Heavily Calcified Occlusive Lesions of the Iliac Artery: Long-Term Patency and CT Findings After Stent Placement

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ABSTRACT

Purpose: To evaluate the influence of heavy calcification on iliac arterial stent expansion and patency and to define the spatial relationship between the stent and heavy calcifications on computed tomography (CT).

Materials and Methods: Thirteen patients (11 men, two women; mean age, 66.5 y) with 14 heavily calcified iliac arteries received primary stent treatment between 1998 and 2008. Anatomic success was defined by less than 30% residual stenosis on final follow-up CT angiography. Hemodynamic success was defined as an increase in the ankle-brachial index (ABI) of at least 0.15 versus baseline. Clinical success was defined by achievement of clinical improvement of at least one clinical category. Stent patency; anatomic, hemodynamic, and clinical success rate; morphology of heavy calcifications; calcium score; and stent geometry were evaluated.

Results: Stents were successfully inserted in all cases. During a mean follow-up of 33.6 months (range, 8–55 mo), the stent-implanted iliac arteries remained anatomically patent in all patients on final follow-up. The anatomic, hemodynamic, and clinical success rates were 28.6%, 60%, and 78.6%, respectively. Mean ABIs were 0.68 ± 0.22 before the procedure and 0.91 ± 0.23 after the procedure ($P = .021$). Mean luminal stenosis measurements were 77.9% before the procedure and 47.9% after the procedure ($P = .008$).

Conclusions: Iliac stents in heavily calcified lesions showed hemodynamically significant residual stenosis in a considerable number of cases. However, stent patency was not affected even with incomplete expansion of the stent.

ABBREVIATIONS

ABI = ankle-brachial index, MLD = minimum luminal diameter, SIS = signal intensity score, 3D = three-dimensional

Primary stent placement has become an established revascularization procedure for aortoiliac arterial occlusive disease with complex atherosclerotic lesions such as eccentric, calcified, and ulcerated plaques and dissections (1–5). Long-term patency rates of iliac arterial stents are comparable to those seen with surgical bypass procedures, and the reported 5-year primary patency rates in the medical literature range from 46% to 83% (6–10).

Because most iliac arterial lesions are atherosclerotic in origin, calcifications are common in the affected arteries. In general, focal or shell-like wall calcifications in the target iliac artery do not preclude iliac arterial angioplasty and stent implantation unless there is a buildup of dense and heavy-volume calcific mass. However, the presence of heavy calcification or heavily calcified plaques may cause significant problems with percutaneous coronary artery interventions and carotid artery intervention (11,12). Although small numbers of cases of heavy calcification in the iliac artery have been included in large published studies, the influence of

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heavy calcifications on iliac arterial stent expansion and stent patency has received little attention.

The purpose of this study was to evaluate the influence of heavy calcifications on iliac arterial stent expansion and deployed stent patency and to define the spatial relationship between the stent and heavy calcification on computed tomography (CT).

MATERIALS AND METHODS

Patients

The institutional research review board approved exemption of this retrospective clinical study, and informed consent was not required for retrospective investigation of preexisting hospital data without infringement on patient privacy. Between May 1998 and December 2008, a total of 443 patients (422 men [95.2%] and 21 women [4.8%]; mean age, 65.3 y) who underwent iliac arterial stent placement were evaluated according to established inclusion criteria. All these patients had conventional angiographic images during the procedure, and preoperative evaluation was performed with CT angiography (n = 392) or ultrasonography (US; n = 51). Patients were included who (i) underwent primary stent placement, (ii) had more than 50% luminal stenosis or complete occlusion of arterial lumen caused by calcifications exclusively (defined as heavy calcification) on CT and three-dimensional (3D) CT images reconstructed with 3D software (Aquarius; Terarecon, San Mateo, California), and (iii) underwent preoperative and follow-up CT angiography. Patients with hemodynamically significant iliac arterial stenosis or obstruction that was caused by noncalcified plaques, partially stippled calcified plaques, or plaques with combined shell-like calcification or circumferential bandlike calcifications not occupying the intraluminal area were excluded.

A total of 13 patients (11 men [84.6%] and two women [15.4%]; mean age, 66.5 y; age range, 54–75 y) met the inclusion criteria. All clinical, preprocedural, and demographic data were obtained by review of the electronic and scanned records. The risk factors included the presence of diabetes mellitus, hypertension, hyperlipidemia, and smoking (**Table 1**).

Table 1. Demographic Data and Clinical Staging

Characteristic	Value
Mean age (y) ± SD	66.5 ± 5.6
Sex (M/F)	11/2
Risk factors	
Smoking	3
Hypertension	6
Diabetes mellitus	7
Hyperlipidemia	5
Preintervention Rutherford classification	
0 (Asymptomatic)	0
1 (Mild claudication)	0
2 (Moderate claudication)	5
3 (Severe claudication)	7
4 (Resting pain)	1
5 (Necrosis/gangrene)	0
No. of lesions	
Right common iliac artery	8
Left common iliac artery	5
Right external iliac artery	1

CT Imaging Parameters

All CT examinations were performed with one of four helical scanners: LightSpeed QX/i, LightSpeed16, LightSpeed Ultra (GE Medical System, Milwaukee, Wisconsin), or Aquilion (Toshiba, Tokyo, Japan) in all patients except one. A total of 120 mL of nonionic contrast material (Iopromide; Ultravist 300, Schering, Berlin, Germany) was injected with an automatic injector (OP 100; Medrad, Indianola, Pennsylvania) at a rate of 3–4 mL/s. An arterial-phase scan was started 18 seconds after an automatic arrival time (when the attenuation of the aorta at celiac trunk level was > 100 HU) just above the celiac trunk level and carrying down to the feet. Scan parameters were as follows: 2.5-mm slice thickness, 2.5-mm reconstruction interval, 1.375:1 beam pitch, and 0.727/0.727-mm pixel spacing. X-ray tube voltage was 120 kV, and the current was 330 mA. The source images of CT angiograms were reformatted on 3D software capturing the both iliac arteries. Multiplanar reformation was performed for each patient on the basis of the source images by an intervention radiologist (I.S.C.). The multiplanar reformation images were created at 90° intervals about the longitudinal axis of the iliac artery with 1-mm thickness.

Lesions and Stent Placement

A total of 14 primary intravascular stents were placed in 13 patients with significant stenosis (n = 8) and total occlusion (n = 6) caused by heavy calcification. The lesions were located in the external iliac artery in one patient and common iliac artery in 12 patients. Fourteen SMART stents (Cordis, Miami Lakes, Florida) were used. Stent lengths varied from 4 cm to 12 cm. Twelve patients underwent stent placement in the angiographic suite of our department under local anesthesia and one patient underwent intraoperative stent placement. Routine sedation was not performed. Clinically, five patients had moderate claudication (Rutherford category 2), seven patients had severe claudication (Rutherford category 3), and one patient had ischemic pain (Rutherford category 4).

The iliac arterial lesions were identified on the initial angiography with ipsilateral common femoral arterial access. A reference diameter for the stent was chosen in the adjacent normal vessel or the contralateral corresponding artery. The stent was placed with an over-the-wire technique to completely cover the segment of the lesion. To achieve adequate stent expansion and minimize the risk of