Radial approach and single wiring as first intentional strategies in chronic total occlusions of the left anterior descending coronary artery

Yasser Nassar a,⇑, Nicolas Boudou b, Didier Carrie b

a Cairo University, Critical Care Dept; b Toulouse Rangueil University, Cardiology Dept

⇑Corresponding author. Address: 2 gameat aldoal alarabiah st., flat 23, Giza 12311, Egypt. Tel.: +20 1001115553.
E-mail addresses: ysnnassar@hotmail.com, ysnnassar@kasrelainy.edu.eg (Y. Nassar).

Background: Percutaneous coronary intervention (PCI) for chronic total occlusion (CTO) of the left anterior descending coronary artery (LAD) specifically is associated with improved long-term 5 years survival as compared to PCI failure. Simpler PCI techniques may be successful and safer than complex techniques which are perceived to have high failure rates and technical complexity.

We aimed to describe the safety and effectiveness of first intentional single wiring and radial approach in the treatment of patients with a CTO of the native LAD coronary artery at Toulouse Rangueil university hospitals.

Patients and methods: The study was a single center prospective registry. All patients showed evidence of myocardial viability in LAD territory. The operators’ initial strategy was to start by a radial access as a first choice whenever feasible; if not, a femoral access was chosen. The initial strategy for lesion crossing in either antegrade or retrograde approaches was single wiring by lesion crossing using one guidewire (GW) as a simple technique.

Results: A total of 30 patients with 30 LAD CTO lesions (100%) were recorded. Mean age was 71.6 ± 15 years, 77% were males and 23% were females. The access route was radial 66% of the time and femoral 54% of the time and with double access for contralateral injection in 40% of the patients. Sheaths and catheters sizes 6F were used in 53% of the patients, and 7F in 73% of the patients.

Overall lesion success rate was 83% of lesions. Single wiring was the prevailing technique used in 97% of successful lesions (83% of total cases), while only 3% were by multiple wiring techniques. Successful single antegrade wiring represented 63% of our total study cases with a GW success rate of 92% of cases. Successful single retrograde wiring represented 13% of our cases with a GW success rate of 67%. Q-wave myocardial infarction (MI), stent thrombosis, stroke, emergency coronary artery bypass graft (CABG), major bleeding, radiation dermatisis, cardiac tamponade or clinical perforation requiring any hemostatic maneuvers did not occur. There was a post-procedural Troponin rise of 3x normal levels in 30% of patients, and contrast induced nephropathy in 7%. Intra-aortic balloon counterpulsation (IABCP) was used in 3% of patients and cardiac death occurred in 3% of patients.

Conclusion: Single wiring and radial access as initial strategies in PCI for LAD-CTO lesions in either approaches antegrade or retrograde are associated with a high procedural success rate and an acceptable incidences of adverse events.

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Introduction

A coronary chronic total occlusion (CTO) is defined to be: “the presence of a thrombolysis in myocardial infarction (TIMI) 0 flow within the occluded segment with an estimated occlusion duration of >3 months duration.” [1,2] It is a common angiographic finding in 30% of patients undergoing coronary angiography, and in 52% of patients with significant coronary artery disease [3] demonstrating a very variable clinical presentation ranging from silent ischaemia, stable angina, ischemic heart failure, or discovered as a coincidence during a primary intervention for another culprit vessel [2].

Antegrade contrast filling of the segment beyond the occlusion can occur through intraluminal channels below the threshold of angiographic resolution [4], or non-intra-luminal ipsilateral bridging collaterals giving a false impression of a functional incomplete occlusion [4]. Retrograde contrast filling beyond the occlusion can occur through collateral coronary. The presence of collateral filling distal to the CTO is not a justification for a conservative approach since it only supplies 40% of the pressure level of the open artery [5] which is a barely sufficient blood flow to maintain viability of the myocardium supplied by the occluded artery [2]. It is almost always insufficient to avoid the effort induced angina/ischaemia, as during exercise, only about 5% of patients will have collaterals with enough functional reserve to increase collateral perfusion, whereas more than one-third of patients will experience coronary steal [6,7]. Almost half of the patients with CTOs do not have Q-waves or akinesia in the territory of the occluded artery [8,9] emphasizing the expected benefit of revascularization of ischaemic viable/hibernating myocardium in the CTO territory, even if the patient’s symptoms are acceptably controlled or becomes asymptomatic by medical treatment.

An untreated CTO is a strong predictor of 30 day and 5 year mortality after primary percutaneous coronary intervention (PCI) [10] and causing a threefold increase in cardiac mortality or complications in case of future acute events [11]. PCI recanalization of CTOs is more effective in reducing residual ischemia (>5%) [12]. And may provide better prognosis than optimal medical therapy alone. Its benefit is greatest in patients with moderate (10–20%) or severe (>20%) ischemia [13]. It has been shown to reduce angina and relieve symptoms in nearly 70% of patients. [14], lower mortality and need for coronary artery bypass graft (CABG) [14–16] and increase exercise capacity with an improved left ventricular regional and global systolic function indicating the recovery of hibernating myocardium in the territory supplied by the CTO [8,17,14,18–20].

PCI for CTO of the left anterior descending coronary artery (LAD) specifically is associated with improved long-term 5 years survival as compared to PCI failure [21]. Simpler PCI techniques may be successful and safer than complex techniques which are perceived to have high failure rates and technical complexity.

Aim of the work

do to describe the safety and effectiveness of first intentional single wiring and radial approach in the treatment of patients with a CTO of the native LAD at Toulouse Rangueil University Hospitals.

Patients and methods

The study was a single-center prospective registry. All consecutive patients with a PCI attempt to a native LAD CTO from January to December 2010 were registered. All patients showed evidence of myocardial viability in LAD territory. All other co-existing non-LAD coronary lesions indicated for interventional therapy were treated before attempting the CTO procedure (30% of cases within the same session). All cases were first attempts with no previous attempt failures recorded to the specific CTO-LAD vessel. All patients were pre-treated and maintained on optimal medical treatment including dual antiplatelet therapy and were able to continue on an antiplatelet agent regimen consisting of aspirin indefinitely and Clopidogrel or Prasugrel daily for at least 6 months after the procedure. The study was approved by the ethical committee of Toulouse University. The study was funded by Toulouse University. All patients included agreed to sign an informed consent for inclusion in the study, all protocols were in compliance with the Declaration of Helsinki.

Procedure technique

The operators’ initial strategy was to start by a radial access as a first choice whenever feasible; if not, a femoral access was chosen. Bilateral access was done whenever it was possible to better visualize the distal true lumen through collaterals. Whenever feasible, six French (F) sheaths and catheters were preferred. The decision to perform either an antegrade or a retrograde approach was according to operators discretion dependant on each individual patient’s condition. The initial strategy for lesion crossing in either antegrade or
retrograde approaches, was single wiring by lesion crossing using only one guidewire (GW) as a simple technique. Multiple wiring by lesion crossing using multiple GWs as complex techniques was chosen when single wiring was not feasible.

Lesion success as defined as a final diameter stenosis of <50% with a TIMI three flow. GW crossing success was defined as ability of the GW to cross the occlusion reaching to the distal true lumen. Contrast induced nephropathy (CIN) was defined as either >25% increase of serum creatinine or an absolute increase in serum creatinine (Se Crea) of 0.5 mg/dL after the radiographic examination using a contrast agent. we avoided injecting 4–6x Crea Clearance to minimize the risk of CIN. Post-procedural MI was defined by post-procedural troponin elevation three times the normal value (0.01 and 0.03 ng/m) [23]. Patients were followed up for radiation dermatitis if X-ray exposure as >300 Gy/cm².

Monitoring of complications included dissection, occlusion of major vessel, occlusion of significant side branch, no reflow, perforation with clinical impact or tamponade, major bleeding, intra aortic balloon counterpulsation, post-procedural infarction (troponin elevation of >3 times normal values), Q-wave myocardial infarction, duration of hospitalization, emergency CAGB within 30 days, target vessel revascularization, stroke, or death within 30 days.

Statistical Methods

Continuous variables were presented as mean ± SD or median and range if appropriate. Discrete variables were expressed as counts and percentages. All statistical analyses were performed with JMP version 8.0 (SAS Institute, Cary, North Carolina).

The authors had full access to and take full responsibility for the integrity of the data.

Results

Patients’ characteristics

Between January and December 2010 a total of 30 patients with 30 LAD CTO lesions (100%) were recorded. Mean age was 71.6 ± 15 yrs (37% were >80 years old), 77% were males, 23% were females. Cardiovascular risk factors: hypertension was present in 63%, Diabetes 27% (insulin dependent 14%), dyslipidemia 57%, smoking 40%, and hereditary in 13% of patients. Baseline kidney functions showed serum creatinine (Se Crea) within normal ranges in 86% of patients while it was elevated in 14% of patients (Se Crea mean 98.8 ± 84, median 75.5, range 45–526 µm/l), Crea Clearance was normal in 63% of patients while it was <60 ml/min in 37% of patients (mean 83.5 ± 40, median 86.5, range 12–170 ml/min), while 3% of patients were known to be maintained on regular dialyses. Duration of hospitalisation was mean 7.03 ± 5.3 days.

Underlying coronary lesions

Upon initial diagnosis of the LAD-CTO the majority of patients originally were 77% multi-vessel disease while only 23% single vessel disease (CTO-LAD). Coronary artery dominance was right in 86%, left 3%, and co-dominance in 11% of patients. Occlusive lesion Length was <20 mm in 53% and >20 mm in 47% of patients. Collaterals were visible antegrade in 58%, retrograde in 32%, both antegrade and retrograde in 31% and absent or non-visible in 7% of patients. Calcification was moderate to severe in 47% of patients. Lesion origin was de novo in 97% and in-stent 3% of patients. Site of lesion was ostial in 7%, proximal 43%, middle in 70% and distal in 13% of patients. The proximal reference artery diam mean 2.99 ± 0.33 mm, median 3, range 2.5–3.5 mm. Bifurcation lesion CTO-diagonal (>1.5 mm) was present in 20% of patients (Table 1).
Access route

The radial route was accessed in 66% of patients (single radial 36%, double radial-radial 10). The femoral route was accessed in 54% of patients (single femoral 24%, double femoral-femoral 10%). A double radial-femoral was accessed in 20% of patients (Figure 1). Sheaths and catheters of size 6F were used in 53% while size 7F were used in 73% of patients. No 8F sheaths were used. Microcatheters were used in 66% of patients (Fincross 56%, Corsair 10%) representing 55% of antegrade and 100% of retrograde procedures.

Overall outcome

An initial antegrade approach was attempted in 80% of cases while initial retrograde approach was attempted in 20% of cases. In antegrade approaches, 97% of lesions were attempted with single wiring and 3% by multiple wiring techniques. Retrograde approaches were all attempted with single wiring (100%) through visible septal collaterals (100%) without attempts through epicardial collaterals (0%) (Figure 2).

GW crossing success occurred in 93% of the total cases (92% of antegrade and 67% of retrograde approaches). GW types achieving successful crossing showed a 44% majority of soft tapered GWs, 36% soft non-tapered, 16% stiff non-tapered GWs, and 4% of stiff tapered GWs.

Overall Lesion Success (final diameter stenosis < 50% with TIMI3 flow) occurred in 83% of total cases (81% in antegrade and 67% in retrograde approaches respectively).

The cause of failure in total patients was balloon crossing failure or dissection (10%) followed by wire crossing failure (7%). In antegrade cases, balloon crossing failure and dissection (12%) and wire crossing failure (7%). The only cause of failure for retrograde approach was collateral wire crossing failure (33%) (Figure 3).

Successful cases were finalized with conventional stenting (83%). Kissing with provisional T-stenting was done in 67% for bifurcational diagonal side branch CTOs, while 33% of cases stenting without kissing. Anchoring in a side branch septal or diagonal to facilitate stent delivery was done in 6% of patients. Rotablateur 3%, IVUS 3%, and Tornus 3% were used to facilitate the procedure with success, and all were with antegrade approaches.

Thirty-day Complications

Contrast induced Nephropathy (Post procedural Creatinine elevation >25%) was reported in 7% of total cases. Post-procedural MI (Troponin >3
times normal value) occurred in 30% of patients. Occlusion in a major vessel occurred in 3%, occlusion of side-branch 3%, dissection in major vessel 3%, dissection in side-branch 7%, transient no-reflow 3%, and intra-aortic counterpulsation 3%. No events were recorded for Q-wave MI 0%, cerebrovascular stroke 0%, stent thrombosis or target vessel revascularisation 0%, major bleeding 0%, perforation with clinical impact or tamponade 0%, CABG within 30 days 0%, while one patient (3%) was referred to CABG scheduled after 30 days. Death occurred in one patient (3%) who was an 83 year old male with multi-vessel disease unfit for surgery, recorded as refractory cardiorespiratory arrest in the intensive care after an apparently angiographically successful procedure (Figure 4).

Discussion
Owing to the ongoing evolution in dedicated materials and techniques of PCI to CTOs during the past decade, success rates jumped from 51% in the balloon angioplasty era to 70% in the DES era [24] and 86.6% in experienced hands after patient selection [25]. The choice of the most simple technique and the smallest sizes of invasive catheter materials by a radial access may be a safe and effective strategy to obtain a good success rate and lower adverse events or complications.

Patient characteristics in our study showed a high incidence of diabetes (27%) consistent with reports showing diabetes (22%) [26] and (43%) [25]. Chronic dialysis in our study was (3%) comparable to other reports showing (4%) [25]. The underlying coronary lesion was single vessel disease in 23% of our patients, while in other reports was 28.9% [27] and 28.8% [26] were single vessel disease, and the rest of the patients had multi-vessel disease. Our study involved LAD–CTO lesions in all patients (100%) while in other registries it was 36% [25] and 31% [26]. In our study 97% were de novo lesions of native LAD comparable to the other registries 93.8% [26] and 93.7% [25]. Bifurcation lesion CTO-diagonal (>1.5 mm) was present in 20% of our patients versus 16% in other reports (28 Rathore et al. 2009). Proximal reference artery diameter in our patients mean was 2.99 ± 0.33 versus 2.9 ± 0.7 mm in the J-CTO Registry [25].

Access route in our study was predominantly radial 66%, femoral 54% versus femoral 87% and radial in only 8% in the J-CTO Registry [25]. Double access and contralateral injection in our study occurred in 40% of total patients versus 62% according to the Euro-CTO Club Consensus [2] and 70% in the J-CTO Registry [25]. Sheaths and catheters sizes used in our study were composed of size 6F in 53%, 7F in 73% of patients, while no 8F was used in any patient (0%) versus 6F in just 10%, 7F in 82% and 8F in 7% in the J-CTO Registry [25]. There is a general consensus that the use of 6F catheters are probably sufficient for more straightforward CTOs while in the most complex lesions only 7F guiding catheters are probably sufficient for more straightforward CTOs while in the most complex lesions only 7F guiding catheters are sufficiently large to advance two wires and two OTW catheters (micro-catheters) for parallel wire technique [2].

The isolated GW success rate in our study was 93% in total cases comparative to 87.7% in the J-CTO Registry [25]. Overall lesion success rate in our study was 83% of lesions, in comparison to the high records of 86.2% success rate in the CONQUEST registry [28] and the 86.6% success rate of the J-CTO registry [25]. Lesion success rate of primary antegrade procedures was 79% in our study versus 74% of the J-CTO Registry [25]. On the other hand,
lesion success rate of primary retrograde procedures was 67% in our study versus the relatively high 79.2% of the J-CTO Registry [25].

Single wiring was the prevailing technique in our study being used in 97% of successful lesions (83% of total cases) versus 50% single wiring in the J-CTO Registry [25], while only 3% were by multiple wiring techniques. Successful single antegrade wiring represented 63% of our total study cases with a GW success rate of 92% of cases versus 55.5% with a GW success rate of 91.8% in the J-CTO Registry [25]. Successful single retrograde wiring represented 13% of our total study cases with a GW success rate of 67% versus 12.4% of cases with a GW success rate of 84.5% in the J-CTO Registry [25].

Lesion failure due to GW crossing failure occurred in 7%, while lesion failure due to balloon crossing failure and/or dissection occurred in 10% of cases. In the antegrade approach, balloon crossing failure and dissection (12%) and wire crossing failure (7%). In the retrograde approach, collateral wire crossing failure was the only cause of lesion failure (33%). GW crossing failure was the most common cause of CTO lesion failure according to the Euro-CTO Club Consensus [2].

Complications

Cardiac death was seen in 3% of the patients in our study, while it was seen only in 0.2% of cases of the J-CTO Registry [25]. This apparent difference is probably due to the relative small number of cases. Cardiac tamponade or clinical perforation requiring any hemostatic maneuvers was not found in our study (0%), as with the J-CTO registry which was strikingly low at 0.4%, compared with the previous reports (a range of 0.8% to 1.9%) [24,28]. In their case, the balloon tamponade was sufficient to seal it with heparin reversal in the J-CTO Registry [25]. Post procedural Troponin 3x normal occurred in 30% of patients in our study. The high incidence of post-procedural elevation of highly sensitive Troponin may be an overestimation of peri-procedural infarction and not correlating with clinical symptoms. A TnT more than three times the 99th percentile has been proven to occur in 27% of low risk procedure patients [31], and CK-MB in that case may be more clinically relevant [29] Recently, the third universal definition of myocardial infarction declared that myocardial infarction associated with PCI is arbitrarily defined by elevation of cTn values >5x 99th percentile URL in patients with normal baseline values” [32].

Contrast induced nephropathy incidence in our study was 7% in the non-HD patients while it was unexpectedly low (1.2%) in the J-CTO Registry [25]. The contrast volume was below 4x Crea Clearance in 68% of patients, and approximately 5x creatinine clearance in 32% of patients, and never exceeded 6x Crea Clearance value (0%). A V/CrCl ratio 3.7 was a significant and independent predictor of an early abnormal increase in serum creatinine after PCI. [30]. Reduction of contrast volume might be achieved by marker retrograde GWs and super-selective injections from the collateral channel using a micro-catheter.

Q-wave MI was not recorded in our study (0%) compared to (0.24%) in the J-CTO Registry. [25] There was no stroke (0%), stent thrombosis (0%), emergency CABG, major bleeding (0%) or Radiation Dermatitis (0%) during the hospital stay. This is comparable to the rare occurrence of any significant in-hospital complications, emergent CABG, access site surgery, and gastrointestinal bleeding in the J-CTO Registry [25].

Limitations

The numbers of cases are small and are from a single center. The results of this study could be influenced by selection criteria, operator skills, judgment, individual experience in varying techniques .There is a lack of follow-up beyond 30 days. Finally, the techniques are still in continuous evolution and newer devices and techniques were introduced during the course of the study. Three patient’s data of materials documentation used in the cath lab were not retrievable.

Conclusion

Single wiring and radial access as initial strategies in PCI for LAD-CTO lesions in either approaches antegrade or retrograde are associated with a high procedural success rate and an acceptable incidences of adverse events.

References


