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Active greeting technique: a mother-and-child catheter based technique to facilitate retrograde wire externalization in recanalization of coronary chronic total occlusion

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Abstract

Although retrograde approach has greatly improved the success rate of percutaneous coronary intervention (PCI) for coronary chronic total occlusion (CTO), retrograde wire externalization still remains challenging and time-consuming in some cases. Cases utilizing “Active Greeting Technique (AGT)”, a mother-and-child catheter based technique to facilitate retrograde wire externalization, were extracted from Chronic Total Occlusion Club, China (CTOCC) database. AGT was performed by
deep intubation a mother-and-child catheter (Guidezilla™ extension, 4 or 5 Fr inner catheter, and etc.) in combination with either reverse controlled antegrade or retrograde subintimal tracking (CART) technique or retrograde wire crossing technique. A total of 111 patients with 112 CTO lesions treated with this technique were retrospectively analyzed. Reverse CART technique and retrograde wire crossing technique were performed in 90.2% and 9.8% of all procedures. The utilization of Guidezilla™ extension, 4 Fr, and 5 Fr inner catheter accounted for 94.6%, 3.6%, and 1.8%, respectively. Externalization of retrograde wire was successful in all cases. No procedural complications were adjudicated to AGT. Complications independent of AGT included two target vessel perforations and two collateral perforations. No in-hospital major adverse cardiac events were found. AGT is a feasible and safe technique that facilitates retrograde wire externalization.

Key words: Percutaneous coronary intervention; Chronic total occlusion; Retrograde wire externalization; Active greeting technique

1. Introduction

Even with novel devices and innovative techniques, percutaneous coronary intervention (PCI) for chronic total occlusion (CTO) remains a technical challenge for interventional cardiologists. Contemporary retrograde approach is a promising for successful CTO-PCI [1]. In patients with favorable collateral and unfavorable antegrade-approach morphology, primary retrograde approach may be considered for CTO-PCI. However, even after successful retrograde occlusion crossing, wire externalization is frequently difficult and time-consuming, especially with non-
antegrade guiding catheter. Wire externalization may still be difficult even with the deployment of microsnare [2] or self-made trapping system. By utilizing the GuidelinerTM (Vascular Solutions) catheter, JC Spratt et al., presented a case report of a novel “capture” technique with reverse controlled antegrade or retrograde tracking (CART) technique[3]. Previously, we have described the GuidezillaTM (Boston Scientific) reverse CART technique in the long tortuous CTO lesions [4].

On the previous principles, we herein modified the capture technique by diversifying the extension catheters and extending its application into the retrograde wire crossing technique.

In the present study, we evaluated the feasibility and safety of mother-and-child catheter to facilitate retrograde wire externalization, termed “Active Greeting Technique (AGT)”.

2. Materials and methods

2.1. Technique description

In combination with reverse CART technique, AGT preparations are as follows: (1) Advanced the retrograde guidewire into the occluded segment; (2) Prepare a mother-and-child catheter (Guidezilla™, Guideliner™, 4 or 5 Fr inner catheter, and etc.) and suitable size balloon in the antegrade guiding catheter; (3) Dilate the occluded segment via the antegrade guidewire; (4) Using the dilated balloon as anchor, advance the mother-and-child catheter as far as possible; (5) Manipulate the retrograde wire into mother-and-child catheter.

In retrograde wire crossing technique, AGT is prepared as follows: (1)
retrograde guidewire through the occluded lesion; (2) Advance the mother-and-child catheter as far as possible. Use anchoring technique when appropriate; (3) Manipulate the retrograde wire into mother-and-child catheter.

2.2. Study Population

Demographic and procedural data of all CTO-PCI were prospectively collected into the Chronic Total Occlusion Club, China (CTOCC) database. A total of 111 patients with 112 CTO lesions treated with AGT between July 2015 and January 2018 were enrolled into this study. All patients without contraindication received 300 mg clopidogrel and 100 to 300 mg aspirin before PCI. Heparin was introduced intravenously to achieve an activated clotting time of 250 to 350 seconds during the procedure. All CTO-PCI procedures were performed according to the current standard practice [5, 6]. Each CTO-PCI was performed by experienced operators from CTOCC. Study protocol was approved by the Institutional Ethics Committee of Zhongshan Hospital, Fudan University. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

2.3. Definition

Coronary CTO was defined as total occlusion with an occlusion duration $\geq$ 3 months. Angiographic evaluation of CTO lesions included stump morphology, calcification, tortuosity ($>45^\circ$), occlusion length, and grade of collaterals [8]. J-CTO score was calculated according to the research previously reported [9]. Technical success was
defined as a visual assessment of recovery antegrade TIMI flow grade III in the target vessel and residual stenosis < 30%, while the process success is defined as technical success without in-hospital major adverse cardiac events.

In-hospital major adverse cardiac events includes the following adverse events: death from all causes, stent thrombosis [10], Q-wave myocardial infarction, ischaemia-driven revascularization, either PCI or emergency cardiac surgery. Donor vessel dissection, target vessel perforation, collateral perforation, and cardiac tamponade were assessed as procedural complications.

2.4. Statistical Analysis

Continuous variables with normal distribution were presented as mean ± standard deviation. Categorical variables were presented as frequencies (%). Descriptive analyses were used.

3. Results

The clinical characteristics were detailed in Table 1. The average age was 60.1±11.5 years with 91.0% male patients. The prevalence of hypertension, diabetes mellitus, and prior myocardial infarction were 57.7%, 36.9%, and 36.0%, respectively.

Table 1: Baseline clinical characteristics of patients

<table>
<thead>
<tr>
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<th>Overall (n=111)</th>
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<tbody>
<tr>
<td>Gender, male</td>
<td>101 (91.0%)</td>
</tr>
<tr>
<td>Age, yrs</td>
<td>60.1±11.5</td>
</tr>
<tr>
<td>Clinical presentation</td>
<td></td>
</tr>
<tr>
<td>Asymptomatic</td>
<td>1 (0.9%)</td>
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</table>
Table 2 and 3 summarized the angiographic and procedural characteristics. Right coronary artery was the most prevalent site of CTO lesion in this study (93/112, 83.0%). The mean J-J-CTO score was 2.9±1.0. Primary retrograde strategy was employed in 29.5% of all procedures. Reverse CART technique and retrograde wire crossing technique was implemented in 90.2% and 9.8% of all procedures, respectively.

Table 2: Angiographic Characteristics

<table>
<thead>
<tr>
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<th>Overall (n=112)</th>
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<tr>
<td>Multiple-vessel disease</td>
<td>81 (72.3%)</td>
</tr>
<tr>
<td>ISR CTO</td>
<td>4 (3.6%)</td>
</tr>
<tr>
<td>CTO vessel</td>
<td></td>
</tr>
<tr>
<td>LM</td>
<td>1 (0.9%)</td>
</tr>
<tr>
<td>LAD</td>
<td>16 (14.3%)</td>
</tr>
</tbody>
</table>
Retrograde wire externalization was successful in all procedures. The prevalence of Guidezilla™, 4 Fr, and 5 Fr inner catheter were 94.6%, 3.6%, and 1.8%. Technical success was achieved in all patients. No procedural complications were adjudicated to AGT. Complications independent of AGT included two target vessel perforation and two collateral perforations. No in-hospital major adverse cardiac events were found. (Table 4).

<table>
<thead>
<tr>
<th>Access site</th>
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<tbody>
<tr>
<td>Radial only</td>
<td>13 (11.6%)</td>
</tr>
<tr>
<td>Femoral + radial</td>
<td>83 (74.1%)</td>
</tr>
<tr>
<td>Femoral only</td>
<td>16 (14.3%)</td>
</tr>
<tr>
<td>Blunt stump at proximal cap</td>
<td>65 (58.0%)</td>
</tr>
<tr>
<td>Calcification</td>
<td>71 (63.4%)</td>
</tr>
<tr>
<td>Vessel tortuosity</td>
<td>53 (47.3%)</td>
</tr>
<tr>
<td>Occlusion length&gt;20mm</td>
<td>102 (91.1%)</td>
</tr>
<tr>
<td>Blunt stump at distal cap</td>
<td>53 (47.3%)</td>
</tr>
<tr>
<td>Diffuse lesion in distal segment</td>
<td>69 (61.6%)</td>
</tr>
<tr>
<td>Side branch at landing zone</td>
<td>65 (58.0%)</td>
</tr>
<tr>
<td>J-CTO score</td>
<td>2.9±1.0</td>
</tr>
</tbody>
</table>

Note: Values are mean ± SD or n (%). ISR indicates in stent stenosis; CTO, chronic total occlusion; LM, left main; LAD, left anterior descending artery; LCX, left circumflex artery; RCA, right coronary artery.
An example of AGT implemented with reverse CART technique was illustrated in Fig. 1a–h. A 67-year-old man who was failed in attempt recanalization for RCA CTO in local hospital, was transferred to our hospital with symptoms of severe angina. He had history of hypertension and smoking.

A 6 Fr SAL1.0 SH guiding catheter (Medtronic) and a 7 Fr EBU 3.5 guiding catheter (Medtronic) were used (Fig. 1a). Primary retrograde approach was applied, due to unfavorable of CTO morphology and promising collateral channel present. After a Sion wire (Asahi intecc) and 150 cm Corsair (Asahi intecc) crossing the septal channel, contemporary reverse CART technique was attempted (Fig. 1b-d). A Guidezilla™ extension (long arrow-head) was advanced as far as possible with the deployment of the reverse CART technique (Fig. 1e). After balloon dilatation, the retrograde wire (short arrow-head) was successfully manipulated into the Guidezilla™ extension and retrograde wire externalization with RG3 (Asahi intecc) was completed (Fig. 1f, g). Final angiogram showed successful recanalization of the RCA CTO (Fig. 1h).

Another example of AGT implemented with retrograde wire crossing technique was illustrated in Fig. 2a–f. A 68-year-old man with multivessel coronary disease was transferred to our hospital with symptoms of severe angina. The patients has history of hypertension and smoking. In 2003, he received coronary angiogram and a stent was implanted in RCA, of which the detailed angiogram was not available. The previous attempt in recanalization for RCA CTO was unsuccessful in local hospital.
In the index procedure, a 6 Fr AL0.75 guiding catheter (Medtronic) and a 6 Fr EBU 3.5 guiding catheter (Medtronic) was used. Retrograde approach was applied after the failed antegrade attempt (Fig. 1b, c). After successful retrograde wire crossing of the occluded segment, it was very difficult to advance the retrograde wire into the antegrade guiding catheter. A Guidezilla™ extension (long arrow-head) was advanced as far as possible to greet the retrograde wire (short arrow-head) (Fig. 2d). With the help of Guidezilla™ extension, the retrograde wire was easily manipulated into antegrade guiding catheter (Fig. 2e). Final angiogram demonstrated successful recanalization of the RCA CTO (Fig. 2f).

4. Discussion and conclusion

In the present study, we described a technique termed AGT to facilitate retrograde wire externalization. All of the cases achieved successful retrograde wire externalization with AGT and no complications were related to AGT.

Previous studies have described techniques to assist in the retrograde wire externalization, such as the use of microsnare [2] or self-made trapping system [11], which may still be difficult. In reports by JC Spratt et al. and ourselves [3, 4], the Guideliner™ and Guidezilla™ were utilized in reverse CART technique for wire externalization. In the present study, we modified this technique to include mother-and-child catheter systems, either 4F or 5F inner catheter. In addition, we expanded the application to retrograde wire crossing technique. In tortuous and/or small artery, Guidezilla™ extension deep intubation may be difficult due to its large profile. In this scenario, 4 or 5 Fr catheter may be a more suitable option. In the
study, 6 cases were treated with 4 or 5 Fr mother-and-child catheter.

To allow retrograde wire engagement into antegrade guiding catheter as quickly as possible, combined utilization of AGT with reverse CART or retrograde wire crossing technique may be favorable. There are several details to take into consideration during the implementation of the AGT technique. First, before manipulating the retrograde guidewire, the tip of the mother-and-child catheter should be delivered as close to the limited space created by reverse CART or the segment close to proximal entry point. If the mother-and-child catheter is only advanced to ostium or proximal coronary artery, the efficacy of AGT would be diminished. Secondly, during deep intubation, anchoring technique is often required for better support. However, vessel wall damage should be carefully monitored during deep intubation. To minimize the risk of dissection, mother-and-child catheter advancement over a balloon catheter or microcatheter is preferred to advancement over a 0.014” coronary wire. Third, we believe the time frame to initiate AGT is right before the deployment of reverse CART technique or immediately after successful retrograde wire crossing technique. However, if the retrograde wire requires a prolonged time to pass through the occluded segment after reverse CART, ischemia caused by deep intubation should be questioned.

The AGT is a feasible technique that allows quick retrograde wire externalization after successful reverse CART or retrograde wire crossing. This technique demonstrates a high success rate, and is easy and safe to perform.

5. Limitations

The following limitations of the study should be considered. First, the limited number
of the patients may subject the study to sampling bias. Second, the findings of the present study are limited by its retrospective design. Third, due to the retrospective design and lack of indicators such as time consuming and X-ray exposure, historical comparison with approaches using microsnare or self-made trapping system could not be performed and advantages of this technique maybe was not fully demonstrated. Furthermore, the procedures in our study were performed by limited CTO-PCI experts from CTOCC. The inter-operator technique variation should be taken into consideration.

Conflict of interest:

The authors declare that they have no conflict of interest.

Acknowledgments

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References


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**Figure Legends**

Figure 1. An example of AGT implemented with reverse CART.

The long arrow-head indicates the Guidezilla™ extension and the short arrow-head
indicates the retrograde wire.

AGT, active greeting technique; CART, controlled antegrade and retrograde subintimal tracking.

Figure 2. An example of AGT implemented with retrograde wire crossing technique.

The long arrow-head indicates the Guidezilla™ extension and the short arrow-head indicates the retrograde wire.

AGT, active greeting technique.