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Case Report
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Zone Zero Thoracic Endovascular Repair for Acute Type A Aortic Dissection

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Abstract

Objectives: Endovascular stenting of the ascending aorta has been performed for various aortic pathologies, especially in patients with Type A Acute Aortic Dissection (TAAAD) for whom open surgery is prohibitively risky.

Methods: This case is of an 88-year-old man with multiple comorbidities with TAAAD.

Results: A percutaneous thoracic endovascular aortic repair was successfully performed with three stents to cover zones 0B and 0C.

Conclusion: The Medtronic Valiant Navion stent graft system is useful for treating cases of TAAAD because it has the advantages of a reduced profile delivery system, and its offering of two types of proximal configurations.

Keywords: Type A Acute Aortic Dissection (TAAAD); Thoracic Endovascular Aortic Repair (TEVAR); 3D reconstruction

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Introduction

Type A Acute Aortic Dissection (TAAAD) is a common yet life-threatening emergency disease requiring immediate surgery; nevertheless, surgery is extremely dangerous, especially in older persons because to their fragility and multiple comorbidities. Additionally, leading Japanese population-based research reveals that octogenarians had a greater hospital death rate and a longer hospital stay [1]. Another research investigated the quantitative evidence regarding the surgical indications and outcomes of these difficult procedures in elderly individuals. The present risk ratings and frailty assessments played a significant role in the discussion [2]. While open surgical repair is still the gold standard for TAAAD, Thoracic Endovascular Aortic Repair (TEVAR) is considered an alternate method for patients who are not candidates for open surgery [3]. Arbabi et al. [4] conducted the first prospective study based on their experience of applying the Valiant Navion stent graft system (Medtronic, Santa Rosa, CA, USA) on descending thoracic aortic aneurysms; the authors reported the system's low rate of deployment failures, high efficacy when used in highly tortuous routes, and low incidence of endoleaks. However, essential anatomical elements that may affect the successful exclusion of the aneurysm include tortuosity, thrombus at the implantation zone sites, and short landing zones. In particular, a more extended landing zone may be required to obtain adequate sealing and fixation if anatomical limitations are present.

The present case report features an 88-year-old man with multiple comorbidities that made open correction risky. We used computerized tomographic 3D reconstruction and 3D Slicer software (version 4.13.0; 3D Slicer contributors, http://www.slicer.org) to clarify the spatial relationships in the patient-specific geometry. We then successfully applied the Valiant Navion stent graft system to treat this patient. This case report adheres to the SCARE criteria and reporting standards for TEVAR as stipulated by the Society for Vascular Surgery [5,6].

Case Presentation

An 88-year-old man with a past medical history of infrarenal aortic dissection and hypertension presented to the emergency department after being found unconscious. A Computed Tomography

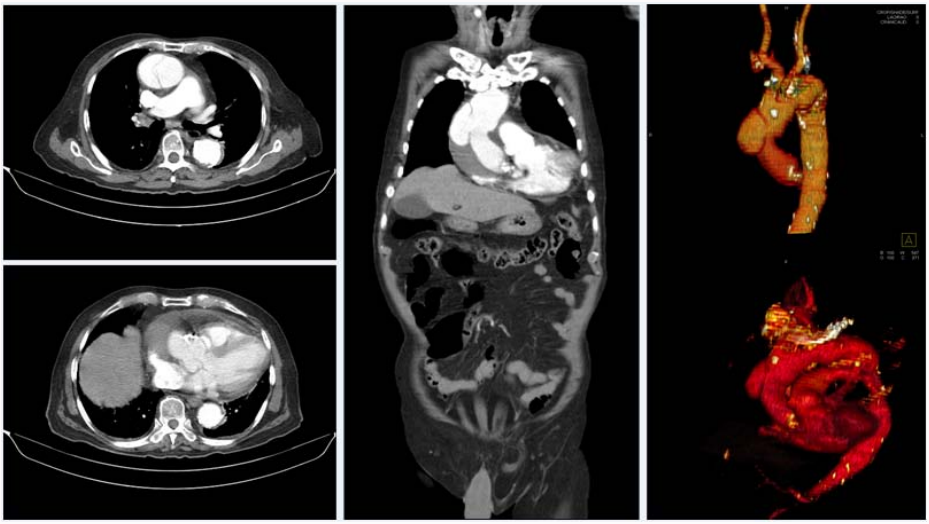

Figure 1: Computed tomography scan of the aorta shows a thickened aortic wall, intimal flap, bilateral pleural effusion, and mild pericardial effusion: (A) Ascending aortic dissection and thickened aortic wall and pleural effusion; (B) Intimal flap; (C) pericardial effusion.

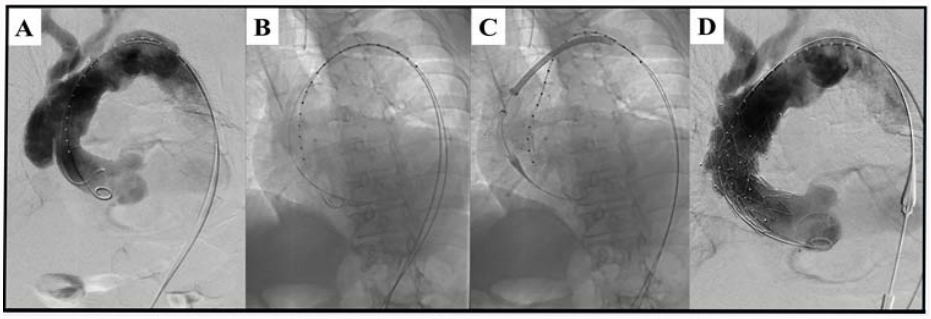

Figure 2: (A) Initial angiography showed the localized flap just in front of right innominate artery and disclosed the orifices of coronary artery; (B) Confida Brecker Curve Guidewire passed through aortic valve into left ventricle as supporting system; (C) The distal CoveredSeal graft was deployed just proximal to the innominate artery orifice; (D) Final angiogram showing complete coverage of entire lesion without evidence of endoleak by three Medtronic Valiant Navion CoveredSeal stents as a module.

(CT) of the head revealed no notable findings. However, his chest exhibited a small pericardial effusion and acute DeBakey type II dissection, with one extensive tearing whole lesion originating from the middle of the ascending aorta with a part of a thrombus extending down to the coronary Ostia and up to the near origin of the innominate artery. It formed one large pseudoaneurysm-like cavity near the ascending aorta. The ascending aorta measured 55.6 mm at its most significant dimension. The Sinotubular Junction (STJ) measured 34.6 mm × 31.9 mm. The location of the entry tear hole was discovered to run along the greater curve 67.5 mm and lesser curve 38.0 mm distal to the STJ and 23.8 mm proximal to the innominate artery. The distal landing zone was 40.8 mm × 40.3 mm at the level of the innominate artery (Figure 1).

To precisely determine whether the TEVAR device can be applied to this patient, we used Three-Dimensional (3D) Printing (3DP) and a reconstructed image. An accurate segmentation process is foundational to the physical reconstruction of the anatomy (which is 3D printed) when a preliminary simulation of the therapy is required. A cardiac CT image was acquired and loaded into 3D Slicer software using the DICOM importer. Cardiac structures were segmented in 3D Slicer, and the target of the stent graft was defined on the cardiac CT image based on the aligned map. We then applied the TEVAR device to the reproduced physical model. Finally, after a thorough discussion with the patient and his family, we chose the alternative strategy, TEVAR, instead of open surgical procedures.

The patient underwent the surgical procedure under general anesthesia. Critical stenosis was induced in the patient by predilating his right femoral artery using a 7-mm PACIFIC balloon. Subsequently, we applied the pre-embedded puncture site closure system using two ProGlide vascular closure devices (Abbott Vascular, Redwood City, CA, USA). The left femoral artery was used as the pigtail angiography route. We planned to use three Medtronic Valiant Navion CoveredSeal stents to cover the dissection sac. Ascending aorta angiography revealed the ascending aorta dissection flap and localized sac in front of the right innominate artery (Figure 2A). To achieve accurate deployment and ensure noninterference with the orifice of a right innominate artery, we used the Confida Brecker Curve Guidewire 0.035" 260-cm stiff wire (Medtronic). We placed the wire into the left ventricle as a support system. The first 40 mm × 55 mm CoveredSeal stent was placed with its distal end landing just proximal to the innominate artery take-off. A part of the proximal end entered the sac through the inlet at the proximal side (Figure 2B). Subsequently, the second stent with dimensions 43 mm × 55 mm was accurately deployed with its proximal end slightly above the plane of the coronary artery orifice; a part of the second stent entered the sac through the inlet at the distal side.

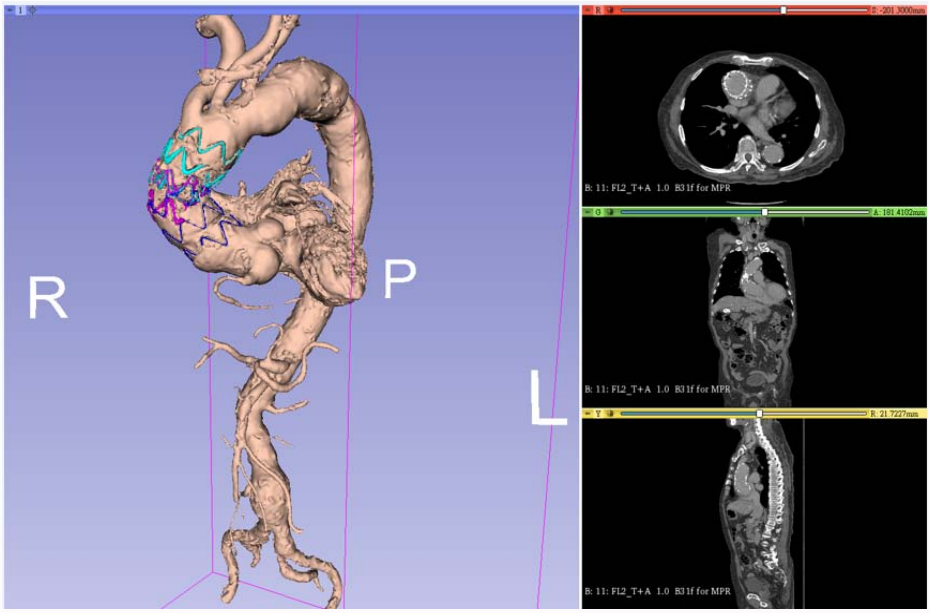

Figure 3: Computerized tomography 3D reconstruction showing the severe tortuous ascending aorta with off-labeled use of Valiant Navion stent graft system. Three CoveredSeal graft stents cover the entire lesion of dissection.

The third 43 mm × 55 mm CoveredSeal stent overlapped with the aforementioned two stent grafts to occlude the stent gap junction and sac inlet (Figure 2C). The patient's final angiography revealed complete coverage of the dissection with satisfying apposition and no evidence of endoleak (Figure 2D). The patient recovered from the procedure well and was discharged on postoperative day 5. At a 3-month follow-up, his Computed Tomography Angiography (CTA) indicated complete thrombosis in a false lumen, with a small fusiform aneurysm approximately 0.8 cm in size (Figure 3). Our patient was in stable condition and received regular follow-up at an outpatient clinic; he had no stent graft–related complications and required no reintervention.

Discussion

Recent advances in computed tomography and echocardiography have allowed clinicians to access valuable information on the structures of patients with cardiovascular diseases. In addition, the realism afforded by 3DP has allowed clinicians to better plan for complex surgical procedures, particularly the different stages of TEVAR. In preprocedural planning, 3DP models can be used to identify the appropriate position of the stent graft and lessen risks entailed by procedures such as using three stent grafts instead of one stent. Moreover, simulating the position of dissection sac was covered with stent grafts. The selection of prosthesis size is of paramount importance in TEVAR.

This patient had several characteristics that made repairing his aortic dissection challenging. First, endovascular approach was made more difficult by the severe stenosis of the femoral artery, the tortuosity of the aorta (with an aortic tortuosity index of 2.3), and the broad range of the ascending aorta involved in dissection. Second, we had to use a stable wire system to accurately deploy the stent in a manner to not interfere with the right innominate artery and coronary artery. Specifically, we placed the preshaped Confida Brecker Curve Guidewire into the left ventricle to obtain a robust support system; this allowed us to securely and accurately deploy stent grafts inside the ascending aorta and minimized the risk of ventricular perforation during the entire procedure. Furthermore, because the stent-graft length was fixed, so as not to interfere with the orifices of the critical vessels, we decided to use three stent grafts as a module in this particular pathology of the patient's ascending aorta. Certainly, the best option for this patient was open ascending-aorta prosthetic graft interposition. However, because the patient's family was concerned about his old age and poor health, we offered this option of a stent graft. Fortunately, he was successfully treated using these three Medtronic Valiant Navion stent grafts and exhibited no complications or need for reintervention after a 3-month follow-up.

Previous trials of the Valiant thoracic stent graft have demonstrated that the reduced-profile delivery system provided better conformability. The two-step deployment system of the Medtronic Valiant Navion system provides accessibility to patients with unfavorable structures. In addition, the two types of proximal configurations, FreeFlo and CoveredSeal, can be flexibly applied to various clinical scenarios; CoveredSeal prevents vessel walls from being exposed to bare metal, and FreeFlo allows for the preservation of transverse flow [5,8,9]. Considering that the branch arteries are not involved and that the aorta is highly fragile, we adopted CoveredSeal. This device is a promising third-generation TEVAR device because of its improved graft design and broad choice of graft size. The present case was an older adult with a fragile aorta, highly tortuous thoracic aorta, and anatomy that made approach unfavorable. We used 3DP to clarify the spatial relationships in the patient-specific geometry, and we successfully executed treatment using three combined stents. However, continued follow-up is necessary for the evaluation of long-term outcomes.

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Research Ethics and Patient Consent

The study recruited the patient with TAAAD who were eligible for consented to undergo a series of examinations and follow-ups. The Institutional Review Board (IRB) of National Cheng-Kung University Hospital (under contract number: A-ER-110-229) approved this study.

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