Surgery for acute type A aortic dissection in pregnant patients with Marfan syndrome

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Brief title: Acute type A aortic dissection during pregnancy.

Word count:

Abstract: **Text:**

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(Abstract)

Objective: Acute type A aortic dissection during pregnancy can be fatal to both the mother and the fetus. The goal of the present study was to characterize the prevalence, treatment and outcomes of this dangerous condition in an effort to determine optimal management.

Methods: A retrospective study was conducted using data from four Marfan patients with acute type A aortic dissection during pregnancy at our institution between 1991 and 2003.

Results: The mean gestational period at the time of operative repair was 31 weeks, with a range of 26-34 weeks, and the aortic root diameter ranged from 35 to 85 mm. Two of the four patients underwent a combined operation with caesarean section followed by aortic repair. One patient underwent operative aortic repair following spontaneous delivery. The final patient underwent aortic repair with the fetus remaining *in situ*. Median sternotomy and cardio-pulmonary bypass were established via the femoral artery with direct right atria drainage and left atrial venting in all patients. Composite graft replacement combined with re-implantation of the coronary artery and aortic valve replacement were performed in three patients, and aortic valve replacement with coronary artery bypass grafting of the right coronary artery was performed in one patient. Three of four patients underwent aortic arch repair utilizing antegrade cerebral perfusion and deep hypothermia with total circulatory arrest. The patent that underwent operative correction with the fetus remaining in situ experienced fetal demise with miscarriage just after cardiac surgery, and the patient died four days later secondary to disseminated intravascular coagulation and multi-organ failure. The remaining three cases recovered uneventfully, and the mothers and babies were discharged in good condition.

Conclusions: Based on these data, we advocate Caesarean section with concomitant aortic repair for patients with Marfan syndrome and acute type A aortic dissection during pregnancy. Minimization of deep hypothermic circulatory arrest time is also recommended for cases in which the fetus remains in situ.

Key words: Aortic dissection, Pregnancy, Cardiopulmonary bypass.

1. Introduction

Acute aortic dissection in pregnant woman is often associated with catastrophic outcomes for the mother and

fetus unless prompt surgical management is undertaken. Marfan syndrome is a particularly important predisposing factor for aortic dissection in pregnancy. Because previous studies suggest that type A dissection during pregnancy is associated with aortic root enlargement (> 4cm) or an increase in aortic root size during pregnancy in patients with Marfan syndrome [1.2], echocardiographic monitoring of pregnant patients with Marfan syndrome is critical. The present study reviews four cases of type A acute aortic dissection during late pregnancy in patients with Marfan syndrome . None of the patients had received preconceptional counseling regarding the risks of pregnancy at their institutions nor underwent echocardiographic monitoring of aortic root size. Ultimately, all four patients were referred to our institution for emergent aortic repair. The present study characterizes the treatment and outcomes of these patients in an attempt to further out understanding of this phenomenon and improve management decisions.

2. Materials and Methods

Patient Data

Four cases of acute type A aortic dissection during pregnancy in patients with Marfan syndrome at our institution between 1991 and 2003 were retrospectively reviewed. All four patients had a diagnosis of Marfan syndrome and displayed almost all the classic clinical manifestations of the disease (tall, thin appearance, arachnodactyly, funnel chest, ectopia lentis) as well as a family history of aortic dissection. Two patients were diagnosed with Marfan syndrome during childhood, and all patients were referred for routine prenatal care. However, the diagnosis of Marfan syndrome was not recognized by the obstetrician at the time of referral to our hospital. Thus, none of the patients had received preconceptional counseling regarding the risks of pregnancy at their institutions nor underwent echocardiographic monitoring of aortic root size. The preoperative condition of all patients is summarized in Table 1. Mean patient age was 31.8±2.28 years, with a range of 28-34 years old. The mean gestational period at the time of operative repair was 31 weeks, with a range of 26-34 weeks. One patient experienced threatened premature birth. Three of four cases consisted of DeBakey type I aortic dissection, while the remaining case was classified as DeBakey type II aortic dissection. The diagnosis was confirmed by

echocardiography and/or computerized tomography, which demonstrated an enlarged aortic root (diameter range, 35-85 mm).

3.Results

Operations

All cases underwent operative repair within one day of referral to our institution. Treatment and operative procedures are summarized in Table 2. Two of the four patients underwent a combined operation, consisting of caesarean section followed by aortic repair. One patient underwent operative repair following spontaneous delivery, because the patient's cervix was dilated and effaced, and premature rupture of the membrane had already occurred (case 3). The patient with threatened premature birth progressed rapidly, leaving insufficient time to establish epidural anesthesia. The remaining patient underwent operative repair with the fetus remaining in situ, because the patient refused caesarean section (case 2). Fentanyl anesthesia was selected by all the patients for cardiovascular repair, and general anesthesia with fentanyl was used for Caesarean section in two patients. In one case, a baby was delivered with a 1-min Apgar score of 1, necessitating intubation. This outcome is likely related to the high dose fentanyl anesthesia.

Median sternotomy and cardiopulmonary bypass were established for all patients via cannulation of the femoral artery with direct right atrial drainage and left atrial venting through right upper pulmonary vein. Next,cross-clamping of ascending aorta and aortotomy were performed, and St. Thomas solution was selectively infused into each of the coronary artery ostia. One patient with destruction of right coronary ostium required retrograde myocardial protection for right coronary. Three patients underwent antegrade cerebral perfusion and deep hypothermia (blood temperature of 20°C) with total circulatory arrest for aortic arch replacement, while the remaining patient underwent mild hypothermia (blood temperature of 32°C). Composite graft replacement combined with reimplantation of the coronary artery and aortic valve replacement were performed in three patients, and aortic valve replacement with coronary artery bypass grafting of the right coronary artery was performed in one patient. Aortic arch replacement and 'elephant trunk' for distal anastomosis of the descending aorta was performed in three patients. The operative time, cardiopulmonary bypass time, aortic clamping time,

anterior cerebral perfusion time, are circulatory arrest time are summarized in Table 2. Uterine and vaginal bleeding did not occur in any of the patients during or after cardiovascular repair.

Morbidity and Mortality

Outcomes following operative repair are summarized in Table 3. One mother and baby died (case 2); this patient underwent operative repair with the fetus remaining in situ and experienced fetal loss just after completing surgery. During cardiopulmonary bypass, maternal blood pressure was controlled between 70-80 mmHg with a pump blood flow rate of 2.6-3.0 L/min/m^2 per minute, but the fetal heart rate showed gradual deceleration with subsequent arrest. Total aortic arch replacement and aortic root replacement proceeded with antegrade cerebral perfusion and deep hypothermia. Fetal monitoring failed to detect a sustained heart rhythm after weaning from cardiopulmonary bypass and completion of cardiovascular repair. Fetal demise was diagnosed, and a stillborn fetus was delivered spontaneously on the following day. Postoperatively, her laboratory data demonstrated severe hepatic, renal dysfunction, acidosis, and coagulopathy. And the patient developed multi-organ failure and disseminated intravascular coagulation, and she died four days later.

The remaining three patients recovered uneventfully, and the mothers and their newborns were discharged in good condition. Three live fetuses were delivered (caesarean section, n=2; spontaneous delivery, n=1). Birth weights were 1680, 2132 and 1443g, respectively, and the 1-min Apgar scores were 1, 5 and 10, respectively. The newborn with the Apgar score of 1 required intubation, but all newborns were discharged in good condition. Neurological or mental impairment or Marfan-like appearance was not observed in any of the newborns.

The three surviving women were healthy at an average follow-up time point of 86.3 months after their date of discharge (range, 18 to 168 months). Subsequent pregnancies did not occur in any of the patients. One patient required graft replacement of the descending aorta two year later, thoraco-abdominal graft replacement two year later, and graft replacement of the right subclavian artery 12 years later secondary to chronic dissection. The three children that were discharged were alive and healthy and did not experience any operation-related adverse events.

4. Discussion

Aortic dissection is rare in young women but is more frequent in the context of pregnancy secondary to the hyperdynamic and hypervolemic circulatory state associated with pregnancy [1]. Marfan syndrome is a particularly important predisposing factor for aortic dissection in pregnancy, and women with this disease should receive preconception counseling regarding the risks to both the mother and the fetus [1][2]. Review of more than one million patient records between 1991 to 2003 at our institution identified five patients that developed acute aortic dissection during pregnancy. The four patients with type A dissection were described in the present study, while identification of one patient with type B dissection (33 year old female, 38th week of gestation) resulted in the safe delivery of a healthy newborn without complications to the mother.

Another study [3] identified five cases of aortic dissection in a total of 44 women with Marfan syndrome (78 pregnancies beyond 24 weeks of gestation). Unfortunately, the prevalence of acute aortic dissections in pregnant patients with Marfan syndrome could not be determined from retrospective review of our records, because: (1) patients were either unaware of their diagnosis of Marfan syndrome or simply uninterested in the implications of the disease towards and their pregnancy, or (2) many gynecologists in Japan are unaware of the implications of a diagnosis of Marfan syndrome in pregnant patients and, thus, do not perform proper screening for the disease.

Rossiter et al [2] and Immer et al [4] reported that favorable maternal and fetal outcomes in the context of Marfan syndrome were associated with an aortic root diameter of < 40 mm and the absence of subsequent aortic root dilatation. However, in the present study, one patient presented with aortic dissection despite having an aortic root diameter of < 40 mm. Thus, smaller aortic root diameter cannot rule out the occurrence of aortic dissection in pregnant Marfan parents.

Surgery for acute aortic dissection during pregnancy has been described by other investigators [4.5], and favorable outcomes for pregnant women with acute type A dissection occurring late in pregnancy have been reported [4.5]. However, in most cases, the fetal outcome was relatively poor [4], likely secondary to variables associated with delivery of the fetus, fetus maturity and the condition of the fetus in situ. In combination with the present cases series, these data suggest that, in cases of fetal maturity, caesarean section should be performed before or in combination with cardiovascular surgery [4]. However, the appropriate surgical management for acute type A dissection with an immature fetus in utero remains unclear. Review of the literature suggests that

cardiopulmonary bypass during pregnancy is associated with maternal mortality of only 3% but a fetal poor mortality of 20% [6]. Thus, cardiopulmonary bypass with the fetus in utero may itself represent a risk factor. Further, studies have demonstrated that hypothermia during cardiopulmonary bypass results in uterine contraction and reduces placental blood flow [6], while re-warming from hypothermia may induce uterine contractions and premature labor. By contrast, Becker [7] suggested that high-flow, high pressure normothermic perfusion during cardiopulmonary bypass is probably safer for the fetus than the use of hypothermia during cardiopulmonary bypass.

Cardiovascular operation using deep hypothermia with total circulatory arrest for aortic repair may be associated with an even higher risk of fetal mortality. Mul et al. [8] reviewed a case of acute type A aortic dissection at 29 weeks' gestation. The patient underwent aortic root replacement under deep hypothermia and circulatory arrest, resulting in delivery at 38 weeks' gestation of a female infant with progressive brain atrophy. However, another study described a case of successful repair of a ruptured aortic arch aneurysm using deep hypothermic circulatory arrest at 21 weeks' gestation [9].Both the mother and the fetus survived, and a normal infant was delivered at 39th weeks of gestation.

The case in which operative repair was attempted with the fetus remaining in situ resulted in death of the mother and fetus. During cardiopulmonary bypass in this case, maternal blood pressure was controlled, but the fetal heart rate showed gradual deceleration with subsequent arrest. Of note, the cardiopulmonary bypass and deep hypothermia with circulatory arrest times were relative long (Table 2). Further, the aortic dissection extended from the aortic root to the iliac bifurcation. This, combined with the face that the femoral artery was used for cardiopulmonary bypass, raises the possibility that the patient developed interruption of splanchnic blood flow, resulting in bowel, hepatic, renal and placental ischemia and necrosis. Moreover, despite fetal immaturity, caesarean section at gestational week 26 may have produced improved outcomes for both the fetus and the patient, as postnatal therapy for immature infants has rapidly improved over the past decade. Thus, in retrospect, the patient may have benefited from cardiopulmonary bypass with cannulation of the right axillary artery and femoral artery for prevention of malperfusion and/or from caesarean section before aortic repair.

In conclusion, emergent delivery of the fetus is recommended for pregnant women with type A aortic

dissection prior to emergent aortic repair. Other strategies, including minimization of deep hypothermic circulatory arresting time and institution of concomitant right axillary and femoral artery cannulation for cardiopulmonary bypass may be of benefit in cases in which the fetus remains in situ.

Table 1. Patient characteristics.

Case	1	2	3	4
Patient				
Age (y)	32	33	28	34
Gravida	1	1	1	3
Para	0	0	0	2
Gestation (wk)	33	26	30	34
Marfan	Yes	Yes	Yes	Yes
Dissection type	Stanford A DeBakey I	Stanford A DeBakey I	Stanford A DeBakey II	Stanford A DeBakey I
Aortic valve regurgitation	mild ~ severe	severe	severe	severe
Aortic root diameter	35mm	55mm	85mm	60mm

Table 2. Operative procedures of the patients

Case	1	2	3	4
Fetus delivery				
Delivery method	Caesarean section	(fetus in utero)	Spontaneous delivery	Cesarean section
Anesthesia	General anesthesia with fentanyl	-	Local anesthesia	General anesthesia with propofol and fentanyl
Birth weight	2132g	-	1443g	1680g
1-min Apgar score at birth	5	-	10	1
Cardiovascular surgery				
Operative procedure	Aortic valve replacement, CABGx1 and arch replacement	Aortic root replacement and arch replacement	Aortic root replacement	Aortic root replacement and arch replacement
Operation time	1475min	665min	440min	513min
CPB time	357min	367min	177min	287min
Cannulated artery	femoral artery	femoral artery	femoral artery	femoral artery
Lowest temperature	20℃	20℃	32℃	20℃
Open distal anastomosis	Yes	Yes	No	Yes
Circulatory arresting time	104min	80min	-	66min
Cerebral perfusion	Antegrade	Antegrade	Antegrade	Antegrade

CABG : coronary artery bypass grafting CPB : cardiopulmonary bypass

Table.3 Outcomes of the mother and fetus

Case	1	2	3	4
Mother				
Complications	None	MOF and DIC	Respiratory failure	none
Early outcome	Alive	Dead (4 days after surgery)	Alive	Alive
Late outcomes	Alive and well in 168 month	-	Alive and well in 73 in 73 month	Alive and well in 18 in 18 month
Late operations	Operation of thoraco-abdominal aortic aneurysm and rt. subclavian arterial aneurysm	-	-	-
Fetus				
Early outcomes	Alive	Dead	Alive	Alive
Complications	No	Disappearance of the fetal heart sound after CPB	No	No
Neurological impairment	No	-	No	No
Mental impairment	No	-	No	No
Late outcomes	Alive and well	-	Alive and well	Alive and well

MOF : multiple organ failure DIC : disseminated intravascular coagulation

CPB : cardiopulmonary bypass

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