected left limb, advancing the stent graft through the bifurcated graft and deployment of the bringing stent graft would be extremely challenging in this particular anatomy. Due to the same anatomical reasons, a periscope stent graft to the left IIA was also rejected as a possible option. Also, the possibility of recurrent disconnection and new type IIIa endoleak that would threaten any further treatment could not be excluded.

In the preoperative CT scan the inferior mesenteric artery was occluded. Also no patent lumbar arteries were noted. Based on these CT findings we decide not to place coils in the aorta and the common iliac artery aneurysms to eliminate any type II endoleak causing further sac expansion. Completion angiography did not demonstrate a endoleak and we decided not to perform any additional interventions.

To conclude, our hybrid technique resulted in safe and successful treatment of a complex type IIIa endoleak. Such a technique may therefore be considered when standard endovascular treatments are not an option.

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The perivascular hypodense rim in carotid body tumor surgery

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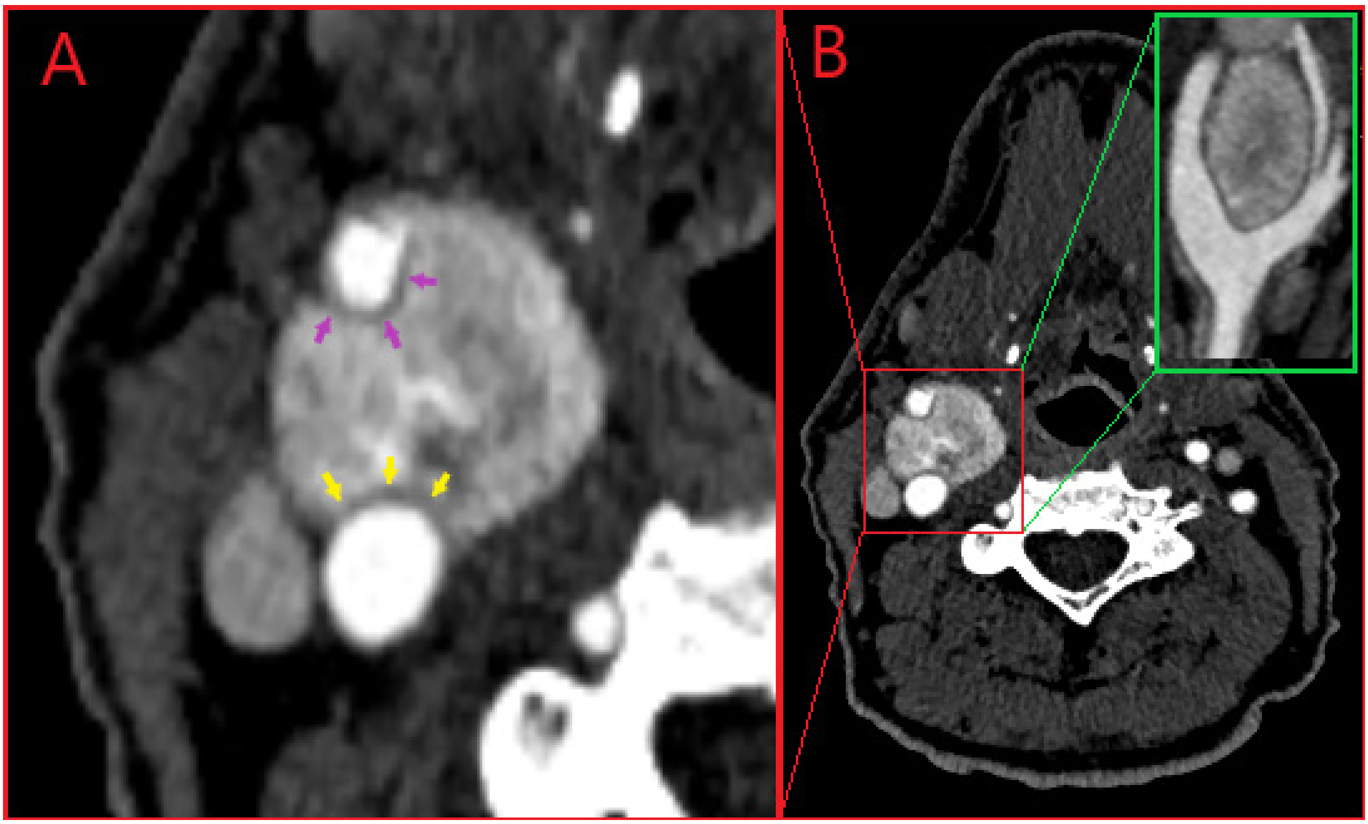

Figure 1: Computed Tomography Angiography (CTA) revealed the presence of a hypodense rim indicating the intact fat plane between the tumor and the adjacent internal carotid artery (A: Purple arrows show the rim around the external carotid artery (ECA) while yellow arrows show the rim around the internal carotid artery (ICA), B: CTA demonstrates the classic 'splaying' of the ICA and ECA.

A 57-year-old male, current smoker presented with a three-year history of a right neck mass progressively enlarging. Computed Tomography Angiography (CTA) established the diagnosis of a Shamblin II carotid body tumor (CBT) 2.5x3.0cm in size. An inactive pheochromocytoma was also depicted in the left adrenal gland, 1cm in size. The internal carotid artery (ICA) was partially engaged in the tumor at 140° along its circumference while the external carotid artery (ECA) at 245°. A perivascular hypodense rim was apparent (Figure 1). The patient underwent surgical excision of the CBT with partial clamping of the ECA to aid haemostasis (Figure 2). Postoperative course was uneventful, and the patient was discharged on the 3rd postoperative day.

The presence of a perivascular hypodense rim in our patient indicates safe tumor resectability without need for ICA reconstruction or ECA excision. It corresponds to the fat plane normally lying around the arteries. Loss of this avascular plane indicates infiltration of the vessel wall by the tumor, making subadventitial dissection impossible. In a recent series from Jasper et al, the absence of this rim displayed as loss of tumor adventitia interface was significantly different between the Shamblin groups (33.3% in Shamblin I, 60% in II and 95,2% in

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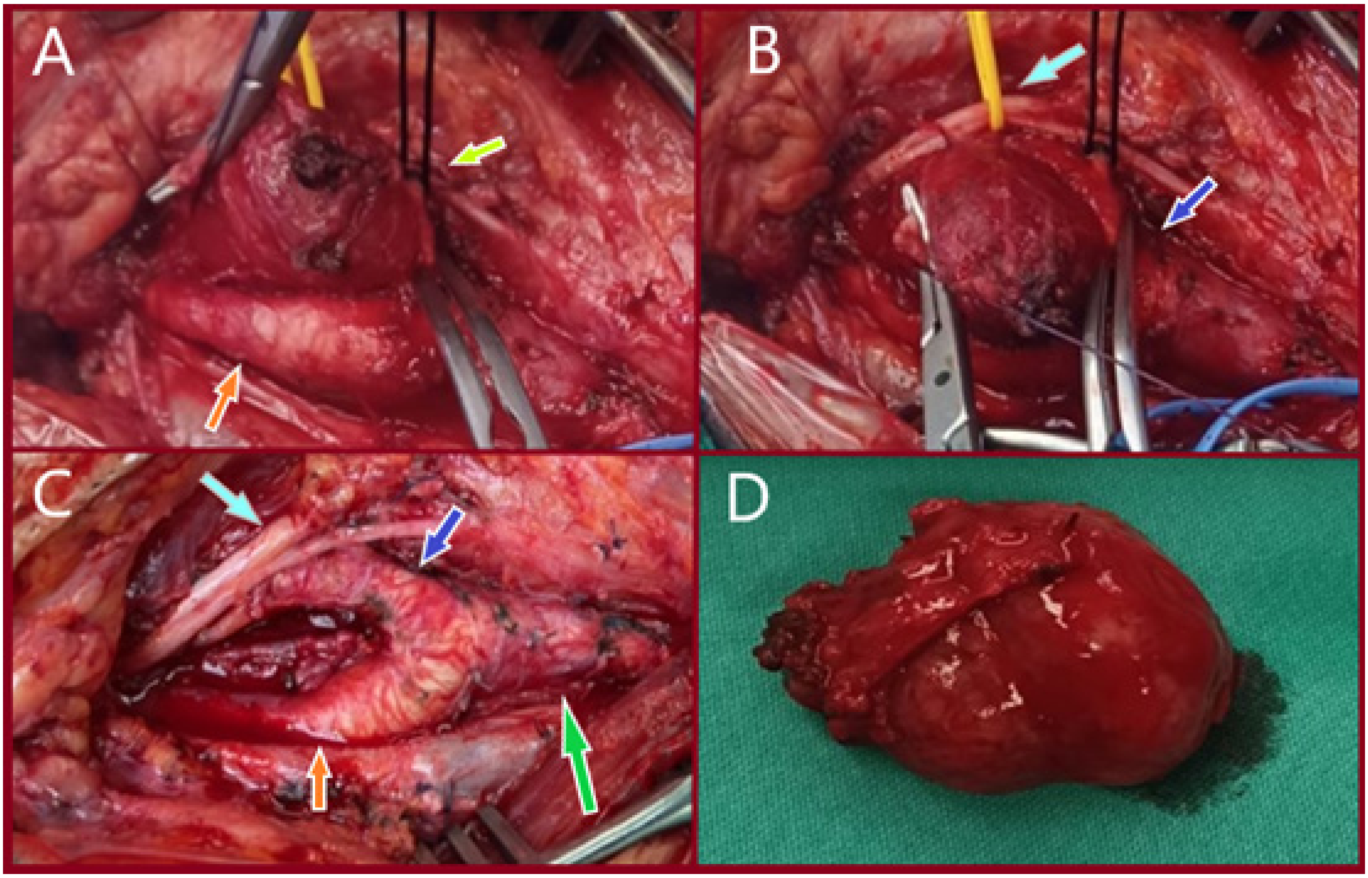

Figure 2: Intraoperative photos, A: The tumor was dissected free from the internal carotid artery (ICA) through a subadventitial avascular plane (Orange arrow: ICA, light green arrow: superior thyroid artery), B: Partial external carotid artery (ECA) clamping was performed (Blue arrow),(Light blue arrow: the hypoglossal nerve) C: Carotid bifurcation after tumor excision (Green arrow: Common carotid artery, orange arrow: ICA, blue arrow: ECA, light blue arrow: the hypoglossal nerve), D: The excised carotid body tumor

III)[1]. Consequently, lack of this radiological sign increases the likelihood for tumor adherence to ICA needing arterial reconstruction and higher morbidity is anticipated (e.g., strokes and cranial nerve palsies).

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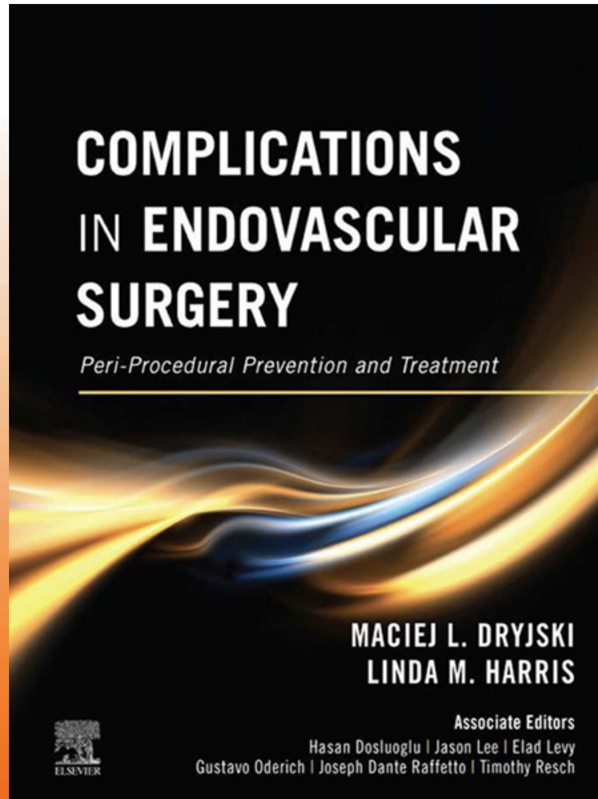

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