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Major cardiovascular events in failed versus successful coronary revascularization in patients with chronic total occlusion

Eventos cardiovasculares mayores en revascularización coronaria fallida versus exitosa en pacientes con oclusión total crónica

Andrea Janet López Valencia,* Enrique Alfredo Bernal Ruiz,* Germán Ramón Bautista López,* Adolfo Asahel Hernández Padilla,* Martha Alicia Hernández González‡

Keywords:
Chronic total occlusion, stable angina, percutaneous coronary intervention, failed revascularization, major cardiovascular events.

Palabras clave:
Oclusión total crónica, angina estable, intervención coronaria percutánea, revascularización fallida, eventos cardiovasculares mayores.

ABSTRACT

Introduction: Chronic coronary occlusions are associated with a negative impact on long-term prognosis. **Objectives:** To know if there is a difference in major cardiovascular events in patients undergoing successful revascularization versus failed revascularization of chronic total occlusion lesions instable angina. **Material and methods:** Cross-sectional, correlational study with two independent groups. **Results:** 71 patients were evaluated, in a context of stable chronic angina, in the High Specialty Medical Unit of Bajio, from January 2013 to February 2020; 41 patients with successful revascularization (RE) and 30 with revascularization was failed (RF). The revascularization success rate was 57.7%. The rate of major cardiovascular events found among patients with RE vs RF in this study were: unstable angina events post-revascularization in 12.5% of the RE group and in 13.3% of the RF group (p = 0.918). AMI (acute myocardial infarction) occurred in 0% of the RE group and in 3.3% of the RF group (p = 0.245). Death of cardiac origin occurred in 0% of the RE group and in 3.3% of the RF group (p = 0.245). In contrast 0% of the RE group and 6.7% of the RF group patients needed new vascularization. The survival rate in RF patients was 96.7%, and in RE patients, it was 100%. **Conclusions:** Successful versus failed revascularization did not show statistically significant differences in the rate of major cardiovascular events.

RESUMEN

Introducción: *Las oclusiones coronarias crónicas se asocian con un impacto negativo en el pronóstico a largo plazo.* ***Objetivos:*** *Conocer si existe diferencia en los eventos cardiovasculares mayores en pacientes sometidos a revascularización exitosa vs revascularización fallida de lesiones de oclusión total crónica en angina estable.* ***Material y métodos:*** *Estudio correlacional, transversal, con dos grupos independientes.* ***Resultados:*** *Se evaluaron 71 pacientes, en un contexto de angina crónica estable, en la Unidad Médica de Alta Especialidad del Bajío, del periodo de enero de 2013 a febrero de 2020, se obtuvieron 41 pacientes con revascularización exitosa (RE) y 30 con revascularización fallida (RF). La tasa de éxito de revascularización fue de 57.7%. La tasa de eventos cardiovasculares mayores encontrados entre pacientes con RE vs RF en este estudio fueron: eventos de angina inestable postrevascularización en 12.5% del grupo RE y en 13.3% del grupo RF (p = 0.918). El grupo de revascularización exitosa tuvo ausencia de infartos agudos al miocardio y en 3.3% del grupo RF (p = 0.245) sí hubo. Ocurrió muerte de origen cardiaco en 0% del grupo RE y en 3.3% del grupo RF (p = 0.245). Mientras que tuvieron necesidad de nueva vascularización el 0% del grupo RE y el 6.7% de los pacientes del grupo RF. La tasa de supervivencia de pacientes con RF fue de 96.7% y en pacientes con RE fue de 100%.* ***Conclusiones:*** *La revascularización exitosa vs fallida no demostró diferencias estadísticamente significativas en la tasa de eventos cardiovasculares mayores*

INTRODUCTION

Chronic total occlusions (CTO) can be considered the end-stage of obstructive coronary disease (CAD) and are associated with a negative impact on long-term prognosis. A CTO is defined as a complete luminal obstruction of a native coronary artery for

* Cardiologist.
‡ Cardiologist and PhD in Medical Sciences.

Mexican Social Security Institute. High Specialty Medical Unit of Bajio T1. Leon, Mexico.

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a duration of equal to or greater than three months. CTOs are classified according to the TIMI flow grade, as a scale that evaluates epicardial coronary blood flow, thus being a «true» CTO with a TIMI 0 flow grade and a «functional» CTO with invasive coronary angiography. TIMI 1 flow grade. In large clinical records, CTO was diagnosed in 16-18.4% of CAD patients.[1,2] These large registries showed that the current mainstay in treating patients with CTO is optimal medical therapy (OMT), and only a minority of these individuals receive additional surgical (22-26%) or percutaneous (10-22%) revascularization.[3]

The true prevalence of CTO lesions is difficult to confirm because many patients with CTO have no symptoms and are not referred for medical evaluation. In some registry studies,[2,4] the prevalence of CTO among patients undergoing coronary angiography was approximately 18.4 to 52%. Unfortunately, most patients lacked obvious symptoms and signs[2] contributed to a delay in the diagnosis and treatment of CTO. Mortality at one year in patients with CTO was higher than in patients without CTO, and the prognosis was even worse when more than one CTO lesion was found.[5]

In general, patients with CTO are seen more frequently in men and have a relatively unfavourable cardiac risk factor profile than patients with non-occlusive CAD. A higher prevalence of diabetes mellitus (34 vs 26%), hypertension (75 vs 68%), hyperlipidemia (82 vs 78%), current smoking (33 vs 24%), peripheral vascular disease (8 vs 4%) and a previous myocardial infarction (MI) is observed (40 vs 23%) in patients with CTO compared to patients with non-occlusive CAD.[1]

An undiagnosed or untreated acute thrombotic event is the origin CTO development, which is supported by the electrocardiographic evidence of pathological Q waves corresponding to the terminal myocardium subtended by an occluded artery in a quarter of patients.[4] However, most patients (60%) with a CTO did not have a previous MI. In these patients, the occlusion appears to result from a long-term gradual luminal narrowing that allows the recruitment of fibroblasts, calcium, cholesterol, and inflammatory infiltrate into the occluded vessel. Collateral recruitment has a protective role by supplying myocardial blood flow to the CTO territory, thus preventing acute myocardial ischemia. Therefore, the preserved viable myocardium subtended by the occluded artery, and the absence of cardiac symptoms are therefore common observations.[2]

The development of a CTO, either after a thrombotic event or by a long-term gradual luminal narrowing, is not reserved only to the natural vascular wall and can occur in a stent previously implanted in patients treated with early PCI, going beyond three months as the definition indicates, however, approximately one in four CTO patients experience no symptoms. Chest pain is a fairly late expression in the ischemic cascade, and symptoms may even be absent in the presence of moderate to severe intermittent ischemia. The lack of symptoms may be amplified due to autonomic neuropathy in diabetic patients, strongly represented in the OCD patient population.[6]

In symptomatic patients with CTO, typical cardiac chest pain may be less prominent than shortness of breath or atypical symptoms including physical activity limitation, extensive fatigue, or palpitations due to ventricular arrhythmias. Patients with a CTO and an implantable cardioverter-defibrillator for the primary or secondary prevention of sudden cardiac death have a higher incidence of appropriately administered shocks and therapies compared to patients with ischemic cardiomyopathy without a CTO.[6]

Objectives: Main goal: Know if there is a difference in major cardiovascular events in patients undergoing successful vs failed revascularization of chronic total occlusion lesions in stable angina.

Secondary objectives: Establish the success rate of successful revascularization in patients with stable angina and chronic total occlusion lesions in our hospital. Know the rate of immediate complications during the procedure and hospitalization related to successful or failed revascularization of patients with stable angina and injuries with chronic total occlusion.

MATERIAL AND METHODS

This study that was carried out through a cross-sectional, correlational study of patients with

lesions with chronic total occlusion, which required management with percutaneous coronary intervention to manage the symptoms, observing the result of the findings found in cardiac catheterization and focusing on the management Invasive treatment of all coronary arteries with significant lesions, and depending on the findings of the coronariography / angioplasty, they were classified as successful or failed.

The database of patients with chronic total occlusions, treated by percutaneous coronary intervention, of the hemodynamic service of the UMAE Bajío T1 was analyzed. Being the universe of study, the patients captured in the database of the hemodynamic service of the UMAE Bajio T1. With the following selection criteria:

Inclusion criteria: comply with the definition of chronic total occlusion type lesions, over 18 years of age and intervened by percutaneous coronary intervention in the hemodynamics service at UMAE Bajio T1.

Non-inclusion criteria: loss of follow-up by the institution.

Elimination criteria: desire not to participate in the study.

The following variables were evaluated, such as major cardiovascular events: Unstable Angina, Acute Myocardial Infarction (according to the 4 definition of Infarction), death from cardiac causes, and need for new revascularization as qualitative variables.

Quality of life was assessed through angina's functional class using the Stable Angina Classification of the Canadian Cardiovascular Society.

Coronary intervention technique used: anterograde and retrograde in a single patient. Materials used: right and left guide catheter 3.5, size 6 French. Angioplasty Guides, size 0.014. Various angioplasty balloons and drug-eluting stents.

The sample size was obtained from the results published in the article Explore, which found a proportion of patients with chronic total occlusions and percutaneous coronary intervention of 26.4% and patients with chronic total occlusions and medical treatment of 13%, in relationship with major cardiovascular events-Giving a sample size of 30 patients to have an Alpha error of 0.5, a Confidence of 95%, a Beta error of 0.2, and a Power of 80%.

The sampling was obtained by the data by appointments and / or by telephone of the patients intervened for chronic total occlusions that are registered in the database of the Hemodynamics service of the UMAE Bajio T1.

The variables that were used are defined below.

Operative definitions: chronic total occlusion: complete luminal obstruction of a native coronary artery for a duration of greater than or equal to three months. MACE (major cardiovascular events): time to cardiovascular death, myocardial infarction, cerebral infarction, hospitalization for unstable angina, or coronary revascularization. Percutaneous coronary intervention: invasive, the interventional procedure of a coronary artery with a significant stenosis > 70%, in which it is possible to improve coronary blood flow, decrease myocardial ischemia, using a balloon catheter (coronary angioplasty) or by placing a stent. Successful percutaneous coronary intervention: referring to a percutaneous coronary intervention, which is achieved by revascularization. Failed percutaneous coronary intervention: referring to a percutaneous coronary intervention, which cannot be revascularized. Acute myocardial infarction: acute myocardial damage with clinical evidence of acute myocardial ischemia and detection of an increase or decrease in high sensitivity troponin values, with at least 1 value above the upper limit of the 99th percentile and at least 1 of the following conditions: symptoms of myocardial ischemia, new ischemic changes on the electrocardiogram, appearance of pathological Q waves, imaging evidence of loss of viable myocardium, or new regional wall motility abnormalities following a pattern consistent with an ischemic etiology, identification of a coronary thrombus by angiography or autopsy (not in MI types 2 or 3), The post mortem demonstration of acute atherothrombosis in the culprit artery of the infarcted myocardium meets the criteria of MI (myocardial Infarction) type 1, evidence of an imbalance myocardial oxygen supply and demand not related to acute

atherothrombosis meets criteria for MI type 2, cardiac death in patients with symptoms compatible with myocardial ischemia and presumed new ischemic changes on the ECG (electrocardiogram) before troponin values are available or they are altered meets the criteria for type 3 MI. Unstable angina: anginal pain prolonged (> 20 min) at rest or new-onset (de novo) angina (Canadian Cardiovascular Society class II or III) or recent destabilization of previously stable angina with at least class characteristics of angina III (angina in crescendo) of the Canadian Cardiovascular Society or acute post-MI angina. Classification of the Canadian Cardiovascular Society: it is the most commonly used classification to measure the severity of angina, in patients with stable angina, distinguishing four classes based on the limitation that this supposes in the daily activity of the patient. Coronary perforation: the adverse effect caused by of the coronary vessel wall caused by the instrumentation in the interventional procedure by permuting coronary artery. Ventricular arrhythmias: arrhythmias that originate in the ventricular myocardium or the His-Purkinje system include premature ventricular beats, ventricular tachycardias that can be sustained or nonsustained, and ventricular fibrillation.

DA: anterior descending coronary artery. CD: right coronary artery. CX: circumflex coronary artery. PL: Posterolateral coronary artery. OM: obtuse marginal coronary artery. The non-reflow phenomenon: it is defined as the persistence of inadequate flow lower than TIMI 3 during coronary angioplasty in the absence of a macroscopic obstruction in the epicardial coronary arteries. Cardiovascular death: cause of death that causes any heart condition that manifests itself through diseased blood vessels, structural problems, and blood clots. Need for new revascularization: the patient who is reoperated for percutaneous coronary revascularization. SYNTAX-II: score derived from clinical trials of the same name, which classifies coronary lesions based on the anatomical characteristics of coronary disease, is recommended by practice guidelines to decide between drug-eluting stent angioplasty or revascularization surgery. Collateral arteries: arteries that derive from the main vessel.

Using, for statistical management, the SPSS statistical computer program, with JAVA platform, analyzing, with the different variables searched, for which in turn, the following statistical methods were used: χ^2 for qualitative independent variables, t Student for quantitative independent variables, Kaplan-Meier curves to assess prognosis and morbidity and mortality, a difference of two proportions to calculate the sample of qualitative variables between the two groups. Moreover, the difference of two means to calculate the sample of the qualitative variables of the two groups.

RESULTS

Success of revascularization

We found a success of revascularization was 57% and failed revascularization 42%.

Demographic characteristics and comorbidities of the patients

When comparing the patient's demographic characteristics in both groups, the mean age in patients undergoing successful revascularization was 63.0 ± 9.4 years and in patients with failed revascularization 63.3 ± 8.8 years (p = 0.908). There were significant differences in sex between groups, but no significant differences were found in comorbidities between groups *(Table 1)*.

Coronary arteries affected

The most commonly affected coronary arteries were the right coronary artery in both groups (34.1% in the RE group and 36.7% in the RF group), followed by the anterior descending (31.7% and 30.0%, respectively) and the circumflex (9.8%) and 10.0%, respectively *(Figure 1)*.

Characteristics of the surgical procedure

The surgical technique used for revascularization was antegrade in 97.6% of the patients who underwent successful revascularization, and 100% failed revascularization. Retrograde revascularization was performed only in one patient in the RE group. However, no significant

Table 1: Comparison of demographic characteristics and comorbidities between patients undergoing successful and failed revascularization.

Characteristic	Group RE n = 41 (%)	Group RF n = 30 (%)	p
Age	63.0 ± 9.4	63.3 ± 8.8	0.908
Sex			
Female	11 (26.8)	20 (6.7)	0.030
Male	30 (73.2)	15 (50.0)	
Comorbidities			
Previous AMI	18 (43.9)	18 (60.0)	0.742
Mellitus diabetes	24 (58.5)	14 (46.7)	0.322
Hypertension	33 (80.5)	23 (76.7)	0.697
Dyslipidemia	26 (63.4)	19 (63.3)	0.994
Current smoking	27 (65.9)	18 (60.0)	0.613
Chronic kidney disease	0 (0.0)	0 (0.0)	1.000

RE = successful revascularization, RF = revascularization failed, AMI = acute myocardial infarction.

differences were found in the number of collaterals found in the right, circumflex, and anterior descending coronary arteries between groups *(Table 2)*.

SYNTAX-II score between patients in both groups

The mean SYNTAX-II score in the RE group was 26.2 ± 12.1, and in the RF group, it was 29.0 ± 8.9 (p = 0.375).

Comparison of immediate complications between patients with successful and failed revascularization

When comparing the immediate complications between patients with successful and failed revascularization, it was found that 97.6% did not present complications in the RE group. The only complication was the vagal reflex, which occurred in only one patient (2.4%). While, in the RF group, complications occurred in five patients (16.7%; p = 0.242). The complications that occurred in the RF group were: non-reflow phenomenon (3.3%, n = 1), ventricular arrhythmias (3.3%, n = 1), coronary perforation (9%, n = 3) *(Figure 2)*.

Comparison of the rate of major cardiovascular events between patients with successful and failed revascularization

Next, the rate of major cardiovascular events was compared between patients with successful and failed revascularization, finding that post-revascularization unstable angina events occurred in 12.5% of the patients in the RE group and in 13.3% of the patients in the RF group (p = 0.918). AMI (acute myocardial infarction) occurred in 0% of the RE group patients and in 3.3% in the RF group (p = 0.245). Death of cardiac origin occurred in 0% of the patients in the RE group and in 3.3% of the patients in the RF group (p = 0.245). In contrast 0% of the RE group patients and 6.7% of the patients in the RF group needed new vascularization *(Table 3)*.

Subanalysis of Comparison of the rate of major cardiovascular events between patients with successful and failed revascularization with the involvement of only the anterior descending coronary artery

A subanalysis of major cardiovascular events was performed in patients only affected by total occlusions in the anterior descending artery. Finding 15 patients with chronic total occlusions in the RE group and 11 patients with chronic total occlusions in the RF group, of whom they presented 2 patients with angina in the RE group and two patients with angina in the RF group (p = 1), 0 patients with infarction in the RE group and 0 patients with infarction in the RF group (p = 0), 0 patients in need of new revascularization in the RE group and 1 patient in need of new revascularization in the RF group (p = 0.34), 0 deceased patients in the RE group and 0 deceased patients in the RF group (p = 0) *(Table 4)*.

Factors associated with failed revascularization

Next, it was determined which clinical characteristics were associated with failed revascularization by calculating the Odds Ratio (OR), finding that the male sex was associated with a greater probability of

failed revascularization OR = 5.1 (95% CI 1.04-25.22, p = 0.030). No other factors were significantly associated with failed revascularization, including age, affected coronary artery, surgical technique, history of AMI, hypertensive diabetes, dyslipidemia, smoking, chronic kidney disease, chronic kidney disease, or SYNTAX-II score.

Comparison of survival in patients with failed and successful revascularization

The survival rate between patients with failed and successful revascularization was compared, finding that in patients with failed revascularization it was 96.7% and in patients with successful revascularization it was 100%. The Kaplan-Meier curve is presented in *(Figure 3)*.

Classification of the severity of angina by the Canadian Cardiovascular Society

Through the classification of the severity of symptoms in patients with stable chronic angina, according to the Canadian Cardiovascular Society, the level of symptoms of the patients was assessed, finding 36 patients (87.5%) of the group of RE with class I symptoms, 26 patients (86.7%) of the RF group with class I symptoms, 5 patients (12.5%) of the RE group with class II symptoms, 2 patients (6.6%) of the RF group with class II symptoms and 2 patients (6.6%) of the RF group with class III symptoms (p = 0.918) *(Figure 4)*.

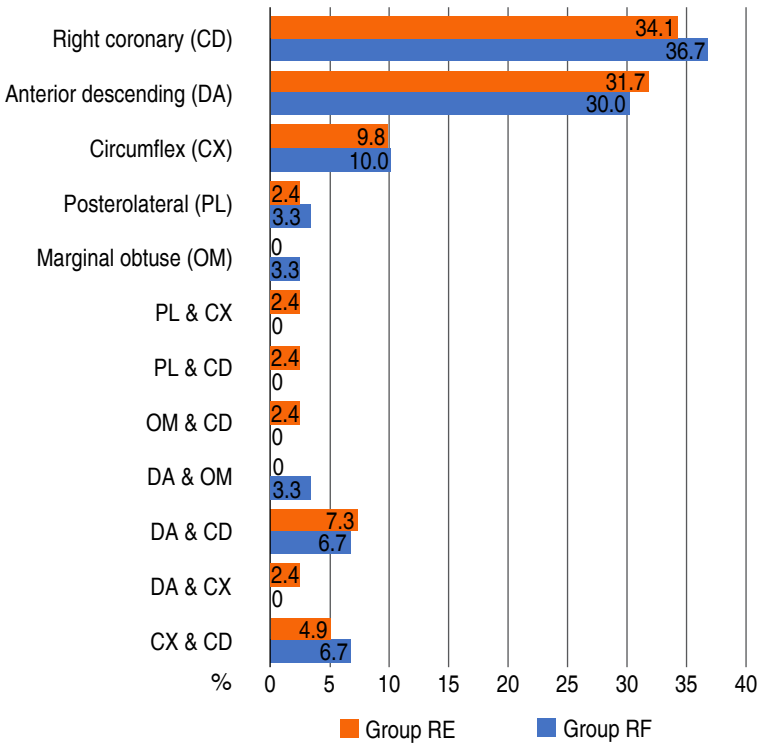

Figure 1: Affected coronary arteries.

DISCUSSION

71 patients were evaluated, in a context of stable chronic angina, in the Bajio High Specialty Medical Unit, from January 2013 to February 2020, which demonstrated chronic total occlusion in coronary angiography, proceeding to perform an intervention percutaneous coronary artery, of these, 41 patients achieved successful revascularization, and in 30 cases the revascularization was failed. With a revascularization success rate of 57.7%.

When comparing the patient's demographic characteristics in both groups, the mean age in patients undergoing successful revascularization was 63.1 ± 9.4 years and in patients with failed revascularization 63.3 ± 8.8 years (p = 0.908) in this study. There were significant differences to have a failed revascularization of a chronic total occlusion being a man, also, of having a chronic total occlusion (p = 0.03). No significant differences were found in comorbidities between groups.

In general, patients with CTO are more frequently identified in men, having a relatively unfavourable cardiac risk factor profile than patients with non-occlusive CAD. A higher prevalence of diabetes mellitus (34 vs 26%), hypertension (75 vs 68%), hyperlipidemia (82 vs 78%), current smoking (33 vs 24%), peripheral vascular disease (8 vs 4%) and a previous myocardial infarction (MI) is observed (40 vs 23%) in patients with CTO compared to patients with non-occlusive CAD.[3]

In this study, the most commonly affected coronary arteries were the right coronary artery in both groups (34.1% in the RE group and 36.7% in the RF group), followed by the anterior descending (31.7 and 30.0%, respectively) and circumflex (9.8 and 10.0%, respectively). The

Table 2: Comparison of surgical characteristics between patients undergoing successful and failed revascularization.

Surgical characteristic	Group RE n = 41 (%)	Group RF n = 30 (%)	p
Surgical technique			0.389
Antegrade	40 (97.6)	30 (100.0)	
Retrograde	1 (2.4)	0 (0.0)	
Number of stents placed	2.0 ± 0.9	0.1 ± 0.4	< 0.001
0	0 (0.0)	30 (100.0)	
1	15 (36.6)	0 (0.0)	
2	14 (34.1)	0 (0.0)	
3	10 (24.4)	0 (0.0)	
4	2 (4.9)	0 (0.0)	
Number of CD collaterals	0.3 ± 0.5	0.5 ± 0.5	0.069
0	28 (68.3)	14 (46.7)	0.067
1	13 (31.7)	16 (53.5)	
Number of CX collaterals	0.3 ± 0.5	0.3 ± 0.5	0.944
0	27 (65.9)	20 (66.7)	0.943
1	14 (34.1)	10 (33.3)	
Number of DA collaterals	0.4 ± 0.5	0.2 ± 0.4	0.134
0	26 (63.4)	24 (80.0)	0.130
1	15 (36.6)	6 (20.0)	

RE = successful revascularization, RF = failed revascularization, CD = right coronary artery, CX = circumflex, DA = anterior descending.

surgical technique used for revascularization was antegrade in 97.6% of the patients who underwent successful revascularization, and 100% of failed revascularization. Retrograde revascularization was performed only in one patient in the RE group.

No significant differences were found in the number of collaterals found in the right, circumflex or anterior descending coronary arteries between groups. The mean SYNTAX-II score in the RE group was 26.2 ± 12.1, and in the RF group, it was 29.0 ± 8.9 (p = 0.375).

Angiographically well-developed collaterals to the occluded artery are often assumed to be sufficient to prevent ischemia. Non-invasive and invasive studies have clearly demonstrated the limited functional capacity of collaterals to provide sufficient myocardial perfusion in the vast majority of patients. Therefore, the existence of well-developed collateral should not guide the indication for revascularization.[1,2,5]

When comparing the immediate complications between patients with successful and failed revascularization, it was found that 97.6% in the RE group did not present complications. The only complication that was evidenced in the RE group was a vagal reflex that occurred in only 1 patient (2.4%). While, in the RF group, complications occurred in 5 patients (16.7%; p = 0.242). The complications that occurred in the RF group were: non-reflow phenomenon (3.3%, n = 1), ventricular arrhythmias (3.3%, n = 1) and coronary perforation (9.9%, n = 3). The rate of major cardiovascular events found among patients with successful and failed revascularization in this study was: unstable angina events post-revascularization in 12.5% of the RE group patients and in 13.3% of the patients in the RF group (p = 0.918). AMI occurred in 0% of the RE group patients and in 3.3% in the RF group (p = 0.245). Death of cardiac origin occurred in 0% of the patients in the RE group and in 3.3% of the patients in the RF group (p = 0.245). In comparision 0% of the patients in the RE group and 6.7% of the patients in the RF group needed new vascularization.

In addition, a subanalysis of major cardiovascular events was performed in patients only affected by total occlusions in the anterior descending artery, finding 15 patients with chronic total occlusions in the RE group and 11 patients with chronic total occlusions in the RF group, of which presented 2 patients with angina in the RE group and two patients with angina in the RF group (p = 1), 0 patients with infarction in the RE group and 0 patients with infarction in the RF group (p = 0), 0 patients in need of new revascularization in the RE group and 1 patient in need of new revacularization in the RF group (p = 0.34), 0 deceased patients in the RE group and 0 deceased patients in the RF group (p = 0).

While CTOs are diagnosed in 16-18.4% of patients with CAD (coronary artery disease), one report stated that PCI (percutaneous coronary intervention), in patients with CTO represented only 4.8% of the total volume of PCI in 2013 in the United States.[4,7,8] In our hospital, Bajio High Specialty Medical Unit, of Mexican Social Security Institute, 780 angioplasties are performed annually, of

which CTO angioplasties account for 2% of the total. Because the specific material used for the management of CTO angioplasties is not routinely found in the hemodynamic service, which leads the interventional cardiologist not to attempt the procedure.

The SYNTAX II study demonstrated the incremental value of developing new strategies in the field of complex PCI where CTO is included, in patients with triple vessel disease, leading to improved clinical results compared to PCI performed in similar patients. In the original SYNTAX-I trial in 2012, a hybrid percutaneous treatment algorithm was introduced that focuses on retrovascularization of percutaneous CTO in the safest, most effective and efficient way.[9-11] Our center showed a success rate of 57%, which is lower than that described in the literature because, as previously mentioned, the specific material is not routinely available.

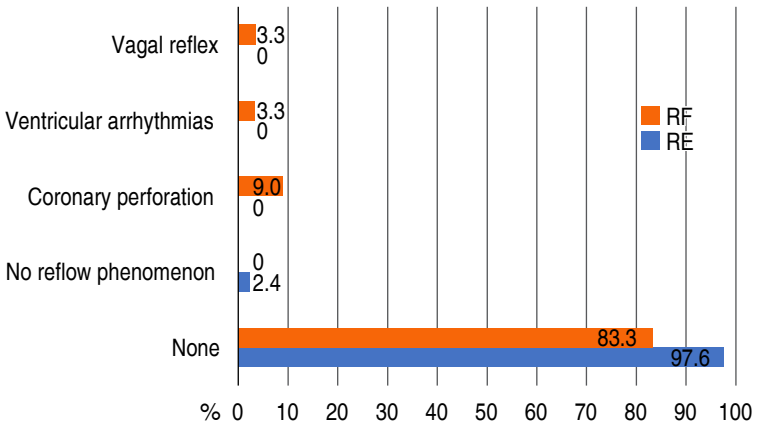

Figure 2: Comparison of complications between groups.

Table 3: Comparison of the rate of major cardiovascular events between patients with successful and failed revascularization.

Event	Group RE n = 41 (%)	Group RF n = 30 (%)	p
Unstable angina	5 (12.5)	4 (13.3)	0.918
Acute myocardial infarction	0 (0.0)	1 (3.3)	0.245
Need for new revascularization	0 (0.0)	2 (6.7)	0.098
Death from cardiac cause	0 (0.0)	1 (3.3)	0.245

RE = successful revascularization, RF = failed revascularization.

Retrograde approaches are complementary techniques to AWE (antegrade wire escalation) and have allowed a significant increase in technical success rates. However, they are often used for CTO lesions of greater anatomical complexity and are regularly the key to successful CTO crossover after a failed antegrade approach.[6,12]

The hybrid algorithm (antegrade and retrograde technique) provides a consistent and reproducible format that allows flexible switching to other techniques when one fails. The PROGRESS CTO score and the RECHARGE score are easy-to-use predictive tools to assess the risk of technical failure in ICP in CTO.[13-15] Both scores are based on the presence or absence of various angiographic features related to CTO and are validated in a cohort of CTO PCI based on the hybrid approach.[16-18] In our center, only 1 retrograde approach has been performed, and it was performed after a failed anterior approach, which was successful.

In this study, determined which clinical characteristics were associated with failed revascularization by calculating the Odds Ratio (OR), finding that the male sex was associated with a greater probability of failed revascularization OR = 5.1 (95% CI 1.04-25.22, p = 0.030). No other factors were significantly associated with failed revascularization, including age, affected coronary artery, surgical technique, history of AMI, hypertensive diabetes, dyslipidemia, smoking, chronic kidney disease, chronic kidney disease, or SYNTAX-II score. In addition, the survival rate between patients with failed and successful revascularization was compared, finding that in patients with failed revascularization was 96.7% and in patients with successful revascularization was 100%.

CURRENT PERSPECTIVES

CTOs are commonly diagnosed in CAD patients and have a negative impact on the quality of life and long-term prognosis. Observational studies point to additional benefits of ICP in OTC over OMT (optimal medical therapy) alone.[19-22] In the SYNTAX-I trial, a SYNTAX residual score greater than eight was associated with higher all-cause mortality at five years compared with

Table 4: Comparison of the rate of major cardiovascular events between patients with successful and failed revascularization with involvement of the anterior descending artery.

Event	Group RE n = 15 (%)	Group RF n = 11 (%)	p
Unstable angina	2 (13.3)	2 (18.1)	1.000
Acute myocardial infarction	0 (0.0)	0 (0.0)	0.000
Need for new revascularization	0 (0.0)	1 (9.09)	0.340
Death from cardiac cause	0 (0.0)	0 (0.0)	0.000

RE = successful revascularization, RF = failed revascularization.

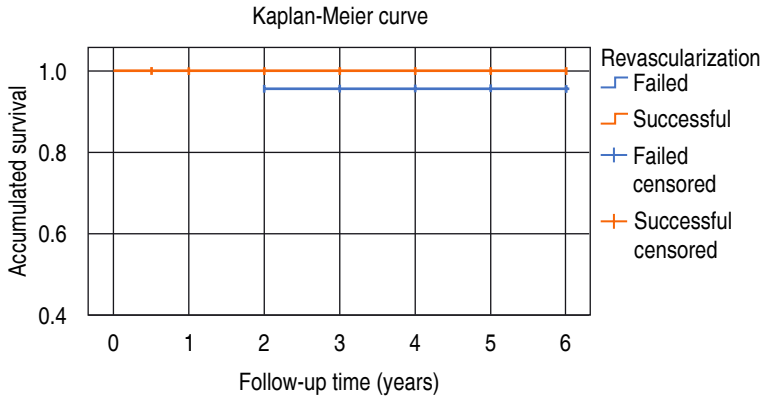

Figure 3: Kaplan-Meier survival curve of patients with successful and failed revascularization.

a SYNTAX-I residual score less than 8.9, despite the enormous evolution of the catheter-based intervention tools and techniques for CTO-PCI, the presence of a CTO itself represents the most frequent cause of incomplete coronary revascularization in general.[23-25]

The EXPLORE trial,[26,27] the only published randomized controlled trial to assess the impact of PCI in patients with OTC, found negative results and demonstrated that PCI could not improve left ventricular ejection fraction (LVEF) or reduce the risk of adverse heart failure or major cardiovascular events compared to OMT.[28-30] Most surprisingly, the proportion of patients who accepted repeat PCI in the percutaneous intervention group was higher than in the OMT group (26.4 vs 13.0%, p = 0.004) after a follow-up of four months. However, some cohort studies[28-30] indicated that PCI was associated with better long-term survival and a better prognosis relative to OMT.

We did not find significant differences in the MACE, which agrees with the EXPLORE study's findings. We may also contribute that 50% of the treated coronary arteries correspond to the CD and CX, which irrigate a territory smaller than the DA, explaining the absence of difference, although clinically the functional class of patients with complete revascularization improved compared to patients with incomplete revascularization.[31,32]

To assess symptoms in patients with stable angina was used the criteria scale of the Canadian Cardiovascular Society, described in 1976, is the most commonly used classification to measure the severity of angina, distinguishing 4 classes (I, II, III and IV) depending on the limitation that this supposes in the daily activity of the patient. Of which: class I is in which patients have no limitation of normal life. Angina only appears with strenuous exertion. class II is one in which patients have a slight limitation of physical activity. Angina appears when walking fast or climbing stairs or hills. The patient can walk more than 1 or 2 blocks or go up one floor of stairs. class III is one in which there is a marked limitation of physical activity. Angina appears when walking one or two blocks or when climbing a floor of stairs and finally class IV, where there is an inability to perform any activity, since angina occurs, which can appear at rest.[31-33]

It was obtained by classifying the severity of symptoms in patients with stable chronic angina, according to the Canadian Cardiovascular Society, the level of symptoms of the patients, finding 36 patients (87.5%) of the group of RE with class I symptoms, 26 patients (86.7%) of the RF group with class I symptoms, five patients (12.5%) of the RE group with class II symptoms, two patients (6.6%) of the RF group with class II symptoms and two patients (6.6%) of the RF group with class III symptoms (p = 0.918), thus demonstrating a better functional class of patients with success revascularization compared to patients with failed revascularization.

The most recent study that comparing OMT and PCI in patients with stable angina

is the ISCHEMIA presented on 16 November 2019 at the American Congress of Cardiology, carried out in 320 centers in 37 countries and included 5,179 patients with the disease. Stable coronary artery, preserved ejection fraction and moderate or severe ischemia in imaging studies or exercise tolerance marks an important watershed in patients with stable chronic angina, the primary end point at six months was 5.3% in the invasive strategy vs. 3.4% in the conservative and at five years the cumulative event rate was 16.4 vs 18.2%, respectively (95% CI 4.7 to 1.0). All-cause mortality was low and similar in both groups. At a mean of 3.3 years (2.2 to 4.4 years), the primary end point rate was 13.3 for the invasive group vs 15.5% for those with medical treatment only (HR 0.83; 95% CI 0.8 to 1.08). The event curves up to five years showed that the conservative strategy had fewer events in the first five years, while the invasive strategy was better between three and five years. The absolute difference between the two groups was almost identical, and it is planned to follow the patients for a further five years.[32,33] For the combined end point of death and infarction, the event curves follow a similar pattern, crossing around two years, but without differences at four years (13.9% for conservative treatment vs 11.7% for invasive treatment).[32,33]

Analyzing the rest of the study' objectives. It can be affirmed that a strategy with OMT carries a lower risk of presenting periprocedural myocardial infarction or hospitalization for heart failure. In comparison an initial strategy with PCI carries a lower risk of suffering from spontaneous myocardial infarction or unstable angina hospitalization. It is associated with an undeniable symptomatic benefit and an improvement in the quality of life in patients with anginal symptoms, for which ISCHEMIA re-establishes the importance of aggressive medical management in patients with stable coronary disease. However, it shows that revascularization improves the quality of life and has symptomatic benefit in patients.[32,33]

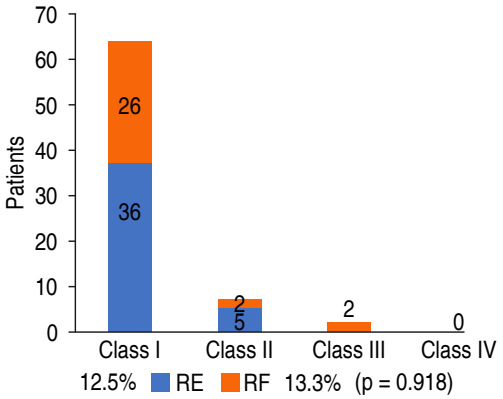

Figure 4: Classification of the severity of angina by the Canadian Cardiovascular Society in patients with successful and failed revascularization.

In the 2019 European guidelines for cardiology, the use of revascularization is discussed in the context of relieving symptoms in patients with angina and/or improving the prognosis of ischemic heart disease. The decision to revascularize for percutaneous coronary intervention or coronary bypass surgery is based on the clinical presentation (presence or absence of symptoms) and/or previous ischemia documentation (present or absent). In the absence of prior documentation of ischemia, indications for revascularization depend on an invasive evaluation of the severity of the stenosis or indications for prognosis. However, these could change if further studies were carried out demonstrating the usefulness of percutaneous coronary intervention in patients with stable chronic angina.[32,33]

Therefore, this study opens a panorama to be able to delve into patients with chronic total occlusions in the context of stable angina and assess the usefulness of complete coronary intervention in major cardiovascular events and the long-term benefit in patients.

CONCLUSIONS

The success rate of revascularization of CTO lesions in our unit is 57%, and successful vs failed revascularization did not show statistically significant differences in the rate of major cardiovascular events between patients; however, it did in the functional class of the patients.

Knowledge of our center's experience is very useful since it will allow us to guide the treatment of CTO lesions in patients with stable angina treated in our hospital.

LIMITATIONS OF THE STUDY

The main limitations present in the following study correspond to the lack of specific material to revascularize CTO lesions, which leads hemodynamists not to treat these lesions, decreasing our rate of revascularization successes and the number of patients treated.

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Correspondence:
Andrea Janet López Valencia
E-mail: andrea.jlv@gmail.com