

Microsurgical and Endovascular Management of Congenital Iliac Aneurysms in the Neonatal Period: Two Cases and a Literature Review

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WHAT THIS PAPER ADDS

The management of congenital aneurysmal disease in neonates is largely based on experience treating similar pathologies in larger children and adults. Congenital iliac artery aneurysms have been discussed even less than their aortic counterparts in the literature, and management decisions are therefore difficult to make in such cases. This study assembles the authors' experience with congenital iliac aneurysms with previously published reports to guide surgeons to confidently work up, refer, and manage neonates with these rare, but life threatening congenital anomalies.

Introduction: Congenital aneurysms of major arteries are very rare diagnoses and prognosis can be poor if treatment is not initiated rapidly. This is the presentation of two cases of infants with congenital iliac aneurysms who underwent treatment in the neonatal period. The report then proceeds with a literature review of paediatric iliac aneurysms.

Report: *Case 1:* A female neonate was diagnosed antenatally with right common iliac (CIA) and internal iliac (IIA) artery aneurysms. Embolisation on day of life (DOL) eight was impossible because of partial thrombosis. The infant was subsequently observed for several months and the aneurysm was injected percutaneously with thrombin on DOL 78. A small residual aneurysm was coil embolised at five months of age. Satisfactory results were observed at one year follow up. *Case 2:* A female neonate was diagnosed antenatally on routine third trimester ultrasound with voluminous, bilateral CIA aneurysms. The patient underwent surgery on DOL 9 for aneurysm resection and microsurgical vascular reconstruction. The intervention was successful with triphasic flow through the anastomoses on colour Doppler ultrasound at six week follow up.

Discussion: Ten cases of congenital iliac aneurysms have been reported previously, with just two diagnosed in the neonatal period and eight undergoing surgical intervention. Definitive management to avoid aneurysm rupture or thrombosis should be timed carefully, and sometimes delayed with watchful waiting, to maximise success and minimise complications. Surgery is the key treatment modality, but endovascular intervention can be considered in selected cases. Congenital iliac aneurysms should be addressed at the safest time for the patient. Following resection, primary microvascular anastomosis is the ideal reconstructive technique, but other options for neonates have been described. Endovascular treatment should be considered for anatomically amenable saccular aneurysms. © 2021 Published by Elsevier Ltd on behalf of European Society for Vascular Surgery. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

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INTRODUCTION

Aneurysmal disease of major arteries is an overwhelmingly rare diagnosis in the paediatric population, and even more so in the neonatal period. Most such aneurysms are secondary to connective tissue disorders, vasculitides, or trauma.¹ True primary or congenital aneurysms are even less common. Although genetic mechanisms have been suggested through associations with syndromic causes, the aetiology of congenital aneurysms is uncertain.

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Aneurysmal disease of the aorta carries a mortality of up to 30% in the neonatal population.² Iliac aneurysms, an even rarer pathology than their aortic counterparts, can also be lethal if they rupture. The potential mortality of aorto-iliac aneurysms in neonates highlights the importance of timely and effective treatment of these rare disorders. This study presents institutional experience with two cases of congenital iliac aneurysms treated using endovascular and microsurgical techniques by a multidisciplinary group of neonatologists, paediatric intensivists, surgeons, and interventional radiologists. This is followed by a detailed review of the literature on congenital iliac aneurysms.

CASES

Case 1

The female singleton foetus of a healthy mother was born by induced vaginal delivery at an outside institution at 40 weeks' gestation. The pregnancy was notable for an antenatal diagnosis of a presumed right ovarian cyst in the foetus on the 34 week ultrasound. A colour Doppler ultrasound on the first day of life (DOL) revealed aneurysmal dilatation of the right iliac artery, for which the child was transferred to the study centre. A repeat ultrasound at the centre was followed by abdominal CT angiography (CTA), revealing a $2.0 \times 2.2 \times 4.0$ cm saccular aneurysm of the right common iliac artery (CIA) beginning at the bifurcation with extension into the internal iliac artery (IIA). The sac was partially thrombosed inferiorly (Fig. 1A) and there was absence of opacification of the external iliac artery (EIA) but opacification of the common femoral artery via collaterals from the IIA. Extensive collateralisation provided circulation to the right lower limb. Genetic, cardiac, and rheumatological workups ruled out connective tissue disorders and vasculitides.

On DOL 8, abdominal angiography was undertaken via left axillary artery access (Fig. 1B). The proximal right CIA was noted to be normal over a length of 1.0 cm. The

aortography revealed dilatation of the distal part of the CIA with absence of opacification of the EIA. Aneurysmal thrombosis was noted to have progressed compared with the initial CTA and it was therefore elected to observe the patient given the possibility of spontaneous aneurysm closure. The procedure was complicated by left axillobrachial occlusion secondary to thrombosis and/or spasm, which resolved with 48 hours of systemic heparinisation.

The patient was subsequently followed as an outpatient and ultimately brought back on DOL 78 for an attempt at ultrasound guided percutaneous puncture of the aneurysm (Fig. 2A). Thrombin (150 IU) was injected directly into the aneurysm sac (Fig. 2B). A follow up ultrasound at five months of age demonstrated a residual 1.8×1.2 cm aneurysm. The case was discussed at multidisciplinary rounds and a decision made to proceed with a third angiogram via the left axillary artery. Complete absence of angiographic opacification of the EIA was noted with collateralisation from the middle sacral artery. The residual aneurysm was successfully embolised with four interlocking detachable coils (IDC) (Fig. 2C and D). At one year of follow up, the patient was healthy with a patent left axillary artery, and no residual iliac aneurysm or signs of peripheral vascular disease or limb length discrepancy.

Case 2

A singleton female was born at the study institution by induced vaginal delivery at 38 weeks' gestation for voluminous bilateral iliac artery aneurysms diagnosed on antenatal ultrasound at 21 weeks' gestation. She was born from a non-consanguineous union to a healthy 25 year old woman of Central African origin with a history of two prior uneventful pregnancies. There was no family history of congenital anomalies, collagen disorders, or vascular malformations. The patient was seen postnatally by the cardiology, dermatology, and genetics services, who found no evidence of cardiac anomalies, stigmata of neurofibromatosis, nor any

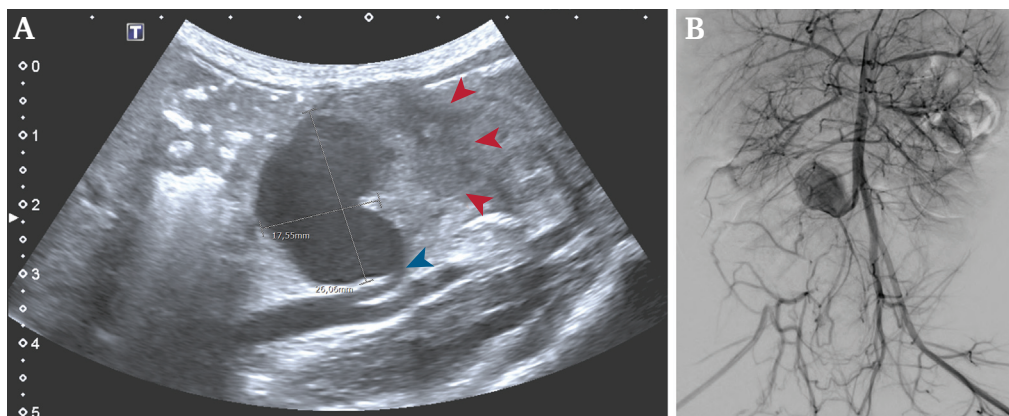


Figure 1. (A) Ultrasound of the right iliac region on day of life 2 showing a 1.75×2.61 cm hypoechoic lesion, with evidence of thrombosis of the inferior portion (red arrowheads) and ingress of a vascular structure (blue arrowhead). (B) Abdominal angiography on day of life 8 demonstrates a large saccular aneurysm of the right common iliac artery with extension into the internal iliac artery and extensive collateralisation to supply circulation to the distal external iliac artery.

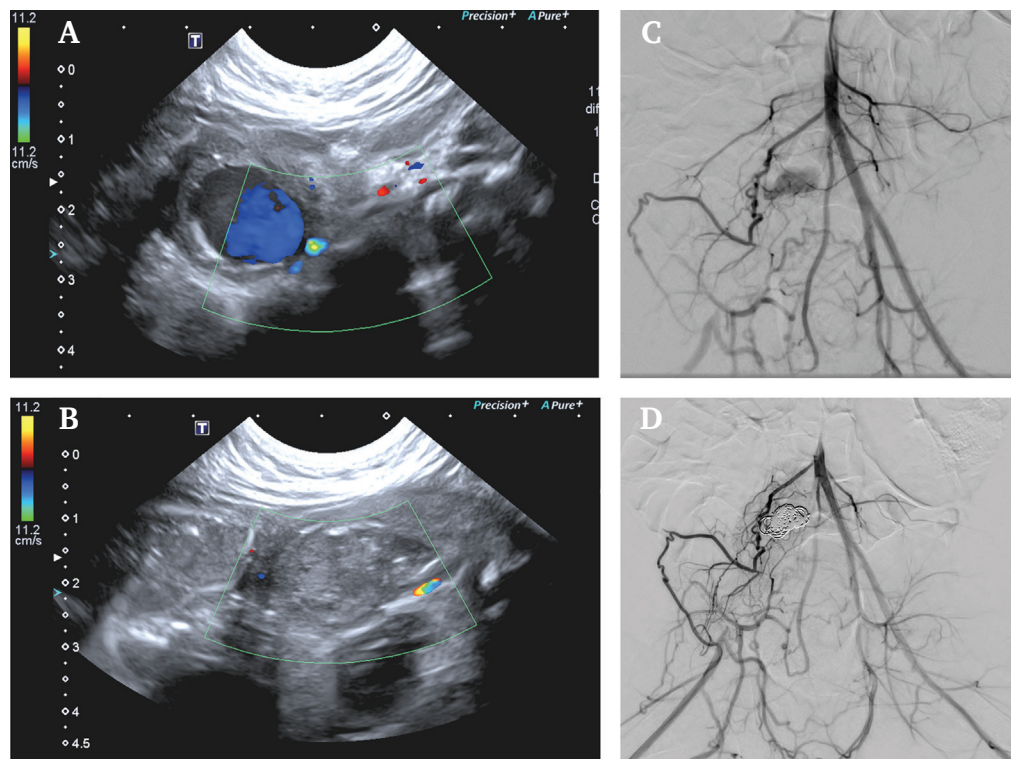


Figure 2. (A) Colour Doppler ultrasound of the right common iliac artery aneurysm on day of life 78 showing blood flow within the dilatation. (B) After percutaneous injection of 150 IU of thrombin, no blood flow is seen. (C) At five months of age, repeat abdominal angiography reveals partial opacification of the aneurysm sac, with a small right common iliac artery and a large middle sacral artery perfusing the right lower extremity along with multiple small retroperitoneal collaterals. (D) After deployment of four interlocking detachable coils, no opacification of the aneurysm is noted.

dysmorphism. A panel for Marfan's disease and collagen vascular diseases was normal. Whole genome analysis revealed no disease causing mutations.

An abdominal CTA was performed on DOL 1 revealing a saccular aneurysm of the right CIA just below the bifurcation measuring $2.3 \times 3.7 \times 2.3$ cm and the right IIA measuring $2.1 \times 2.0 \times 3.3$ cm (Fig. 3). The right EIA emerged from the first sacculatum and the right IIA emerged from the second. An additional saccular aneurysm of the left CIA starting just below the bifurcation measured $2.1 \times 2.4 \times 2.5$ cm. A fusiform aneurysm of the right renal artery measured $4.9 \times 3.9 \times 3.8$ mm. The patient was taken to the angiography suite on DOL 2 to better characterise these anomalies. It was elected not to proceed with coil embolisation of the aneurysms because of the perceived threat to lower extremity perfusion.

The patient was subsequently taken to the operating room on DOL 9 for aneurysm resection and vascular reconstruction because of the significant risk of rupture. Following a midline laparotomy, the distal aorta and iliac tree were exposed. Proximal and distal control were obtained using vessel loops. Heparin 75 IU/kg was administered. The left CIA aneurysm ended above its bifurcation and was resected to this level. The right CIA aneurysm took off just beyond the aortic bifurcation, occupying the entirety of the CIA and the proximal right IIA. Its two sacculatums were indistinct and

were resected en bloc (Fig. 4A). The right IIA was filiform and its distal stump was ligated.

Microsurgical anastomosis of the aorta to the left CIA was performed with interrupted 7-0 polydioxanone suture in an end to end fashion. The right EIA was anastomosed to the left CIA in an end to side fashion using interrupted 9-0 nylon sutures (Fig. 4B). Aortic cross clamp time was 105 minutes. The patient was anticoagulated with heparin 28 IU/kg/hour and administered acetylsalicylic acid (ASA) 2 mg/kg daily in the immediate post-operative period. Her post-operative course was uneventful aside from ileus and concern for possible bacterial translocation, for which she was treated with a 14 day course of piperacillin-tazobactam and prophylactic fluconazole. She was discharged home on POD 16 with ASA, amoxicillin-clavulanic acid, and fluconazole. Colour Doppler abdominal ultrasound six weeks post-operatively revealed triphasic flow through the reconstructed vascular tree with a small, haemodynamically insignificant proximal narrowing and no false aneurysm.

DISCUSSION

Congenital iliac artery aneurysms: a review of the literature

Per the International Society for the Study of Vascular Anomalies (ISSVA), true congenital arterial aneurysms are

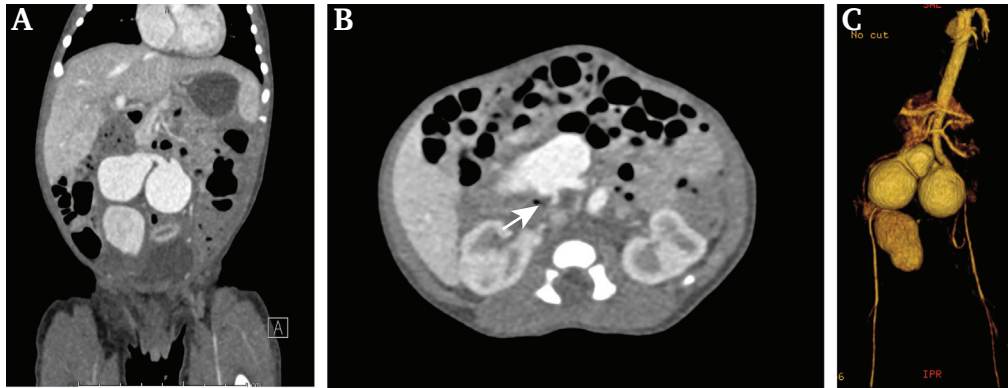


Figure 3. (A) A coronal cut of abdominal computed tomography angiogram performed on day of life 1 reveals aorto-iliac aneurysmal disease with three distinct sacculations. (B) An axial cut demonstrates take off of the aneurysmal dilatation from the distal aorta (arrow). (C) Three dimensional reconstruction allows anatomic visualisation of the two right sided saccular aneurysms and the single sacculaton affecting the left common iliac artery (see Fig. S1 for an animated version of this 3D reconstruction).

classified as truncular malformations of major named vessels.³ They are defined through the absence of causative pathology, such as connective tissue disorders (e.g., Marfan's syndrome, Loey's-Dietz syndrome, vascular-type Ehlers Danlos syndrome, tuberous sclerosis), vasculitides (e.g., Kawasaki's disease, Takayasu arteritis, giant cell arteritis), or trauma.¹ Isolated aneurysms of the iliac arterial system are very rare, with an estimated prevalence of 0.03%,⁴ and congenital cases are rarer still. To identify previously reported cases of congenital iliac artery aneurysm, a search was undertaken of the MEDLINE database using the PubMed search tool and the terms "iliac aneurysm" [MeSH Major Topic] AND "congenital abnormalities" [MeSH Major Topic] OR (congenital iliac artery aneurysm) on 19 April 2020. The bibliographies of papers were assessed for possible inclusions. Studies were manually reviewed for inclusion by the first author (HI) and included if they described cases of isolated iliac artery aneurysms diagnosed in the paediatric period without causative pathology.

Ten cases of isolated congenital iliac artery aneurysms have been reported previously in the English language literature (Table 1). Of these, only two were diagnosed in the neonatal period: one neonate underwent successful coil embolisation,⁵ while the other did not undergo treatment despite developing an eccentric mural thrombosis that decreased vessel calibre, but was healthy at eight months of age.⁶ All other cases were diagnosed between two and 11 years of age after presenting most commonly with a chief complaint of abdominal pain.^{7–11} One case presented with discrepancy in lower limb growth,¹² one presented with an abdominal mass,¹³ while another presented with sepsis and hydroureteronephrosis secondary to extrinsic compression of the ureter.¹⁴ Unilateral CIA involvement was present in five cases, with one further case of bilateral CIA involvement. The IIA was affected along with the CIA in two patients, and the EIA alone in two. Thrombosis was noted in three patients. All non-neonatal patients were treated surgically, with risk of rupture frequently cited as the reason for

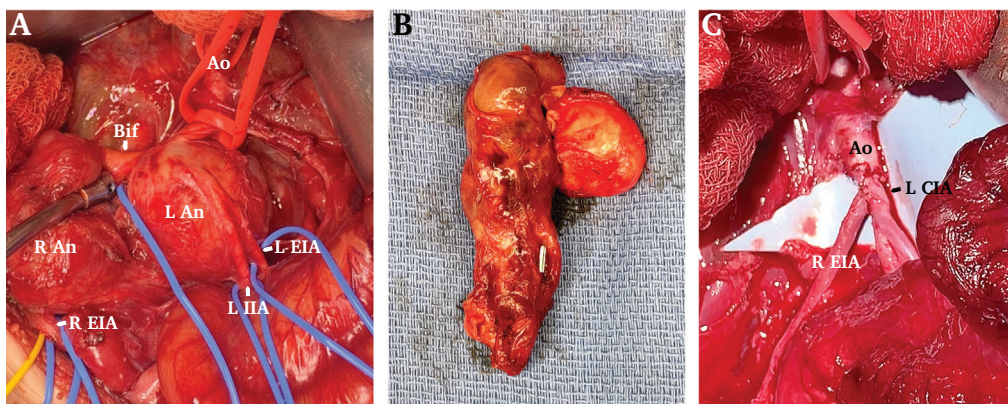


Figure 4. (A) An intra-operative photograph of the aneurysmal anatomy shows the emergence of iliac artery branches from right (R) and left (L) sided aneurysmal masses. (B) Gross examination of the resected aneurysms demonstrates en bloc removal of the right sided common iliac artery (CIA) and internal iliac artery (IIA) aneurysm, and the separate left CIA aneurysm. (C) An intra-operative photograph of the completed microsurgical anastomosis shows the end to end anastomosis of the distal aorta to the L CIA, and the end to side anastomosis of the R EIA to the L CIA. Ao = aorta; Bif = aortic bifurcation; An = aneurysm; EIA = external iliac artery.

Table 1. Clinical characteristics, treatment modalities, and outcomes of 10 previously reported cases of congenital iliac artery aneurysms and the two cases presented in this study

Author, year	Age at diagnosis	Sex	Presentation	Aneurysm location	Maximum diameter – cm	Thrombosis	Age at treatment	Treatment	Outcome
Villani et al., 1985 ¹⁴	7 y	Female	Abdominal pain, hydronephrosis	Left EIA	3	No	7 y	PETE graft	Healthy 14 w post-surgery
Moritz, 1986 ⁷	2.5 y	Female	Vague abdominal pain	Left CIA, IIA	6	No	2.5 y	Resection, anastomosis	None reported
Sarkar et al., 1991 ¹³	4 y	Female	Abdominal mass	Right CIA	6	No	4 y	Cross over ilio-iliac arterial graft	Healthy 9 mo post-surgery
Taketani et al., 1997 ¹²	18 mo	Male	Pulsating abdominal mass, leg growth discrepancy	Multiple left EIA	6	No	3 y	6 mm PTFE graft	Healthy post-surgery (time not specified)
Zimmermann et al., 2009 ¹¹	11 y	Female	Acute abdominal pain	Left CIA	4.2	No	11 y	Autologous femoral vein graft, iliofemoral bypass with GSV graft	None reported
Lopez-Gutierrez et al., 2012 ⁶	DOL 1	Male	Left lower limb hypoplasia	Left CIA, tortuosity of whole limb arterial vasculature	Not specified	Yes	N/A	None	Healthy at 8 mo of age
Chithra et al., 2013 ¹⁰	3 y	Male	Intermittent abdominal pain	Bilateral CIA	3	No	3 y	Autologous femoral vein grafts	Healthy 3 mo post-surgery
Lee et al., 2016 ⁹	4 y	Female	Intermittent abdominal pain	Right CIA	5	Yes	4 y	Excision	Healthy 5 mo post-surgery
Krysiak et al., 2019 ⁵	3 d	Female	Routine abdominal U/S for prematurity	Right CIA	4.5	No	61 d	Coil embolisation	Healthy 3 mo post-treatment
Zaidan et al., 2019 ⁸	9 y	Female	Acute abdominal pain	Right CIA, IIA	8.3	Yes	9 y	7 mm PTFE graft	Healthy 24 mo post-surgery
Iyer et al., 2020	34 w GA	Female	Antenatal ultrasound (as ovarian cyst)	Right CIA, IIA	4.0	Yes	78 d	Percutaneous thrombin injection, coil embolisation	Healthy 1 y post-treatment
Iyer et al., 2020	21 w GA	Female	Antenatal ultrasound	Right CIA, IIA; Left CIA	3.7	No	9 d	Excision, anastomosis	Healthy 1 mo post-surgery

EIA = external iliac artery; PETE = polyethylene terephthalate (Dacron); CIA = common iliac artery; IIA = internal iliac artery; PTFE = polytetrafluoroethylene (Gore-Tex); GSV = great saphenous vein; DOL = day of life; U/S = ultrasound; GA = gestational age.

operative intervention. Simple excision and re-anastomosis was used in two of six cases, autologous grafting with the femoral vein was used in another two, and prosthetic grafts were used in the final three. The only reported complication was a single case of surgically managed post-operative bleeding.¹¹

The present study adds to the existing literature by presenting two new cases of CIA aneurysms diagnosed antenatally and managed during the neonatal period. One patient was successfully managed by early surgical resection and primary anastomosis on DOL 9 (case 2), while the other underwent percutaneous endovascular techniques in a slightly more delayed fashion because of technical difficulty with definitive management early on (case 1). Prompt management with surgery or endovascular therapy is paramount given the high risk of death in the event of aneurysm rupture. Further, the use of microsurgery can decrease the risk of anastomotic stricture in small neonatal vessels.

Watchful waiting appears to be safe in carefully selected patients

A 2015 systematic review of 26 reported cases of congenital abdominal aortic aneurysms (AAA) revealed an overall mortality rate of almost 31%, with rupture, renal and cardiovascular failure being the most common causes.² When patients died, they did so prior to five weeks of life. Rupture occurred in three of 26 patients: on DOL 1, DOL 28, and one year of age. All aneurysm ruptures were immediately fatal. The review of the literature revealed no reported deaths from congenital iliac artery aneurysm rupture, and diagnosis was made after two and up to 11 years of age in six of nine heretofore described cases. While the true incidence and rate of rupture are difficult to ascertain without population based post-mortem data, this indicates that a large subset of aneurysms progress indolently over the course of early childhood. Taketani et al. reported the longest wait between diagnosis and treatment with a safe delay of 18 months,¹² during which time the child probably grew making operative intervention safer.

Although the timeline for aneurysm thrombosis development is ill defined in the neonatal population, one case report diagnosed aortic thrombosis at DOL 9 in a 2.5 cm aneurysm,¹⁵ while another did so at eight months of age in a 3 cm lesion.¹⁶ The authors' own experience with a case of neonatal AAA¹⁷ revealed thrombosis as early as DOL 2 in a large, 3.3 cm sac. Progression of this thrombus despite anticoagulation spurred the surgical team to operate on DOL 14. The review of the literature and cases revealed thrombosis in four of 12 known cases of congenital iliac artery aneurysms, although these were diagnosed anywhere between the neonatal period and nine years of age. The natural history of progression and risk of embolisation is unclear in the absence of further data.

Both the literature and the authors' own experience seem to suggest that it may often be safe to delay the management of congenital iliac aneurysms until such time

as the child has achieved sufficient size and physiological reserve to allow easier, complication free surgery with greater potential for success and reduced mortality. Surgery in the neonatal period is fraught with difficulties and should be avoided if possible to safely do so. Endovascular intervention is equally difficult in tiny infants. Large aneurysms, growing aneurysms, or thrombosed aneurysms represent exceptions to this rule as their risk of rupture or embolisation can outweigh the benefits of waiting. Symptomatic disease, especially in a child of sufficient size to tolerate treatment, can also be addressed immediately. In those patients who are candidates for watchful waiting, serial abdominal ultrasounds are an important tool that can identify a rapidly growing aneurysm or developing thrombus.

Wang's review of congenital AAA showed that, of seven patients treated conservatively, five died, with two deaths directly attributable to aneurysm burden.² Conservative management, in the authors' view, should be limited to patients with an already limited life expectancy that cannot reasonably be extended by treatment, or to those for whom surgery carries an unacceptably high risk of death. The chief modalities of conservative management are observation with serial imaging as described previously, as well as symptomatic treatment. Pharmacological measures such as antihypertensives and antiplatelet agents have no proven role in counteracting the pathophysiology of congenital disease. If appropriate expertise does not exist in a given centre, early transfer to a centre with microsurgical and endovascular experience in neonatal patients should be pursued to reduce the incidence of complications.

Crucial to early treatment is early diagnosis, with the latter ideally occurring antenatally. Of the previously reported 26 cases of congenital AAA, only seven were diagnosed on routine prenatal ultrasound between 19 and 34 weeks' gestation. While some authors have suggested a role for foetal MRI in further characterisation of the malformation,^{18,19} the two cases described above were detected on ultrasound between 21 and 36 weeks' gestation, allowing for maternal transfer to the quaternary mother-child hospital for prenatal investigations, delivery, and subsequent management of the infant in the neonatal intensive care unit.

Surgery is the mainstay of treatment

Although an endovascular approach may be considered in the neonatal population, aneurysmal location, anatomy, progression, and thrombosis may preclude the effective use of such techniques. Surgery then becomes the main therapeutic avenue in preventing the potentially deadly complications of aorto-iliac aneurysms. Reduced vessel calibre in neonates adds an additional challenge to a difficult procedure, but the inclusion of microsurgeons and an operating microscope in the surgical plan can compensate for this. Plastic and reconstructive microsurgeons are trained in the meticulous handling of vessels down to the sub-millimetric scale. Their involvement in paediatric living

donor hepatic transplantation has been shown to decrease hepatic artery thrombosis rates to under 5%,²⁰ and modern day series of free flap reconstruction have success rates over 98%.²¹

Vascular surgery in neonates comes with the additional concern of choosing the right reconstructive technique, given the increased risk of thrombosis in small calibre vessels and potential for graft-vessel size mismatch with growth. A systematic review of 26 AAAs included nine that were repaired with alloplastic interposition grafts, three with cryopreserved allografts, and only one by primary anastomosis.² The authors' own review of iliac aneurysms revealed two cases where PTFE grafts were used, two cases of autologous vein grafting, and just one case of primary anastomosis (Table 1).

In the authors' view, aneurysm excision is best followed by primary anastomosis to avoid graft related complications. Unfortunately, this is sometimes technically not feasible. Autologous vein grafting is the next best option, using iliac veins, recanalised umbilical veins, or great saphenous veins. Autografts have no risk of immunologically mediated thrombosis or growth restriction with age. Saphenous vein harvest has, however, been associated with a low rate of aneurysmal change in the long term, mostly described in coronary artery bypass grafting,²² and carries the long term risk of donor site venous stasis, while some autologous grafts may be too small to be easily used in small neonates. Allografts from cadaveric sources,²³ or xenografts such as bovine jugular veins,²⁴ have shown good mid to long term patency and advantages over prosthetic reconstruction with respect to thrombosis and growth,²⁵ albeit mostly in pulmonary artery reconstruction with uncertain translatability to the higher pressure iliac system. Prosthetic grafting is suboptimal in the neonatal population because of susceptibility to thrombosis at calibres under 6 mm.²⁶ Their inability to grow can lead to size mismatch at the time of surgery, or later in life with resultant stenosis and the need for re-operation. In addition, they carry long term risks of late infection, false aneurysm, and calcification.²⁷

Saccular aneurysms are most amenable to endovascular intervention

Endovascular intervention for aorto-iliac aneurysmal disease has evolved over the past two decades to become the default approach for even the most complex cases in many adult centres, but endovascular stent grafts have yet to be developed for paediatric indications. Usefulness of such grafts would be limited by fabrication from non-growing synthetic materials and neonates' propensity to develop robust collateralisation.

Among congenital aneurysms, saccular outpouchings that can be embolised with thrombin injection and/or coils are best treated endovascularly, as use of this approach avoids the placement of foreign material within a vessel lumen, and the associated risks of downstream stenosis or endoleak. The development of collateral circulation may help in minimising the risk of developing distal ischaemia. The percutaneous avenue for aneurysm embolisation is certainly attractive

when anatomy permits; the thin, non-adipose abdominal wall of neonates makes this technically possible. This avoids cannulation of peripheral arteries and associated complications such as thrombosis, bleeding, or dissection.

Only one other case report described endovascular management of congenital iliac artery aneurysms. Krysiak et al. reported in 2019 on the percutaneous placement of six coils and 350 IU of thrombin in a growing right CIA aneurysm in a 61 day old female.⁵ Robust collateral circulation to the right common femoral artery allowed for embolisation of this vessel. Care must be taken with thrombin injection to ensure that distal embolisation to limb vasculature does not occur, and that thrombolytic agents are readily available in case it does. In the first case described here, percutaneous injection of thrombin into a saccular right CIA/IIA aneurysm was performed at DOL 78, with further treatment by coil embolisation required five months later. Coil embolisation is also an effective, permanent solution for inducing thrombosis when the anatomy permits. Shoji et al. reported in 2018 on the successful deployment of microcoils into a mycotic IIA aneurysm in a 28 day old infant.²⁶ Interlocking detachable coils (IDC) are a judicious choice for embolisation given evidence of decreased procedure time, radiation dose, and time to vessel occlusion,²⁸ all particularly important considerations in a neonate.

Conclusions

Congenital iliac aneurysms are rare and care must be taken in planning and expediting treatment to minimise complications. The presented cases and review of the literature demonstrate the importance of early diagnosis and prompt intervention. Surgical intervention with primary microvascular anastomosis should be performed if possible, whereas cadaveric or prosthetic grafting is indicated when primary anastomosis is not feasible. Endovascular techniques may be considered when the aneurysm anatomy is amenable to such therapy. The genetic mystery of congenital aorto-iliac aneurysms has yet to be solved, but future therapeutic avenues may include regenerative bioengineering using the patient's own cells to generate a neo-vascular tree that can be grafted *in vivo*.

CONFLICT OF INTEREST

None.

FUNDING

None.

APPENDIX A. SUPPLEMENTARY DATA

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.ejvsf.2021.06.007>.

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