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REVIEW ARTICLE

Left Ventricular Assist Devices: A Short Review

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ABSTRACT
Studies have concluded that "VAD is a kind of MCS device that may be used to support the function of an HF in either a partial or total manner". Furthermore, studies also concluded that the blood that the LVAD pumps out of the LV enters the aorta's ascending branch. These devices should be considered for use in any patient with ESHF and decreased ejection fraction who does not have any other life-limiting conditions since they considerably increase both survival and QOF and because they should be considered in such patients. Thus, in our review article, we have discussed LVAD with different generations, history, indications, contraindications, patient selection, and future directions.
Keywords: *LVAD, QOF, LV, HF, Generations, ESHF.*

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INTRODUCTION

Researchers also found that there has been a steady decline in the global incidence of heart transplants (HTx).[1] In the last 15 years, studies revealed that " there has been a threefold increase in the number of patients awaiting HTx, while the number of eligible donor organs has decreased by one-third over this same time period".[1] According to data, in 2015, there were only 286 people who were candidates for HTx, on the other hand now it is around 790 patients.[1] This decline is most likely attributable to the growing age of donors as well as the existence of additional medical issues in those who are receiving the donations, since these individuals are more likely to have them.[2] Studies also concluded that over thirty percent of patients need mechanical circulatory support(MCS) in the form of left ventricular assist devices (LVAD) as a stopgap solution.[3] In addition, there is a possibility that roughly 15 percent of the patients are on the Tx may pass away before an organ is made available for donation.[4] Researchers also found that there has been an increase in the need for permanent MCS. Over the course of the last decade, studies concluded that "LVAD systems underwent substantial developments in terms of size, durability, reliability, and noise emission".[5] Additionally, studies revealed that patients who were eligible for this treatment option included those who suffered from ESHF.[5] As a result of this, studies concluded that increase LVAD implantation was seen within 5 years since then.[1]

HISTORY

Researchers also found that, MCS surgery started from 1953 with first heart-lung machine (H-LM) for complex open-heart surgery (O-HS). In one study it was concluded that, "after cardiopulmonary bypass operation, simple pumps to provide temporary MCS have been created for treating patients with low CO.[6] In 1964, studies concluded that the "Artificial Heart Program" began receiving funds from US. This cash was allotted to support the development of devices for use in clinical settings over an extended period of time. In the year 1966, Dr. DeBakey and his associates were successful in implanting the first pneumatically powered LVAD.[7] Researchers also found that, in "1969, Denton A. Cooley implanted the first total artificial heart (TAH) intended as a BTT in a patient who was awaiting HTx." [8] Studies also concluded that the failing native heart of the patient was intended to be replaced by this TAH device.[8] In the "1970s, there was a shift in focus away from the development of systems that were more biocompatible for long-term therapy and toward developing those systems". The JARVIK-7 TAH was first used as a treatment in 1982, and it was intended to be a long-term solution. The device was implanted for

the first time. However, after 112 days, the patient went away due to severe sepsis, which caused the failure of numerous organs.[9] This resulted in the death of the patient.

GENERAL OVERVIEW OF GENERATIONS

First Generation VAD

People who did the research also discovered that the field of VADs began to form when people moved away from thinking of the TAH as a HTx and toward making single-chamber pumps to help the heart. Studies have also concluded that VSD works in combination with the affected ventricle to increase blood flow.[1] In the first generation, the prosthetic HVs that were used as the entry and exit ports for the membrane pumps created pulsatile flow. Studies also concluded that pneumatic or electrical power may be used to power these pumps.[1] Studies also proved that , they are attached to the heart via cannula, which are utilized on either isolated left-, right-, or biventricular. Studies have also shown that when they are utilized for the purpose of BVS pump chambers have to be positioned extracorporeally due to the fact that they are so large. For the purpose of providing fundamental LV support, intracorporeal implantation may or may not be possible, depending on the kind of VAD that is being used [Figure 1]. [1] Studies have also concluded that in 1984, doctors performed the first transplantation that was successful after the implantation of an LVAD. The downsizing of the devices over the years has opened up new opportunities, including the discharge of an increased number of patients onto VADs while still being listed for Tx and awaiting evaluation.[10] However, studies also concluded that "the first generation of VADs had a number of drawbacks. These included a large size, noise emission, infections of the cannulas, and malfunctions caused by tears in the membrane or deterioration of the valves. These issues made day-to-day living difficult and occasionally led to fatal consequences".[1]

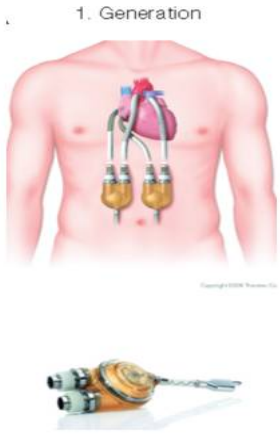

FIGURE 1: THORATEC PVAD [1]

Second Generation VAD

Studies have also concluded that the invention of continuous flow centrifugal pump devices in the 1990s led to an improvement in patient outcomes by reducing the patient's overall size as well as their susceptibility to infection[Figure2].[1] This resulted in an increase in the overall number of successful treatments. This resulted in an overall improvement in the health of the patient population as a whole. In addition, people's quality of life greatly improved as a direct result of the significant reduction in noise that took place.[1] Only LVAD utilization was possible since the devices were too bulky to be employed as BIVADs. They were developed specifically with the end goal of being implanted intrathoracically. The Heartmate II, an LVAD of the second generation that is made by Thoratec and has its headquarters in Pleasanton, California, in the US, is the model of second-generation LVAD that is used the most often.[1] Studies have also concluded that the device consists of a propeller [surrounded by impeller (IP)]metal housing. The positioning of the IP, which is a mix of mechanical and magnetic forces, increases the IP lifetime to at least five years. However, studies also concluded that the "Heartmate II may now be used either as a BTT. This provides patients with a superior QOL, including increased mobility and the restoration of endorganic function, and in some cases even permits them to return to work".[11]

FIGURE 2: THORATEC HEART MATE II [1]

Third Generation VAD

Studies have concluded that , introduction of LVADs was seen with is generation but with reduction in size. According to studies, LVAD, made by HeartWare (HW) (HW Inc., Framingham, Massachusetts, United States)[Figure 3].[1] Studies concluded that because it is small in size so biventricular implantation (BVI) is not impossible. With a radial pump design, magnetic and hydraulic positioning, and a predicted endurance of ten years, wear-out is not something that should be anticipated with this product. Furthermore, research has shown that the second and third generations of VADs can now be implanted through a bilateral thoracotomy instead of a full sternotomy. [12] Studies have also concluded that the capacity to generate a flow rate of up to 10 liters per minute. Because of Thoratec's HeartMate 3, there is now an additional LVAD device available on the market that belongs to the third generation and was developed specifically for the treatment of ESHF.[1] This LVAD features a completely new function that enables it to make pulsatile flow patterns by making frequent adjustments in the rotor speed. This function allows the LVAD to produce pulsatile flow patterns. This will result in the prevention of blood from pooling in the LV and the device, which will result in a decreased risk of complications such as bleeding or clotting.[1] In addition, the use of systems that are miniaturized and have a flow capacity of little more than three liters per minute may be utilized in order to provide a portion of the necessary circulatory support. The CircuLite System is a good illustration of this in clinical practice. This includes an "inflow cannula that is positioned in the right atrium, and it also has an outflow cannula that empties into the right subclavian artery".[1]

FIGURE 3: HEART WARE LVAD [1]

INDICATION [13]

1. "Frequent hospitalisation for HF
2. Intolerance to neurohormonal antagonist
3. NYHA IIIb-IV functional limitations despite OMT
4. EOD owing to low CO
5. ID requirements
6. CRT non-responder
7. In otrope Dependence
8. Low peak Vo_2(<14 ml/kg/min)"

CONTRAINDICATION [13]

1. "Irreversible (IR) Hepatic Disease
2. IR Renal Disease
3. IR Neurological Disease
4. Medical Nonadherence
5. Severe Psychosocial Limitations"

PATIENT SELECTION (PS)

Studies have also concluded that it is "vital to do an MCS evaluation (E) in order to identify those patients who may benefit from device I and to exclude those patients who are considered a waste of time for device therapy".[14] This may be accomplished by comparing the patients' MCS scores to a standard. A comparison of the patients with an MCS-E instrument may be one way to attain this goal. The first stage in the process of PS includes, an appropriate estimation of the CSHF disease. With the beginning of this first step comes the selection of patients. Additionally, studies revealed that a "sizable number of US medical professionals advise using the HFSS[14] and the Seattle Heart Failure Model (SHFM)".[15,16] [16] Studies have also concluded that the "ESC assess the patient's prognosis using variables such as findings in history and physical examination (NYHA class, blood pressure, signs of congestion, etc.), laboratory tests (serum sodium, liver enzymes, troponins, etc.), neuro-hormonal activity (plasma renin activity, angiotensin II, etc.), and functional (peak VO2) and hemodynamic variables".[17,18] In the same spirit, studies also concluded that it has become clearly obvious that progressive HF may manifest itself in a variety of phenotypes. Studies have also concluded that patients who have an INTERMACS profile of 1 to 3 are being treated with temporary inotropes or MS, while patients who have a profile of 4 to 7 do not need inotropes for treatment.[19,20] Additionally, studies also concluded that INTERMACS profiles may offer predictive information as well as guidance for the best time of implantation and information about the risk that is associated with doing so.[21,22] Thus, studies have come to the conclusion that the "post-implantation mortality rate of patients with an INTERMACS profile of 1 or 2 who are treated with LVAD is 44% higher than the mortality rate of patients with 3 or 4 profile. This difference was due to healthier heart".[23] Moreover, the patients who have gotten the device are compared to those who have not received the device using these scores. [19,23]. The second step of the E process involves screening for significant co-morbidities and other diseases. According to different studies from the past, this search includes looking for R causes of HF, like OSA,MS testing when possible, invasive hemodynamic E, laboratory E of organ function, such as pulmonary function tests for the lungs, renal, liver, and hematologic function". In order to estimate the patient's mental state, drug addiction risk, compliance with treatment, and supportive environment, all patients undergo a psychosocial evaluation.[23,24] Studies have also concluded that RVF is a leading cause of mortality after LVAD installation.[23] Numerous studies have been conducted in an effort to establish whether patients who have had LVAD implantation are at risk for failure of the RV.[24,25,27,28,29,30,31] The last step in the process of assessing whether or not a patient is a candidate for a LVAD is the estimation of the patient's overall frailty(F). [32,33] Studies have also concluded that frailty, which is extremely common in HF patients, has a detrimental influence on the prognosis.[34,35] Studies have concluded that F is associated with a higher post-implant complication rate and a higher mortality rate in patients who receive LVADs.[33,36]

FUTURE DIRECTION

Studies have also concluded that the substantial increase in the number of patients who will be treated with LT-MCS will be the direct result of the increase in the prevalence of HF. These devices are more manageable in size and easier to implant due to their simplified construction. Additionally, studies revealed that "they are intended to feature more flexible percutaneous leads in an effort to decrease the risk of infection".[37,38] Future devices will be able to automatically adapt to the patient's physical activity rate and posture and will be more biologically accurate. In addition, in the not too distant future, there will be devices that support transdermal charging, which will allow the system to be totally enclosed within the body. Patients will be able to go swimming and take showers without any limits placed on their normal activities as a result of this additional decrease in the risk of infection.[13]

CONCLUSION

The demand for mechanical circulatory support in the management of advanced HF is on the rise, while the availability of donor organs for HTx is declining, leading to an increased need for alternative treatment options. The remarkable decrease in size, improved performance optimization, and expanded clinical application were all outcomes of technological advancements. The improved durability and nearly maintenance-free components of the second and third generations of LVAD offer not only a bridge to

transplant but also a destination therapy, presenting an alternative treatment choice for patients who are not eligible for transplantation. In addition, MCS has become a crucial choice for advanced HF, with a growing number of patients undergoing treatment using this method. For patients who have been carefully chosen, these devices have a notable effect on both survival and QOL. Understanding the unique consequences and clinical manifestations is crucial for the long-term care of VAD patients.

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CONFLICT OF INTEREST
There are no conflicts of interest

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