

# Retrograde Angioplasty: An Option for Total Coronary Artery Occlusions

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The safety and effectiveness of angioplasty for chronic total occlusions of the coronary arteries have been demonstrated in several studies, but the success rate is less than for conventional interventions. The complexity of the procedures presents a major challenge. In selected cases, performing angioplasty of the occlusion via a retrograde approach has been used as an alternative. We present the first published Spanish series, comprising 11 procedures in 9 patients, in which a retrograde approach was used to eliminate obstructions caused by chronic total coronary artery occlusions. The characteristics, outcomes and complications of the procedure were assessed.

**Key words:** *Coronary angioplasty. Chronic total occlusion. Coronary stents.*

## Angioplastia vía retrógrada: una alternativa en las oclusiones totales coronarias

La angioplastia en oclusiones totales crónicas coronarias ha demostrado su efectividad y su seguridad en diversos estudios, aunque con una tasa de éxitos menor que en intervenciones convencionales. Constituye un reto por la complejidad de los procedimientos. Para casos seleccionados, se ha desarrollado una técnica de angioplastia por vía retrógrada a la localización de la oclusión. Presentamos la primera serie publicada en nuestro país con 11 procedimientos en 9 pacientes en los que se realizó un intento de desobstrucción de la oclusión total crónica por vía retrógrada y evaluamos las características del procedimiento, los resultados y complicaciones.

**Palabras clave:** *Angioplastia coronaria. Oclusión total crónica. Stents coronarios.*

## INTRODUCTION

Chronic total occlusion (CTO) of a coronary artery is defined as thrombolysis in myocardial infarction (TIMI) flow 0 lasting 3 months or more.<sup>1</sup> There is evidence that reopening the artery is beneficial if the vessel territory is viable.<sup>2</sup> However, the procedures involved are technically complex and demanding on time and resources, with a lower success rate in revascularization.

Normally, an antegrade approach was used to reach the occlusion. Recently, several Japanese groups have developed and perfected the technique of retrograde approach to the occlusion via collateral vessels to the affected vessel. The technique is more complex, but the success rates can be almost 90% in the most experienced teams.<sup>3</sup>

The retrograde procedure consists of cannulating the 2 coronary ostia and advancing a guidewire from the unoccluded artery to the region distal to the occlusion via collaterals originating from the healthy artery. Preferably, septal vessels are used because the risk of tamponade in the event of vessel rupture is lower and because of the lower risk of inducing significant infarctions as these are small vessels. However, collateral epicardial vessels can also be used in certain cases.

Retrograde guidewire advancement increases the chances of success, as anatomopathological studies have shown that the posterior capsule of the occlusion is more fragile than the proximal one.<sup>4</sup>

In this article, we review our experience with the retrograde approach in 11 patients who underwent the procedure between December 2007 and October 2009.

## METHODS

The selected patients had a CTO defined as TIMI flow 0 in the target vessel lasting more than 3 months. All patients had exercise-induced angina and the viability of the territory had been demonstrated

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**TABLE 1. Summary of Patients Treated by the Retrograde Approach**

Patient	Age	Artery	Approach Used	Retrograde Attempts	Prior Anterograde Attempts	Success of Retrograde Approach	CTO Wire Crossing Technique	Reason for Failure	Periprocedural Complications
1	63	Mid RC	Septal	1	1	Yes	CART		Septal rupture with limited hematoma
2	41	Mid LAD	Septal	1	1	Yes	Retrograde guidewire crossing through posterior capsule + externalization of the guidewire		None
3	73	Proximal LAD	Epicardial	1	1	Yes	Crossing of retrograde guidewire through posterior capsule + externalization of the guidewire		
4	71	Proximal RC	Epicardial	1	1	Yes	Inverted CART + externalization of the guidewire		
5	72	Proximal RC	Septal	1	0	No		Unable to pass through the occlusion with the retrograde guidewire	None
6	69	Proximal RC	Septal	2	1	Yes	Kissing wire + anterograde angioplasty		None
7	68	Distal CD	Epicardial	2	0	No		Unable to pass through the occlusion with the retrograde guidewire in both cases	Rupture of the intracoronary guidewire without any clinical repercussions
8	76	Mid RC	Septal	1	Anterograde	No		Unable to advance through the septal vessel	None
9	67	Distal RC	Septal	1	0	No		Unable to advance through the septal vessel	

CART indicates controlled antegrade and retrograde subintimal tracking; CTO, chronic total occlusion; LAD, left anterior descending artery; RC, right coronary artery.

by different methods: isotope study, stress echocardiography, gadolinium-enhanced cardiac magnetic resonance imaging, ventriculography, and echocardiography.

Patients received dual antiplatelet therapy with acetylsalicylic acid and clopidogrel at least 5 days before the procedure.

The criteria for ending the procedure were as follows: success of the procedure, serious complication, contrast volume administered, and fluoroscopy time, or prolonged procedures according to the judgment of the operator.

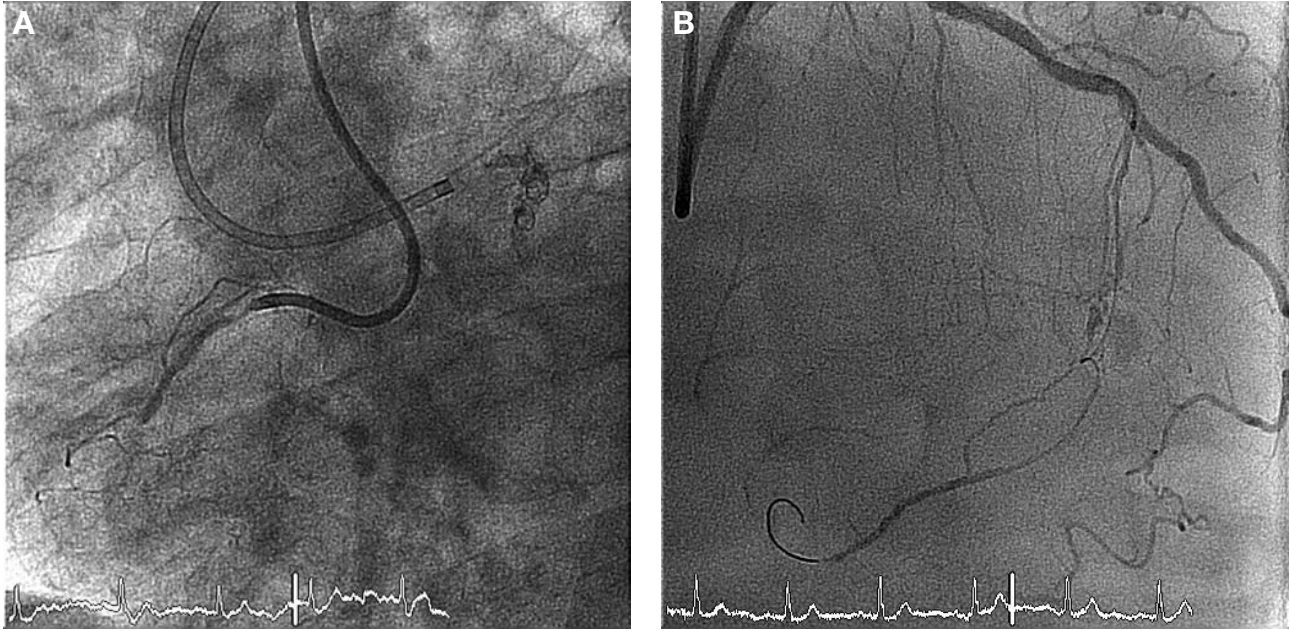
After the procedure, all patients remained on a conventional ward for at least 24 hours to monitor the outcome. Laboratory tests measuring cardiac

enzymes and electrocardiography were done throughout their stay in hospital.

Clinical follow-up was done at 1 month, 6 months, and 1 year. In addition, angiographic study was undertaken at 6 and 9 months.

**RESULTS**

Eleven procedures were performed in 9 patients: seven (78%) were men. The mean age was 66.9 years (range, 41-76 years). The right coronary artery was the target artery in 7 patients (78%); in the 2 remaining patients, the target artery was the left anterior descending artery. Epicardial approach was used in 4 of the 11 procedures (36.4%). No



**Figure 1.** Patient with chronic total occlusion of the mid right coronary artery. A: angioplasty catheters are shown in both coronary arteries, with selection injection in the right coronary artery, where diffuse disease can be discerned with an occlusion in the mid artery. B: a retrograde approach was performed by advancing an angioplasty guidewire from the septal branch of the left anterior descending artery to the distal portion of the occlusion.

patient showed clinical evidence of prior infarction in the territory of the target vessel. Of the 9 patients, 7 (77.7%) had other diseased arteries besides the occluded one treated in the procedure.

The mean duration of the procedure was 225 minutes (range, 100-436 minutes) and fluoroscopy lasted 99 minutes (range, 78-247 minutes). The volume of contrast administered was 358.7 mL (range, 190-500 mL).

The retrograde attempt was successful in 5 of 11 procedures (success rate per procedure, 45.5%) and 5 of 9 patients (success rate per patient, 55.6%). In 1 of these patients, it was possible to reopen the vessel using an antegrade approach. In 3 of the 11 attempts (27%), the retrograde approach was used as the first option; in the remaining procedures, this approach was used after prior failures of other approaches. In the 3 patients in whom the attempt using the retrograde approach was the first option, a second attempt using the antegrade approach was used without success. The success rate of the procedures performed in the last year was 83.3% (5/6 procedures from October 2008 through October 2009), whereas the success rate in earlier procedures was 0 (5 procedures between December 2007 and September 2008).

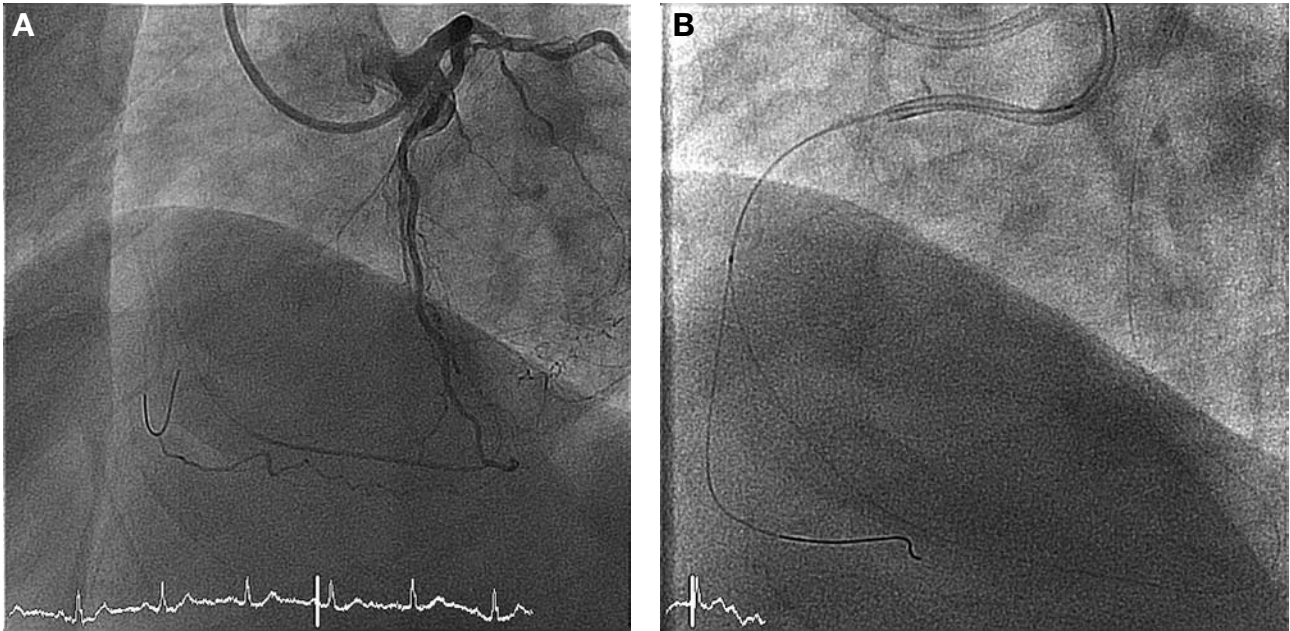
Periprocedural complications were scarce and mild in nature (Table 1). The mean follow-up of these patients was 366 days (range, 41-718 days). Only 2 events were reported: in 1 patient, contrast-induced nephropathy occurred but this did not require dialysis and significant creatinine elevation

was not observed in any other patient; and in 1 patient radiodermatitis presented on the right leg after 15 days, progressing to ulcer but resolving after treatment. Although a mild increase in troponin I occurred in all patients during the procedure (from 0.11 to 5.63  $\mu\text{g/L}$ ), no periprocedural myocardial infarctions were reported (defined as creatinine kinase  $>3$  times the upper limit of normal or the appearance of new Q waves at 2 contiguous leads). Control catheterization procedures showed success in all cases; restenosis of the vessel did not occur in any of the patients.

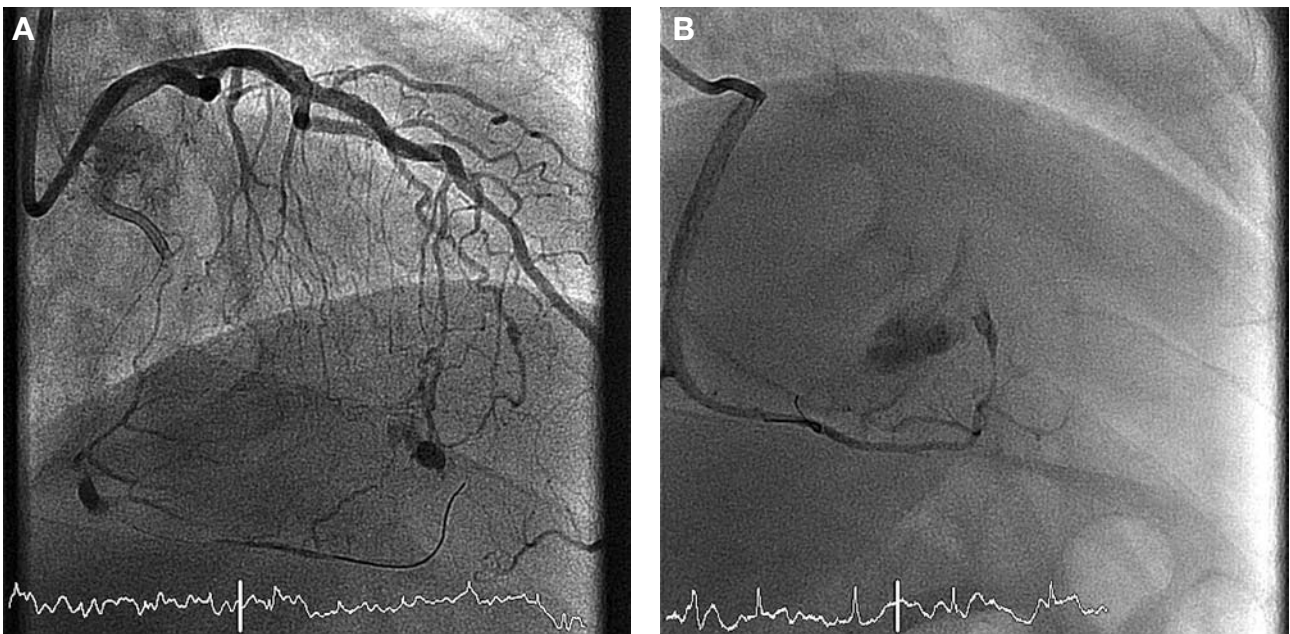
## DISCUSSION

Our series shows that the technique of CTO angioplasty by a retrograde approach is feasible in our hospital with the techniques and materials currently available to us. The rate of complications is low and most that do occur are of no clinical significance. The small periprocedural elevation in troponin I may be due to several factors, including surgical lesions in the collaterals used or explored and loss of secondary branches when advancing the angioplasty guidewires through the subintimal space.

Of note is the difference in success rate between the initial and most recent procedures, pointing to a steep learning curve. We think that this is due to 3 factors: more extensive experience and confidence in the new technique, better patient selection and evaluation, and the incorporation of specific



**Figure 2.** The same patient as in Figure 1. A: advancement of the retrograde guidewire to the distal portion of the occlusion via the posterolateral branch of the right coronary artery. B: finally, the retrograde guidewire manages to pass through the obstruction and is introduced into the catheter of the right coronary artery. After balloon dilatation, the guidewire is advanced in an anterograde direction to the distal portion of the right coronary artery.



**Figure 3.** A: passage of an angioplasty balloon has caused rupture of the septal branch used. B: in the final angiography after the procedure, the right coronary artery is patent with several stents implanted in the region of the occlusion and a fistula from septal rupture to the right ventricle. This complication did not lead to hemodynamic deterioration and the patient was discharged 4 days later.

materials for the technique. The first cases were used to try out the technique; after a review of the description of the technique in the literature, course attendance and invitation of operators experienced in the procedure, the improvement in success rate was evident. In each center, we think that it is essential that the technique be performed by just 1

or 2 operators with the necessary experience, given the low number of cases. For the same reason, the procedures should be restricted to certain reference centers, and it is not very feasible to generalize the use of these techniques.

Although development of this technique for the treatment of CTO is relatively recent, progress

has been rapid with the implementation of new strategies and the use of new materials. This has contributed to an increase in the success rates for percutaneous interventions for CTO when performed by experienced staff. Although only this approach used to be employed when the antegrade approach had failed, currently it is the first choice in patients with good heterogeneous coronary flow and in those patients in whom an antegrade approach seems complex a priori. While the septal approach is preferable when viable, the epicardial approach is a possibility, as shown in our series, though always taking care not to damage the vessel. In large series at reference hospitals, the success rates applying both approaches (antegrade and retrograde) is 86.3%.<sup>3</sup> The rate of intrahospital complications in the successful procedures was low, with a mortality of 0.25% and a rate of major cardiac events of 1.5%. With regard to local complications in the target or collateral vessels, these were few (vessel occlusion, 0.83%; distal embolization, 3%; lateral branch involvement, 4%; coronary dissection, 13.9%; and vessel perforation, 7.4%). Most of these local complications did not lead to deterioration of the patient's condition and resolved spontaneously (Figures 1-3).

With regard to the epicardial approach, in some series, this is used in up to 30%,<sup>5</sup> with outcomes comparable to those mentioned earlier (success rate, 86%) and very acceptable rates of in-hospital

complications (no deaths or ST-elevation myocardial infarctions, and non-ST-elevation myocardial infarctions in just 6% of the patients).

Therefore, the retrograde approach is a safe and effective technique for revascularizing CTO and has enabled higher success rates in these procedures. The technique has a promising future as more experience is gained and specialized tools become available.

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