Review

Medicine

Surgical Treatment of Severe Carotid Artery Stenosis in Conjunction with Coronary Artery Stenosis

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Patients who suffer from atherosclerosis disease frequently experience coronary heart disease in addition to carotid atherosclerotic stenosis as a complication of their condition. It is of the utmost importance to identify a course of treatment that will optimize the benefits for patients who are suffering from both diseases at the same time and need to undergo surgical intervention. In this review, surgical treatments and perspectives on carotid artery stenosis and coronary artery stenosis were discussed in conjunction with one another.

Keywords: Carotid Artery Stenosis; Coronary Artery Stenosis; Surgeries; Therapeutic Sequence; Outcomes

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ATHEROSCLEROTIC disease, a systemic chronic vascular disease that invades the large and middle arteries, frequently results in carotid and coronary artery lesions. Carotid atherosclerotic stenosis in conjunction with coronary heart disease is a common problem in patients with atherosclerotic disease (1, 2). Current surgical interventions for such patients primarily include carotid endarterectomy (CEA) and coronary artery bypass grafting (CABG), or a two-stage approach. It is critical to find a treatment strategy that maximizes the benefits for patients who have both diseases at the same time and require surgical intervention; however, there is no unified opinion in clinical guidelines for CEA and CABG surgery at the same time or in stages (3).

The selection and research progress of the two surgical intervention plans are reviewed by analyzing the current situation and existing problems of the implementation of the simultaneous and staged surgical plans.

The Prevalence of Carotid Artery Stenosis in Association with Coronary Heart Disease

Atherosclerotic disease affects the entire body. Carotid artery stenosis is frequently found in preoperative ultrasound screening of carotid and vertebral arteries in patients with coronary heart disease who are planning to undergo cardiac surgery (4). According to one study, the incidence of carotid artery and coronary artery disease at the same time ranged from 1.7% to 12% (5). Another study found that 5% of patients diagnosed with coronary heart disease via coronary angiography also had carotid artery disease (6). Severe carotid artery stenosis, similarly, among patients with carotid artery stenosis requiring intervention, the rate of patients with coronary heart disease discovered on examination ranges from 13% to 86% (7).

Treatment Problems of Carotid Artery Stenosis Complicated with Coronary Heart Disease

Carotid artery stenosis is an independent risk factor for periop-

erative stroke in patients with coronary heart disease who require CABG (8). Patients with unilateral carotid artery occlusion have a 12% risk of perioperative stroke (9); patients with severe carotid artery stenosis who require CEA surgery and severe coronary heart disease have a significantly increased risk of perioperative acute myocardial infarction (AMI) (10). Furthermore, the correlation analysis revealed a significant positive correlation trend between the degree of coronary stenosis and the progression of carotid artery stenosis (11).

There is currently no relevant guideline that provides clear guidance on whether CEA and CABG surgery should be performed concurrently or in stages. Early consensus from the American Heart Association believed that simultaneous CEA and CABG surgery is feasible in patients with asymptomatic carotid artery disease greater than 60% (12), but large-scale clinical trials have not confirmed its efficacy (3). As a result, whether surgery on the carotid artery and coronary artery is performed at the same time, and whether simultaneous or staged surgery is used as the treatment strategy, can reduce the risk of perioperative stroke, AMI, and death in these patients still needs further investigation.

Current Treatment Approaches

According to recent studies, the intervention methods for patients with both carotid artery stenosis and coronary heart disease include either simultaneous or staged surgery. CEA + CABG simultaneous operation, carotid artery stenting (CAS) combined with CABG, and CEA combined with cardiac stenting are examples of simultaneous operations. These points are discussed further below.

CEA and CABG Synchronization

Bernhard et al. reported the world's first case of performing CABG surgery immediately after CEA surgery under the same anesthesia in 1972 (13). A study conducted by the Levy et al. on patients with stable or unstable coronary heart disease and symptomatic or asymptomatic carotid artery stenosis found that performing CEA and CABG at the same time can reduce perioperative complications (14). The incidence of intraoperative complications was the same in both procedures, and there was no statistically significant difference in the risk of AMI, stroke, or death within 30 days.

Clinical studies have shown that combining CEA and CABG surgery has the following advantages (15): (i) lower perioperative mortality in patients with symptomatic severe carotid stenosis complicated by coronary heart disease; (ii) lower hospitalization and surgery-related costs; (iii) reduce patient hospitalization time and related medical waste; and (iv) lower risk of stroke events in long-term follow-up.

Simultaneous CEA+CABG surgery has obvious advantages for patients with severe symptomatic carotid stenosis (> 90% stenosis or occlusion on one side) complicated by coronary artery stenosis. Some researchers believe that patients with severe carotid artery stenosis may have impaired central vascular autoregulation as a result of long-term cerebral ischemia, putting them at a higher risk of perioperative stroke when undergoing CABG surgery alone (16). Furthermore, in the selection of CABG surgical methods, CABG under off-pump CABG has unique advantages (17): reduction of aortic operation, avoidance of cardiopulmonary bypass-related complications, such as severe water and electrolyte disturbances, difficulty in cardiac resuscitation, accidental aortic intubation, and air embolism, the occurrence of microthrombosis; and it can reduce the incidence of postoperative stroke when compared to conventional CABG.

There have been numerous reports of CEA+CABG combined surgery around the world, and its efficacy and benefits are worthy of confirmation through clinical observation.

CEA First, then Staged CABG Surgery

CEA+CABG appear to have a clear advantage in symptomatic patients with severe carotid stenosis. On the other hand, some studies have shown that the mortality rate of CEA and CABG surgery in stages is 6.0%, which is not statistically different from the mortality rate of CEA + CABG surgery (5.1%) in the same period (18). However, the perioperative period of CEA + CABG surgery in the same period is not statistically different from the perioperative period of CEA + CABG surgery (5.1%). The stroke rate is approximately 3.8%, which is significantly higher than that of staged CEA and CABG surgery, which has a perioperative stroke rate of only 0.2 %. As a result, some researchers believe that CEA followed by CABG staging can significantly reduce the risk of perioperative stroke in patients with unilateral asymptomatic carotid artery stenosis and coronary artery disease (19). However, it has been reported that staged CEA and CABG surgery may result in an increased risk of AMI (20).

Furthermore, because of the reduction in surgical complexity and the reduction in single operation time in staging surgery, the requirements for medical centers are correspondingly lower than those of the same period of surgery. As a result, some researchers prefer to use the CEA staging method and perform CEA surgery before coronary revascularization. This method is typically reserved for patients who have stable coronary symptoms. This viewpoint is supported by related studies, which conducted a systematic review of 94 clinical studies and found that concurrent CEA + CABG in patients with asymptomatic carotid stenosis and coronary stenosis has a higher stroke and mortality rate (21). The study did not, however, rule out the impact of factors like medical center strength and operator experience on the occurrence of perioperative risk factors.

The "Reverse Staging" Method: CABG First Followed by CEA

There have also been reports about the method of performing CABG after CEA. On the one hand, this method effectively reduces the incidence of perioperative AMI; on the other hand, it significantly increases the incidence of perioperative stroke. A study of 75 patients who underwent "reverse staging" surgery by Illuminati et al. found that delayed CEA surgery was associated with a higher incidence of postoperative stroke; 7 patients developed ipsilateral ischemia within 90 days of CABG (22). This could be due to the high variability of hemodynamics during CABG surgery and the inability to detect the occurrence of stroke in real time while under general anesthesia.

In sum, "reverse staging" surgery is not a routine or safe procedure. This is not based on a comprehensive evaluation of

the patient, but rather on objective factors such as anesthesia level and insufficient collaboration between disciplines, which prompts the medical team to choose to perform "reverse-staging" surgery on the patient. This is something clinicians should consider and improve in the future.

Additional Revascularization Procedures

Recently, stent placement combined with surgical treatment, such as CAS combined with CABG surgery, has formed a certain scale, and its effectiveness has gradually been recognized. The effectiveness of this approach is based on the use of minimally invasive stents and quick postoperative recovery. Paraskevas et al. systematically analyzed data from 2,727 recent cases of simultaneous or staged CAS combined with CABG surgery (23). According to the meta-analysis, the incidence of adverse events such as death or stroke within 30 days of staged CAS + CABG surgery was 8.5% (95% CI 7.3-10.5); and for patients who underwent concurrent CAS combined with CABG surgery (concurrent means that the two operations were performed on the same day), the incidence was 5.9% (95% CI 4.0-8.5). There is no evidence, however, that prophylactic CAS surgery reduces the risk of adverse events such as stroke and death. As a result, for patients with mild plaque calcification and relatively stable properties who expect "less trauma," CAS combined with CABG surgery can be considered as a concurrent surgery option.

It is important to note that anticoagulation therapy after stent placement may conflict with the standard perioperative anticoagulation therapy for CABG, so clinicians should exercise with caution. The American Heart Association (AHA) recommends that aspirin be continued before CABG and resumed within 6 hours of surgery; however, clopidogrel should be discontinued before CABG to avoid an increased risk of perioperative bleeding (24). This contradicts the traditional use of aspirin and clopidogrel after CAS (25). Furthermore, patients with severely calcified or ulcerated plaques are not candidates for carotid artery stenosis with stent placement, implying that CAS has limitations (26). In-stent restenosis, on the other hand, has become a major complication following CAS, and this is where this surgical approach needs to be improved (27).

Prospective

Despite multiple studies demonstrating the feasibility and safety of each treatment, there is still debate about which strategy best reduces the risk of neurological adverse events following coronary revascularization. Meta-analysis found that 30 days after CAS + CABG, the outcomes were broadly like those seen after CEA + CABG. Furthermore, previous studies were unable to eliminate the influence of objective factors: CEA + CABG in the same period has higher requirements on surgical skills, corresponding anesthesia, and multi-department collaborative teams in medical institutions, and the surgical process is lengthy. If it is difficult to maintain stable hemodynamics during the operation, this will obviously result in a higher perioperative stroke rate.

There are no randomized, prospective studies or relevant level 1 evidence to date to demonstrate which treatment strategy is the safest. As a result, strict control of patients' blood pressure during surgery, monitoring of cerebral hypoxia, and close collaboration with multiple disciplines based on detailed and individualized patient evaluations are more important. Furthermore, the current patient's surgical plan is more related to the patient's first consultation, preoperative examination, and anesthesia-related risks, and is more based on the medical center's experience rather than individualized for the patient.

If the relationship between medical institutions that restrict plan formulation can be reversed, and the patient-oriented, based on the premise of multi-departmental cooperation, giving patients an individualized and comprehensive assessment of the condition and choosing a simultaneous or staged surgery plan may make accepting the ladder impossible. Patients who had staged surgery or concurrent surgery benefited clinically more.■

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