SPECIAL ARTICLE

Neuropsychological changes following coronary artery bypass surgery

Surender K. Malhotra, MD

Professor of Anesthesiology, MM Institute of Medical Sciences and Research, Mullana, Ambala (India)

Correspondence: Professor S.K.Malhotra, MD, Department of Anesthesiology, MM Institute of Medical Sciences and Research, Mullana, Ambala 133207(India); Cell: 0091-9814435137; E-mail: drskmalhotra@yahoo.com

ABSTRACT

The various studies conducted till date reveal that up to 40% patients undergoing coronary artery bypass surgery are associated with minor or persistent neuropsychological disorders. A significant concern has been emphasized on short and long term morbidity in cases of CABG procedure. The outcome in the form of morbidity after this surgery, irrespective of co-existing medical diseases, is prevalent in presence of neuropsychological problems, such as anxiety, depression and cognitive impairments, though the exact mechanism of this behavioural aspect is obscure. As such, there may not be serious psychological dysfunction but chances of incident delirium at the time of admission are quite high. These neuropsychological deficits may continue over time, especially if the features persisted in preoperative period, too. To improve the detection of these psychological disorders in CABG surgery cases, the clinicians must consider the use of specified screening methods. Perioperative factors, as well as patient-related risk factors, play a vital role in development of cognitive dysfunctions. Recent literature emphasizes the possibility of a grave complication in the form of ischaemic stroke in post- CABG surgical patients. The microemboli may enter cerebral circulation during surgery leading to cognitive decline, postoperatively. In the recent literature, that include various studies covering the neuropsychological areas, conflicts and limitations in methodology are prevalent.

Key words: Coronary artery bypass surgery; Neuropsychological disorders; Cognitive delirium; Depression; Anxiety; Stroke

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INTRODUCTION

More than one million patients undergo coronary artery bypass graft (CABG) surgery every year.[1] The procedure is undertaken even in patients with co-existing diseases, such as diabetes, hypertension and pulmonary diseases who are at high risk of complications. Most of the elderly patients undergoing CABG are likely to have neurological consequences that may be of serious nature leading to longer hospital stay and even morbidity.[2] A prospective study observed 2108 cases undergoing CABG surgery at 24 hospitals in the United States.[3] In general, 6.1% patients developed a cerebral complication. Various documented neuropsychological changes that may follow CABG surgery may include cognitive dysfunction, delirium, depression, anxiety and even stroke. The treating clinicians have appreciated the importance of detecting these neuropsychological disorders well in time so that morbidity may be minimised. An overview of the studies carried out in this field covering neuropsychological effects, perioperatively as well as in the long term has been discussed. The causative factors and results of cognitive dysfunctions, delirium, anxiety, depression and stroke following CABG surgery have been elaborated in this article.

CORONARY ARTERY BYPASS SURGERY

The surgical procedure of coronary artery bypass graft is carried out under general anesthesia and the heart is brought to stand still to perform the

procedure. Cardiopulmonary bypass is utilized to maintain delivery of oxygen and circulation to the body. Anticoagulant drug is added so that the blood does not clot in the heart-lung machine and same is reversed to prevent bleeding after the procedure is over and the pump removed. The use of bypass pump is associated with many neuropsychological problems following CABG surgery. Recently, off-pump CABG has been used without using bypass pump. Now the neuropsychological changes following off-pump technique are also being studied.[4]

COGNITIVE DYSFUNCTIONS

Various studies involving neuropsychological screenings following CABG surgery have revealed that 3 to 80% of cases develop postoperative cognitive dysfunction (POCD), such as decline in memory, motor reflexes, alertness and other cognitive functions.[5] The features may be very fine and minor that may be demonstrated only by specific modern tests or there may be frank clinical delirium.

The incidence of cognitive disorders following CABG surgery vary since many underlying factors play role such as inconsistency in surgical procedure, lack of control and study groups, techniques to detect cognitive functions and disparity in follow-up period.[6] In one study, significance of control group has been emphasized where the cognitive functions were studied at baseline, 3 months and one year after CABG surgery with two control groups; one with coronary disease but without surgery and second with normal heart.[7]

Possible mechanism of cognitive dysfunction

The mechanism is based only on speculation and may not be a causative factor in all the patients. This clinical entity has been named as "Post-perfusion syndrome" or "Post- pump syndrome". One possibility is that this dysfunction may be due to cerebral microemboli. As compared to non-cardiac procedures such as for peripheral vascular disease, post CABG surgery patients develop neuropsychological disturbances.[8] Various factors that may result in development of microemboli are handling of heart and aorta at the time of aortic cannulation and suctioning during cardiopulmonary bypass. During and after CABG surgery, microemboli are prevalent as shown by transcranial Doppler.[9] In a study involving forty cases, the development of new ischemic lesions, as revealed by MRI, have been shown to be associated with reduction in cognitive functions. But the studies have not shown a significant correlation between number of microemboli identified during surgical procedure and the degree of cognitive decline.[10] Cognitive dysfunction may also be due to hypotension and oxygen desaturation that occurs, intraoperatively.[11] The role of vascular mechanism may be confirmed by the preoperative presence of risk factors that are likely to cause stroke.[12]

Postoperative hyperthermia, as shown by a study involving three hundred patients, may cause cognitive impairment after six weeks, implying that temperature modulates cerebral injury.[13] One clinical trial showed that on-pump surgical procedures are not associated with higher risk of cognitive dysfunctions than off-pump CABG cases.

Postoperatively, the cognitive deficits may slowly resolve and may become almost normal within three to twelve months and less severe impairment may result in long term recovery.[14]

Long-term cognitive deficit

The post-CABG surgery patients are at greater risk for long-term cognitive deficit. A series of screening in patients after CABG in one study showed a cognitive decline of more than 20%, which was considered significant. The incidence was 53, 36, 24 and 4 % at discharge, six weeks, six months and five years.[15]

Various studies have shown that late deficit in cognitive function appearing one to five years after CABG surgery may be due to underlying cerebral or vascular disease and not due to cardiopulmonary bypass or cardiac surgery.[16]

Delirium

Delirium, an acute confusional state, is a momentary syndrome highlighted by distorted consciousness with reduced attention period and changes in cognition or perception.[17] Related symptoms include sleep-wake as well as emotional and psychomotor disorders.

The incidence of post CABG delirium is 3 to 32 percent. Various underlying factors that contribute to the development of postoperative delirium after CABG surgery include old age, alcohol consumption, chronic dementia and stroke.[18] Sometimes, the postoperative delirium may be attributed to anesthetic drugs, sedatives and narcotics administered, perioperatively. The additional factors that may contribute to the postoperative delirium are thyroid disorders, renal dysfunction, liver failure and stroke, especially the

one involving right parietal side.

Management of postoperative delirium involves finding the underlying causes that may be conveniently reversed. The electroencephalogram would be normal in a psychiatric disease but would show abnormal pattern in postoperative delirium following CABG surgery.

In general, the delirium may continue to exist for more than 7 to 10 days and may coexist with other neurocognitive deficits. In one prospective study involving 225 cases, those who had postoperative delirium were more likely than those who did not have constant cognitive deficit over baseline (40 versus 24% at six months and 31 versus 21% at 12 months, that were statistically significant).[19] One more prospective study, observed that risk factor for late mortality was CABG, particularly in patients with hazard ratio of 2.4 and those who were less than sixty five years of age.[20]

Depression

The greater chances of depression are prevalent in patients, who are already having diabetes, hypertension and coronary artery disease. It is commonly observed that stroke is followed by depression.[21] There is a term 'vascular depression' which includes a subgroup of the patients belonging to older age group with severe depression.[22]

It has been observed that in patients with ischemic cerebrovascular disease, there is late onset depression in elderly patients. A few studies observed the presence of white-matter hyperintensities in depression in old age.[23] In 94% of patients with late onset depression, there can be a possibility of "silent stroke".[24]

There may be cognitive deficits in cases of vascular depression, mainly affecting the executive functions.[25] Ultimately, it is believed that depression plays a major role in causing postoperative cognitive disorders.

In about 25% of patients after CABG surgery, depression is clinically observed.[26] Recent observations reveal that preoperative mood plays a vital role in development of postoperative acquired depression.[27] In postoperative depression, executive functions are mainly affected but there is no change in memory.[28] It has been observed that memory functions are decreased in cases of postoperative cognitive disorder.

Stroke

In CABG surgery, the chances of postoperative stroke are 0.8 to 5.2% in various studies.[29] One survey showed that incidence of stroke has decreased and in 2009 it was 1.6% only.[30]

About 30 % of strokes occur intraoperatively, and others take place in 1 to 2 days postoperatively and not common after 7days.[31]

Stroke during surgery: These occur mainly due to cerebral hypoperfusion that may be due to hypotension. The mean blood pressure of 50 to 70 mmHg is sufficient to prevent the stroke.[32] Arterial microemboli blocking the cerebral vessels may be the other mechanism. Emboli may be in the form of air, thrombus or atheromatous and may occur when ascending aorta is unclamped. Air emboli may get into circulation from cannulation sites and when the cardiac chambers are open.

Stroke following CABG surgery: the stroke that occurs postoperatively may be due to emboli that are cardiogenic in origin.[33] Atrial fibrillation may contribute to this kind of embolism. Various risk factors that may lead to postoperative stroke in CABG surgery have been described (Box 1) History of prior stroke is a vital risk factor in postoperative period. Atherosclerosis of aorta, especially with the atheroma of aortic arch is also a significant risk factor.[34] The risk of stroke is also enhanced if the temperature of cardiopulmonary bypass is increased.[35] In case there is a prior history of intracranial haemorrhage, a thorough neurological assessment must be performed after CABG surgery.[36]

Box 1: Perioperative risk factors for stroke following CABG surgery

- Hypertension
- Diabetes
- Atrial fibrillation
- Myocardial ischemia/angina
- Left ventricular disorders
- Elderly patient
- Atherosclerosis of cerebral arteries, aorta
- Peripheral vascular disease
- Renal dysfunction

There is possibility of ophthalmic complications such as infarction of retina, as seen in 26% patients out of 312 patients undergoing CABG surgery.[37]

Diagnosis of acute ischemic events may be made if brain MRI is undertaken which is a reliable test.[38] A postoperative stroke indicates ongoing underlying factors such as atrial fibrillation or cerebrovascular

disease.

Management of postoperative stroke : In case stroke occurs in postoperative period, hypotension should be avoided by administering sufficient fluids and if required phenylephrine.[39] Oxygen therapy is recommended to keep the saturation above 95%. Hyperthermia is associated with poor outcome following stroke, therefore must be treated with antipyretics. In case of acute stroke, anticoagulant therapy is discouraged as complications like hemopericardium may result. Following CABG surgery, neurological problems may be minimised by antiplatelet therapy. In case air emboli occurs, hyperbaric oxygen has been recommended.

Prognosis of stroke: The outcome is poor in case of postoperative stroke following CABG surgery. In a study involving 35733 patients after CABG surgery, there was postoperative stroke in 1.6% patients and a threefold increased incidence of mortality. The mortality following stroke in hospital after CABG surgery ranges from 14 to 30% and is more during intraoperative than postoperative period.[35]

CONCLUSIONS

Neuropsychological changes following CABG surgery are not uncommon and may amount to about 6 percent. Postoperative stroke may become evident within two days. There are increased chances of neuropsychological changes when CABG surgery is combined with another cardiac surgery, such as valvular surgery. The various factors leading to stroke following CABG surgery include cerebral hypoperfusion, embolism, atherosclerosis of aorta or cerebral arteries. Management of the stroke includes sufficient fluids and avoiding tissue plasminogen activator. Other cerebral consequences may include postoperative delirium, depression, anxiety and even seizures. A section of patients may develop cognitive dysfunctions in CABG surgery, postoperatively. In these patients, cerebrovascular involvement and metabolic disturbances must be evaluated and excluded.

Conflict of interest: Nil

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