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Angioplasty of Chronic Total Coronary Occlusions With the Use of Six French Guiding Catheters

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The efficacy of 6 French guiding catheters for angioplasty of chronic total coronary occlusions was evaluated in 61 consecutive patients. The duration of the occlusion was determined angiographically, or estimated from an index clinical event. Endpoints were procedural success, defined as recanalization with less than 50% residual stenosis without major complications; and the need to change to larger-sized guiding catheters. Recanalization was attempted in 62 chronic total occlusions; 35 were located in the left anterior descending coronary artery, 18 in the right coronary artery, and 9 in the left circumflex coronary artery. The mean duration of the occlusion was 6.0 ± 6.6 months; the range was 2–39 months. Lesion morphology included abrupt or diffuse occlusion (55%), a side branch originating at the occlusion (47%), and bridging collaterals (23%). Death, urgent coronary bypass surgery, or myocardial infarction did not occur. Recanalization was successful in 51 of the 62 total occlusions (82%); 49 were completed successfully with a 6 French guiding catheter, and 2 were successful after changing to a larger-sized guiding catheter (which was required for peripheral vessel tortuosity in one patient, and to obtain better back-up support in another). Three other attempts remained unsuccessful after a changing. A total of 12 Palmaz-Schatz stents were implanted in 11 patients for an unsatisfactory result or type C dissection, using the same 6 French guiding catheters. These preliminary findings indicate that 6 French guiding catheters are both effective and safe for angioplasty of chronic total occlusions. *Cathet. Cardiovasc. Diagn. 40:255–260, 1997.* © 1997 Wiley-Liss, Inc.

Key words: coronary occlusion; angioplasty; 6 French guiding catheters

INTRODUCTION

The use of small-sized guiding catheters for coronary angioplasty offers several advantages. First, the smaller arterial puncture potentially reduces the risk of vascular complications and facilitates early ambulation. Furthermore, 6 French guiding catheters may reduce the occurrence of coronary wedging and the risk of ostial dissection, while the flexible small-sized guiding catheters enable deep coronary intubation to obtain adequate backup support.

Coronary angioplasty of chronic total occlusions has become an increasingly important revascularisation treatment that represents up to 20% of all procedures in some institutions [1]. Successful angioplasty of totally occluded coronary arteries, although associated with a high restenosis rate [2,3], results in significant relief of symptoms and reduces the need for coronary bypass surgery [4]. Although improved technical refinements of angioplasty equipment and increased operator experience over the years have led to higher success rates for this procedure [5], recanalization of a total coronary occlusion remains a challenge to the angioplasty operator. Optimal guiding catheter support and adequate visualization seem to be prerequisites, in addition to operator experience and careful selection of guidewires and balloon catheters.

The purpose of the present study was to evaluate the efficacy and safety of 6 French guiding catheters for angioplasty in consecutive patients having chronic total coronary occlusions.

METHODS

This study was initiated after the completion of a one-year pilot phase in which we evaluated the use of 6 French guiding catheters for elective coronary angioplasty procedures.

Study Patients

Between July and November 1995, 61 consecutive patients underwent coronary angioplasty for chronic total coronary occlusion at our center. During this period, 6 French guiding catheters were routinely used in all elective angio-

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plasty procedures except atherectomy or elective stent implantation with systems that were incompatible with a 6 French guiding catheter. The angioplasty procedure was performed because of symptoms of angina, classified according to the Canadian Cardiovascular Society Criteria, and objective evidence of myocardial ischemia documented by a positive exercise test or scintigraphic examination.

Definitions

A total occlusion was defined as a complete interruption of epicardial filling of contrast of a coronary artery without antegrade flow (thrombolysis in myocardial infarction [TIMI] flow grade 0). Patients with 'functional' coronary occlusions (TIMI flow grade 1), or patients with a total coronary occlusion in the setting of an acute myocardial infarction, were not included in the study. A chronic total occlusion was defined as a total coronary occlusion with an estimated duration of more than two months. The duration of the occlusion was determined from previous angiographic information, or was estimated using an index clinical event such as a myocardial infarction or a sudden change in anginal symptoms.

Angiographic characteristics were documented, including morphological features of the occlusion ('abrupt,' concentric, or eccentric tapered), the presence of bridging collateral vessels, the presence of a side branch at the point of the occlusion, and the presence of calcification, proximal tortuosity, or bending at the point of the occlusion. The length of the occlusion was estimated on visual assessment when there was good contrast filling of the distal part of the occluded coronary artery by ipsilateral or contralateral collateral vessels.

Angioplasty Procedure

All patients were pretreated with aspirin, 100–300 mg, and were given 5000 IU of heparin as a bolus after insertion of the arterial sheath. An additional dose of 2500 IU of heparin was given if the procedure lasted more than 90 minutes. All procedures were started with 6 French sheaths and guiding catheters (PinkPower lumen 0.061', Schneider, Zurich, Switzerland; petit Britetip lumen 0.062', Cordis Corp., Miami, FL). The total coronary occlusion was approached with an over-the-wire system (Edge 2.0 mm, Advanced Cardiovascular Systems, Santa Clara, CA; Merlin 2.0 mm, Braun, Melsungen, Germany; Takumi OTW 2.0 mm, Schneider) or a rapid exchange system (Goldie 2.0 mm, Schneider; Passage 2.0 mm, Cordis) over a flexible wire (0.014' Hi-Torque Floppy II, Advanced Cardiovascular Systems). It was demonstrated in the pilot phase that these balloon catheters in combination with 6 French guiding catheters provided adequate visualization. The balloon catheter was introduced over the flexible guidewire in front of the occlusion in order to obtain optimal support of the wire. If the lesion could not be crossed with the flexible guidewire, progressively stiffer wires were used (J-Flexy 0.012' or 0.014', Schneider). After initial dilatation, the small-sized balloon catheter was exchanged for larger-sized balloon catheters in accordance with the vessel size, to obtain an optimal angiographic result. Stent implantation was considered in cases with a suboptimal result after balloon angioplasty or in case of major coronary dissection.

Procedural success was defined as a less than 50% residual stenosis with TIMI grade 3 anterograde flow without the occurrence of complications such as death from any cause, urgent coronary bypass surgery, or acute myocardial infarction defined as a creatine kinase-MB elevation of more than twice the upper limit of the normal.

TABLE I. Clinical Characteristics (n = 61 patients)

Age (yr)	58 ± 10[a]
Range (yr)	33–78
Male patients	50 (82%)
Prior myocardial infarction	40 (65%)
Prior coronary artery bypass graft surgery	2 (3%)
Angina class[b]	
I–II	11 (18%)
III–IV	50 (82%)
Extent of coronary artery disease	
1-vessel	32 (52%)
2-vessel	23 (37%)
3-vessel	6 (10%)

[a]Values presented are mean value ± SD or number (%) of patients.
[b]Canadian Cardiovascular Society classification.

RESULTS

Patient Characteristics

The baseline clinical characteristics of 61 patients are summarized in Table 1. Recanalization of 62 total occlusions was attempted in 61 patients, and the location and the angiographic features of these occlusions are listed in Table 2. The duration of the occlusion could be determined in 49 (81%) patients; 12 (19%) patients whose occlusions were of a duration that could not be estimated were also included, but each such occlusion lasted at least more than two months based on angiography (Table 3).

The Use of 6 French Guiding Catheters

All procedures were started with standard Judkins-shaped flexible guiding catheters (FR4, FL4, FL5 PinkPower, Schneider) for the right and left coronary artery, which were incidently replaced by different catheter shapes (AL2, ELG PinkPower, Schneider) for optimal cannulation of the coronary artery and back-up support. In many cases this could be obtained through the deep engagement that can be achieved with the soft 6 French catheters. Deep engagement of the guiding catheter was performed in 45 of 62 cases (72%), either to advance the balloon in front of the coronary occlusion or to facilitate passage of the balloon catheter across the occlusion (Fig.

TABLE II. Angiographic Characteristics

Target vessel	
Right coronary artery (RCA)	18 (29%)[a]
Left anterior descending artery (LAD)	35 (57%)
Left circumflex coronary artery (LCX)	9 (14%)
Occlusion morphology tapered	
concentric	3 (5%)
eccentric	25 (40%)
''cul de sac''/diffuse	34 (55%)
Lesion length (mm)	
≤5 min	3 (5%)
>6 < 20 mm	34 (55%)
≥20 min	25 (40%)
Side branch at total occlusion	29 (47%)
Bridging collaterals	14 (23%)
Collateral filling	51 (82%)
Bending at total occlusion	
moderate	19 (31%)
severe	7 (11%)
Tortuosity of total occlusion	19 (31%)
Ostial	9 (14%)
Calcification	17 (27%)

[a]Values presented are number (%) of lesions (n = 62).

TABLE III. Estimated Duration of Occlusion

Mean ± SD (months)	6.0 ± 6.6
Range	2–39
>2, <3 months	9 (14%)[a]
>3, <6 months	24 (39%)
>6 months	17 (28%)
Unknown, at least 2 months	12 (19%)

[a]Values presented are number (%) of lesions (n = 62).

1). If necessary, stiffer and somewhat more 'aggressive' catheter shapes were used (petit Britetip, Cordis: XB for the left, AL2 for the right coronary artery). A total of 110 guiding catheters were used for 62 occlusions (1.7/occlusion) (Table 4). Optimal visualization of the vessel distal to the occlusion by contrast injection of the contralateral artery, using a 6 French diagnostic catheter in the other femoral artery, was performed in 22 (35%) of the 61 procedures (Fig.2).

Exchange for a larger guiding catheter was attempted in 5 of 62 occlusions. This resulted in a successful completion of the procedure in two cases: In one patient, a rigid 8 French guiding catheter (Marathon JR4, Baxter, Irvine, CA) was needed to enable the cannulation of a right coronary artery through a very tortuous femoral artery and descending aorta; in another patient, switching

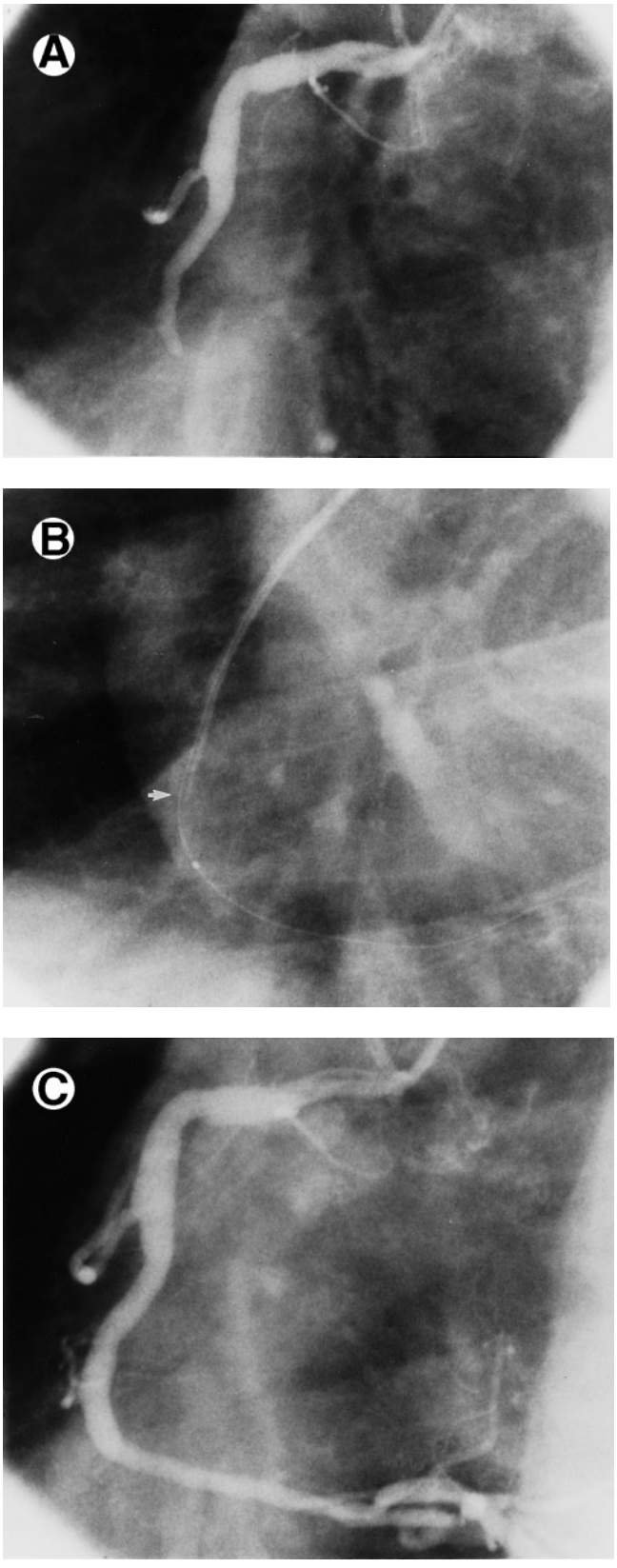

Fig. 1. A: Angiography of the right coronary artery (left anterior oblique view) showing a blunt total coronary occlusion of 9 months duration. B: Crossing of the coronary occlusion with a 2.0 mm over-the-wire balloon catheter is facilitated by deep intubation of a 6 French ELG guiding catheter (PinkPower, Schneider, Zurich, Switzerland) *(arrow indicates the tip of the guiding catheter).* C: The angiographic result after completion of the procedure with a long (30 mm) 3.5 mm balloon catheter.

TABLE IV. Procedural Data

Skin-to-skin time[a]	114 ± 44 min.
Fluoroscopy time	45 ± 22 min.
Guiding catheters/occlusion	1.77
Guidewires/occlusion	2.4
Successful type of guiding catheter[b]	(number of procedures)
Right coronary artery:	
FR4 (PinkPower)	6
ELG (PinkPower)	3
AL2 (Britetip)	2
AL2, 7 French (Zilla)	1
FR4, 8 French (Marathon)	1
Left anterior descending artery:	
FL4 (PinkPower)	23
AL2 (PinkPower)	2
XB (Britetip)	6
Left circumflex coronary artery:	
FL4 (PinkPower)	1
AL2 (PinkPower)	5
XB (Britetip)	1

[a]Defined as time from arterial puncture to sheath removal.
[b]Abbreviations: AL = Amplatz left; ELG = El Gamal; FL = Judkins left; FR = Judkins right; XB = extra back-up.

to a 7 French AL2 (GuideZilla, Schneider USA, Minneapolis, MN) provided adequate back-up support for successful recanalization of a right coronary artery. The three other procedures remained unsuccessful in spite of the change to a larger-sized guiding catheter (Table 5).

Guidewire and Balloon Catheter Selection

An over-the-wire system was initially chosen in 40 of 61 procedures, and a rapid exchange system was used in the other 21. In all these procedures, balloon catheter support was required to cross the wire beyond the occlusion. The initially chosen soft guidewire was successful in 31 occlusions; progressively stiffer wires were subsequently successful in 20 procedures, and did not cross the occlusion in 10 procedures; a false lumen was created in one. A total of 149 guidewires were used (2.4/occlusion). In six procedures a double-wire technique was used to protect or dilate major side branches after the initial crossing of the occlusion.

Results of Angioplasty

Successful recanalization was achieved in 51 of 62 total occlusions (82%). There were no major complica-

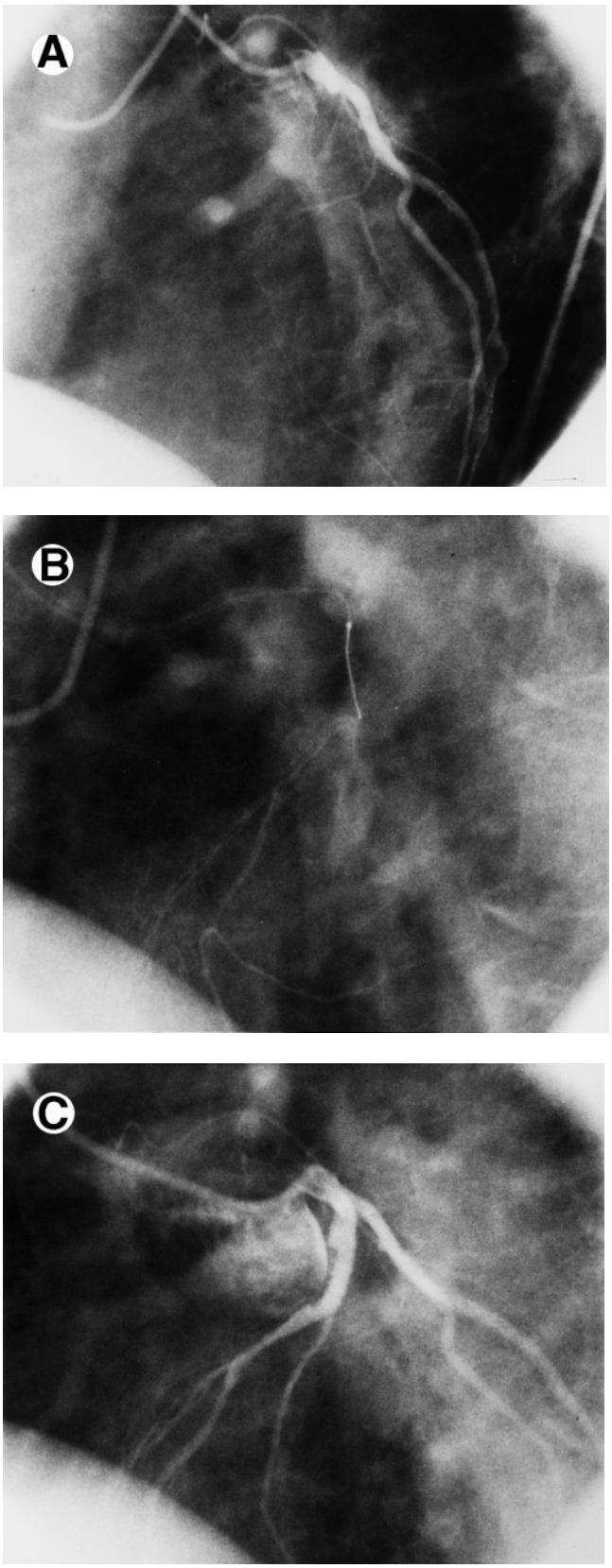

Fig. 2. A: Angiography of the left coronary artery, caudo-cranial view, showing an ostial occlusion of 6.5 months duration of the left anterior descending coronary artery. B: Contrast injection of the right coronary artery showing opafication of the distal part of the occluded left anterior descending coronary artery by collateral vessels, in order to direct the guidewire. C: Angiography of the left coronary artery, caudo-cranial view, after completion of the procedure with a 3.5-mm balloon catheter.

TABLE V. Results of Angioplasty of Total Occlusions (n = 62) With 6 French (F) Guiding Catheters

Successful recanalization	51/62 (82%)[a]
Right coronary artery (RCA)	13/18 (72%)
Left anterior descending artery (LAD)	31/35 (88%)
Left circumflex coronary artery (LCX)	7/9 (77%)
Success with 6 F guiding catheter	49 (79%)
Exchange for larger guiding catheter	5 (8%)
Success after exchange (2 × RCA)	2 (3%)
Failed after exchange, (2 × RCA, 1 × LAD)	3 (5%)
Unsuccessful angioplasty	11 (18%)
Wire unable to cross	9
Balloon unable to cross	0
Creation of false lumen	1
Perforation	1

[a]Values presented are number (%) of lesions (n = 62).

tions such as death, urgent coronary bypass surgery, or myocardial infarction. The most common reason for procedural failure was inability to cross the lesion with the guidewires (Table 5). All lesions that were crossed with a guidewire could be dilated successfully. One procedure was terminated after the creation of a false lumen. A perforation with the guidewire occurred in one patient, without subsequent complications such as a myocardial infarction or the need for pericardiocentesis (Table 5).

Successful recanalization was followed by implantation of one (10 cases) or two (one case) Palmaz-Schatz (Johnson & Johnson Interventional Systems, Warren, NJ) stents, manually crimped on the balloon, for an unsatisfactory angiographic result (n = 8), or to treat a type C coronary dissection (n = 2). All stents were implanted using the same 6 French guiding catheters. Successful angioplasty of additional, non-occlusive lesions (n = 33) was performed in 26 procedures.

Clinical Course

The sheaths were removed immediately after the procedure in all but two patients. Hemostasis was obtained by manual compression and maintained with an inguinal compression bandage. In the case of procedures using a 6 French guiding catheter (n = 54), the bandage was removed after four hours of bedrest in a supine position and the patients were mobilized. The compression bandage was maintained overnight after a procedure with a 7 or 8 French guiding catheter (n = 5). There were no puncture-site complications either at discharge or after a 48-hour follow-up telephone call. Puncture of both femoral arteries for visualization of the contralateral coronary artery did not influence the ambulation time nor did it induce additional vascular complications.

Prolonged treatment with heparin and sheath removal the following day were considered necessary in the two patients with a stent implantation for a type C coronary dissection. Additional heparin was given for 24 hours after sheath removal for a temporary side branch occlusion in one patient. Prolonged clinical observation was considered necessary for a patient with an asymptomatic but large false lumen and for a patient with a coronary perforation. The clinical course was uneventful for both patients.

DISCUSSION

The present study demonstrates the efficacy and safety of using 6 French guiding catheters for angioplasty of chronic total occlusions. The overall success rate was 82%: In all but two cases the procedure was completed successfully with a small-sized guiding catheter. A change to a larger guiding catheter was needed for peripheral vessel tortuosity in one patient and to obtain better back-up support in another; three other attempts remained unsuccessful after a change.

Chronic coronary occlusions have often been excluded in the evaluation of small-sized guiding catheters from either the femoral or radial approach [6,7]. Experienced operators have expressed their reluctance to use 6 French guiding catheters for chronic total occlusions, possibly because of poorer visualization, reduced back-up support, or incompatibility with the Magnum-Meier system [8].

The results of the present study suggest that a lack of back-up support did not explain the unsuccessful cases. The relatively soft guiding catheters (PinkPower, Schneider) that were used in the majority of the procedures allowed deep cannulation of the coronary artery, thus providing ‘active‘ back-up support. The application of this technique, i.e., advancement of the guiding catheter down to, or almost down to the point of the occlusion, depended upon the site of the coronary occlusion. Stiffer 6 French guiding catheters without deep intubation were in some cases useful for both proximal right and ostial left anterior descending coronary artery occlusions. Since the occlusions were approached with the balloon catheter as a support to the guidewire, the adequacy of the visualization might have been critical. However, balloon catheters with a shaft diameter of preferably no more than 2.8 French allowed adequate visualization of the occluded coronary artery. Furthermore, contrast injection of the contralateral coronary artery in order to visualize the distal part of the occluded artery by collateral vessels appeared very helpful. The choice of a 6 French guiding catheter by no means interfered with the use of a double-wire technique or the implantation of intracoronary stents, as has been reported in detail by others [9,10].

A review of angioplasty of chronic total occlusions reported procedural success rates ranging from 53% to 68% in studies in the 1980s [5]. More recently, a procedural success of more than 70% has become more common [4,5,11,12], possibly related to increased operator experience [1,13], improved patient selection, and better angioplasty equipment [14]. Furthermore, some

studies indicate the possible value of other devices: A 69% procedural success in 453 chronic total occlusions has been reported with the use of the Magnum wire [15]; recently, a procedural success rate of 58% was reported with the excimer laser wire in 252 total occlusions with a mean clinical duration of 27 weeks (range 2–1040) [16]. The estimated duration of the occlusion, in most studies a strong predictor of failure of the procedure [2,5,13], was 6.0 ± 6.6 months in the present study. Furthermore, morphologic characteristics unfavorable for successful recanalization [1,5,13] were present in more than 50% of the lesions. Nevertheless, the results indicate that 6 French guiding catheters allow the performance of angioplasty in chronic coronary occlusions with a procedural success that corresponds with the results of more recently reported series [1,11,12,13,14].

Our approach with low-dose heparin [17] and immediate removal of the sheath enabled ambulation without complications four hours after a 6 French procedure. Since lower complication rates have been described after angioplasty of chronic total occlusions compared with angioplasty in non-occluded stenoses [1], this group of patients seems to be particularly appropriate for early ambulation and discharge.

High restenosis rates have been reported after successful angioplasty of chronic total coronary occlusions [2,3,5], and preliminary reports suggest favorable effects of stent implantation after recanalization [18]. In our population, stents were implanted only in the case of a major dissection or a suboptimal result. However, when elective stent implantation appears to become the therapy of choice to prevent restenosis after recanalization of chronic total coronary occlusions, the use of 6 French guiding catheters for these procedures may have additional value in preventing peripheral vascular complications.

CONCLUSION

These preliminary findings indicate that 6 French guiding catheters are both effective and safe for angioplasty of chronic total occlusions. This data supports the notion that 6 French guiding catheters can currently be considered the standard for coronary angioplasty.

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