Editorial

Surgical ventricular reconstruction for the treatment of advanced heart failure—return of the surgeons?

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Introduction

Heart failure (HF) is one of the leading causes of death (1-3). Its prevalence continues to rise globally despite better treatment due to demographic trends (3). Ischemic heart disease (IHD) remains one of the leading factors in the etiology of HF, it alone representing as much as 60% of HF etiology in many areas of the world (3). There is, however, considerable international variation. In developed countries, such as the USA and most of Western Europe, patients with acute myocardial infarction usually receive coronary angiography and stent insertion within a short period of time, while in less developed countries such as China or India, a certain percentage of the population still does not have rapid access to this kind of immediate emergency intervention and even more so, lacked access during the last decades. Therefore, it is not surprising that these countries have a higher number of patients with un- or undertreated myocardial infarction which often results in severely reduced left ventricular ejection fraction (LVEF), extensive scar tissue, and aneurysm of the heart wall (2-5). Given the increasing numbers of patients in developing countries and the aging of populations in developed countries and some developing countries, IHD may eventually become the dominant etiology of HF around the globe (1-3).

IHD has several well-known risk factors and comorbidities including hypertension, dyslipidemia, diabetes mellitus, smoking, chronic obstructive pulmonary disease (COPD), peripheral artery disease, obstructive sleep apnea, obesity, lack of physical activity, poor diet, and many more (1,2). Some of these factors are readily modifiable by lifestyle interventions such as smoking cessation, dietary changes, and regular physical exercise, while others require medical treatment. The effective management of these risk factors can reduce the likelihood for the development and progression of HF (1,2). Some of these risk factors, such as COPD, can also complicate treatments for end-stage HF such as heart transplantation (HTX) and worsen their clinical outcomes (6).

Management of HF itself involves pharmacotherapeutic, interventional, and surgical approaches. Pharmacotherapy for HF is currently based upon the ‘fantastic four of HF treatment’ including angiotensin receptor/neprilysin inhibitors (ARNIs), beta blockers, sodium-glucose cotransporter 2 (SGLT2) inhibitors, and mineralocorticoid receptor antagonists (MRAs), which provide additive benefits with substantial decrease in cardiovascular mortality, all-cause mortality, hospitalizations for HF, and

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all-cause hospitalizations (7). Additional drugs used in the treatment of HF are diuretics, ivabradine, digitalis, and vericiguat (7).

Interventional approaches include percutaneous coronary intervention (PCI) with stenting, cardiac resynchronization therapy (CRT), transcatheter edge to edge repair (TEER), and ventricular tachycardia (VT) ablation (7,8).

Surgical options include coronary artery bypass grafting (CABG), heart valve replacement, surgical ventricular reconstruction (SVR), left ventricular assist device (LVAD), and HTX (1,2,6,9,10).

In this editorial, we focus on the use of CABG and SVR in the treatment of advanced HF.

Surgical ventricular reconstruction

SVR is a surgical intervention that is considered in certain cases of HF where the left ventricle (LV) of the heart has become enlarged and weakened (aneurysm of the heart wall), most often due to ischemia caused by severe myocardial infarction (11). SVR involves removing a portion of the damaged or scarred tissue from the LV and reshaping the remaining tissue (12). The main goal of the procedure is to restore the anatomic shape and size of the LV by removing dys- or akinetic portions of the diseased ventricle. This can improve the heart's function by increasing LVEF and reducing symptoms of HF. SVR is typically considered in patients with advanced HF who have significant LV dysfunction (LVD) and symptoms that are not well-controlled with medications. SVR is a complex surgical procedure that requires careful case selection to ensure that treatment benefits outweigh its substantial risks. It is often combined with heart valve replacement and/or CABG which is a type of surgery that establishes a new passageway for blood to pass around an obstructed section of the coronary artery using a healthy blood vessel from another part of the body (11,12).

Early pioneers of SVR include the surgeons Cooley, Jatene, Fontan, and Guilment (11). Based upon these works, Dr. Vincent Dor developed the use of a circular patch to reconstruct the LV in patients with severe HF due to IHD, and later refined his technique to offer a more uniform ventricular remodeling operation (13). Further methodological developments have been made since then (14,15) but success has been inconsistent and none of the approaches has been adopted as an established method that is consistently used in clinical practice due to a lack of standardization, varying clinical outcomes, and a lack of more long-term data from large, multi-center cohort studies (16). A large meta-analysis (17) of 92 articles and 7,685 patients who underwent SVR between 2000 and 2020 concluded that, in patients with IHD, SVR reduces LV volumes and improves systolic function leading to symptomatic improvement. However, a quantitative comparison for CABG versus CABH + SVR could not be performed due to the lack of comparative arms in most studies (17). SVR is now less commonly used than in the past for several reasons. First, there has been a shift toward pharmacotherapy with the 'fantastic four of heart failure treatment' and interventional approaches with PCI, CRT, TEER, and VT ablation (1,2,7). Second, other surgical techniques, such as LVAD and HTX, have emerged as more effective treatments for advanced HF (1,2,7,16,17). Finally, studies have suggested that long-term benefits of SVR may not be as significant as originally thought, and that it may not improve mortality rates or quality of life for all patients (16-18). The results of the Surgical Treatment for Ischemic Heart Failure (STICH) trial (18) in particular questioned the benefits of CABG + SVR leading to a decrease in its popularity (16,17). As a result, SVR is presently often limited to patients who are not eligible for or have failed other treatments, or for those with specific anatomical features that make them good candidates for the procedure (16,17).

New clinical data on surgical ventricular reconstruction

Dr. Yang and colleagues conducted a recent study (19) to compare the long-term outcomes of CABG with or without SVR in patients with HF and severe LVD. The study included 140 patients with chronic HF caused by severe IHD requiring surgical coronary revascularization. The inclusion criteria consisted of: (I) IHD with more than 70% stenosis in at least two major vessels that require surgery; (II) shortness of breath as the main symptom; (III) prior Q wave myocardial infarction on electrocardiogram which had to have occurred at least three months prior to surgery; and (IV) LVEF of 35% or lower, a minimum of two neighboring segments showing resting wall motion abnormalities, and left ventricular anterior dyskinesia or akinesia on cardiac magnetic resonance imaging (CMR). Patients were excluded if they met any of the following criteria: (I) previous cardiac surgery or additional cardiac surgery such as valve replacement or repair; (II) myocarditis or hypertrophic obstructive cardiomyopathy; (III) contraindications for contrast-enhanced CMR, including allergy to contrast agents, claustrophobia, or presence of ferromagnetic objects (19).

Furthermore, two independent experienced radiologists, who were unaware of the patients' clinical data, assessed the extent of transmural cardiac late gadolinium enhancement (LGE) in each segment using the following grading system: LGE of 0% = grade 0, LGE of 1–25% = grade 1, LGE of 26–50% = grade 2, LGE of 51–75% = grade 3, and LGE of 76–100% = grade 4. An LGE threshold of 50% was considered optimal for determining the viability for each segment in order to predict possible improvement of LVEF. However, the surgical team had the final decision regarding which procedure was most suitable for each patient (19). Post-hoc statistical analysis demonstrated that both groups were well matched in terms of an array of parameters. This included baseline characteristics such as age, sex, smoking history and status, comorbid conditions, family history, New York Heart Association (NYHA) class, LVEF, mitral grade, and EuroScore. Perioperative data such as CABG outcomes, grafts per patient, hospital stay, and intensive care unit (ICU) duration likewise showed no significant differences. Particularly noteworthy is the fact that pre-operative CE-CMR results such as the spatial extent, the number of scar, viable, and dysfunctional segments, as well as LVEF, were also similar between both groups (all P≥0.05) However, as expected with a more extensive surgical procedure, perioperative parameters such as operation time, cardiopulmonary bypass time, cross clamp time, and ventilation time were all significantly longer in the CABG + SVR group (19).

During an average follow-up of more than 10 years, the CABG + SVR group had fewer rehospitalizations for HF (4.3% versus 19.1%, P=0.007), a higher percentage of patients in NYHA class I or II (85.5% versus 69.1%, P=0.030), and a higher increase in LVEF (12.0% versus 7.8%, P=0.002). Although overall mortality differences between both groups were statistically insignificant (P=0.987), patients in the CABG + SVR group showed a higher cardiovascular event-free survival (87.0% versus 67.6%, P=0.007) (19).

Advantages and drawbacks of surgical ventricular reconstruction

SVR has several advantages. Overall, the literature on SVR so far has shown that SVR can improve cardiac function by reducing the size of the LV and returning it to a more physiologic anatomic shape (16). By improving LVEF, this can improve HF symptoms like shortness of breath and fatigue in some patients. SVR is a complementary approach which can be used in conjunction with other treatments such as CABG, CRT, and pharmacotherapy. Some studies have also shown specific mortality benefits (16). However, both, the new study discussed above (19) as well as a recent large meta-analysis (17) could not demonstrate any overall mortality benefits. An important confounding mechanism to consider is that existing advantages of SVR may be lessened by the positive effects of other treatments that improve some of the same parameters. For example, pharmacotherapy can improve LVEF and CRT can reduce mortality by preventing death in patients who develop VT (1,2). This could decrease the size of SVR's positive effect on these parameters and thereby make it even harder to demonstrate them statistically.

A further downside to SVR are the additional surgical risks that a more extensive and complicated procedure entails. Selecting the right patients that benefit most from SVR has also remained a challenge. Utilizing CE-CMR with spatial modeling and scar scoring as Yang and colleagues (19) have done here may offer a non-invasive method to predict which patients are best suited to undergo SVR. However, for this to work best in clinical practice the thresholds used in terms of what constitutes a viable segment and how many non-viable segments there should be and how they should be distributed to produce optimal SVR benefits would have to be confirmed in further studies, ideally with randomized assignment of patients to different groups. Most of the available studies on SVR are however retrospective (17). Undertaking large multi-center randomized trials of SVR including different subgroups is very challenging because SVR is an overall rare procedure, that is likely to get even less common as heart attacks are treated more effectively and large ventricular defects are thereby preempted.

Conclusions

SVR is a valuable tool for the treatment of advanced HF. While the pool of appropriate patients is likely to continue to decline, SVR will probably continue to offer a benefit to a well-defined group of patients improving quality of life and cardiovascular event-free survival. When determining the suitability for SVR, it is important to consider the patient's individual medical history and condition, ensuring that the decision is made on an individualized basis. Yang and colleagues have made a valuable contribution to the literature with their current study (19). Their results are in line with many previous studies and strengthen the idea that careful patient selection by an experienced surgical team is key in ensuring patients benefit from this procedure. An attempt to elucidate this further can be found in a recent study by Dr. Gaudino and colleagues (20) who compared a cohort of patients with CABG + SVR at San Donato Hospital (Milan, Italy) with data from the STICH trial (18) using an inverse probability treatment-weighted Cox regression. In the 4-year follow-up, the researchers discovered a notable decrease in mortality among the San Donato Hospital cohort in comparison to the STICH-SVR cohort (adjusted hazard ratio: 0.71; 95% confidence interval: 0.53–0.95; P=0.001). These findings suggest that patients with postinfarction LV remodeling who underwent SVR at a high-volume SVR center achieved superior long-term outcomes compared to those reported in the STICH trial (20). Given these new data, further studies, especially of the prospective and, ideally, randomized kind, could help delineate more precisely which patients may or may not benefit the most from SVR.

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