CASE REPORT

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A case of innominate artery aneurysm in a pregnant woman treated by endovascular stent grafting

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ABSTRACT

Innominate artery aneurysms are rare, accounting for only 0.26% of all aneurysms. Although usually asymptomatic, they carry a significant risk of rupture, which can be fatal, making timely diagnosis and treatment essential. There is limited literature on the management of innominate artery aneurysms during pregnancy, and no established treatment guidelines exist. In this case, a 42-year-old multigravida woman was diagnosed with an innominate artery aneurysm four years prior to pregnancy. Genetic panel testing ruled out inherited connective tissue disorders, including Marfan syndrome. The aneurysm measured 24×36 mm and possessed a saccular configuration. At 23 weeks of gestation, due to the high risk of rupture, the patient underwent successful endovascular stent grafting without complications. Later, the patient developed preeclampsia and fetal growth restriction, necessitating an emergency cesarean section at 33 weeks. A female infant was delivered, and both mother and neonate were discharged without further complications. Open surgical intervention with cardiopulmonary bypass is the standard therapeutic approach for innominate artery aneurysms. However, maternal and fetal mortality rates associated with cardiopulmonary bypass during pregnancy are high. This case suggests that although innominate artery aneurysms during pregnancy are exceedingly rare, endovascular repair with stent grafting may be a viable treatment option to avoid the serious maternal and fetal risks associated with aneurysm rupture or open surgical repair.

Keywords: endovascular repair, innominate artery aneurysm, pregnancy, preeclampsia, stent grafting

INTRODUCTION

The innominate artery, also known as the brachiocephalic artery, is a major artery that branches directly from the aortic arch, dividing into the right common carotid and right subclavian arteries. Aneurysms of the innominate artery are extremely rare, accounting for only 0.26% of all aneurysms,[1] and 3% of supra-aortic vessel aneurysms.[2] The majority of innominate artery aneurysms

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are asymptomatic; however, approximately 11% carry a significant risk of rupturing,[3] which can lead to life-threatening consequences. Therefore, early diagnosis and timely comprehensive intervention are crucial. However, there is a paucity of literature regarding pregnancy complicated by innominate artery aneurysm, and the optimal approach for perinatal management remains unclear. Herein, we present the case of a pregnant woman with an innominate artery aneurysm successfully treated with endovascular stent grafting at 23 weeks of gestation.

CASE REPORT

A 42-year-old woman, gravida 3 para 2, was referred to our hospital at 19 weeks of gestation due to pregnancy complicated by an innominate artery aneurysm. At the age of 18, she underwent open abdominal surgery following a car accident. Subsequently, she experienced two uncomplicated vaginal deliveries at the ages of 21 and 29. At 38 years old, during a physical exam, a computed tomography scan, incidentally revealed an aneurysm in the brachiocephalic trunk. The short diameter of the aneurysm was approximately 23 mm, and it had been monitored annually since then.

Before pregnancy, the patient's systolic blood pressure had consistently remained around 130 mmHg. During pregnancy, she was prescribed nifedipine 20 mg as needed when her systolic blood pressure exceeded 130 mmHg. However, due to a drug rash, nifedipine was shifted to amlodipine 5 mg daily. At 22 weeks of gestation, a follow-up contrast-enhanced computed tomography scan revealed a saccular aneurysm at the origin of the innominate artery. The aneurysm measured 24×36 mm, showing no significant change from four years prior (Figure 1). Although the patient had no significant family medical history, genetic testing was conducted to rule out inherited conditions such as Marfan syndrome, Loeys-Dietz syndrome, or Ehlers-Danlos syndrome, which are associated with aortic aneurysms and dissections. A genetic panel test covering 17 related genes was performed after comprehensive genetic counseling (Table 1). The results confirmed no pathological variants in these genes.

Given the heightened risk of aneurysm rupture or dissection due to the elevated blood volume and heart rate associated with pregnancy, therapeutic intervention was deemed necessary. After a multidisciplinary discussion involving cardiac surgery, neonatology, and obstetrics, endovascular stent grafting was proposed. The patient consented to the procedure. At 23^{+6} weeks of gestation, under general anesthesia, a stent graft was successfully inserted in the innominate artery

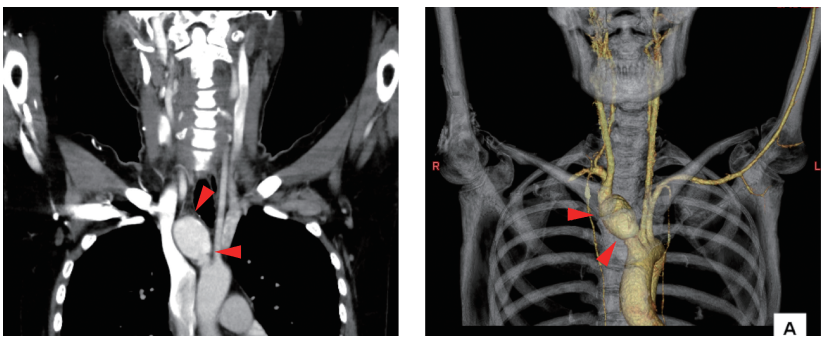

Fig. 1 Images of computed tomography scan before treatment
Preoperative contrast enhanced computed tomography scan (left panel), and three-dimensional reconstruction (right panel) showing saccular aneurysm at the innominate artery (arrowheads).

Table 1 Genes related to hereditary connective tissue disorders

ACTA2: actin alpha 2, smooth muscle
COL1A1: collagen type I alpha 1 chain
COL3A1: collagen type III alpha 1 chain
EFEMP2: epidermal growth factor containing fibulin extracellular matrix protein 2
FBN1: fibrillin 1
FBN2: fibrillin 2
FLNA: filamin A
MYH11: myosin heavy chain 11
MYLK: myosin light chain kinase
PRKG1: protein kinase cyclic guanosine monophosphate-dependent 1
SLC2A10: solute carrier family 2 member 10
SMAD2: SMAD family member 2
SMAD3: SMAD family member 3
TGFB2: transforming growth factor beta 2
TGFB3: transforming growth factor beta 3
TGFBR1: transforming growth factor beta receptor 1
TGFBR2: transforming growth factor beta receptor 2

aneurysm via the right axillary artery (Figure 2). During the procedure, a transesophageal echo probe was placed on the maternal abdominal wall to monitor the fetal heart rate continuously.[4] Postoperatively, the patient was prescribed amlodipine 7.5 mg and aspirin 100 mg, and she was discharged on the 10th postoperative day.

At her 28-week gestational checkup, her blood pressure was 153/95 mmHg, and her urine protein-to-creatinine ratio was 0.84 g/gCr, leading to a diagnosis of superimposed preeclampsia, which necessitated hospitalization. Her amlodipine dosage was increased to 10 mg/day, and labetalol 150 mg/day was initiated. Although her condition remained stable for a time, at 31 weeks of gestation, fetal ultrasound revealed signs of fetal growth restriction. At 33^{+1} weeks of

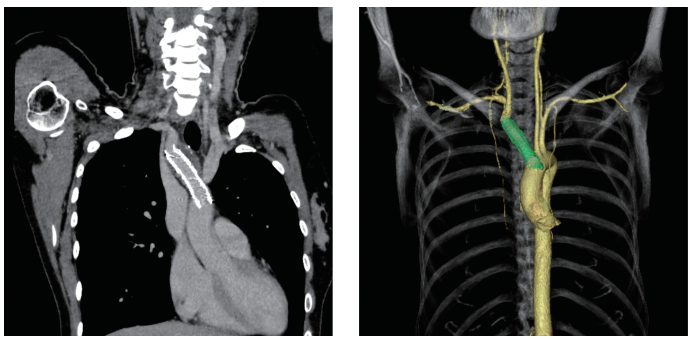

Fig. 2 Images of computed tomography scan after treatment
Postoperative computed tomography scan (left panel) and three-dimensional reconstruction (right panel) showing an adequate position of the stent graft.

gestation, despite antihypertensive treatment, her blood pressure reached 154/100 mmHg, and her urine protein-to-creatinine ratio increased to 5.69 g/gCr. Betamethasone was administered in preparation for possible preterm delivery. At 33^{+3} weeks of gestation, an emergency cesarean section was performed due to the patient's complaints of severe headache and general fatigue. A female infant weighing 1,402 g (-1.9 SD) was delivered, with Apgar scores of 8 (1 min) and 9 (5 min). The umbilical artery pH was 7.332. Although the patient continued to require antihypertensive medication, her postoperative course was favorable, and she was discharged on the ninth postoperative day. The baby was discharged at day 40 without any sequelae.

Written informed consent was obtained from the patient for the publication of this case report and the accompanying images. All procedures in studies involving human participants were performed in accordance with the 1964 Declaration of Helsinki and its later amendments. Ethical approval was not required by the local guidelines of Kyoto University Hospital for this study.

DISCUSSION

To the best of our knowledge, this is the first reported case of a pregnant woman with an innominate artery aneurysm successfully treated with endovascular stent grafting during pregnancy, resulting in a favorable outcome.

Innominate artery aneurysms can arise from a variety of causes, including atherosclerosis, bacterial infection, arteritis, connective tissue diseases, or blunt trauma.[3,5] In this case, it was crucial to initially rule out hereditary connective tissue disorders, as these conditions are known to cause aortic dissection or arterial rupture, particularly during pregnancy, significantly worsening maternal prognosis.[6-8] The presence or absence of hereditary connective tissue disorders plays a critical role not only in determining the treatment strategy but also in deciding whether to continue the pregnancy. The genetic counseling was provided to the patient and her husband by a board-certified clinical geneticist and a certified genetic counselor in our clinical genetics unit. They explained that upon confirmation of a hereditary connective tissue disorder diagnosis, appropriate management protocols may be implemented during pregnancy according to the type of disease. Furthermore, they informed the patient that her decision to decline genetic testing would also be respected. In our case, genetic testing ruled out hereditary connective tissue disorders. While no definitive cause was identified, it was hypothesized that the patient's car accident and subsequent open abdominal surgery at age 18 may have contributed to the development of the aneurysm.

Generally, innominate artery aneurysms measuring over 3 cm in diameter or displaying a saccular configuration are considered high-risk for rupture and are thus recommended for treatment.[3] However, this recommendation is based largely on expert opinion rather than robust evidence, as the rarity of this condition has precluded large-scale studies and the development of established treatment guidelines. Despite this, the severe consequences of rupture, such as major hemorrhage and cerebral ischemia, underscore the need for aggressive treatment in most cases. During pregnancy, the risk of rupture and or dissection of an aneurysm should not be underestimated, particularly in the context of connective tissue disorders, such as Marfan syndrome.[6] In our case, considering the aneurysm's dimensions (24×36 mm) and its saccular configuration, we deemed prompt intervention was warranted, ideally before 28 weeks of gestation, when maternal plasma volume reaches its peak.

We selected endovascular stent grafting to minimize the invasiveness of the procedure for both the mother and fetus during pregnancy. Open surgical intervention, typically involving the replacement of the aneurysm with a synthetic graft, is generally regarded as the standard

therapeutic approach for innominate artery aneurysms. However, this procedure often requires cardiopulmonary bypass, which significantly elevates the risks to both the mother and fetus. A literature review by Sepehripour et al[9] reports that in the 1990s, maternal and fetal mortality rates associated with cardiac surgery using cardiopulmonary bypass during pregnancy were 2.9–5.1% and 19–29%, respectively,[10-12] and by the 2010s, mortality rates were still notable at 4.8% for mothers and 14.3% for fetuses.[13] While various innovations have improved outcomes,[4] it remains challenging to conclude that cardiopulmonary bypass during pregnancy is adequately safe and satisfactory, particularly in terms of fetal mortality. In contrast, endovascular repair presents a promising alternative for aneurysm treatment.[14,15] This approach offers advantages such as fewer complications and shorter hospital stays. However, it is constrained by the anatomical requirement of sufficient landing zones for the stent graft, both proximal and distal to the aneurysm. In this case, the aneurysm met these criteria, making endovascular treatment feasible.

It is of note that there is no clear evidence regarding the efficacy and outcome of stent grafting for innominate artery aneurysm due to its very rare incidence. In contrast, in the field of abdominal aortic aneurysm, endovascular stent-graft placement has spread dramatically around the world since 1991, resulting in a significantly reduced mortality rate related to aneurysm compared with no intervention (adjusted hazard ratio, 0.53; 95% confidence interval, 0.32 to 0.89).[16] In addition, a meta-analysis examining the outcomes of endovascular versus open repair for abdominal aortic aneurysm confirmed the advantage of lower mortality in the endovascular repair group in the first 6 months.[17] Given these considerations, it is reasonable to postulate that endovascular stent grafting for innominate artery aneurysm is similarly effective in mitigating the risk of rupture. Although endovascular procedures lack long-term outcome data and carry the disadvantage of radiation exposure, the potential risks associated with open surgery and cardiopulmonary bypass during pregnancy made endovascular repair a reasonable treatment option in this patient.

In this case, an exacerbation of superimposed preeclampsia necessitated prompt preterm delivery, resulting in an emergent cesarean section. The feasibility of vaginal delivery in patients with innominate artery aneurysm repaired by endovascular stent graft remains uncertain. According to the guidelines from the American College of Cardiology and the American Heart Association for the diagnosis and management of aortic disease, cesarean delivery is recommended for women with a history of aortic dissection, while vaginal delivery is advised for pregnant patients with an aortopathy and an aortic diameter of less than 4.0 cm.[18] However, these guidelines do not specifically address patients who have undergone surgical or endovascular treatment for aortic aneurysm during pregnancy. Although these guidelines cannot be directly applied to this case, the successful treatment of our patient with a stent graft suggests that vaginal delivery with epidural anesthesia may not be contraindicated, provided that strict blood pressure monitoring is maintained.

In conclusion, while innominate artery aneurysms during pregnancy are exceedingly rare, endovascular repair with a stent graft may be a valid treatment option to prevent serious maternal and fetal complications associated with aneurysm rupture or open surgical repair.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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None.

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