Original Article

Coronary Artery Bypass Grafting Combined with Total Occlusion of Internal Carotid Artery

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Abstract

Background: *The presence of significant carotid stenosis in coronary artery bypass grafting (CABG) patients increases the risk of either transient ischemic attack or stroke. However, there is a dearth of data on the risk for patients with unilateral total occlusion of the carotid artery. We herein report our results of cardiac surgery in patients with unilateral total occlusion of the carotid artery.*

Methods: *We examined 10,000 patients who underwent carotid artery duplex scanning before CABG or other cardiac procedures between January 2001 and September 2006 at Tehran Heart Center. The occlusions were detected via carotid Doppler screening and were confirmed through conventional or MR angiography. Among these patients, 15 (0.15%) patients had unilateral total occlusion of the internal carotid artery, and all of them underwent elective cardiac surgery. During cardiopulmonary bypass, the mean arterial pressure was maintained at above 60 mmHg with vasopressure drugs and increasing flow pump.*

Results: *There were 4 patients with left and 11 patients with right carotid occlusions. Four patients had a history of cerebrovascular accident. The mean cross-clamp time (min) and perfusion time (min) was 50.7±17.3 and 94.2±26.7, respectively. The mean graft number was 4.1±0.9. One of these patients expired intraoperatively because of low cardiac output. In one (6.66%) patient, postoperative cerebrovascular accident occurred on the contralateral side of the totally occluded region. All the patients recovered uneventfully.*

Conclusion: *Our results suggest that CABG can be performed in patients with unilateral total occlusion of the internal carotid artery without ipsilateral stroke using our strategies.*

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Introduction

Coexistence of symptomatic coronary artery disease and significant carotid artery stenosis ranges from 3.4% to 22%.[1] Stroke incidence after open heart coronary artery bypass grafting (CABG) is estimated at between 0.8% and 6%, which is relatively high when compared to the decreasing rates of other perioperative complications.[2] The presence of

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significant carotid stenosis in CABG patients increases the risk of either transient ischemic attack (TIA) or stroke from 1.9 to 9.2.[3] There is, however, precious little information in the existing literature about the risk for patients with total occlusion of the carotid artery.[4] In the past two decades, the high-risk potential for neurologic dysfunction after CABG in patients with concomitant carotid stenosis has been a real challenge for surgeons in terms of determining which operative sequence offers the highest freedom from cardiac or cerebral complications.[1]

Previous studies vary widely in reporting perioperative stroke frequencies for patients with internal carotid artery (ICA) occlusion or stenosis. Some of these reports have shown no increase in the risk of ipsilateral stroke in patients with an occluded ICA undergoing CABG,[5-7] whereas others have reported an increased frequency (15%) of perioperative transient ischemia or cerebrovascular accident (CVA).[8]

In 1992, Berens et al.[9] reported their results with routine carotid duplex scanning (CADS) for all cardiac surgical patients aged 65 years or older; the risk of stroke was 10.9 percent for unilateral carotid artery occlusion.

There is, therefore, no recommended strategy for these patients. We report our results of cardiac surgery in patients with total occlusion of the carotid artery.

Methods

Perioperative and postoperative data were collected prospectively in all 12,000 patients who underwent CADS, as the initial screening procedure for cerebrovascular disease, before elective CABG or other elective cardiac procedures between January 2001 and September 2006 at Tehran Heart Center. Preoperative CADS was successfully performed in 10,000 (83.3%) patients, 15 (0.15 %) of whom had total occlusion of the ICA.

Carotid Doppler was carried out by an expert radiologist, who had practiced Doppler studies on a daily basis for over 5 years. The device used was a Logic 5 Expert GE with linear 7.5 MHZ and convex 3.75 MHZ transducers. A standard protocol based on the Nicolaides criteria was applied to all the patients.[10] MRA was done preoperatively for the patients diagnosed with total occlusion of the carotid in their carotid Doppler.

Patient data included the following variables: age, sex, hypertension, hypercholesterolemia (whether the patient had a history of hypercholesterolemia diagnosed and or treated by a physician and or patient had been assured previously of a. TG>200, b. LDL≥130, c. HDL<30, d. admission cholesterol>200 mg/dl), diabetes mellitus (defined as a history of diabetes, regardless of the duration of the disease or need for anti-diabetic agents), mean of ejection fraction, history of CVA or TIA, number of grafts, aortic cross-clamp time, perfusion time, and perioperative stroke (defined as a persistent focal or multifocal neurologic deficit that was explained by the ischemia of the brain or brain stem from the time of surgery until the 30th postoperative day and confirmed by computed tomography (CT) scan). During cardiopulmonary bypass, the mean arterial pressure was maintained at above 60 mmHg with vasopressure drugs and increasing flow pump. Only mortality and morbidity resulted by the total occlusion of the ICA in the patients were considered

Results

From among 10,000 patients who underwent CADS before cardiac surgery, 15 patients (10 men and 5 women at a mean age of 65±8.9 years) had unilateral total occlusion of the ICA. The mean ejection fraction was 48±10.9 (mean±SD). There were 4 patients with left and 11 patients with right carotid occlusions. Significant carotid stenosis (≥50%) contralateral to the occluded ICA was detected in 2 patients, for whom surgical treatment for cerebrovascular lesions was not necessary because there were no ischemic signs. Of these 15 patients, 12 (80%) had hypertension, 11 (73.3%) had diabetes mellitus and hypercholesterolemia, and 4 (26.6%) had a history of CVA or TIA, with CVA occurring on the same side as the total occlusion of the ICA in 3 of them. The baseline characteristics of the patients are depicted in Table 1.

Table 1. Patients' characteristics*

ICA occlusion	15 (0.15)
Age (y)	65±8.9
Male/female	10/5
Graft numbers	4.21±0.8
Cross clamp time (min)	50.7±17.3
Perfusion time (min)	94.2±26.1
Hypertension	12 (80)
Diabetes	11 (73.3)
Hypercholesterolemia	11 (73.3)
Ejection fraction (%)	48±10.9

*Data are presented as mean±SD. Numbers in parenthesis show the related percentage
ICA, Internal carotid artery

One patient underwent mitral valve repair and the other 14 patients had CABG, all the procedures being elective. There was one (6.66%) intraoperative death due to low cardiac output. Atrial fibrillation (AF) was detected in 2 (13.33%) patients. Perioperative stroke was observed in one (6.66%) patient; in this case with total occlusion in the right ICA, brain ischemic stroke occurred 36 hours after surgery because of emboli in the left internal capsule. On the other hand, postoperative CVA occurred on the contralateral side of the total occlusion region. The surgical procedures and

outcomes for these 15 patients are summarized in Table 2. Postoperative CT scan was performed for all the patients. In our study, all the patients recovered uneventfully, because no mortality or morbidity occurred as a result of the total occlusion of the ICA.

Discussion

There is limited information available regarding the morbidity and mortality of patients with an occluded ICA undergoing CABG, with the reported perioperative stroke rate ranging from 4.8% to 23.1%.[11]

Ischemic stroke can be subdivided into at least 4 categories: large-artery disease, small-artery disease, cardio-embolic disease, and cryptogenic.[12,13]

Atherosclerosis and thrombosis are important components of large-artery disease in vessels such as the carotid and vertebral arteries.[14] Embolic events from the atherosclerosis of the carotid artery are well documented as a major contributing factor in the development of stroke.[15] Cerebral embolism is considered the most frequent cause of a perioperative stroke. However, embolism from a carotid stenosis triggered by the surgical procedure may be rather unusual in contrast to embolism from the aortic arch. More likely, carotid stenosis may induce cerebral infarction via hemodynamic compromise during cardiopulmonary bypass. Be that as it may, risk of hemodynamic infarction distal to carotid stenosis is linked to impaired cerebral autoregulation. Therefore, the incidence of perioperative stroke even in severe carotid disease may be increased only in patients with an exhausted cerebral vasodilatative response to low perfusion pressure.[16]

Mickleborough et al.[17] showed that the incidence of perioperative stroke among CABG patients who had unilateral ICA occlusion was 16.6%. In their study of CABG patients, Brener et al.[8] examined 32 patients who had an occluded carotid artery and demonstrated the incidence of perioperative stoke to be 15.6%. Schwartz et al.[18] studied 21 CABG patients who had an occluded carotid artery; the perioperative stroke rate in this study was 4.8%.

Table 2. Summary of clinical information and results

Case No	Age (y)	Sex	Symptom	CADS	Surgery	Number of grafts	Outcome (stroke)
1	77	M	-	rt-ICA occlusion	CABG	5	No deficit
2	61	F	-	lt-ICA occlusion	Mitral valve repair		No deficit
3	71	M	-	rt-ICA occlusion	CABG	5	No deficit
4	63	F	-	rt-ICA occlusion	CABG	3	No deficit
5	76	M	OCI	rt-ICA occlusion	CABG	4	No deficit
6	64	M	OCI	rt-ICA occlusion	CABG	2	No deficit
7	75	F	-	rt-ICA occlusion	CABG	4	No deficit
8	62	F	-	lt-ICA occlusion	CABG	4	No deficit
9	74	M	-	rt-ICA occlusion	CABG	4	Expire
10	65	M	-	rt-ICA occlusion	CABG	4	No deficit
11	55	M	TIA	rt-ICA occlusion	CABG	5	No deficit
12	70	M	-	lt-ICA occlusion	CABG	5	No deficit
13	45	M	OCI	rt-ICA occlusion	CABG	5	No deficit
14	58	M	-	lt-ICA occlusion	CABG	4	No deficit
15	59	F	-	rt-ICA occlusion	CABG	5	No deficit

CADS, Carotid artery duplex scanning; rt, Right; ICA, Internal carotid artery; CABG, Coronary artery bypass graft; lt, Left; OCI, Old cerebral infarction; TIA, Transient ischemic attack

A recent study by Dashe et al.[19] included 25 CABG patients having an occluded carotid artery; their incidence of perioperative stroke was 8%. In a study by Tunio et al.,[11] among the 61 CABG patients with occluded carotid artery, the perioperative stroke rate was 6.5% and the mortality rate was 8.6%. This suggests that patients with ICA occlusions are indeed more prone to perioperative stroke and mortality.

Conversely, Faggioli et al.,[5] and Barnes et al.,[6] reported

no increase in the risk of ipsilateral stroke in patients with an occluded ICA who underwent CABG. In our study, new neurological events did not occur in any patients and all of them recovered uneventfully. Our results showed that CABG can be performed without ipsilateral stroke in patients with unilateral total occlusion of the ICA. Nevertheless, there is still no consensus about the rate of stroke after CABG with ICA occlusion, and the management of these patients is still controversial.

Patients with contralateral carotid occlusion are intuitively considered a higher surgical risk for multiple reasons, e.g. reduced collateral circulation during carotid clamping, cerebral hemorrhage secondary to hyperperfusion syndrome, and the overall advanced status of the vascular disease.[20]

In general, the mechanisms that cause neurological complications in CABG are thought to be multifactorial. Embolization of the atherosclerotic debris from the ascending aorta and carotid artery and events related to cerebral hypoperfusion are posited as the major causes of stroke in CABG patients.[7,21-23] Low perfusion could also be an important factor in these patients. When there is insufficient collateral supply, ICA occlusion can decrease the perfusion pressure in the ipsilateral hemisphere; the altered circulatory state may be sufficient to produce severe ischemia in the most distal borderline area, with eventual watershed infarction.[12] Therefore, perioperative care is important, particularly maintaining perfusion pressure in the area that supplies the occluded ICA and maintaining adequate perfusion pressure during surgery and postoperative course. It seems that all the patients in our study had an adequate collateral supply, which preserved the cerebral flow to the occluded areas; that could explain why none developed neurological disorders.

Conclusion

In conclusion, among 10,000 patients, 15 (0.15%) cases had total occlusion of the ICA. Ipsilateral cerebrovascular accident occurred in none. According to our study, CABG can be performed with no risk of the development of ipsilateral stroke if adequate perfusion pressure is maintained intra and postoperatively. In our study, despite an adverse risk profile in most patients, a favorable outcome was achieved.

Finally, it remains difficult to decide the most appropriate strategy for patients with unilateral total occlusion of the ICA and much work is needed before we can declare any sound and reliable method.

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