# Endovascular management of unilateral common iliac artery ostial occlusive disease; bilateral kissing stents, unilateral stent with contralateral supporting balloon or unilateral stent with contralateral safety wire; comparative study

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**Aim**
To evaluate the safety, early, and short-term efficacy of kissing stents, unilateral common iliac artery (CIA) stent with contralateral supporting balloon, and unilateral CIA stent with contralateral safety wire in patients with symptomatic unilateral CIA ostial occlusive disease.
**Patients and methods**
This prospective study was carried out from April 2016 to November 2019 at 6 October Insurance Hospital, Cairo, and Sohag University Hospitals on 79 patients complaining of de novo unilateral CIA ostial occlusive disease, Rutherford category 3, 4, and 5, who were divided randomly into three groups to be treated endovascularly by bilateral kissing stent technique (group A), unilateral CIA stent in affected side associated with supporting balloon in the contralateral CIA (group B), or unilateral CIA stent in affected side associated with a safety wire in the contralateral CIA (group C). Patients were scheduled to be evaluated and followed up for 1 year.
**Results**
Technical success rate was 100, 87, and 67.9 in groups A, B, and C, respectively ($P$=0.006). One-year primary patency rate was 91.7, 90.9, and 87.5% in groups A, B, and C, respectively ($P$=0.998). A total of seven (9.3%) patients developed significant stenosis. Of the seven patients, and three continued medically, as they were claudicant; three cases were treated by drug-coated balloon angioplasty, and one patient by aortofemoral bypass. Plaque shift incidence was 4.3 and 14.3% in groups B and C, respectively ($P$=0.095). Distal embolization occurred in the contralateral side in 8.7 and 17.9% in groups B and C, respectively ($P$=0.083).
**Conclusion**
Kissing stent technique for treatment of unilateral ostial CIA occlusive disease achieves excellent technical success with minimal early and short-term procedure-related complications compared with unilateral stent with contralateral supporting balloon or unilateral stent with contralateral safety wire.

**Keywords:**
bilateral kissing stents, ostial, safety wire, supporting balloon, unilateral common iliac artery, unilateral stent

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## Introduction

Aortoiliac occlusive diseases are recognized as the most consistent sites for atherosclerosis and represent approximately one-third of peripheral arterial disease [1]. Aortic bifurcation is a major issue, representing ~10% of all iliac lesions. It most commonly affects the ostia of both common iliac arteries (CIA) or in some cases includes unilateral ostial disease [2].

Bypass surgery represents the gold standard treatment for aortoiliac lesions because of its effectiveness, with acceptable patency rates of ~90–95% and 82–87% at 5 and 10 years, respectively [3]. However, it carries its own significant complications and mortality especially in high-risk patients in addition to laparotomy complications, for example, incisional hernia and adhesions [4].

Comparing these mortality and morbidity with the rarity of mortality and low morbidity of endovascular intervention in addition to the short hospital stay and the most convenient method of treatment, endovascular intervention is now considered the preferred option according to the new guidelines and recommendations of European Society for Vascular

and Endovascular, Surgery, especially in critical limb ischemia (CLI), as an alternative approach to surgical repair [5]. Moreover, it carries an excellent 5-year patency rate that reaches up to 80–90% [6].

Different endovascular techniques are used. Balloon angioplasty of iliac arteries was the standard therapy, particularly for short lesions (TASC A and B), with acceptable long-term patency rate of 60–90% over 3–5 years. However, its use was limited by initial residual stenosis and late restenosis [7] as well as high rate of distal embolization [8]. Stents are frequently used especially in lesions involving the distal aorta or origin of CIA [9]. The concept of the kissing technique is owing to the concern about hazards of plaque shift and distal embolization to the contralateral iliac artery [10].

Suh *et al*. [11] had treated the unilateral ostial CIA disease by using a single stent deployed in affected side only and concluded that single stent technique was safe and showed comparable mid-term outcomes with those of kissing stents.

In literature, there is a debate about the best treatment strategy of unilateral aortoiliac bifurcation lesions, whether kissing stent technique or enough single stent in the diseased artery, with certain precautions toward the contralateral CIA.

## Patients and methods

This prospective study was carried out from April 2016 to November 2019 at 6 October Insurance Hospital, Cairo, and Sohag University Hospitals on 79 patients complaining of de novo unilateral CIA ostial occlusive disease, Rutherford category 3, 4, and 5, who were divided randomly into three groups to be treated by endovascular management either bilateral kissing stent technique (group A), unilateral CIA stent in affected side associated with supporting balloon in the contralateral CIA (group B), or unilateral CIA stent in affected side associated with a safety wire in the contralateral CIA (group C).

Inclusion criteria were patients with disabling claudication or those who had CLI caused by CIA ostial occlusive disease with adequate distal run-off vessels while the contralateral CIA had hemodynamically insignificant lesion by duplex ultrasound (US) and computed tomography angiography (CTA). Exclusion criteria were CIA lesions not affecting the ostium, diseased bilateral CIA, aortic bifurcation lesions previously treated by endovascular or bypass surgery, patients with multilevel occlusions or inadequate run-off vessels, patients with nonsalvageable limb, or those with life-threatening infection.

All patients were admitted and signed a written informed consent. This series was approved by the hospital ethical committee. Patients were assessed clinically, including history of risk factors, such as diabetes mellitus, smoking, hypertension, cardiovascular, and renal impairment. All patients were examined carefully including the presence of weak or absent femoral pulsation of the affected limb, assessment of contralateral femoral pulse as well as bilateral radial pulsation, assessment of limb salvage, and measuring the ankle brachial pressure index (ABI). Preprocedural diagnostic workup included duplex US examination and CTA, which were performed for all cases to confirm the site of occlusion, characteristics of the lesion, stenosis/occlusion, state of the contralateral CIA, as well as distal run-off vessels. Echocardiography was performed to evaluate left ventricular function. All patients were subjected to full laboratory investigations with special concern to renal functions and coagulation profile.

### Procedure details

Periprocedural medications with dual antiplatelet therapy in the form of salicylates 100 mg and clopidogrel 300 mg as a loading dose followed by daily maintenance dose 75 mg clopidogrel continued postoperatively for at least 3 months in all cases were given. The procedure was done under local anesthesia in all cases through left brachial access. Overall, 70–100 U/kg of unfractionated heparin was injected intra-arterially after sheath insertion. Strategy of treatment included transbrachial access, antegrade recanalization of the CIA lesion in addition to retrograde femoral approach to the contralateral iliac arteries.

A 0.035 Terumo stiff-angled guide wire (Radifocus, Terumo, Japan) was used in combination with 4-Fr vertebral catheter to navigate through the aorta to the level of aortic bifurcation and down toward the nondiseased CIA. Insertion of 7-Fr long sheath of 90 cm (Cook Medical, Bloomington, Indiana, USA) with its tip a few centimeters above the level of aortic bifurcation was done.

Preintervention angiography was performed to confirm the lesion characteristics: length, stenosis/occlusion, contralateral CIA, and distal run-off vessels. Patients were randomly classified into groups A, B, and C. The

guide wire and the vertebral catheter were used to negotiate the CIA lesion either intraluminal or subintimally with re-entry to the lumen proximal to common femoral artery.

Contralateral 7-Fr femoral sheath was inserted. Another 0.035 Terumo stiff-angled guide wire was advanced toward the abdominal aorta. Angiographic re-assessment was done before starting the technique.

#### Group A patients (kissing stent group)

CIA lesion was predilated using 5–6-mm low-profile standard balloon for 1–2 min in their nominal pressure. Balloon size was smaller than the reference vessel to facilitate advancement of the stent without risk of dislodgement. Balloon-mounted stents were bilaterally introduced and positioned at the aortic bifurcation starting few millimeters from the distal aorta to allow optimal reconstruction of new aortic bifurcation. Deployment of stents was performed simultaneously on both sides, side by side not crossing each other to avoid the shearing effect. The type of used stent was balloon expandable stent (Express Stent; Boston Scientific, Boston, Massachusetts, USA) 7–8 mm in diameter. Stent diameter was equal to the reference vessel diameter without over sizing. In lengthy lesions requiring more than one stent, another self-expandable stent was used with 5-mm overlap to avoid stent fracture. Caution was taken not to cover the ostium of internal iliac artery until it was mandatory.

#### Group B patients (unilateral common iliac artery stent with supporting balloon in contralateral side)

CIA lesion was predilated using low-profile balloon. Balloon-mounted stent of the same size of reference vessel was advanced and positioned over the ostium of CIA extending few millimeters into the distal aorta. The contralateral CIA was supported by balloon of the same size and length to the size and length of the used stent. Deployment of the stent and inflation of the contralateral balloon was performed simultaneously by the same nominal pressure. Bail-out stent was deployed in contralateral CIA in cases of flow-limiting dissection or evidence of distal embolization.

#### Group C patients (unilateral common iliac artery stent with safety wire in contralateral side)

CIA lesion was predilated using low-profile balloon. Balloon-mounted stent of the same size of reference vessel diameter was introduced and positioned over the ostium of CIA extending few millimeters into the distal aorta. The contralateral wire should be inserted in the other CIA through the contralateral femoral approach before stent deployment. Bail-out stent was deployed in contralateral CIA in cases of plaque shift or evidence of distal embolization.

Completion angiography was performed routinely down to the below-knee run-off vessels to assess the technical success and presence or absence of contralateral dissection or distal embolization.

Follow-up was conducted daily during the period of admission and then in vascular surgery outpatient clinic at 30 days, 3, 6, 9, and 12 months of follow-up period. During the hospital stay, patients with ischemic foot ulcers or gangrene received standard wound care, debridement, and/or minor amputation. During follow-up visits, clinical assessment was done by regaining pulse, ABI, disappearance of rest pain, and wound healing. The target vessel patency was assessed by duplex US. Peak systolic velocity more than 180 cm/s or peak systolic velocity ratio more than 2.4 was considered significant stenosis.

All patients were discharged on dual antiplatelet therapy (aspirin 100 mg/day and clopidogrel 75 mg/day for at least 3 months).

#### Definitions

(1) Technical success was defined as successful revascularization of the aortic bifurcation without occurrence of contralateral plaque shift, dissection, or distal embolization.
(2) Clinical success was defined as wound healing, improvement in Rutherford category after the procedure, and increase in ABI.
(3) Primary patency was defined as uninterrupted patency without the need for further procedures after the initial intervention.
(4) Secondary patency was defined as any successful procedure that restores patency after the initial treatment.
(5) Primary end points were technical success and 1-year primary patency of both CIA.
(6) Secondary end points included freedom of TLR, major adverse events, and/or procedural complications.

#### Statistical analysis

Descriptive statistics were used to present continuous data as mean±SD. Categorical variables were expressed as numbers and percentages. Comparisons of continuous variables between groups were performed using analysis of variance test. Categorical variables were compared using $c^2$ or Fisher exact test.

## Results

A total of 79 patients with unilateral CIA ostial occlusive disease, Rutherford category 3, 4, and 5, were enrolled in this study. In four of 79 patients, procedure was aborted owing to extensive iliac dissection or failure of re-entry to the true lumen during the procedure and therefore those patients were managed surgically by aortobifemoral bypass procedure.

Group A consisted of 24 patients (14 males and 10 females), with a mean age of 54 years (range, 50–72 years) treated by bilateral kissing stent technique; group B consisted of 23 patients (13 males and 10 females), with a mean age of 51 years (range, 52–69 years) treated by unilateral CIA stent in affected side associated with supporting balloon in the contralateral CIA; and group C consisted of 28 patients (16 males and 12 females), with a mean age of 61 years (range, 49–71 years) treated with unilateral CIA stent in affected side associated with a safety wire in the contralateral CIA. There were no significant differences among the three groups in patient age, male/female sex, cardiovascular risk factors, or concomitant diseases. Major risk factors were diabetes and smoking in all patients groups. Patients' criteria and demographic data are summarized in Table 1.

In patients of group A, mean lesion length was 3.8 ±1.8 cm. Of 24 patients, 10 (41.7%) patients were Rutherford category '5,' eight (33.3%) patients Rutherford category '4,' and six (25%) patients Rutherford category '3.' In group B patients, mean lesion length was 4.1±2.1 cm. Of 23 patients, 10 (43.5%) patients were Rutherford category '5,' eight (34.8%) patients Rutherford category '4,' and five (21.7%) patients Rutherford category '3.' In group C patients, mean lesion length was 4.3±1.2 cm. Of 28 patients, 12 (42.9%) patients were Rutherford category '5,' nine (32.1%) patients Rutherford category '4,' and seven (25%) patients Rutherford category '3.' There were no significant differences among the three groups (Table 1).

Left brachial access was the main access site for crossing the CIA lesion. Predilatation was performed in occlusion but not mandatory in stenotic lesions to facilitate accurate positioning of the stent. Stent diameter was 7–8 mm. One stent was enough for CIA ostial lesion except in nine patients, where more than one stent was used owing to long lesions extended to external iliac artery or flow-limiting dissection during the predilatation procedure.

One patient in group B and four cases in group C needed rescue stents owing to unfavorable plaque shifting to the contralateral side. Those patients were excluded from the study. Technical success was achieved in 100, 87, and 67.9% in groups A, B, and C, respectively, with highly significant *P* value (*P*=0.0.006) (Fig. 1). One year primary patency was 91.7% (22/24), 90.9% (20/22), and 87.5% (21/24) in groups A, B, and C, respectively. Primary patency rates were comparable between study groups without significant difference (*P*=0.998) (Table 2 and Fig. 2).

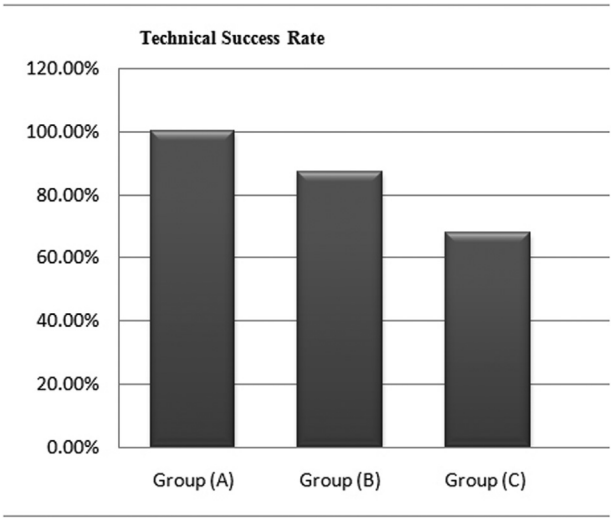
Significant stent stenosis rate among study cohorts was 9.3% (seven patients, comprising two patients from group A, two patients from group B, and three patients

**Table 1 Demographic data, risk factors, and lesion characteristics**

| | Group A (*N*=24) [*n* (%)] | Group B (*N*=23) [*n* (%)] | Group C (*N*=28) [*n* (%)] |
|---|---|---|---|
| Age (years) | 54 (50–72) | 51 (52–69) | 61 (49–71) |
| Males/females | 14 (58.3)/10(41.7) | 13 (56.5)/10 (43.5) | 16 (57.1)/12 (42.9) |
| Risk factors | | | |
| DM | 18 (75) | 17 (73.9) | 20 (71.4) |
| Smoking | 16 (66.7) | 15 (65.2) | 18 (64.3) |
| Hypertension | 14 (58.3) | 12 (52.2) | 16 (57.1) |
| Ischemic heart disease | 10 (41.7) | 10 (43.5) | 12 (42.9) |
| Renal insufficiency | 6 (25) | 5 (21.7) | 6(21.4) |
| Rutherford classification | | | |
| Rutherford category '3' | 6 (25) | 5 (21.7) | 7 (25) |
| Rutherford category '4' | 8 (33.3) | 8 (34.8) | 9 (32.1) |
| Rutherford category '5' | 10 (41.7) | 10 (43.5) | 12 (42.9) |
| Lesion length | 3.8±1.8 | 4.1±2.1 | 4.3±1.2 |
| Type of lesion | | | |
| Stenosis | 14 (58.3) | 13 (56.5) | 16 (57.1) |
| Occlusion | 10 (41.7) | 10 (43.5) | 12 (42.9) |

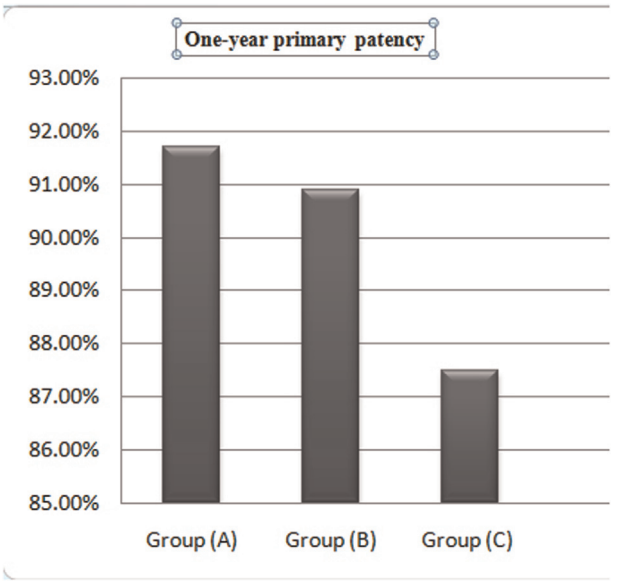
DM, diabetes mellitus.

**Figure 1**




Technical success was highly significantly in group A in comparison with groups B and C (*P*=0.006).

**Figure 2**




One-year primary patency was comparable between study groups without significant difference (*P*=0.998).

**Table 2 Study end points**

| | Group A (*N*=24) [*n* (%)] | Group B (*N*=23) [*n* (%)] | Group C (*N*=28) [*n* (%)] | P value | | | |
|---|---|---|---|---|---|---|---|
| | | | | 3 groups (A, B, and C) [*n* (%)] | A vs. C | A vs. B | B vs. C |
| Technical success | 24/24 (100) | 20/23 (87) | 19/28 (67.9) | 0.006 | 0.011 | 0.288 | 0.101 |
| Primary patency | 22/24 (91.7) | 20/22 (90.9) | 21/24 (87.5) | 0.998 | 0.637 | 0.927 | 0.711 |
| Plaque shift | 00 | 1/23 (4.3) | 4/28 (14.3) | 0.095 | 0.076 | 0.499 | 0.242 |
| Distal embolization | 00 | 2/23 (8.7) | 5/28 (17.9) | 0.083 | 0.038 | 0.233 | 0.30 |

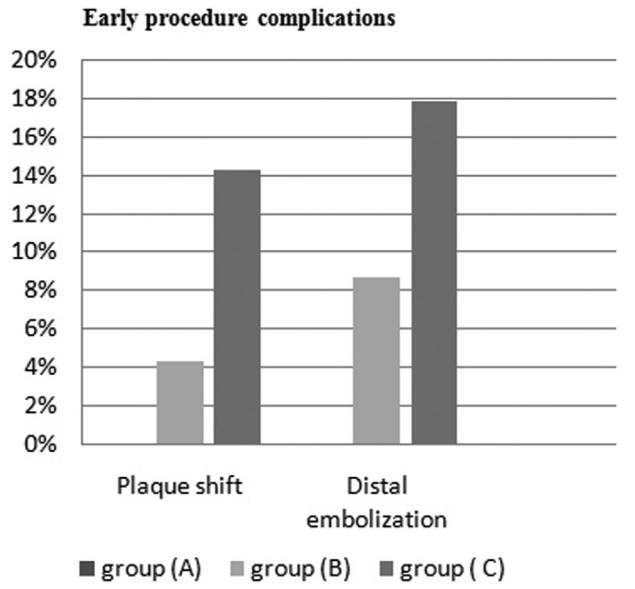
from group C). Most of them occurred within 7th–12th month postoperatively. Three cases of them passed conservatively as they were claudicant. The other four cases developed CLI and were treated by drug-coated balloon in three cases and the fourth one by aortofemoral bypass. It should be noted that stent stenosis occurred at the side of previously diseased CIA.

Regarding early procedure outcomes (within 30 days), plaque shift to the contralateral CIA and subsequent dissection was noticed more in patients of group C (4/28, 14.3%) than in group B (1/23, 4.3%) (*P*=0.095). Isolated comparison of the iliac dissection between groups A and C and groups A and B revealed *P* values of 0.076 and 0.499, respectively, denoting that the plaque shift incidence increased much in safety wire group C, less common in supporting balloon group B (Table 2 and Fig. 3).

Distal embolization did not happen in group A, whereas it was reported in 8.7 and 17.9% in groups B and C, respectively (*P*=0.083). Isolated comparison of its incidence between groups A and C and between groups A and B revealed *P* values of 0.038 and 0.233, respectively, denoting that distal embolization can be avoided more with kissing stent technique rather than others. Distal embolization was noticed during the procedure, and it was commonly seen in distal external iliac artery or in proximal SFA. It was treated by either thrombolysis or thrombectomy.

Spasm of left brachial artery occurred in 4/75 (5.3%) cases, and it was temporary and relieved spontaneously, not necessitating intervention. No recorded cases developed acute upper limb ischemic manifestation. Six (8%) patients among the study cohorts developed groin hematoma, which resolved spontaneously. Major limb amputation was performed in one patient of the

**Figure 3**




Plaque shift to the contralateral CIA and distal embolization were higher in group C than other groups ($P$=0.095 and 0.083, respectively). CIA, common iliac artery.

study cohorts owing to extensive life-threatening infection. No deaths or iliac perforation was reported.

## Discussion

Complex iliac artery occlusion was usually treated surgically by either aortofemoral bypass or extra-anatomical revascularization, for example, femoro-femoral bypass, which were considerable options in patients with unilateral iliac disease. Although highly effective, it is associated with procedure-related morbidity and mortality [12].

European guidelines recommended the endovascular treatment as a first option for aortoiliac lesions (TASC) II type A, B, and C [4]. In 2015, TASC II update reported that the choice of treatment strategy must be based on each center experience considering patient comorbidities. Many experienced centers today advocate an 'endovascular first' approach for all iliac lesions in spite of the serious complications such as distal embolization, arterial dissection, and/or iliac perforation [13,14].

There are different accesses for lesion tackling: brachial access, retrograde approach via ipsilateral common femoral artery, and crossover approach via contralateral common femoral artery. Antegrade negotiation minimizes the risk of subintimal tracking of the guide wire in area of aortic bifurcation and subsequently aortic dissection [11]. Brachial access was the main approach in crossing the ostial CIA lesion in this study. This concept agreed with Alvarez-Tostado *et al.* [15], who stated that brachial approach offered better pushability and minimal access-related complication. Ipsilateral retrograde approach has many disadvantages, for example, difficult femoral puncture distal to occluded segment and difficult to navigate the guide wire intraluminally through the occlusion, which may result in extensive dissection. It has been described to be one of the causes of technical failure during iliac recanalization attempts [16]. Flachskampf *et al.* [17] created iliac artery stenting through a new approach: transradial access using 6-Fr sheath and 6-mm Palmaz stent.

Express stent, balloon expandable type was used in this series. Troisi *et al.* [18] had reported that no ideal stent was the best for all iliac lesions. Many physicians prefer balloon expandable stents in treatment of focal and calcified lesions near the aortic bifurcation, whereas self-expanding stents in tortuous iliac vessels. Balloon-mounted stent has many favorable mechanical properties: straight nature, higher radial force to overcome the reconfiguration tendency of calcified or eccentric lesions, as well as precise deployment without jumping or shortening. However, it carried the risk of arterial rupture in severely calcified vessels [19].

Accurate positioning of kissing stents is highly important and requires meticulous attention to avoid stent misalignment. They should be placed side by side at an equal height inside the aorta [9]. This is to reduce atheroma displacement or embolization of the thrombotic material by stent struts. Saker *et al.* [20] studied the shear stress variations caused by aortoiliac kissing stents and its effect on neointimal hyperplasia formation. They recommended that whenever possible, the proximal ends of the stents should not exceed more than 5 mm over the aortic bifurcation. They also reported that shear stress may theoretically be augmented if they were placed in a crossing configuration. Failure of accurate deployment may result in impairment of blood flow to any of iliac limbs [9].

Balloon dilatation of totally occluded and heavily calcified lesion before stent deployment is mandatory by using low-profile balloon smaller than vessel diameter. This is to allow optimum stent adjustment without friction. Optimal prestent dilatation might disrupt the atheromatous plaques, induce iliac perforation, or enhance thrombus migration [3].

There are several factors affected the outcome of iliac revascularization, for example, lesion length, eccentricity, calcification, and presence of occlusions

or stenosis. Comparing the outcome of CIA occlusion in relation to stenosis, it was found that patency rate after stenosis revascularization was somewhat higher than those of occlusion, and therefore, occlusion was considered as a significant predictor of reduced patency rate. This might be attributed by increased atherosclerotic and thrombotic burden of occlusions than stenosis that required more dilatation forces and induced more trauma to the vessel wall [21]. It was also noticed that revascularization of iliac artery occlusion had higher incidence of distal embolization in comparison with iliac stenosis. STAG trial [8] concluded that management of iliac occlusions by PTA alone might place the patient at higher risk of limb loss. Scheinert *et al.* [19] had also confirmed that balloon angioplasty was an effective method of recanalization of iliac artery stenosis with low complication rates and long-term results with technical success rates of 95% and 5-year patency rates of 80–90%. Goode *et al.* [8] assessed the lesion length as another parameter for outcome and confirmed that iliac occlusions more than 8 cm had high risk of distal embolization and therefore primary stenting was mandatory. Several challenges should be considered during treatment of total occlusion. One of them was safe advancement of a guide wire through the lesion which could be achieved better by antegrade recanalization. Another challenge was maintenance of vessel patency after successful recanalization by stent deployment to eliminate restenosis [6].

Regarding the ideal management of unilateral iliac lesions, there are limited data comparing the outcomes between kissing stents and any other endovascular techniques [11].

Kissing stent technique was first described by Kuffer *et al.* in the last decade, and since then, it has been approved for complex aortoiliac bifurcation lesions, as it achieves excellent immediate outcome and few complication rate [11]. It is well known that stent placement in an apparently healthy vessel is undesirable. Faheez *et al.* [9] had reported that its use is highly essential as the large atheromatous plaques if not adequately covered may extend beyond the top of the stent resulting in contralateral embolization. Regarding the effect on the nondiseased contralateral iliac limb, they also reported in their series that there was no stent occlusion in the nondiseased contralateral CIAs after the kissing stents during follow-up period of 3 years.

Balloon angioplasty at the ostium of CIA may induce shifting of atheromatous plaque across the aortic bifurcation or embolizing atherosclerotic debris down the contralateral iliac artery. Kissing balloons technique in which balloons were positioned at the ostium of both iliac arteries and inflated simultaneously was developed to minimize such complications. It provided reasonable procedural and clinical success. However, there is ~9% incidence of dissection, thrombosis, distal embolization, and significant residual stenosis [22]. Because of these drawbacks, balloon angioplasty of common iliac lesions has not been recommended [21]. On the contrary, van't Riet *et al.* [23] had appreciated the kissing balloon technique and concluded that the risk of plaque dislodgment was sometimes noticed with unilateral PTA alone.

Dutch randomized iliac trial [24] demonstrated equivalent results of primary versus selective stenting of iliac artery lesions. However, the preferred technique is still controversial. Many authors advocate routine primary stenting even after uncomplicated PTA of such lesions to improve the long-term results, whereas others advised limited use of stents because of its restenosis rate caused by intimal proliferation [7]. Indications for bail-out iliac stenting were residual stenosis more than 30%, difference of pressure gradient of more than or equal to 5 mmHg across the treated segment, and flow-limiting dissection [23].

Bosch and Hunink [25] compared six series of PTA alone (1300 patients) and eight series of PTA with selective stent placement (816 patients) and found that routine stenting was associated with better 4-year patency rates than PTA alone.

Few years ago, Suh *et al.* [11] had treated the unilateral CIA ostial lesion by a single stent placed in the affected side and confirmed that single-stent technique was safe and achieved similar primary patency rates and freedom of TLR as kissing stents technique. This technique appears to be cost-effective because it requires fewer stents and also preserves the contralateral femoral approach for future endovascular intervention. Contralateral bail-out stent was needed in a low incidence (3%) because of unfavorable plaque shift [11]. However, Faheez *et al.* [9] reported in their series that placement of single stent carried the risk of impairment of contralateral limb flow.

Recently, aortoiliac stent type has changed from bare metal stent (BMS) to covered stent [26]. This is to improve its outcome and therefore considered a valid alternative to surgery [27]. It is characterized by cast encapsulation technology covering its stainless steel content with a thin outer and inner PTFE coating.

This lining acts as a mechanical barrier between the intima and the lumen [28], and therefore, covered stents decrease the restenosis rate by preventing the migration and proliferation through the stent struts and subsequent intimal hyperplasia [21]. Covered stent also allows better thrombus entrapment between the stent graft and the vessel wall and therefore reducing distal embolization rate [3].

Covered versus bare metal balloon expandable stent trial (COBEST trial) in severe iliac occlusive disease demonstrated that both covered stents and BMSs produce similar and acceptable results for TASC B lesions, whereas covered stents have a lower rate of restenosis for TASC C and D lesions on long-term follow-up [29].

Regarding its patency rate, covered stent reported primary patency rates of 100, 95, and 85% at 1, 6, and 12 months of follow-up. They concluded that these results were comparable to open surgery and superior to BMS. There was no statistically significant difference in clinical outcome or safety [30]. Therefore, covered stents are currently reserved for special circumstances such as perforations and clot or aneurysm exclusion [28]. In this series, no covered stents were used.

Technical success, defined as successful recanalization of aortic bifurcation without occurrence of contralateral plaque shift or dissection, was achieved in 100, 87, and 67.9% in groups A, B, and C, respectively ($P$=0.006). Nearly similar results were obtained by Allam *et al.* [12] and Schmalstieg *et al.* [30] in kissing stent group. In literature, technical success of aortoiliac kissing stents was reported to be 86–100% [21]. Mouanoutoua *et al.* [22] reported that technical failure does not preclude further management either surgically or by repeating the endovascular procedure.

One-year primary patency rate was 91.7, 90.9, and 87.5 in groups A, B, and C, respectively. It was comparable between study groups without significant difference ($P$=0.998). Significant stent stenosis rate was 9.3% (seven patients); three cases of them passed conservatively as they were claudicant. The other four cases developed CLI and were treated by drug-coated balloon in three cases and the fourth one by aortofemoral bypass. All cases of stent stenosis occurred in the same side of previously diseased CIA. Mouanoutoua *et al.* [22] reported similar restenosis rate, whereas Murphy *et al.* [31] reported higher incidence (17.8%). They attributed the low rate of stenosis by the relatively larger caliber of iliac vessels at this location. In-stent stenosis occurred by several mechanisms: extensive calcification at the ostium or intimal hyperplasia caused by altered flow patterns, and inflammatory reaction on injured endothelium [23]. Stent stenosis or occlusion can be successfully treated by endovascular intervention or bypass surgery.Plaque shift to the contralateral CIA and subsequent dissection was noticed more in patients of group C (four cases, 14.3%) than in group B (one patient, 4.3%) ($P$=0.095). Isolated comparison between groups A and C and groups A and B revealed $P$ values of 0.076 and 0.499, respectively, denoting that the plaque shift incidence occurred much in safety wire group C. It was manifested by disappearance of blood flow in contralateral CIA, and therefore, immediate stent was deployed to restore adequate flow. Suh *et al.* [11] reported plaque shift in two (3%) patients in the single stent group.

Distal embolization was recorded in several series and considered a disastrous and significant complication during management of ostial CIA lesion [6]. It may jeopardize blood flow to the opposite extremity that was previously asymptomatic. It is difficult to understand and explain why this specific drawback occurred in the CIA recanalization than elsewhere in superficial femoral artery occlusions. It may be attributed that the atheromatous plaque in iliac arteries is uniquely less adherent than it is elsewhere. It occurred more frequently with retrograde recanalization because of pushing and displacement of the plaque. Regardless of its mechanism, its probability to jeopardize blood flow to the asymptomatic contralateral limb makes this concern serious [32]. Distal embolization did not occur in group A patients, whereas it was reported in 8.7 and 17.9% in patients of groups B and C, respectively ($P$=0.083). Isolated comparison between groups A and C and between groups A and B revealed $P$ values of 0.038 and 0.233, respectively, denoting that the incidence of incidence of distal embolization increased much in safety wire group C, less common in supporting balloon group B. It was treated by thrombolysis or thrombectomy.

It was noticed in this series that performing unilateral stent technique for treatment of CIA ostial occlusive disease achieves comparable patency rate with kissing stent technique with avoidance of stent deployment in un-necessary contralateral CIA with its complications. It also preserves the contralateral access for future endovascular intervention if needed. However, it carries a higher incidence of plaque shift, iliac dissection, and distal embolization, which were serious and should be put in mind during the treatment strategy.

## Conclusion

Kissing stent technique for treatment of unilateral ostial CIA occlusive disease achieves excellent technical success with minimal early and short-term procedure-related complications compared with unilateral stent with contralateral supporting balloon or unilateral stent with contralateral safety wire.

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### Conflicts of interest

There are no conflicts of interest.

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