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Successful revascularization improves long-term clinical outcome in patients with chronic coronary total occlusion

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ABSTRACT

Background: Following the development of breakthrough techniques for percutaneous coronary intervention (PCI) in the treatment of chronic total occlusions (CTO), the initial success rate of PCI in CTO lesions (CTO-PCI) has improved; however, there are few reports regarding the effects of successful CTO revascularization on long-term mortality in Japan. The aim of this study was to compare the long-term clinical outcomes of patients with successful versus failed CTO recanalization and to identify related factors.

Methods and results: From all PCI procedures performed in our hospital between 2006 and 2013, CTO-PCIs were extracted and classified into two groups: PCI success (n = 656 patients) and PCI failure (n = 82 patients). Patients with successful procedures only on a second attempt, CTO-PCI in small branches, or CTOs in more than one vessel were excluded. Survival was determined from a telephone interview or the consultation history in the outpatient clinic. Initial angiographic success was achieved in 88.9% of the patients. A Kaplan–Meier plot with log-rank analysis showed that cumulative all-cause death was significantly lower in the success group than in the failure group ($p = 0.0003$; average follow-up duration in success group vs. failure group was 1531.3 ± 33.5 vs. 1565.3 ± 97.5 days, $p = 0.7$). Moreover, the rate of evident cardiac death was significantly lower in the success group than in the failure group (3.5% [23/656] vs. 15.9% [13/82], $p < 0.0001$).

Conclusions: This study suggests that successful revascularization in patients with CTO improves their long-term clinical outcomes.

1. Introduction

The technology and techniques for the interventional treatment of chronic total occlusion (CTO) in patients with coronary artery disease have advanced significantly over recent years, and have contributed to the higher initial success rate of percutaneous coronary intervention (PCI) for treating CTO (CTO-PCI) [1,2]. However, the effect of this improvement on the chronic outcomes of patients who undergo CTO-PCI is still unclear. It has been reported that successful CTO-PCI might be associated with symptom relief, a lower rate of subsequent myocardial infarction (MI) and coronary artery bypass graft (CABG) surgery, and improved long-term survival, compared with unsuccessful PCI [3–7]. While the initial success rate of CTO-PCI has also reached an acceptable level in Japan, with an acute result that is widely recognized to be better than in other countries, its long-term outcome has not been fully investigated. Therefore, the aim of this study was to compare the long-term clinical outcomes of patients with successful versus failed CTO recanalization and to identify related factors.

2. Methods

2.1. Study design

Consecutive patients who underwent CTO-PCI were extracted from the database at Toyohashi Heart Center, Toyohashi, Japan, in which data were entered prospectively. The database included relevant patient information as well as angiographic and procedural characteristics. A total of 7353 PCI procedures performed between 2006 and 2013 were screened for this study, of which 848 involved revascularization of a CTO. Any patients with CTOs in more than one vessel or lesions in a small coronary branch vessel, as well as those in whom a repeat procedure succeeded after an initial failure, were excluded from the study, as were 17 patients who were untraceable (Fig. 1). We excluded patients

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with CTO lesions in more than one vessel in order to evaluate the effect of a single CTO-PCI recanalization, while small-branch lesions were excluded because of the known lesser clinical advantage in such cases. The remaining 738 patients represented the total population of this study. These patients were then classified into 2 study groups: those with successful CTO-PCI (success group; 656 patients) and those with failed CTO-PCI (failed group; 82 patients) (Fig. 1). The protocol was approved by the ethics committees in each participating center and all participants gave written informed consent. The PCI and stent implantation were performed in a standard manner. Heparin was administered to maintain an activated clotting time > 250 s. The PCI strategy was left to the discretion of the treating physician. The PCI of the CTO was performed using contemporary techniques as they became available: bilateral injection; specialized hydrophilic, tapered-tip, and stiff wires; parallel wires; micro-catheters; and a retrograde approach. In this study, all the stents deployed were drug-eluting stents (DES). After PCI, all patients were prescribed lifelong aspirin; in addition, clopidogrel was prescribed for at least 6 months after implantation of DES. Demographic and procedural data for all patients undergoing PCI were prospectively entered into a dedicated database. Patients were followed prospectively by telephone interview or on regular outpatient visits.

2.2. Definitions

Coronary CTO is defined as a true total occlusion with complete interruption of antegrade blood flow as assessed by coronary arteriography (Thrombolysis In Myocardial Infarction [TIMI] flow grade 0) and with an estimated occlusion duration of 3 months or more. For the procedural background inherent in this study, we examined the total amount of contrast medium, procedure time, and radiation dose. Procedure time was defined as the total duration for which the patient was in the catheterization room (from entry until exit). Fluoroscopy time and radiation dose were recorded automatically by the cine device. Coronary perforation was examined as a complication during the procedure. The following endpoints were evaluated to compare patients with a failed versus a successful procedure: all-cause death, evident cardiac death, MI, and subsequent coronary artery bypass grafting (CABG). The following definitions were used:

- Evident cardiac death was defined as death within 7 days after MI, death associated with cardiovascular interventions within 30 days after CABG or within 7 days after PCI, or unexpected death presumed to be due to ischemic cardiovascular disease and arrhythmia occurring within 24 h after the onset of symptoms, without clinical or postmortem evidence of another cause, as judged according to the information from the telephone interview. Death from uncertain causes was also classified as cardiac death.
- Double CTO was defined as the presence of a CTO lesion in more than one vessel at the same time.
- Procedural success was defined as residual stenosis less than 50% with TIMI flow grade 3 and without major adverse cardiovascular events.
- MI was diagnosed by an increase in creatine kinase level to twice the upper limit of normal.

2.3. Guidewire crossing strategies

Guidewire crossing strategies were followed in a stepwise manner, as described in our previous report [8]. Briefly, as for antegrade approaches, single wiring, parallel wiring, and wiring techniques guided by intravascular ultrasound (IVUS) were included. For retrograde attempts, retrograde wire cross, kissing wire cross, controlled antegrade and retrograde subintimal tracking (CART), and reverse CART (r-CART) techniques were performed.

2.4. Statistical analysis

Data distribution was assessed by the F-test. Variables that did not follow a normal distribution were expressed as medians and interquartile ranges, whereas other continuous variables were expressed as mean ± standard error. Student's t-test or the Mann–Whitney U test was used for the comparison of continuous variables, as appropriate. Event rates were estimated using the Kaplan–Meier method. Follow-up was censored at date of last follow-up or at 7 years, whichever came first. Survival curves with all available follow-up data were constructed for time-to-event variables using Kaplan–Meier methodology

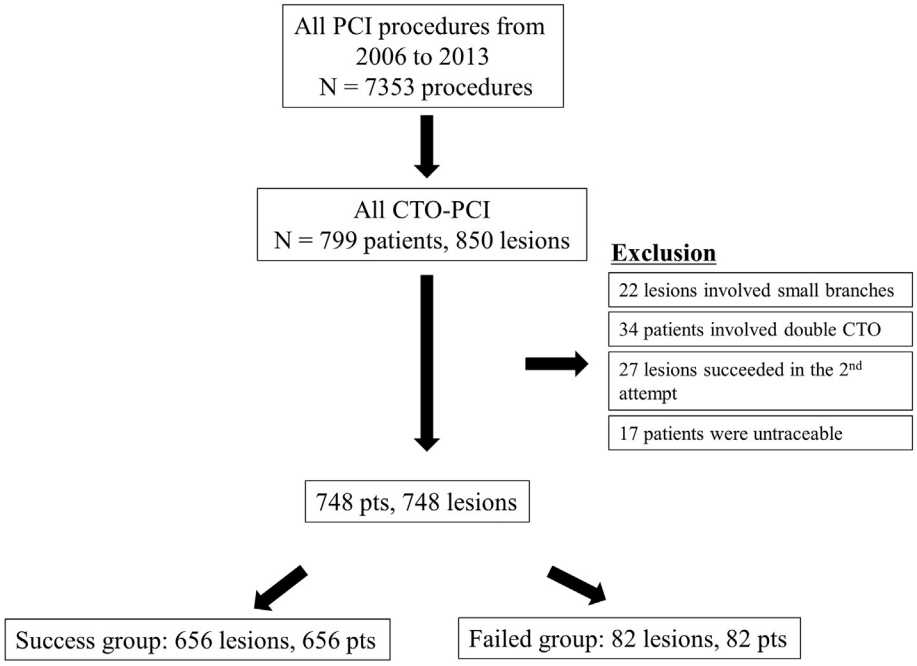

Fig. 1. Flow diagram of the study population. PCI procedures performed between 2006 and 2013. The flowchart indicates lesions, exclusions, and the composition of the study population. CTO = chronic total occlusion; PCI = percutaneous coronary intervention.