

Novel centrifugal pump for heart failure patients: initial success and future challenges

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Provenance: This is an invited Editorial commissioned by the Section Editor Yuan Haiyun [Department of Cardiovascular Surgery, Guangdong Cardiovascular Institute, Guangdong General Hospital (Guangdong Academy of Medical Science), Guangzhou, China].

Comment on: Mehra MR, Naka Y, Uriel N, *et al.* A Fully Magnetically Levitated Circulatory Pump for Advanced Heart Failure. *N Engl J Med* 2017;376:440-50.

Submitted Apr 24, 2017. Accepted for publication May 10, 2017.

doi: 10.21037/jtd.2017.05.68

View this article at: <http://dx.doi.org/10.21037/jtd.2017.05.68>

In June 2014 the worldwide first implantation of a new and promising Left Ventricular Assist System (LVAS) for end-stage heart failure therapy was performed by Dr. Schmitto and his team at Hannover Medical School, Hannover, Germany (1). After quick enrollment of 50 patients within the CE mark trial (June–November 2014) (2) this device received CE Mark in 2016 based on promising results (2-4) and was introduced to the clinical field (5,6). The HeartMate 3 LVAS (HM3; Abbott Laboratories, formerly Thoratec, Inc.) includes a centrifugal flow pump with a fully active magnetically levitated rotor. This feature provides several advantages over the hydrodynamic or mechanical bearings used in contemporary/preceding devices: large gaps between moving rotor and housing resulting in low shear stresses, enhanced wash out, no contact but stable gaps between moving rotor and housing at any time resulting in a “wear-less” device and, last but not least the possibility to facilitate rapid speed changes to create an artificial pulse (7,8). These aspects might lead to minimize shear stress, therefore reducing damage of blood components and might also reduce activation of the coagulation system which might lead to a total decrease of the incidence of pump thrombosis.

The promising results of the CE mark trial have led to the commencement of the CE Mark of the HeartMate 3 (1-4). For the CE Mark trial 50 end-stage heart failure

patients were treated across 10 centers (Germany, Czech Republic, Kazakhstan, Austria, Australia, and Canada). Left ventricular assist devices (LVADs) were implanted in the patients as a bridge to transplantation and destination therapy. Patients showed promising survival rates 30 days and 1 year after implantation. This was accompanied by an adverse event profile (bleeding, driveline infection, gastrointestinal bleeding, and stroke), and improved quality of life similar as reported for other devices. Short term follow-up reported a 30-day mortality rate of 2% (3), 1-year survival 81% (4), and 2-year survival of 74% (9). One year post-transplantation showed a mortality rate of 18%, 74% patients continued on LVAD support, 6% patients receiving cardiac transplants, one patient (2%) underwent device explant due to sepsis and abdominal wall abscess. Overall stroke rate was found with 18% (1-year result) and was “*not expected given the absence of hemolysis and pump thrombosis*”, factors related to these events were reported as procedural factors, infection, high INR, multiple organ failure (4). Encouraging outcome of low gastrointestinal bleeding (8% after 1 year), no pump thrombosis, pump malfunctions and hemolysis was reported for 1- (4) and also 2-year (9) follow up. A single center follow-up study of the HeartMate 3 implantation was performed at the Hannover Medical School with a cohort of 27 patients (5). The 6-month-follow-up



Figure 1 Prof. J.D. Schmitto, Hannover, Germany, with the worldwide first HeartMate 3 patient ~2.5 years after implantation.

revealed excellent patient survival of 88.9% and 85.2% at 30 days and 6 months respectively; during follow-up 1 patient received a heart transplant and 3 patients died. No pump thrombosis or debilitating strokes were observed. Right heart failure was diagnosed in one patient after HM3 implantation (3.7%). No pump exchanges were required (5).

After onset of the CE mark, the HeartMate 3 investigational device exemption (IDE) trial (“MOMENTUM 3”) was initiated in the United States in the last quarter of 2014 and actually this trial is still ongoing. The so-called MOMENTUM 3 trial was set up with an innovative study design (10,11): a randomized, “all-comer” study comparing the HeartMate II (HMII) and the HeartMate 3 LVAS. It shall include 1,028 patients in 3 patient cohorts enrolled in 60 US centers under a single inclusion and exclusion criteria strategy with short term (6 months) and long term (2 years) follow-up studies for non-inferiority and an extended study for superiority comparison of the centrifugal with the axial pump design. In the manuscript discussed (10), data of the short term follow up with 294 patients were presented, out of whom 152 received centrifugal flow (HM3) 142 received axial-flow (HMII) pumps. Primary end point effectiveness was assessed by checking survival, disabling stroke instances (modified Rankin score), as well as reoperation for pump exchange or removal 6 months after implantation. The primary end point was observed to occurred in 131 patients (86.2%) with HM3 and in 109 (76.8%) of HMII group. No significant differences were observed in mortality rates or instances of stroke. HeartMate 3 group showed lower

frequency of pump malfunction and no suspected/confirmed thrombosis, as compared to HMII patients. Within 6-month-follow-up, the paper demonstrates “*equivalence of the novel HeartMate-3-LVAD compared to HeartMate II, as well as its superiority based on 0%*” pump thrombosis and 0% malfunctions (10). Based on our experience (1-6) we can confirm the presented findings of Mehra *et al.* with respect to extremely low thrombosis- and malfunction-rates respectively. Six-month-follow-up with this pump showed similar major event rates and only 8% mortality. However, RHF-incidence of 30% in the MOMENTUM study seems to be relatively high and could potentially be resolved by less-invasive approaches which might help to reduce RHF, and may also even further ameliorate chances of bleeding, intrahospital mortality, and ICU length of stay (12).

Since the HM3 CE Mark trial and following long-term follow up was set up in a classical way, the limitations for a direct comparability study to existing devices are obvious as reported by Krabatsch *et al.* (4): non-randomization, non-controlled study design, with only one device and a relatively small number of patients included in the study. When comparing these data to other outcomes reported in the field, comparisons are biased due to differences in study protocols, and/or study site distinctions in surgery and patient care. The MOMENTUM 3 trial addresses these limitations with their innovative study design. Nevertheless, there are still limiting factors reported (10): blinding of treatment assignment could not be guaranteed for obvious reasons and there might be small study site distinctions in implantation experiences of centrifugal and axial flow pumps; although, study sites are well trained and studies have a well and detailed study protocol. Future studies may include larger multi-centric studies for an even more robust data set with more reliable conclusions on the performance of centrifugal flow pumps, as compared to axial flow pumps. Additionally, investigation for arteriovenous malformations and aortic insufficiency may be included in future studies.

We congratulate all investigators on the success of MOMENTUM 3 trial (10) representing an important milestone in the field of mechanical circulatory support. Within 6-month-follow-up, the paper demonstrates “*equivalence of the novel HeartMate-3-LVAD compared to HeartMate II, as well as its superiority based on 0%*” pump thrombosis and 0% malfunctions (10). Encouraged by our published 1- and 2-year-results (4,9), first series of upgrades LVADs (e.g., from HeartMate II to HeartMate 3) (13-15) and real world 2-year experience (Figure 1), we are looking

forward to the long term results of the CE mark trial as well of the MOMENTUM 3 trial.

Acknowledgements

None.

Footnote

Conflicts of Interest: JDS is PI of the HM3 CE mark and post CE mark study; JDS and GD are consultants for Abbott and Medtronic.

References

- Schmitto JD, Hanke JS, Rojas SV, et al. First implantation in man of a new magnetically levitated left ventricular assist device (HeartMate III). *J Heart Lung Transplant* 2015;34:858-60.
- Netuka I, Sood P, Pya Y, et al. Fully Magnetically Levitated Left Ventricular Assist System for Treating Advanced HF: A Multicenter Study. *J Am Coll Cardiol* 2015;66:2579-89.
- Zimpfer D, Netuka I, Schmitto JD, et al. Multicentre clinical trial experience with the HeartMate 3 left ventricular assist device: 30-day outcomes. *Eur J Cardiothorac Surg* 2016;50:548-54.
- Krabatsch T, Netuka I, Schmitto JD, et al. Heartmate 3 fully magnetically levitated left ventricular assist device for the treatment of advanced heart failure -1 year results from the Ce mark trial. *J Cardiothorac Surg* 2017;12:23.
- Hanke JS, Dogan G, Rojas SV, et al. First experiences with HeartMate 3 follow-up and adverse events. *J Thorac Cardiovasc Surg* 2017. pii: S0022-5223(17)30178-2.
- Ozturk P, Ertugay S, Sahutoglu C, et al. Short-term Results of Heartmate 3 Ventricular Assist Device Implantation for End-Stage Heart Failure. *Transplant Proc* 2017;49:599-602.
- Bourque K, Cotter C, Dague C, et al. Design Rationale and Preclinical Evaluation of the HeartMate 3 Left Ventricular Assist System for Hemocompatibility. *ASAIO J* 2016;62:375-83.
- Farrar DJ, Bourque K, Dague CP, et al. Design features, developmental status, and experimental results with the Heartmate III centrifugal left ventricular assist system with a magnetically levitated rotor. *ASAIO J* 2007;53:310-5.
- Schmitto JD, Pya Y, Zimpfer D, et al. HeartMate 3 Fully Magnetically Levitated Left Ventricular Assist Device for the Treatment of Advanced Heart Failure—CE Mark Study 2-Year Results. *J Heart Lung Transplant* 2017;36:S66.
- Mehra MR, Naka Y, Uriel N, et al. A Fully Magnetically Levitated Circulatory Pump for Advanced Heart Failure. *N Engl J Med* 2017;376:440-50.
- Heatley G, Sood P, Goldstein D, et al. Clinical trial design and rationale of the Multicenter Study of MagLev Technology in Patients Undergoing Mechanical Circulatory Support Therapy With HeartMate 3 (MOMENTUM 3) investigational device exemption clinical study protocol. *J Heart Lung Transplant* 2016;35:528-36.
- Hanke JS, Rojas SV, Avsar M, et al. Minimally-invasive LVAD Implantation: State of the Art. *Curr Cardiol Rev* 2015;11:246-51.
- Hanke JS, Rojas SV, Dogan G, et al. First series of left ventricular assist device exchanges to HeartMate 3. *Eur J Cardiothorac Surg* 2017;51:887-92.
- Hanke JS, Haverich A, Schmitto JD. Exchange of a HeartMate II left ventricular assist device with a HeartMate 3 pump. *J Heart Lung Transplant* 2016;35:944-6.
- Hanke JS, Haverich A, Schmitto JD. Exchange of a HeartWare HVAD to a HeartMate 3 left ventricular assist device. *J Heart Lung Transplant* 2017;36:480-1.

Cite this article as: Feldmann C, Chatterjee A, Hanke JS, Dogan G, Haverich A, Schmitto JD. Novel centrifugal pump for heart failure patients: initial success and future challenges. *J Thorac Dis* 2017;9(6):1429-1431. doi: 10.21037/jtd.2017.05.68