

REVIEW ON INSTRUMENTS USED TO TREAT AND IDENTIFY CARDIOVASCULAR DISEASES

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Abstract: The aim of this review is to present the information regarding the instruments that are available to detect the cardiovascular diseases. Risk factors that are associated with the cardiovascular diseases like fluctuations of blood pressure, lipid levels, body mass index, waist and hip circumferences and smoking behaviour. Surgery may be required to treat the heart conditions like – ischemic heart disease, coronary artery disease, congestive heart failure, diseases and defects of the heart and its valves like endocarditis, rheumatic heart disease. There are some of the common tests and instruments used to identify and manage the conditions like- angiogram, coronary computed tomography angiogram, blood tests, chest x-ray, echocardiogram, ECG, electrophysiology, MRI, stress tests, tilt test. This review describes some of the methods to identify cardiovascular diseases.

Keywords: heart failure, heart surgery, cardiogram, echocardiogram.

INTRODUCTION:

The most common type of the heart disease that effects the united states is the coronary artery disease a condition where the artery that carries blood to the heart will be effected. In the coronary artery disease the causative factor is the formation of plaque that is made of cholesterol and other substances that are present in the artery and the condition called as atherosclerosis.(1) As a result finally leads to the weakening of the heart muscle, irregular heart beat or arrhythmia may occur.

There are different types of heart diseases which effect different part of the heart.

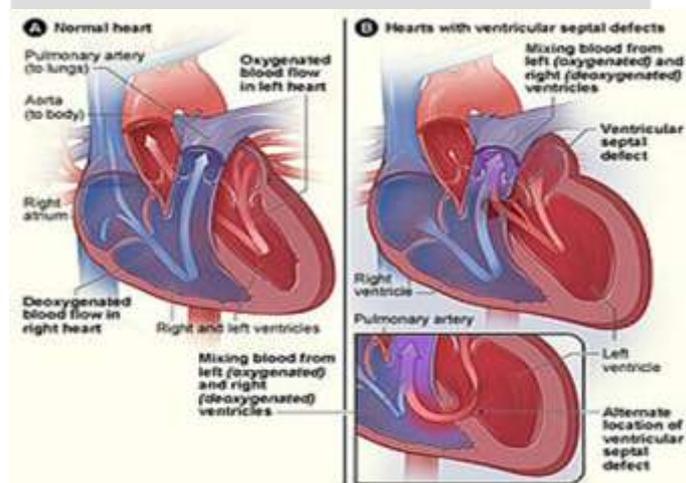
1. Congenital heart disease:

Congenital means existing from birth, congenital heart disease is a kind of heart defect in which the blood vessels present near the heart doesn't develop properly before birth. (2)

Types of congenital heart disease:(3)

Congenital heart disease can be divided into three main categories-

- Heart valve defects- the valve in the heart that directs the blood flow may close up or may leak which effects the hearts ability to pump blood.
- Heart wall defects- the natural wall present between the left and right chambers of the heart doesn't develop properly which causes pumping of the blood back to the heart or build up in the area where it doesn't belong and increases the heart pressure resulting in the high blood pressure.
- Blood vessel defects- the arteries and the veins that carry blood to the heart and back to the body may not function properly.



Figno-1 congenital heart defect

Signs and symptoms

- ✓ Pale gray or blue skin color
- ✓ Rapid breathing
- ✓ Swelling in the legs, hands, feet.
- ✓ Shortness of breath.
- ✓ Lung infections.

Causes:

Causative factor associated with the congenital heart disease might be the changes in the genes or chromosomes. Other factors that causes congenital heart disease are environmental factors, smoking, diet and intake of certain medications during medications.(4)

Associated conditions:

Congenital heart defects occurs with an increased incidence of seven other specific medical conditions, together being called as VACTERL association:

- V — Vertebral anomalies
- A — Anal atresia
- C — Cardiovascular anomalies
- T — Tracheoesophageal fistula
- E — Esophageal atresia
- R — Renal (Kidney) and/or radial anomalies
- L — Limb defects

Treatment:

Congenital heart disease may be cured by medications or surgery, in case of medications like diuretics are given that aids the body in eliminating salts and water, digoxin is used for strengthening the contraction of heart that promotes the slow contraction of the heart there by removal of some of the fluids present in the tissue. In some cases the condition maybe treated by surgery in order to restore circulation back to normal condition.(5)

2. Arrhythmia:

Arrhythmia describe the irregular heart beats-condition where the heart beats either fastly or slowly. Arrhythmia occurs when the electrical signals doesnt coordinate with the heart beats leads to fluttering.(6)

Arrhythmia may broke down into:

- Slow heart beat- bradycardia
- Fast heart beat- tachycardia
- Irregular heart beat- fluttering
- Early heart beat- premature contraction

Types of arrhythmias(7)

- a. Atrial fibrillation: the condition which occurs most commonly in older patients where instead of producing strong contraction the chambers fibrillates and atrium can fibrillate upto 350 per minute and even more sometimes.
- b. Atrial flutter: atrial flutter occurs when the one side of the atrium doesntconduct properly also leads to abnormal pumping of blood. Atrial flutter may be a serious condition which eventually leads to fibrillation if untreated.
- c. Supraventricular tachycardia: it is a type of arrhythmia where abnormal electrical impulse will start in the ventricle and leads to fast heart beat, which often occurs due to the condition where the heart has a scar from previous heart attack.
- d. Ventricular fibrillation: ventricular fibrillation is a life threatening condition where the ventricles do not pump blood properly due to uncoordinated fluttering contraction of the ventricles.

Causes of arrhythmias:(8)

- Alcohol abuse- drinking too much alcohol will effect the electrical impulses and increases the risk of developing atrial fibrillation.
- Drug abuse- over the counter drugs like cough and cold medicine also may contribute to arrhythmia
- Diabetes- coronary artery disease and high blood pressure greatly increases with diabetes
- Excessive coffee consumption-the caffeine causes the fast heart beat that tends to arrhythmia
- Hypertension- this may leads to developing coronary artery disease where the walls of left ventricle becomes stiff and thick that could change the electrical impulse of the heart

- Hyperthyroidism- over active or underactive thyroid gland will raise the risk of arrhythmia.
- Mental stress

Risk factors:(9)

- Electrolyte imbalance- electrolytes such as calcium, sodium, potassium will trigger the electrical impulses that contribute towards the arrhythmias.
- Too much caffeine- excessive consumption of caffeine causes the heart to beat faster and may contribute to the development of serious arrhythmia
- Obstructive sleep apnea- in this disorder, the breathing is interrupted during sleep, that can increase the risk of bradycardia.
- obesity

Treatment for Arrhythmia(10)

For bradycardia: the underlying cause need to be identified first before treating. A pacemaker is a small device which is placed under the skin of the chest in order to control abnormal heart arrhythmia.

For tachycardia:

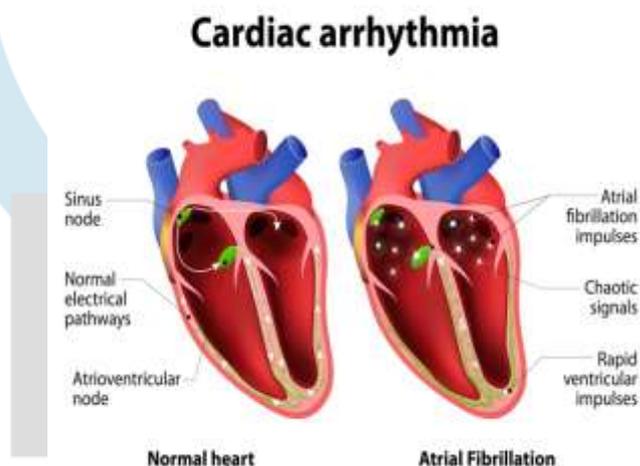
Vagal maneuvers- where certain movements that the patient can do themselves which stops some type of arrhythmia.

Medications – usually effective in reducing certain kind pain due to tachycardia

Cardioversion- doctors uses electrical shock to reset the heart beat.

Maze procedure- surgical incisions are made in the heart they heal into scars and forms blocks that guide the electrical impulses.

Other like coronary bypass surgery, ventricular aneurysm surgery, ablation therapy etc.,



Figno-2: Comparison of Normal heart and Atrial fibrillation

3. Myocardial infarction:

Myocardial infarction is a condition where the blood flow to the heart is reduced due to the formation of partial or complete blockade of coronary artery. Myocardial infarction also called as cardiac ischemia, in which the ability of heart to pump blood reduces and might effect the heart rhythm also.(11)

When the ischemia prolongs for long time, the heart tissues get starved and dies and finally leads to heart attack- literally means “death of heart muscle”

Causes of myocardial infarction.

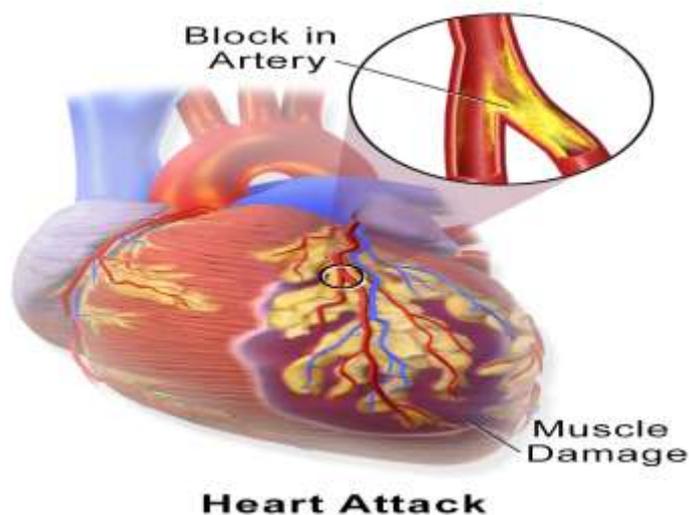
Myocardial ischemia is a condition where suddenly the arteries develop a clog which inturn results in reduced blood flow

Conditions that cause the myocardial infarction like- (12)

Coronary artery disease (atherosclerosis)- atherosclerosis is a most common cause for myocardial infarction where the plaque is formed in the artery wall that restricts the blood flow, plaque mostly developed due to cholesterol.

Blood clot-plaque that formed in the atherosclerosis get ruptured and forms a clot. These clot get settled in the artery and creates a pain that leads to ischemia.

Coronary artery spasm- a condition where the temporary tightening of the heart muscle results in reduced blood flow. This coronary artery spasm is an uncommon cause for the myocardial infarction.



Figno-3: Heart attack- blockade of artery

Procedures to improve the blood flow-(13)

Angioplasty and stenting:

A thin long tube (catheter) is inserted into the narrowed artery and a thin wire to which a balloon is connected is introduced into the narrowed area, inflated at the artery and a stent is placed to keep the narrowed artery widened.

Coronary artery bypass surgery:

In this the vessel from another body part is used to create a graft that allows blood flow to the blocked coronary artery.

Causes of myocardial infarction

1. Bad cholesterol- also called as LDL, this LDL cholesterol will stick to the walls of the arteries and forms a plaque, plaque is a hard substance that blocks the blood flow in the arteries.
2. Saturated fats- they also contribute to the formation of plaque in coronary artery which ultimately leads to the arterial blockage.
3. Transfat – this is usually produced artificially and found in the processed food that even contribute to the clog of arteries.

Symptoms that are associated with the heart attack:

- ✓ Neck or jaw pain
- ✓ Shoulder or arm pain
- ✓ A fast heartbeat
- ✓ Shortness of breath when you are physically active
- ✓ Nausea and vomiting
- ✓ Sweating
- ✓ Fatigue

Risk factors:(14)

- Tobacco
- Diabetes- high blood sugar levels can damage blood vessels and leads to coronary artery disease.
- high blood pressure- high blood pressure can damage the arteries and triggers the formation of plaque.
- high blood cholesterol level
- high blood triglyceride level- triglycerides are a type of fat that clogs the arteries and ultimately forms plaque.
- obesity, lack of physical activity.

Treatment :(15)

Medications used to treat myocardial infarction include:

Blood thinners- Aspirin

Beta blockers- Atenolol, Bisoprolol

Nitrates- Nitroglycerine

calcium channel blockers- Amlodipine, Diltiazem, Nifedipine
 Angiotensin converting enzyme inhibitors- Captopril, Enalapril

4. **Hypertrophic cardiomyopathy (HCM):**

Hypertrophic cardiomyopathy is a type of heart disease in which the heart muscle (myocardium) get thickened and interferes with the blood pumping. HCM results in shortness of breath, chest pain, alteration in the heart electrical impulses and finally leads to cardiac arrhythmias.(16)

Thickening usually occurs in the interventricular septum that separates the lower left ventricle and lower right article. Thickening usually alters the blood flow during which it creates a heart sound while heart beating. In case of familial hypertrophy the symptoms are very rare and may even leads to increased risk to death without symptoms.(17)

Symptoms :(18)

- ✓ Shortness of breath
- ✓ Chest pain, during exercise
- ✓ Fainting
- ✓ Sensation of rapid, fluttering or pounding heartbeats
- ✓ Heart murmur

Causes (19)

- HCM is usually genetically inherited disease which occurs due to some changes in the genes that are associated with the heart muscle proteins.
- Diseases like diabetes and thyroid disease may also cause the HCM.
- The most commonly involved genes are MYH7, MYBPC3, TNNT2, and TNNI3.
- This condition is inherited in an autosomal dominant pattern which means one copy of the altered gene in each cell is sufficient to cause the disorder.

Types of HCM:(20)

Different types of HCM has been described below-

APICAL HYPERTROPHY- the thickened area is present at the bottom of the heart. This usually reduces the volume of the ventricle.

SYMMETRICAL HYPERTROPHY- also called as 'concentric hypertrophy' where the thickening occurs at the left ventricle which effects the volume of ventricle.

ASYMMETRICAL SEPTAL HYPERTROPHY WITHOUT OBSTRUCTION- Without obstruction means the thickness of the septum doesnot effect the blood flow

Treatment

Medications

- Beta blockers- Atenolol
- Calcium channel blockers- Nifedipine, Amlodipine
- Anti-arrhythmic medication- Procainamide, Quinidine
- Anticoagulants- Warfarin, Heparin
- Diuretics- Furosemide, Torsemide

List of the instruments used to detect and treat cardiovascular diseases:

Cardiovascular instruments are the one that are used to treat the disabilities associated with the heart, veins and arteries.

1. Electrocardiogram – It is used to detect the activity of the heart beat. With each heart beat, an electrical impulse travels through the heart, this waves causes the muscles to squeeze and pump blood from the heart. An ECG procedure is an non-invasive that is painless, it generally involves the use of electrodes where 12-13 electrodes will be placed on the different parts of the body like arm, leg and chest. The electrodes are attached by some adhesive patches and the sensors in the electrodes will detect the electrical activity of the heart. Finally results are displayed on the graph paper that are studied by the doctor. (21)

An ECG can be used to detect :(22)

- ✓ Arrhythmias,
- ✓ Coronary artery disease,
- ✓ Heart attacks and
- ✓ Cardiomyopathy.

Types of ECG:(23)

- Resting ECG- carried out while lying down in the comfortable position.
- Stress or exercise ECG- carried out during the exercise condition or on treadmill.
- Ambulatory ECG – in this the electrodes are connected to the portable machine worn at your waist so that the heart condition is monitored at home for one or more days.

❖ Interpretation of major characteristics of the ECG as follows:

A single cardiac cycle produces different wave pattern which contains peaks and valleys can be represented by the P,Q,R,S and T.

P wave – it is the small wave that detects the depolarization of the atria that indicates the contraction of the heart muscle.

QRS complex- detect the rapid down-up-down movement which indicates the ventricular depolarization.

T wave – it states the repolarization of the ventricles.

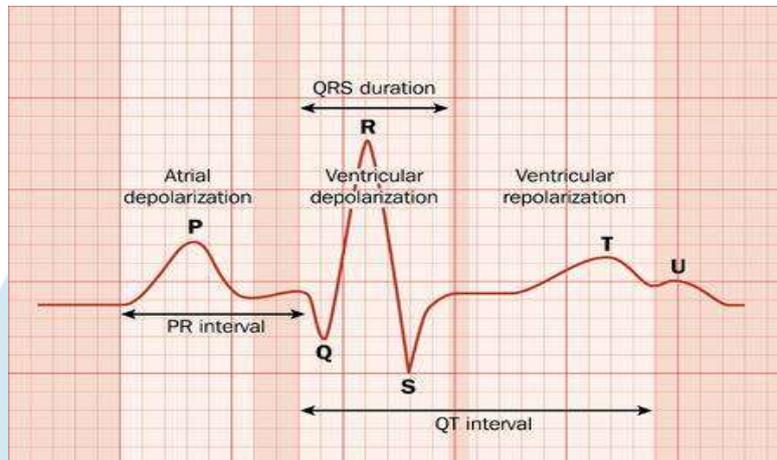


Fig No-4 interpretation of ECG waves

✓ Chest X-rays – generally chest radiology gives the images of the heart, lungs and blood vessels which helps to detect the heart problems.

2. Echocardiogram- the test that uses the ultrasound waves to detect the heart structure and motion and it gives information regarding the thickness of the heart muscle and its pumping capabilities.(24)

An echocardiogram is used to detect:

- Heart attack
- Heart failure
- Cardiomyopathy
- Endocarditis
- Congenital heart disease
- Atherosclerosis
- Aneurysm

▪ Types of the echocardiogram- different types of tests need to be performed.(25)

1. Transthoracic echocardiogram: it consists of a transducer that is placed on the different places of the body like chest, upper abdomen and directed to the heart. The device release the high frequency sound waves which converts the heart impulses to moving pictures of the heart. The pictures may be represented by the 2-D OR 3-D images and states the information regarding the part of the heart will be evaluated.

2. Transesophageal echocardiogram: in this the transducer is replaced with the probe that is directed to esophagus from the mouth. As the esophagus is located right next to the heart that gives the heart sounds without interruptions of the ribs and muscles of chest wall. In this test the patient need to be sedated, it also gives the information regarding the blood pressure and oxygen levels in the blood.

3. Doppler echocardiogram:(26,27) sound waves bounces the solid structures of the heart, they also bounce off the [red blood cells](#) as they circulate through the heart chambers. By the use of Doppler technology, the echocardiogram can detect the speed and direction of blood flow, helping increase the amount and quality of information available from the test.

In cardiac ultrasound Doppler is used in three ways:

- Continuous wave (CW) Doppler
- Pulsed wave (PW) Doppler
- Color flow mapping (CFM)

➤ CONTINUOUS WAVE DOPLER:

It measures the velocity through out the length of the ultrasound wave, as it is a sensitive instrument it doesnot localize the velocity measurements of the blood flow.

➤ **PULSED WAVE DOPPLER:**

It is used to measure the velocity of the blood flow at a specified tissue depth and also used to assess the ventricular in-flow patterns, intra-cardiac shunts.

➤ **COLOR FLOW MAPPING:**

CFM is used to measure the velocity and direction of the blood flow to superimpose a color section on to the 2D image. Generally, flow towards the transducer is red, flow away from the transducer is blue, and higher velocities are shown in lighter shades. To aid the observation of turbulent flow there is a threshold velocity, above which the color changes (in some systems to green). This aids to a "mosaic" pattern at the site of turbulent flow and enables sensitive screening for regurgitant flow.

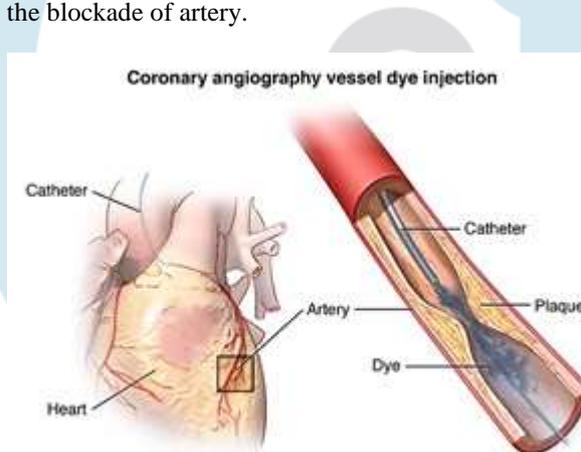
4. Cardiac catheterization – it is the test that is used to detect the cardiovascular conditions. In this a long tube called the catheter is introduced into the artery and threaded through the blood vessels which measures the pumping capabilities and oxygen levels in different parts of the heart.(28)

Cardiac catheterization is used to diagnose :

- Congenital heart disease
- Hemodynamic assessment
- Blocked blood vessels and problem with the heart valves.

Stages involved in the cardiac catheterization

a. **Coronary angiogram**- in this a dye is injected through the catheter that travels through out the arteries, veins, heart chambers and vessels, that determines the blockade of artery.



Figno-5:Dye injection into artery

- b. **Heart biopsy**- a part of the heart tissue is taken and tested.
- c. **Ablation**- generally it is used to treat the heart arrhythmia (irregular heart beat) where the doctor uses radio-frequency energy or cold (nitrous oxide or laser) to either destroy the heart tissue or to stop the irregular heart beats.
- d. **Angioplasty** – in this the doctor introduces a small inflatable balloon into the artery. This balloon is used to widen the blocked artery, angioplasty is combined with the stent placement where a small metal coil is placed in blocked artery to prevent further blockade.
- e. **Balloon valvuloplasty**

5. Radionuclide ventriculography or multiple gated acquisition scanning(MUGA)- it is a form of nuclear imaging in which radioactive material (technetium-99m) is injected through iv that gives information regarding the cardiac chambers to know the pumping capabilities of the heart. Generally the MUGA is used to diagnose the chest pain, trouble breathing, dizziness.(29) During the MUGA a small radioactive substance or tracer called as radionuclide is introduced in to the body that attaches with the blood cells. The gamma camera takes the pictures of the pumping chambers of the heart along with images of the heart. The computer normally analyzes the pictures and detects the which part of the heart muscle is not contracting normally.(30)

6. Pericardiocentesis- also called as the pericardial tap in which a needle or a catheter is used to remove fluid from the pericardium in order to test the presence of the inflammation, cancer(31). Generally a fibrous sac known as pericardium surrounds the heart. The sac is made up of two layers with small amount of fluid that reduces the friction between the layers, the fluid called as pericardial fluid and when the fluid builds up excessively between the layers (pericardial effusion) leads to a condition where it disturbs the normal functioning of the heart called as pericardiocentesis.(32)

Doctors generally treat the condition by the use of the catheter that drains the excess fluid in the heart which can be allowed to stay for several hours or even overnight.

RECENT INVENTIONS:**1. Minimally invasive cardiac surgery:**

It is performed by the specialized surgeons in which they make a small incision on the right of the chest. In this methodology the surgeons do not operate through the breastbone rather they perform through the ribs which makes the patient to feel less pain. It is also called as closed heart surgery in which it promotes the better view of the heart and chambers than the open heart surgery.(33)

Typically heart surgery requires exposure of heart and its vessels and median sternotomy where this is considered to be most invasive and traumatic aspect of open heart surgery which in turn results in hospitalization for 5-10 days.

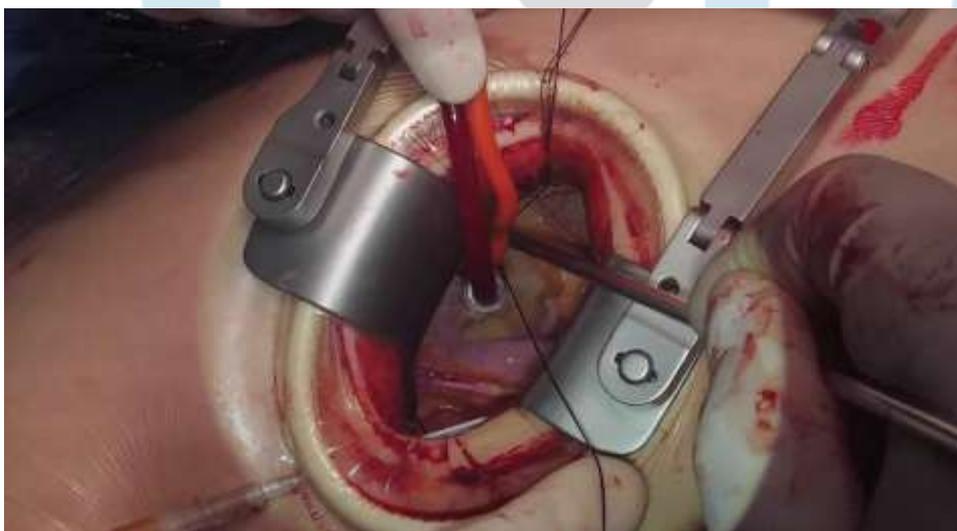
Artificial heart - lung machine is used in patients for coronary artery bypass surgery, the use of this machine results in bleeding problems, brain strokes, more infections.(34)

However this minimally invasive heart surgery overcomes all the effects mentioned above

Minimally invasive heart procedures involve:

❖ **Beating heart bypass surgery**- generally in case of bypass surgery can be done only when heart beat is stopped but in case of the newer devices, it is possible to do coronary artery bypass surgery without stopping the heart. This method was proved to be effective that results in less bleeding problems, less blood transfusion.

❖ **Robotic and videothoracoscopy assisted heart surgeries**- in case of heart surgeries some of the centers have adopted the technique of using technology like video-thoracoscopy and robotics. Mitral valve surgery can be done using a 4cm incision on the side of the chest by using the robotic device. In the future cardiothoracic surgery is likely to undergo major shift towards minimally invasive surgery where patients can be discharged in 2-3 days time. Dr.gokhale CT associates has one of the great experience in india in minimally access coronary bypass and minimally access mitral valve replacements and closure of atrial septal defects.(35)



Figno-6: Robotic and videothoracoscopy assisted heart surgery

Potential benefits:

Potential benefits with minimally invasive heart surgery compared with open heart surgery may include:

- Less blood loss
- Lower risk of infection
- Reduced trauma and pain
- Shorter time in the hospital, fast recovery and quicker return to normal activities
- Less noticeable scars

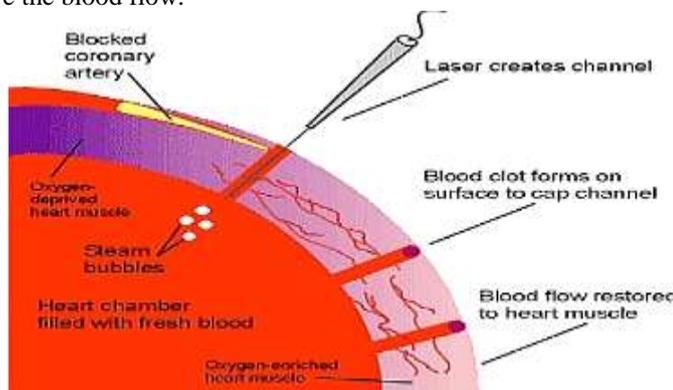
Disadvantages:

- Is not suitable for the patients -Who have undergone previous abdominal procedures are at high risk of abdominal adhesions
- Minimally invasive heart surgery instruments are expensive and maintenance is high.
- Surgeons need specialized training.

2. Transmyocardial revascularization (TMR):

TMR is a surgical procedure that is performed by making a small incision on the left side or the middle of the chest. Now the heart muscles are exposed and the laser hand piece is positioned on the heart where the treatment is required.(36)

- ✓ TMR is considered to be a new treatment that aims to improve the blood flow to the areas of the heart that are not even treated by the angioplasty or surgery.
- ✓ A special type of carbon dioxide based laser has been used to make the channels on the heart, where the no.of channels that should be made will be decided by the doctors.
- ✓ After the incision the outer areas of the channels will be closed whereas the inner areas of the channels remain opened inorder to improve the blood flow.



Figno-7: Transmyocardial revascularization

- ✓ Clinical evidence suggests that blood flow is improved in two ways-(37)
 1. the channel acts as bloodlines, when the ventricle pumps or squeezes oxygen rich blood out of the heart it sends blood through the channels, restoring blood flow to the heart muscle.
 2. the procedure may promote angiogenesis or the growth of new capillaries that help supply blood to the heart muscle.

Potential benefits-

- ✓ Reduced angina pain
- ✓ Return to a more active lifestyle and improved quality of life
- ✓ Possibly reduced need for some of the medications

3. Radiofrequency ablation:

Radiofrequency ablation is also called as catheter ablation that makes the use of a kind of special energy that stops the abnormal heart rhythm. The continuous flow of the electrical current through the heart results in hitting the abnormal tissue which makes it inactive and reduces the problem of abnormal heart beats.(38)

- The process of eliminating the abnormal tissue called as ablation and the use of electrical current called as radiofrequency ablation.
- Cardiac ablation or catheter ablation is a procedure that used to correct the heart problems. When the heart beats, the electrical impulse that cause it to contract must be in coordination with each other if there occurs any interruptions between the impulse that may result in abnormal heart beat.

Types of cardiac surgical ablation-

Surgical ablation involves cutting made on the chest-

Maze procedure: this usually done while having open heart surgery for another problem, like bypass or valve replacement.

Mini maze: doctors make several small cuts between the ribs and uses a camera to guide catheters for either cryoablation or radiofrequency ablation.(39)

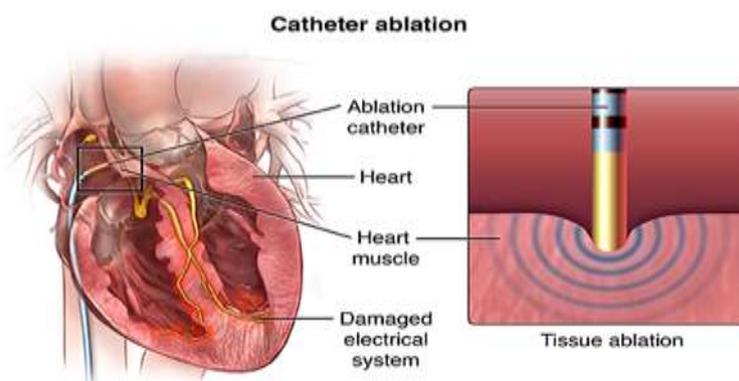
Convergent procedure: the pair of catheter ablation with a minimize, the doctor uses radiofrequency ablation in the pulmonary vein, and small cut is made on the breastbone to use radiofrequency energy on the outside of the heart.

The common arrhythmias treated by RFA are:

- Supraventricular Tachycardia
- Atrial Flutter
- Atrial Fibrillation
- Ventricular Tachycardia
- Ventricular Premature Beats

Disadvantages

- Wide lesions may be necessary when reentered circuit spans a large surface area subendocardially.
- It is less effective than endovenous laser ablation.



Figno-8 Radiofrequency ablation

4. Implantable cardioverter defibrillator :'(ICD)

It is a small power based device that is placed under the skin near the heart and continuously monitors the irregular heart beats.

- During the abnormal heart beats the device delivers the electrical pulses that helps to restore the normal heart rhythm.
- Depending upon the severity of irregular heart beat the ICD will be programmed accordingly.(40)

Low energy pacing- ICD responds to mild disruptions in the heart beat.

High energy shock-ICD may deliver high energy to rectify the abnormal heart beat during which it may result in pain.

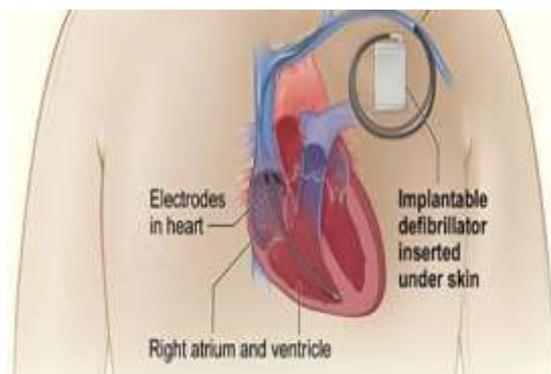
ICD can be used for the conditions like-

- History of coronary artery disease
- Heart condition like abnormal heart muscle

A battery powered based pulse generator is implanted under the skin of the chest or abdomen , just below the collarbone. The generator is about the size of a pocket watch, wires or leads run form the pulse generator to positions on the surface of or inside the heart and can be installed through blood vessels, where it eliminates the need for open heart surgery.

An ICD can also deliver four types of signals to the heart(41)

1. Cardioversion- cardioversion gives a strong signal that can feel like a thump to the heart. It inturn resets heart rhythms to normal when it detects a very fast heart rate.
2. Defibrillation-defibrillation sends a strong electrical signal that makes the heart to restart. This sensation is painful .
3. Antitachycardia – antitachycardia pacing provides a low energy pulse that helps to reset the rapid heart rate.
4. Bradycardia – bradycardia pacing restores to normal speed a heartbeat that is too slow. In this condition the ICD acts as pacemaker.



Figno-9: Interpreting ICD placement in the heart

Potential benefits:

- Can provide protection and life saving therapy
- Treats the dangerous fast heart rate
- Continuously monitors the heart

Disadvantages :

- Infarction at the surgical site
- After receiving Implantable cardioverter defibrillator, limitation with respect to magnetic and electromagnetic radiation, electric, gas powered appliances.

5. Cardiac resynchronization therapy:(CRT)

CRT is also called as biventricular spacing or multisite ventricular spacing. This device sends small electrical impulses to both lower chambers of the heart in order to beat in a more synchronized manner that allows the pumping of the blood and oxygen to the body.(42)

A CRT system is made up of two parts. (43)

- The heart device, actually a tiny computer, plus a battery, contained in a small titanium metal case that is about the size of a pocket watch.
- Insulated wires, called leads, that are implanted to carry information signals from your heart to the heart device and to carry electrical impulses to your heart.

Types of CRTs-(44)

There are two types of CRT devices.

a)Cardiac resynchronization therapy pacemaker or biventricular pacemaker- CRT-P delivers small electrical impulses to the left and right ventricles to help to work coordinately at the same time point in order to make the heart to pump efficiently.

b)Cardiac resynchronization therapy defibrillator CRT-D: This device also treats the heart when it beats faster than can lead to cardiac arrest. This device senses heartbeats that are dangerous fast, it delivers a shock to the heart. This shock stops the abnormal rhythm.

Potential benefits:

- Hemodynamic improvement almost immediately after pacing
- Cardiac resynchronization therapy suppresses premature
- Improved quality of life and decreases hospitalization

Disadvantages :

- very small risk of stroke, heart attack, death, damage to the heart
- there is risk of bleeding and bruising, damage to the artery
- 5-10% chance of the lead dislodging

6. Robotic sleeve:

Harvard university and boston children hospital researcher came up with a soft robot that fits around the heart and helps it beat. The device holds much promise for individuals whose heart has been weakened by a heart attack and are at risk of heart failure.(45)
The robot syncs with the heart through a thin silicone sleeve with soft pneumatic actuators that mimic the outer muscle layers.(46)
It does so without any direct contact with the blood as is the case with most currently available devices.

Potential benefits:

- Offers benefits to patients compared to open heart surgery including shorter hospitalization, reduced pain and discomfort
- Fast recovery time and return to normal activities

Disadvantages :

- Haemorrhage and injury to surrounding tissue
- Costlier procedure
- Chances of breakdown

7. **AL algorithms:**

Established by researcher from google and its health tech subsidiary, based on artificial intelligence algorithm that promised to predict the heart disease just by taking one glance at a patients eye.(47)

Since the interior wall of the eye hides a network of blood vessels, the eye scans revealed telltale signs of heart disease such as high blood pressure.

Although in the testing stage it is able to predict with 70% accuracy whether a patient will suffer a heart issue in the next five years.(48)

Potential benefits:

- Simple approach
- New and improved interfaces

Disadvantages ;

- High cost, difficulty with software development

Summary

Minimally invasive cardiac surgery is proved to be safe and effective approach for various diseases. Continuous research need to done to develop long term outcomes of minimally invasive approach. Transmyocardial revascularization include the potential application of cardiac transplant graft atherosclerosis. Robotic sleeve may be customized to patient-specific needs and may provide a potential bridge to transplant for patient with heart failure. Radiofrequency ablation has improved greatly by reducing the complications of cardiac tamponade, stroke from 6% to 4%. Although ICD implantation is a low risk procedure the ‘kick’ of an ICD can be painful where the ICD batteries lasts upto 5-8yrs.

CONCLUSION:

From the above review it was concluded that a minimal invasive cardiac surgery is safe and effective approach to treat various cardiac disease. Use of modern instruments helps to identify cardiovascular diseases.

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