



International Journal of Allied Medical Sciences and Clinical Research (IJAMSCR)

ISSN: 2347-6567

IJAMSCR | Volume 3 | Issue 4 | Oct - Dec - 2015
www.ijamscr.com

Review Article

Medical Research

Brain damage - Post-operative complication of cardiac bypass surgery

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ABSTRACT

Bypass surgery and angioplasty are probably the most over performed surgeries in the world today. Because of the present lifestyle of people of this era day by day the cases of cardiac surgeries are increasing up the number. Recent recognition of brain damage as a consequence of heart bypass surgery has led to many recent investigations. Dementia and cognitive defects are the most common cases observed in the patients who have undergone bypass surgeries. Microembolisation and inadequate perfusion are found to be the etiological factors of brain damage. With the recent technological development we can easily diagnose the extent of brain damage. As the incidence of cardiac bypass surgeries can't be reduced there is a need to prevent the consequential brain damage occurred. Vasodilators corticosteroids etc., have been used to prevent brain damage in patients undergoing bypass surgery. In the coming era, with the new advancements in technology, one can hope to build a sure safe heart bypass surgeries.

Keywords: Angioplasty, Dementia, Microembolization, Vasodilators, Corticosteroids inflammatory modulators MR brain Imaging.

INTRODUCTION

Cardiac bypass surgery ^[2]

This procedure builds up a new route known as bypass for the blood and oxygen to reach the heart when blockage of vessel supplying heart is seen.

Reasons to perform surgery

- Blockage in one or more coronary arteries which results in deprived supply of oxygen and nutrients to heart- a condition called ischemic heart disease (IHD) or Coronary Artery Disease (CAD).
- Chest pain called Angina which is a consequence of ISD.

Bypass surgery – procedure overview

- Before onset of surgery, general anesthesia is given to the patient.
- An 8-10 inch surgical cut is made in the center of the chest.
- Breast bone is separated so that an opening can be made through which surgeon can see the heart and the aorta.

Heart- lung bypass machine ^[1]

- During surgery heart will be stopped functioning and its functions are carried out by this machine. It adds oxygen to the blood, transports blood throughout the body to all the tissues and removes carbon dioxide from the blood.

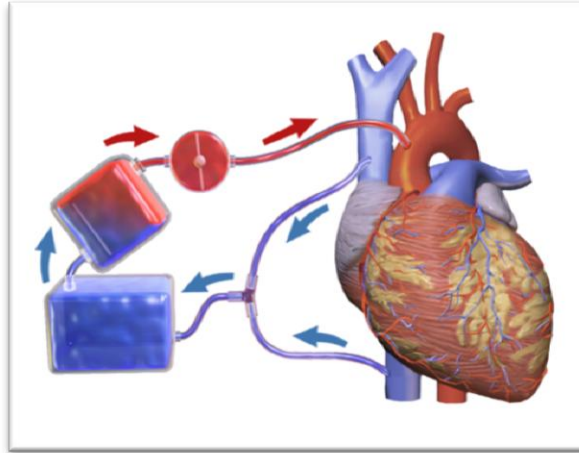


Figure.1- Heart-Lung Bypass Machine

- Recently a newer type of CBS was found which does not use this machine. The surgery is carried out while the heart is still beating-called Off Pump Coronary Artery Bypass (OPCAB).

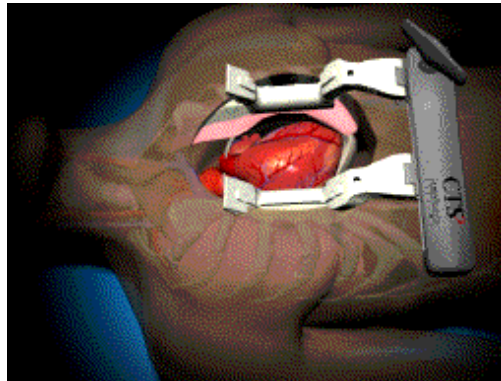


Figure.2. off Pump Coronary Artery Bypass

How is the bypass graft created?

- A vein or artery is taken from another part of the body, most probably vein from leg called saphenous vein is selected.
- This vein is used to make a detour around the blocked area in the artery.
- One end of the graft is sewn to the coronary artery and the other end is sewn to the opening made in the aorta.
- Alternatively doctors can use the Internal Mammary Artery (IMA) as a graft. One end of the graft is already connected to aorta and the other end is connected to the coronary artery.
- Radial artery of wrist also can be used.
- Blood clotting in legs that may travel to the lungs.
- Breathing problems
- Blood loss
- Stroke
- Infection in lungs, urinary tract and chest.
- Brain damage
- Dementia

Angioplasty and stent placement

An alternative to coronary artery bypass graft, Angioplasty is a procedure used to open the blocked blood vessels especially coronary artery. Also called Percutaneous Transluminal Coronary Angioplasty (PTCA)

Risks of cardiac bypass surgery

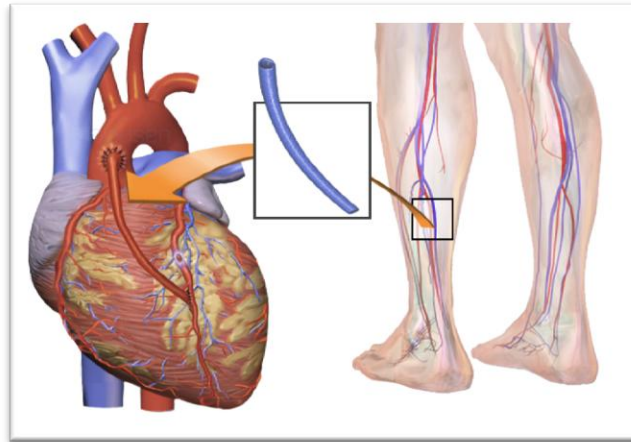


Figure.3. Saphenous vein taken from the leg

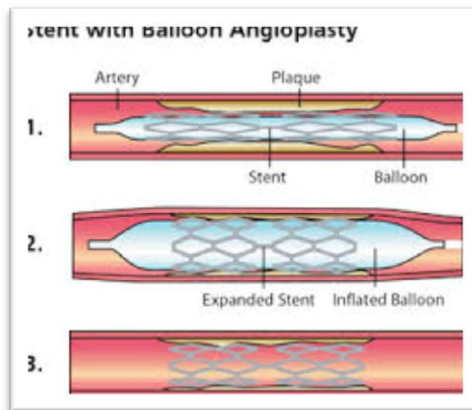


Figure.4. Stent placement with balloon angioplasty

PROCEDURE

- Local anesthesia is given to the patient.
- An incision is made in the arm or groin.
- A catheter with tiny inflated balloon will be inserted into the artery which is blocked.
- Surgeon will guide the way to the catheter by studying the X-ray video and using special dyes.
- Once it reaches the area the blockage the balloon is inflated and thus the artery widens.
- The catheter is equipped with a stainless steel mesh called a stent.
- Stent is used to hold the blood vessel open and prevents it from reblockage.
- Then the balloon is deflated and is removed.
- The cut area in the arm is stitched back.

Risks of angioplasty

- Bleeding , clotting at the point of insertion
- Arrhythmias

- Damage to the blood vessel, valve or artery during surgery.
- Renal damage in people previously suffering from kidney problems.

Angioplasty v/s bypass surgery ^[3]

The choice of angioplasty or bypass surgery is based on physician and patient's preference as well as patient specific characteristics such as cost, prevailing conditions like Diabetes or Heart Failure. When 1, 2 or at maximum 3 arteries are narrowed, then angioplasty can be performed. But when the left main coronary artery or all the 3 major coronary arteries are narrowed, then CABG is the only choice. Patients with Diabetes and Heart Failure are recommended to undergo CABG. In the present world there are several recent advances in surgical techniques and extracorporeal circulation devices.

Still many cerebral disorders occur as a result of heart surgeries. Day by day as the number of open heart surgery procedures increase there is a continuing need to recognize the potential threat of brain damage. Complications of brain damage which are detected have been found to affect all corners of nervous system.^[4] The following complications were detected

- Hemispherical damage with motor and sensory defects.
- Cognitive defects.
- Intellectual impairment.
- Psychiatric disorders.
- Cranial nerve disturbances.
- Peripheral neuropathy.
- Brachial plexus damage.

Most often reported abnormalities are cerebellar damage or lesions of brain stem.

Causes and mechanism of brain damage

Most probable mechanism of brain damage was observed to be :

- i. Microembolisation.
- ii. Inadequate cerebral perfusion

Microembolisation

It is a process of formation of small embolus – aggregation of platelets that blocks an arteriole or the terminal part of an artery. It may originate from the heart or from the extracorporeal circuit^{[6][7]}, which is an apparatus carrying blood outside the body. Composition of emboli has been recognized as air, fat, and fragments of valvular debris, leukocyte aggregation or platelet aggregation. Gaseous microembolisation^[10] which starts from pump and it can be examined by ultrasonic methods like Doppler Ultrasound Monitoring. This can be reduced by microfiltration.

Cerebral perfusion inadequacy

It can be caused by

- Hypothermia^[8]
- Hypoxia
- Hypotension^[9]

In both clinical trials - human and animal studies, cardiac bypass was proved to cause fall in brain metabolic rate. Blood supply to brain also decreases due to Microembolisation. Postoperative cognitive dysfunction (POCD) is the major consequence of bypass. POCD is also seen in patients undergoing valve surgery or combined coronary valve surgery

when compared with patients undergoing CABG alone.

POCD and chronic dementia

There is also a possibility that temporary perioperative brain injury may trigger chronic or progressive dementia and also long term cognitive deficits was by Newmann.et.al^[12]

DIAGNOSIS

Brain MRI

Major patients show symptoms of brain damage in the form of memory loss or thinking disabilities. Even in the absence of symptoms the extent of damage can be detected by Magnetic Resonance Brain Imaging.^[5] It provides a means through which we can identify and quantify the brain injury. The following techniques are applied

1. Diffusion- Weighted Imaging.(DWI)
2. Fluid attenuated inversion recovery sequencing.
3. Proton density – weighted imaging.
4. T₂ sequences.

Cerebral protection during open heart surgery

Over the past 15 to 20 years due to the advancements made in the technology many outcomes have been observed which are used to diminish the brain injury during heart surgery. They include:

1. Membrane oxygenators replacing bubble oxygenators.
2. Arterial filters.
3. Pulsatile perfusion.
4. Heparin bonded circuits.
5. Retrograde perfusion of brain.
6. Improved cannulation techniques.

Therapeutic approach

Most commonly used categories to prevent brain damage during cardiac surgeries are:

- a. Vasodilators.
- b. Corticosteroids
- c. Inflammatory modulators.

Vasodilators^[14]

Hypoxia which occurs as a result of intravascular coagulation vasoconstriction and microembolisation can be prevented by vasodilation. Vasodilator used extemporaneously is Phenoxybenzamine at 1-3 mg/kg dose.

Corticosteroids^[15]

These have been used since 1960's. At that period they were used for their hemodynamic effects, like vasodilation. Later these are used because of their effect in reducing the vasoconstriction and improved perfusion flows which in turn decrease the ICU length of stay.

Eg: methyl prednisolone.

Inflammatory Modulators^[16]

After cardiopulmonary bypass it is observed that serum IL-6 concentrations increase. It acts as marker for the activation of inflammatory cascade. It may result in organ dysfunction and death. Protease inhibitors-aprotinin has been shown to reduce serum concentration of proinflammatory cytokines released during cardiac surgery. Heparin coated cardiopulmonary bypass circuits are effective in reducing inflammatory response.

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CONCLUSION

This review was undertaken to highlight the marking importance to prevent any further brain damage in the patients undergoing cardiac surgeries. Treating patients with vasodilators, corticosteroids and inflammatory modulators is proved to be effective in preventing brain damage. There is a great need for the physicians to examine brain MRI of patients with cardiac surgeries done and thus can prevent further damage to brain. The current predominance of membrane oxygenators over bubble oxygenators has reduced the incidence of gaseous embolization during bypass surgery. Presently ongoing research will surely increase our understanding about the cause and ways to prevent brain damage, thereby reducing the levels of morbidity and mortality of the patient.

How to cite this article: Srija Poreddy, Dr. Prabhu Thilak, Ch. Madhava Reddy, H Srinivas, N Sriram, Brain damage - Post-operative complication of cardiac bypass surgery. Int J of Allied Med Sci and Clin Res 2015;3(4):483-487.

Source of Support: Nil. **Conflict of Interest:** None declared.