# Chapter 2
# Endovascular Treatment of Iliac Artery Chronic Total Occlusions

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## 2.1 Introduction

Approximately 8.5 million American adults are affected by peripheral artery disease (PAD). The iliac arteries and infrarenal aorta are among the arterial circulations most commonly affected by atherosclerotic chronic total occlusion (CTO) and constitute approximately one third of cases of PAD. Percutaneous angioplasty for iliac CTO was first described by Tegtmeyer et al. in 1979 in a 55-year-old diabetic woman with nonhealing foot ulcers in association with a CTO of the right common iliac artery (CIA) [1]. While surgical bypass can be performed with high long-term patency for aortoiliac PAD, endovascular interventions are increasingly being used to treat disabling claudication in such patients [2]. Surgical bypass options vary based on the specific anatomy, but include aortofemoral or aorta bi-femoral bypass, iliofemoral bypass, femoral-femoral bypass, and aortoiliac endarterectomy. Surgical bypass is associated with satisfactory improvement in symptoms and long-term patency rates, but such operations may incur significant operative morbidity and mortality. Thus endovascular aortoiliac interventions are often considered as a first-line treatment strategy for symptomatic patients with aortoiliac disease [2, 3].

The Trans-Atlantic Inter-Society Consensus (TASC) II document provides a classification of aortoiliac lesions according to the level of complexity (types A, B, C, and D) that can be used to guide the revascularization approach (Fig. 2.1) [4].

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Type A lesions

- Unilateral or bilateral stenoses of CIA
- Unilateral or bilateral single short (≤3 cm) stenosis of EIA

Type B lesions

- Short (≤3cm) stenosis of infrarenal aorta
- Unilateral CIA occlusion
- Single or multiple stenosis totaling 3–10 cm involving the EIA not extending into the CFA
- Unilateral EIA occlusion not involving the origins of internal iliac or CFA

Type C lesions

- Bilateral CIA occlusions
- Bilateral EIA stenosis 3–10 cm long not extending into the CFA
- Unilateral EIA stenosis extending into the CFA
- Unilateral EIA occlusion that involves the origins of internal iliac and/or CFA
- Heavily calcified unilateral EIA occlusion with or without involvement of origins of internal iliac and/or CFA

Type D lesions

- Infra-renal aortoiliac occlusion
- Diffuse disease involving the aorta and both iliac arteries requiring treatment
- Diffuse multiple stenoses involving the unilateral CIA, EIA, and CFA
- Unilateral occlusions of both CIA and EIA
- Bilateral occlusions of EIA
- Iliac stenoses in patients with AAA requiring treatment and not amenable to endograft placement or other lesions requiring open aortic or iliac surgery

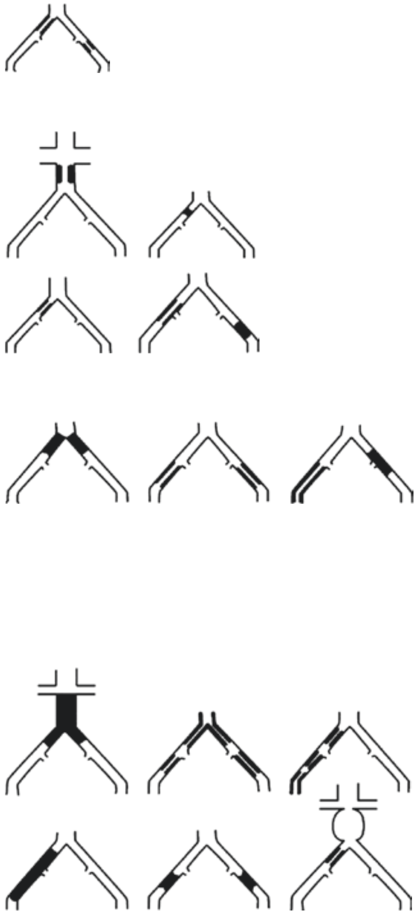

**Fig. 2.1** TASC II classification of aortoiliac peripheral arterial disease. *CIA* common iliac artery, *EIA* external iliac artery, *CFA* common femoral artery, *AAA* abdominal aortic aneurysm (Reproduced with permission from Norgren et al. [4])

Type A lesions are the least complex focal stenoses of the CIA or the external iliac artery (EIA). Type B lesions are unilateral CIA or EIA occlusions (not involving the common femoral artery (CFA) or internal iliac artery (IIA) origins). Type C lesions are bilateral CIA occlusions, unilateral EIA occlusions that are heavily calcified or involve the CFA or IIA origins. Type D occlusions include aortoiliac occlusion, unilateral occlusions of the CIA and EIA, and bilateral EIA occlusions. While the TASC documents recommended endovascular treatment for type B occlusions and surgical bypass for type C and type D lesions, with increasing operator experience, type C and D lesions are increasingly being treated via an endovascular approach [5]. In addition, procedural success rate does not appear to be a function of the TASC II classification (which is primarily defined by anatomic involvement) and may instead be related to underlying characteristics of the occluded segment (e.g., calcification, ease of reentry, etc.).

## 2.2 Outcomes After Endovascular Treatment of Iliac CTOs

Endovascular recanalization assisted with stenting is increasingly being performed in the treatment of iliac CTOs with satisfactory long-term patency rates. Stenting is the primary strategy in the endovascular treatment of iliac occlusions and is associated with high long-term patency rates compared to angioplasty alone [6]. In a meta-analysis of 1300 patients with iliac disease treated with angioplasty or angioplasty with stenting, among patients with stenosis as well as occlusions, patency rates at 4 years were superior for stenting compared to angioplasty alone (61% vs. 54% for chronic limb ischemia patients with iliac CTOs and 53% vs. 44% for claudicants with iliac CTOs) [6].

Most other data regarding long-term outcomes of iliac CTOs treated with stenting are limited to observational studies of one or two centers. Scheinert et al. treated 212 patients with unilateral iliac CTOs via an endovascular approach with excimer laser-assisted recanalization and stent implantation [7]. The authors reported an 84% primary patency rate at 1 year. Contralateral crossover antegrade crossing of the lesion was accomplished in 91%, whereas in the remaining 9% an ipsilateral retrograde approach was used. Similarly, Carnevale et al. treated 69 iliac CTOs with a 97% technical success rate [8]. The primary patency at 1 year was 91%. Leville et al. treated 89 patients with iliac CTOs with a 91% procedural success rate. Three-year primary patency was 76%. The prevalence of TASC B, C, and D lesions was 25%, 34%, and 42%, respectively. Technical success rates were similar at 95%, 94%, and 86% in the different TASC groups, respectively [9].

In a larger observational study, Ozkan et al. treated 127 limbs in 118 patients with iliac CTOs. Lesions were in the common iliac artery, external iliac artery, and combined common and external iliac arteries in 53%, 28%, and 19% of patients, respectively [10]. Seven percent of patients had bilateral common iliac artery (CIA) occlusions, most of whom had total aortoiliac occlusions. Recanalization was attempted from the ipsilateral retrograde approach first, which was successful in 50% of cases. In the case of failed ipsilateral approach, a contralateral crossover antegrade approach was attempted which was subsequently successful in 90% of cases. Primary patency at 5 years was 63%.

Multiple other studies have suggested that the TASC II classification of iliac CTOs may not be associated with procedural success or long-term patency. Chen et al. treated 120 patients with iliac CTOs with successful recanalization in 101 CTOs. 39%, 27%, and 35% of lesions were TASC II types B, C, and D, respectively. A reentry device (Pioneer or Outback) was required in 14% of lesions that were successfully revascularized. The primary patency at 1 year was 86% [10]. Dattilo et al. performed 63 iliac CTO endovascular interventions with a procedural success rate of 97%. 59%, 7%, and 37% of lesions were TASC II types B, C, and D, respectively [5]. Technical success rates were not different in the different TASC II subtypes. Papakostas et al. treated iliac CTOs in 56 limbs in 48 patients by the endovascular approach with stent implantation with a 91% procedural success rate. 30%, 32%, and 38% of lesions were TASC II types B, C, and D, respectively. Primary patency (peak systolic velocity of <2.5% on arterial duplex US) at 3 years was 91%. TASC II type was not associated with procedural success or patency [11].

In summary, current observational studies have demonstrated that iliac artery CTOs can be treated via endovascular techniques with success rates exceeding 90% in most cases. The long-term patency of iliac artery CTOs is also high after successful endovascular treatment, suggesting that endovascular treatment of iliac artery CTOs is a reasonable first-line treatment strategy for most symptomatic iliac artery CTOs.

## 2.3 Treatment Strategies and Illustrative Cases

The approach to iliac CTO endovascular recanalization primarily depends on the anatomic location of the occlusion. This section provides a general overview for treatment of iliac artery CTOs, followed by illustrative cases that demonstrate the technical approach to treatment of specific anatomic subgroups.

### *2.3.1 Overall Approach and Treatment Strategy*

Endovascular treatment of iliac artery CTOs should be based on detailed pre-procedure planning in order to determine the optimal treatment approach and maximize the chances of technical success. In cases where an iliac artery CTO is suspected, pre-procedural CTA imaging can be invaluable in providing specific anatomic detail including the presence and amount of vessel calcification, the location of occlusion and site of reconstitution, and the location of collateral vessels.

Multiple sites of arterial access may be necessary for successful treatment of iliac artery CTOs. Whenever possible, a 7 French sheath should be employed; the larger sheath size makes it possible to deliver covered stents and/or a larger occlusion balloon in the case of iliac artery perforation. The most frequent access involves bilateral common femoral artery access, in order to provide adequate vessel imaging from above and multiple treatment options, including combined antegrade/retrograde crossing in case of challenging lesion crossing. Brachial access may provide additional backup support for challenging lesions, especially ostial or proximal occlusions of the common iliac artery. In such cases, left brachial access should be obtained, and a 90 cm shuttle sheath used to maximize backup support [12]. Radial access may also be useful for aortoiliac imaging or for treatment of proximal common iliac artery disease [13]. However, the shaft length of most endovascular devices makes treatment of more distal external iliac lesions difficult from a radial approach. Rarely, popliteal or pedal access may be necessary for successful treatment of an iliac artery CTO, but should be reserved for cases where there is concomitant common femoral artery disease that may need to be treated from a retrograde approach in order to preserve the bifurcation of the profunda femoris with the superficial femoral artery.

The optimal approach for crossing an iliac artery CTO remains uncertain. Retrograde crossing from ipsilateral common femoral artery access has the advantage of treating from the same side, thereby avoiding the need for a crossover sheath. However, imaging from a retrograde sheath is often suboptimal, and contralateral access may be required regardless to image the proximal lesion cap. Antegrade access may have a higher success rate for crossing of the occlusion, but subsequent treatment usually requires wire externalization, which increases the overall complexity of the procedure. If one wire crossing strategy is not successful, it is reasonable to switch strategies and attempt a "true lumen" crossing from the other direction prior to using dedicated reentry techniques. In some cases, wire advancement may be necessary from both directions simultaneously, followed by a "CART" or "reverse CART" technique to reconcile the subintimal space and cross the cap into the true lumen [14].

No specific data exists on the optimal stent type for treatment of iliac CTOs. Most operators choose a strategy of balloon expandable stents for treatment of common iliac artery disease due to the more predictable deployment of such stents, and a self-expanding stent for treatment of external iliac artery disease, due to the increased conformability of these stents in the tortuous external iliac artery. The COBEST trial did demonstrate superior patency of covered balloon expandable stents in the treatment of TASC C and TASC D lesions, suggesting that this stent type may have some relative benefit in the treatment of complex iliac artery CTOs [15].

### *2.3.2 Ostial Common Iliac or Aortic Bifurcation*

Treatment of ostial CIA occlusion or aortic bifurcation disease involving the bilateral common iliac ostia can most often be accomplished using bilateral retrograde common femoral artery (CFA) access and kissing angioplasty/stenting. Crossing the lesion may be attempted from the retrograde approach initially. Such an approach is associated with 50% success rate [10]. If this approach fails, contralateral crossover antegrade approach is usually successful in crossing the lesion, with a reported 90% success rate based on limited data. Ultrasound guidance or roadmaps are helpful in accessing the patency of the CFA distal to a CIA occlusion, which can determine the use of a short brite tip sheath for distal access. A 7F sheath is required usually due to the caliber of stents required to treat CIA disease, especially if balloon expandable covered stents are used. The stents should be extended approximately 5 mm into the distal abdominal aorta, but the extent of coverage depends on the presence of distal abdominal aorta disease and the angulation of the bifurcation.

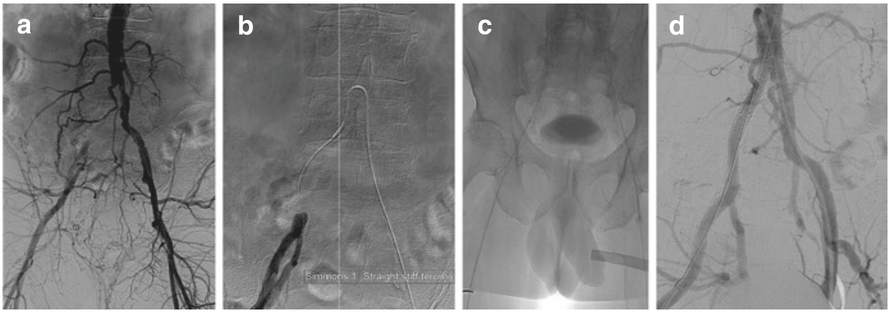


**Fig. 2.2** Digital subtraction aortoiliac angiography showing right CIA occlusion involving the ostium (**a**). Lesion crossed using a 0.035″ straight stiff Glidewire supported by a Simmons 1 catheter (**b**). The wire was exteriorized through the right CFA sheath (**c**). Atrium iCAST stents deployed in kissing stent fashion at bilateral iliac artery origins into the distal abdominal aorta (**d**)

Such an approach will usually prohibit contralateral crossover during subsequent procedures, especially if the stents are extended into the distal aorta. When the common iliac branches are larger in caliber and the distal abdominal aorta may not accommodate the two stents protruding into its lumen, a self-expanding stent may be used. In rare cases, self-expanding covered iliac stent grafts (which are typically used for endovascular aortic repair) may be necessary to accommodate ectatic iliac arteries.

Illustrative cases using an endovascular approach to treat ostial CIA disease are described below:

Case 1. A 65-year-old male with Rutherford Class III right lower extremity claudication and an ostial right CIA occlusion (Fig. 2.2a) was brought to the cardiac catheterization laboratory. 7F bilateral CFA access was obtained using ultrasound guidance and a micropuncture technique. An initial attempt at crossing the occlusion from the right ipsilateral retrograde direction with a 0.035″ straight stiff Glidewire was unsuccessful. A contralateral antegrade approach was successful in crossing the lesion using a 0.035″ straight stiff Glidewire supported by a Simmons 1 catheter (Fig. 2.2a). The wire was exteriorized through the right CFA sheath (Fig. 2.2c) followed by angioplasty and placement of balloon expandable covered stents in kissing stent fashion at the bilateral common iliac artery origins into the distal abdominal aorta (Fig. 2.2d).

Case 2. A 68-year-old male presented with Rutherford Class III bilateral lower extremity claudication. There was a CTO of the left CIA including the ostium and severe proximal stenosis of the right CIA (Fig. 2.3a). 7F bilateral CFA access was obtained using ultrasound guidance and a micropuncture technique. The left CIA occlusion was crossed using a 0.035″ straight stiff Glidewire from the ipsilateral retrograde approach supported by a Navicross catheter (Fig. 2.3b, c). Kissing balloon angioplasty was performed followed by kissing stents placed in the bilateral common iliac arteries proximally extending into the distal abdominal aorta using balloon expandable covered stents (Fig. 2.3d).

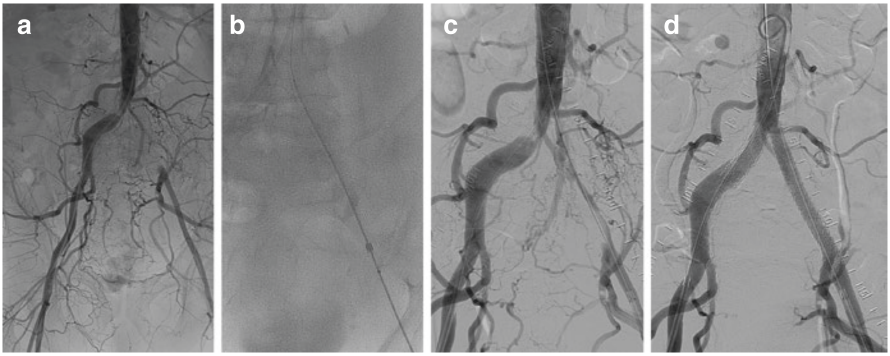


**Fig. 2.3** Digital subtraction aortoiliac angiography showing left CIA occlusion involving the ostium (**a**). The left CIA occlusion was crossed using a 0.035″ straight stiff Glidewire from the ipsilateral retrograde approach supported by a Navicross catheter (**b**, **c**). Kissing stents were placed in bilateral common iliac arteries proximally extending into the distal abdominal aorta using Atrium iCAST balloon covered expandable stents (**d**)

The strategy of using aortoiliac kissing stents has been shown to maintain long-term patency in multiple studies. Mendelsohn et al. treated 20 patients with kissing iliac stents for aortoiliac artery disease involving both ($n = 15$) common iliac artery origins and complex unilateral iliac artery ostial disease [16]. Scheinert et al. treated 48 patients with aortoiliac bifurcation disease (including 22 with unilateral occlusion and contralateral stenosis and one patient with bilateral iliac occlusion) with excimer laser-assisted recanalization and kissing stent placement [17]. The primary angiographic patency at 2 years was 87%. Yilmaz et al. treated 68 patients with aortoiliac disease (including 26 patients with unilateral CIA occlusion and contralateral stenosis) with kissing stents [18]. The primary patency at 1 year was 76%. Self-expanding stents were used in 76%, and balloon expandable stents were used in 24% of patients. Mohamed et al. treated 24 patients with aortoiliac disease with kissing stents and reported a 1-year primary rate of 81% [19]. Predominantly self-expanding stents were used. Bjorses et al. reviewed the use of kissing stents in 173 patients with aortoiliac occlusive disease and reported a 1-year primary patency rate of 97% [20]. Fifty-one percent of patients received self-expanding stents, 30% received balloon expandable stents, 13% received a combination of self-expanding and balloon expandable stents, whereas 6% of patients received covered stents. Haulon et al. reported the results of 106 patients treated with aortoiliac kissing stents with a primary 1-year patency rate of 79% [21]. Self-expanding stents were used in 59% of cases, whereas balloon expandable stents were used in 41% of cases. Some limited data also suggests that covered balloon expandable stents may be superior to bare metal balloon expandable stents at the aortic bifurcation. Sabri et al. treated 26 patients with aortoiliac disease with covered balloon expandable stents and 28 patients with bare metal balloon expandable stents in a kissing stent fashion and noted superior long-term patency with the covered stents (92% vs. 78% 1-year patency rate) [22].

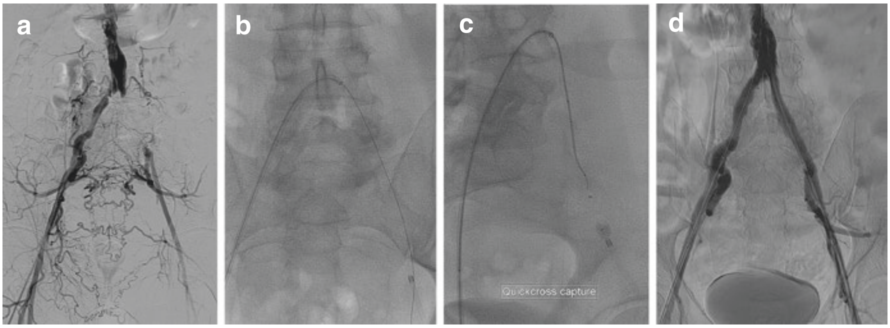


**Fig. 2.4** Digital subtraction aortoiliac angiography showing left CIA occlusion involving the ostium (**a**). Contralateral right CFA sheath was exchanged for a Morph AccessPro steerable sheath which was advanced to the distal abdominal aorta and used to provide support for crossing the left CIA lesion with a straight stiff 0.035″ Glidewire from the contralateral crossover retrograde approach (**b**). A Quick-Cross Capture catheter was advanced in the left CFA sheath and advanced to the left EIA where the wire used to cross the occlusion from the retrograde approach was captured and exteriorized into the ipsilateral sheath (**c**). iCAST covered balloon expandable stents were delivered from the ipsilateral approach into bilateral proximal common iliac arteries and deployed (**d**)

Case 3. A 68-year-old male with severe left lower extremity claudication was found to have a left proximal common iliac CTO involving the ostium (Fig. 2.4a). 7F bilateral CFA access was obtained. After an initial unsuccessful attempt at crossing the lesion from the ipsilateral retrograde approach, the contralateral right CFA sheath was exchanged for a Morph AccessPro steerable sheath, which was advanced to the distal abdominal aorta and used to provide support for crossing the left CIA lesion with a straight stiff 0.035″ Glidewire from the contralateral crossover retrograde approach (Fig. 2.4b). A Quick-Cross Capture catheter was advanced in the left CFA sheath and advanced to the left external iliac artery (EIA) where the wire that had been used to cross the occlusion from the retrograde approach was captured and exteriorized into the ipsilateral sheath (Fig. 2.4c). iCAST covered balloon expandable stents were delivered from the ipsilateral approach into bilateral proximal common iliac arteries and deployed (Fig. 2.4d).

### *2.3.3 Non-ostial Common Iliac Artery and Proximal External Iliac Artery CTOs*

Non-ostial common iliac artery and proximal external iliac artery CTOs can be treated from an ipsilateral CFA retrograde or a contralateral antegrade approach. Common iliac artery CTOs with a proximal stump can also be treated from either the retrograde or the antegrade approach using crossover contralateral access or brachial access.

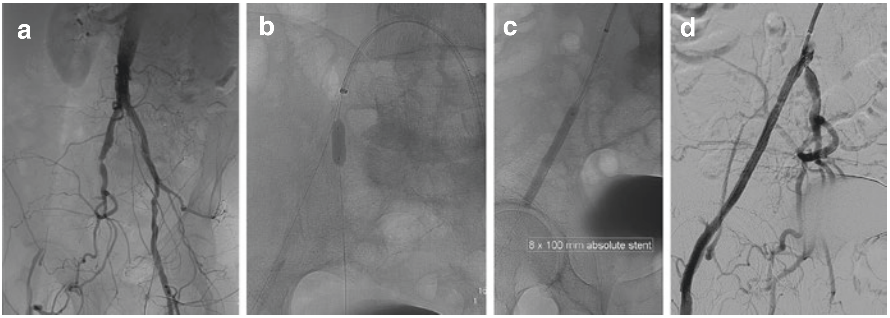


**Fig. 2.5** Digital subtraction angiography with landmarking demonstrated a CTO of the right external iliac artery (**a**). The occlusion is in the proximal external iliac artery, and there is also significant stenosis at the origin of the internal iliac artery. A crossover sheath was advanced to the right common iliac artery, and a straight stiff 0.035″ Glidewire was used to cross the occlusion. Due to significant stenosis at the ostium of the internal iliac artery, a wire was also passed into this vessel, and balloon angioplasty was performed (**b**). A self-expanding stent was placed in the right external iliac artery (**c**). Final angiography revealed patency of the right internal iliac artery and external iliac artery (**d**)

Case 4. A 54-year-old man with a history of Rutherford III right lower extremity claudication underwent lower extremity angiography, which revealed an occluded right external iliac artery just distal to the origin of the right internal iliac artery (Fig. 2.5a). The lesion was approached from a contralateral antegrade approach, and the occlusion was successfully crossed using a straight stiff 0.035″ Glidewire into the true lumen of the distal external iliac artery. Because of the high-grade disease at the origin of the right internal iliac artery, a 0.014″ wire was advanced into the internal iliac artery, and balloon angioplasty was performed at the ostium of the internal iliac artery (Fig. 2.5b). A self-expanding stent was then placed along the length of the right external iliac artery (Fig. 2.5c), with excellent angiographic result (Fig. 2.5d).

### *2.3.4 Distal External Iliac Artery CTOs*

Distal external iliac artery lesions are ideally treated using a contralateral crossover approach, due to the potential difficulty in gaining arterial access in the ipsilateral common femoral artery and attendant lack of sheath support. Balloon expandable stents may be used if in close proximity to the hip joint due to the concern regarding failure of self-expanding stents in this location. A contralateral crossover sheath can be placed with its tip in the CIA and used to cross the occlusion and perform angioplasty and stenting from the antegrade approach.

An illustrative case of the endovascular treatment of an external iliac CTO is described below.

Case 5. A 72-year-old male with Rutherford Class III right lower extremity claudication and a history of prior left EIA stenting was brought to the catheterization laboratory. There was a chronic occlusion of the length of the external iliac artery (Fig. 2.6a). A 6F Morph AccessPro steerable sheath was advanced in the left CFA and directed into the right CIA. A 0.035″ support wire was advanced into the right internal iliac artery for advancement of a crossover sheath into the right CIA (Fig. 2.6b). A 0.035″ stiff Glidewire was directed into the EIA on the right but remained in the subintimal space. Right dorsalis pedis access was obtained, and a Prowater 0.14″ wire was advanced retrograde into the right EIA but remained in the subintimal

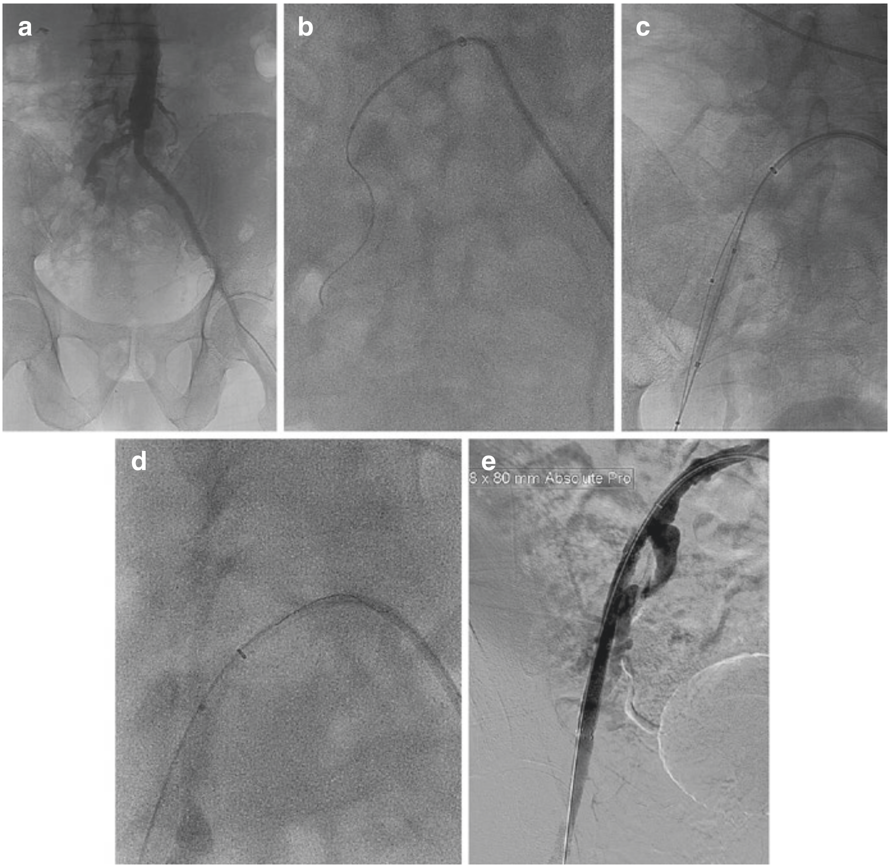


**Fig. 2.6** Digital subtraction angiography showing CTO of the right external iliac artery (**a**). Following placement of a 6F Morph AccessPro steerable sheath was in the left CFA and directed into the right CIA, and 0.035 support wire was advanced to the right internal iliac artery for advancement of a crossover sheath into the right CIA (**b**). Reverse-controlled antegrade and retrograde subintimal tracking (CART) technique. A 0.035″ wire in the subintimal space from the crossover antegrade approach with a Charger balloon and a 0.014″ guide wire placed retrograde in the subintimal space from the ipsilateral DP (**c**). The retrograde advanced Probate wire used to reenter the luminal space and externalized through the cross over sheath in the left CFA (d). An 8 × 80 Absolute Pro self-expanding stent advanced antegrade from the contralateral approach and deployed along the length of the EIA on the right (**e**)

space. A 6.0 × 40 mm Charger balloon was advanced over the 0.035 wire that was advanced antegrade in the subintimal space in the right EIA and inflated in the subintimal space to create a communication with the separate subintimal space created by the retrograde wire within the occlusion of the right EIA. The retrograde Prowater wire was used to reenter the luminal space and directed into the right EIA and CIA and was externalized through the sheath in the left CFA (Fig. 2.6d). The wire was exchanged for a 0.035″ guide wire over which angioplasty was performed from the retrograde approach. An 8 × 80 mm Absolute Pro self-expanding stent was advanced from the contralateral approach and deployed along the length of the EIA on the right (Fig. 2.6e).

The successful use of the controlled antegrade and retrograde subintimal tracking (CART) technique, initially described to facilitate recanalization of coronary CTOs, has been successfully used in the treatment of EIA occlusion in the past [14]. In this case we describe the use of reverse CART technique in which the occlusion is crossed from a retrograde wire in the subintimal space. Intravascular ultrasound-guided true lumen reentry devices have also been used for recanalization of iliac artery occlusion [23]. A 100% technical success rate was reported in a series of 11 patients (seven, one, and three patients had unilateral CIA, EIA, and combined CIA/EIA occlusions). The Pioneer reentry catheter was used in that study, although the Outback catheter can also be used for successful reentry of iliac artery CTOs [10].

## 2.4 Conclusions

Iliac artery chronic occlusions are a source of increased morbidity among patients with PAD. While surgical bypass has a high long-term patency, it is associated with significant morbidity. Recent advances in techniques and equipment used for endovascular recanalization have made the endovascular approach a plausible option for the initial treatment of patients with iliac CTOs, with a procedural success rate exceeding 90%. Future research should better define the optimal initial crossing strategy in order to maximize the chances of expedient occlusion crossing. Additional data regarding the outcomes of different stent types will also be helpful in defining the optimal endovascular treatment of iliac artery CTOs.

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