# Introduction

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The conventional Treatment for patient with cai liovascular disease, in whom deterioration is evident, is directe towards; optimization of electrolytes and Acid-base balance state, oxyg nation and ventilation, heart rate and rhythm and blood volume. Soi e patients remain haemodynamically unstable inspite of maximal phari acological support ***(Richenbacher and Pierce, 2001)***.

Heart failure may be seen in the setting of pos nyocardial infarction, postcardiopulmonary bypass and advanced cardioi yopathies. As well as secondary to congenital heart disease and follow ıg trauma, therapeutic with cardiac transplantation being a common go l. Because donor hearts are increasingly in short supply and some of thes processes are potentially reversible, a variety of cardiac devices and circulatory assist devices have become available for both developmental nd general use ***(Galla et al., 1999)***.

However, the cardiac devices and the mechanical as: st devices are capable of supplementing and replacing cardiac pump f nction for variable length of time. It is assumed that if the devices used orrectly in appropriate patients; mechanical circulatory assistance d vices are successful in prolonging life expectancy and improving the qu lity of that life ***(Thomas and Kramer, 1993)***.

Cardiac pacemaker, ventricular assist devices (VADs) automatic implantable cardioverter defibrillator (AICD), Intra-aortic bi lon pump (IABP), are currently available cardiac and circulatory ass st devices ***(Dinardo, 1998)***.

## Historical review:

Mechanical circulatory assistance for the failing circ ılation has interested and challenged cardiac specialists for decades. T ıe field of mechanical circulatory assistance is dynamic and evc ving one. Technological and engineering advances have contribu :d to the development of mechanical assist devices.

Blood pumps, which are major component in nechanical circulatory assist devices, were taken in consideration for : :searchers. ***Brukhonenko and Tchetchuline (1929)*** have designed a m chine that used an excised lung from a donor animal as an oxygen: or and to mechanically actuated blood pumps. Their machine was used initially to perfuse isolated organs but later was used to perfuse entire an nals. ***Dale and Schuster (1928)*** developed a double perfusion pump c pable of a variable pulsatile output and intended to carry out whole bod perfusion and was the best known at that time.

At the beginning of 1960, cardiopulmonary bypass was ufficiently established to allow open-heart surgery around the world.

Other breakthroughs led to new approaches for as isting the circulation. Improved myocardial perfusion was described by *Cantrowitz (1953)*, when they demonstrated the concept of increasing corc ıary blood flow by retarding the systolic pressure pulse. This phenomer ın, termed diastolic augmentation was further exploited in compressio the aorta during diastole using a surgically transferred hemidiaphragm ( *Cantrowitz and McKinnon, 1959)*.

***Harken (1958)*** described for the first time the concept of counterpulsation, which is the basis of intraaortic balloon pump (IABP) and as originally proposed involved the removal of blood via the femoral artery during ventricular systole and the rapid reinfusion of the same amount during diastole to increase coronary perfusion pressure. By this method, in normotensive preparations, one could decrease left ventricular work and increase coronary blood flow, thereby, improving the balance between myocardial oxygen supply and oxygen demand. However, ***Bregman (1978)*** stated that, this method as described has several drawbacks, among these: appreciable haemolysis, the need for bilateral femoral arteriotomies or subclavian arteriotomy and failure to increase coronary blood flow in hypotensive states.

In the early 1960s, ***Clauss et al. (1961)*** and ***Moulopoulos et al. (1962)*** conceived the concept of using timed inflation of a balloon, positioned in the central aorta, to generate a positive pressure pulse during diastole to improve coronary blood flow, and then deflation of it during systole to reduce resistance to systolic ejection, thereby reducing myocardial oxygen requirements.

***Dennis et al. (1963)*** and ***Osbern et al. (1964)*** conceived the method of external counterpulsation (ECP) for achieving counterpulsation in a relatively noninvasive fashion. Pressure variations are applied to the legs synchronous with the heart beats, thereby using the femoral arterial tree as the pumping chamber in diastole. The initial clinical trials of ECP apparatus produces an effective arterial diastolic augmentations, but the observations concerning systolic unloading are not consistent and some investigators have reported an increase in left ventricular after-load. Major drawbacks seem to be patient discomfort,

haematuria, and varying degrees of injury to the low extrei ities when ECP is used for any length of time ***(Bregman, 1978)***.

However, the first clinical use of intraaortic balloon pump was done by ***Kantrowitz et al. (1968)*** to treat cardiogenic shock. The patient was a 45-year old female who had sustained a posterior wall nyocardial infarction. She was in deep cardiogenic shock, comatosed nd anuric. Over a 7-hour period, balloon pumping restored normal circulatory dynamics. The most impressive moment occurred wher the urine collection bag began to fill with urine.

Subsequently, ***Bregman and Goetz (1972)*** develop d a dual-chambered balloon that was designed with a large proximal b loon and a smaller distal balloon. The rationale behind this design was t produce a unidirectional blood flow proximally to the brain and coronar arteries by initial inflation of the distal smaller balloon. This resulted i locking of the distal blood flow and an augmentation of proximal flow. ater on, in the early 1990s ***Kantrowiz et al. (1992)*** published clinical tudies of a new generation, fully automated intraaortic balloon ump that continuously optimizes diastolic augmentations beat by b at without operator intervention.

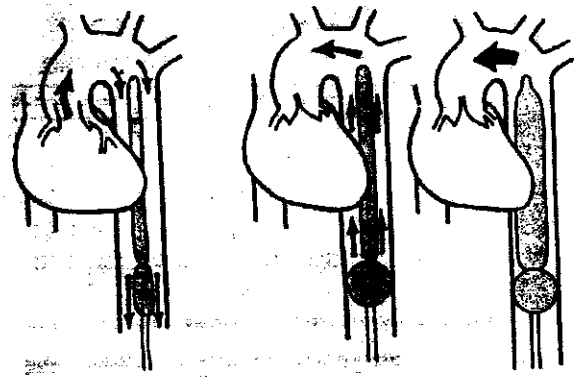

***Fig. (1):*** Dual-chambered intraaortic balloon ***(Bregman, 197***

As the need for different forms of these devices was me e obvious, ***DeBakey et al. (1966)*** performed the first successful ise of an implantable pulsatile, air – driven, ventricular assist device VAD) in a patients of poor condition after aortic valve operation. A hough the patient died of pulmonary complications after four days of : ipport, the assist device functioned well and successfully improved the circulation and haemodynamic parameters.

In the middle of 1960s, DeBakey (1971) used left ventr cular assist device (LVAD) in a female patient with rheumatic aortic and itral valve diseases and left ventricular failure. She underwent dc ible valve replacement, but her heart could not be weaned from cardi pulmonary bypass. The device was used successfully for 10 days and is woman was probably the first patient to be weaned from an assist dc vice and to leave the hospital.

Subsequently, ***Normal et al. (1978)*** performed the first clinical use of a left ventricular assist device as a bridge to cardiac tran plantation. The abdominally positioned, externally powered, and single chambered device supported the patient for five days, after wh h cardiac transplantation was done. Although he died two weeks later f infection, this experience demonstrated that such a device could provi e adequate circulatory support.

Few years later, in the middle of 1980s, the first success il bridge to cardiac transplantation with an implantable left ventricular a sist device done by over and colleagues using electric type into a 51-year old patient with ischaemic cardiomyopathy. In the same year, he used he external pneumatic pierce/Donachy left ventricular assist device to s pport a 47

years old patient with post-infarction cardiogenic shock. The patient was transplanted successfully two days later and survived as the irst success with an external left ventricular assist device ***(Westaby, 1998)***.

Subsequently, in 1992, food and Drug Administration FDA) gave the first approval of a pneumatic left ventricular assist device for use in a patient with postcardiotomy cardiogenic shock while the fi t approval, for use in a patient as a bridge to cardiac transplantation v as given in 1994. on the other hand, the first FDA approved clinical trial n which an electric left ventricular assist device was implanted as a perr anent form of circulatory support was initiated in 1998 and in the same y ear the first approval of such a device for use in a patient as a bridg to cardiac transplantation ***(Richenbacher, 1999)***.

Since the first pacemaker implantation in 1985, cardia pacing has continued to grow. So that today more than 500,000 patients i the united states have implanted pacemakers or pacemaker cardioverter efibrillator (PCD), Approximately 400,000 such devices are implanted vorld wide each year ***(Barrold and Zipes, 1997)***.

Pacemakers are used to treat brady arrhythmias, and can restore normal or near normal hemodynamics during rest and exercis . PCDs are used to prevent sudden death from ventricular tachy arrythmias ***(Kusumoto and Goldschlager, 1996)***.

However, a complication – free device suitable for permanent implantation is not yet available thus. The research and dev lopment of mechanical assist device supported by a vigorous infra-structu es of basic science in biology and medicine, chemistry and ph rmacology engineering and computer technology are going to develop n w and safe techniques and equipment for circulatory support.

This essay has focused on cardiac physiological re iew and the development of the cardiac devices and their rece advances, haemodynamic and pathophysiologic changes associated v th their use and the anesthetic management of patient with one of ese cardiac devices including pre-operative, intraoperative, post-o erative and intensive care management.