Chronic Coronary Occlusion — Treatment Options and Results

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ABSTRACT: Indications for chronic coronary occlusion angioplasty are based on the projected benefit and technical difficulties. With current indications, primary success is around 60% and complications are rare. In successful cases, the main benefits are improvement of symptoms and obviation of the need for bypass surgery. Late improvement of left ventricular function can also occur. Recurrences are frequent, but reocclusions occur only in about 20% of cases.

Several techniques have been advocated to improve the success rate. It is obvious that the stiffer the instrument used the higher the crossing rate but also the risk for perforation. While the laser wire aims at high crossing success, the Magnum wire aims at high safety. In about 800 cases using the Magnum wire, the success rate was 64% before, and 66% after crossover to another technique. Complications were comparable to those of routine coronary angioplasty.

Chronic total occlusions are a major reason for selecting bypass surgery over angioplasty. The technical success with angioplasty leaves room for improvement. However, safety should not be compromised and there are limits to the investment in terms of time and material because the clinical yield is relatively small, albeit uncontested.

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A chronic total occlusion is present in roughly 40% of patients currently undergoing coronary angiography at our center. Only 50% of these patients will have a recommendation for coronary angioplasty compared with 75% in patients without occlusion. Conversely, 30% will be sent for bypass surgery instead of only 20% of patients without occlusion.

The aim of recanalizing a chronic total coronary occlusion is to find the passage with least resistance. This is typically the most recent thrombotic portion of the occlusion. Since there is no way to identify the different components of the occluded segments short of the cumbersome coronary angioscopy, the devices are used blindly and failures are quite common.

Technical Approach. Only occlusions should be attempted for which the occluded (invisible) segment can be fairly well anticipated either from previous films or from diligent study of the course of collaterals. During the recanalization
attempt, iterative injections of contrast medium have to be used until the distal lumen is safely reached and identified. In a difficult case, or when using an aggressive approach, it is advised to regularly check that the path of the recanalization device aims at the most proximal point of the distal vessel filled by collaterals. In the absence of ipsilateral collaterals, this may imply simultaneous injection into the opposite coronary artery or a bypass graft.\textsuperscript{1,2} With modern equipment, a coronary guiding catheter and a diagnostic coronary catheter can easily be introduced through the same groin, using two individual punctures.

Among the dedicated techniques for chronic occlusion angioplasty, three are currently in the limelight. The most recent one is the bare laser wire (Prima Wire, Spectranetics, Colorado Springs, CO), using excimer laser light at 308 nm\textsuperscript{3}. This device is currently under multicenter evaluation and randomized scrutiny.

The hydrophilic guidewire (Glidewire, Terumo, Somerset, NJ) is a universally employable coronary guide wire that has proved particularly helpful for chronic occlusions.\textsuperscript{4,5} These two techniques have a high crossing rate but a significant propensity for perforation. Yet, floppy wires will invariably fail in true chronic occlusions, unless they are stiffened by a far advanced catheter.

The Magnum wire (Schneider, Minneapolis, MN) was introduced in 1987 as a device dedicated to recanalization of chronic coronary occlusions.\textsuperscript{6} It has subsequently been found to be helpful for other indications as well.\textsuperscript{7} The wire features a balltip which is 1.0 mm in diameter in the wire’s original 0.021 inch version and 0.9, or 0.7 mm in the more recent 0.018, or 0.014 inch versions, respectively. The balltip reduces the power to cross chronic occlusions somewhat, but it is meant to prevent perforation, and reduce the risk of subintimal passage.\textsuperscript{8} It allows support of the wire maximally by advancing a bracing catheter or a balloon catheter to the very tip of the wire and to thrust the wire into the occlusion with considerable force.

In more than 800 consecutive attempts at chronic coronary occlusions with this wire, 98% comprised single vessel and 2% double vessel occlusions. In 16% of these cases multivessel angioplasties were attempted. Angiographic success was achieved in 64% of the occlusions with the Magnum wire alone, and in an additional 2% after crossover to another technique. The success with conventional wires in the roughly 60 crossover attempts from failed Magnum cases amounted to 29%. In about 50 occlusions for which an unsuccessful conventional attempt had preceded the Magnum wire use, a success rate of 46% was achieved. The in–hospital mortality amounted to 1.5%, but of the 12 demises only 4 were secondary to problems with the chronically occluded vessel. Emergency bypass surgery became necessary in 0.8% of the cases but again the reason typically was not related to the recanalization attempt. A significant rise of the creatine kinase, or an electrocardiographically documented infarction occurred in 2.1%, damage of a non–occluded vessel, or of important collateral contributors being the typical reasons. Perforation occurred in only 2 cases, none of which needed a surgical intervention. The main reason for failure was the inability to cross the occlusion with the wire (28%). Once the wire was
successfully placed in the distal vessel, the balloon could almost invariably be advanced across the occlusion without predilatation with a small balloon thanks to the sturdy design of the Magnum wire. This robustness also helps to save cost as the use of several wires per case is exceptional in contrast to conventional approaches to chronic total occlusions.

**Indications**

Indications have to balance the projected benefit for the patients against the expected technical difficulties, considering state of the art equipment. In addition, cost becomes an issue more and more. Significant patient improvement can be expected when symptoms from the occluded artery are quite limiting, and the viable myocardium at stake is considerable. A positive influence on life expectancy by a successful recanalization of a chronically occluded coronary artery is unlikely but it has been described. The absence of collaterals to the vessel distal of the occlusion represents a contraindication to a recanalization attempt. Absence of function in the respective myocardial territory does not as this may present stunning, or more likely hibernation. Late improvement of myocardial function may not be the rule, but it can be observed occasionally (Figure 1). In terms of anatomical presentation, a well defined stump is considered a prerequisite. An exception may be an exquisitely short occlusion approached with a laser wire. Extensive bridging collaterals testify to an old occlusion and are a harbinger of failure even if a stump can be identified (Figure 2). Overall, the indications should be based also on the circumstances. The threshold for a revascularization attempt may be lower, if the attempt is carried out during the diagnostic catheterization because cost will be significantly lower than with a separate attempt.

**RESULTS**

Table 1 indicates the pooled results of pertinent reports comprising roughly 3,000 recanalization attempts. The maximum primary success rate in this data pool was only 72% in a paper that included functional occlusions which yielded significantly better results. However, a Japanese group has achieved a success rate of 83% in 300 patients without bridging collateral vessels and an average occlusion time of more than 2 years, and a 75% success rate in patients with bridging collaterals and 4 year old occlusions. Such results clearly stick out from the crowd and indicate a particularly determined team and significant investment in terms of time and material. The key determinants for success are the age and the length of the occlusion which only rarely figure in data banks, and are quantified but in a few reports.

Reocclusion of a recanalized segment, be it acute or late, should not cause a significant infarction as the prior collaterals can be expected to reliably recruit in case of need. Nevertheless, infarctions, need for emergency surgery, and even some mortality is regularly reported with larger series on recanalization attempts. Most of these

| Table 1. Results of conventional angioplasty of chronic total coronary occlusions (pooled data of roughly 3,000 procedures) |
| Age of occlusion (months) | 7 |
| Collaterals visible | 76% |
| Prior infarction | 49% |
| Primary success | 68% |
| Emergency surgery | 2% |
| Infarction | 2% |
| In-hospital death | 1% |
| Mean follow-up (months) | 28 |
| Recurrencea | 64% |
| - restenosis | 46% |
| - reocclusion | 17% |
| Long-term clinical improvementb | 68% |

a per patients with primary success and follow-up angiography
b per patients with primary success, including repeat angioplasty
cases are due to simultaneous angioplasty of non-occluded arteries or to a new problem created during the recanalization attempt. This may be an abrupt closure of a vessel proximal to the chronic occlusion or rarely the impairment of an important collateral contributor.

A long subintimal pathway created by the probing device unable to find the true lumen distal to the occlusion is a relatively frequent reason for failure, but not a complication in itself. It may account for mild prolonged chest pain and some elevation of creatine kinase, but it rarely causes significant ischemia. Moreover, the inflow from the collaterals into the true distal lumen tends to re-establish the situation prior to the recanalization attempt quite promptly. Distal embolization of thrombotic material from the occluded segment is another rare but notable reason for infarction caused by a recanalization attempt. Of more concern is the retraction of thrombotic material with embolization into a proximal non-occluded vessel during pull back of the recanalization device (Figure 3).

The recurrence rate may amount to 3 out of 4. But there is hope. First, the more frequent use of
stents may reduce this rate albeit at added cost. Second, only about every third recurrence is a true reocclusion which is difficult to recanalize. The remainder are significant narrowings in patent vessels which lend to (are good cases for) a repeat angioplasty with high success and minimal risk (all these vessels had previously been occluded).

Patients with a sustained patency of the recanalized vessels typically improve their physical performance, and need significantly less bypass operations than those with a failed attempt.

Perspective

The salutary clinical results of coronary angioplasty for recanalization attempts for chronic total coronary occlusion in selected cases justifies its routine application and further research. Current cost constraints set the boundaries for such endeavors unless randomized studies can clearly establish a good cost benefit and cost effectiveness.

REFERENCES