Surgical Ventricular Restoration

Policy Number: 7.01.103
Origination: 3/2006
Last Review: 3/2020
Next Review: 9/2020

Policy
Blue Cross and Blue Shield of Kansas City (Blue KC) will not provide coverage for Surgical Ventricular Restoration. This is considered investigational.

When Policy Topic is covered
Not Applicable

When Policy Topic is not covered
Surgical ventricular restoration is considered investigational for the treatment of ischemic dilated cardiomyopathy.

Considerations
Surgical ventricular restoration involves increased physician work compared to standard ventriculectomy. For example, the procedure includes evaluation of the ventricular septum and reshaping of the geometry of the heart. Surgical ventricular restoration is described as a global treatment of left ventricular failure, while conventional left ventricular aneurysmectomy represents a local treatment of a transmural infarct.

Description of Procedure or Service

<table>
<thead>
<tr>
<th>Populations</th>
<th>Interventions of interest are:</th>
<th>Comparators of interest are:</th>
<th>Relevant outcomes include:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individuals:</td>
<td>Surgical ventricular restoration as an adjunct to standard coronary artery bypass grafting</td>
<td>Coronary artery bypass grafting</td>
<td>Overall survival</td>
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<tr>
<td>With ischemic dilated cardiomyopathy</td>
<td></td>
<td></td>
<td>Symptoms</td>
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</table>

Summary
Surgical ventricular restoration (SVR) is designed to restore or remodel the left ventricle to its normal, spherical shape and size in patients with akinetic segments of the heart, secondary to ischemic dilated cardiomyopathy.
For individuals who have ischemic dilated cardiomyopathy who receive SVR as an adjunct to coronary artery bypass grafting, the evidence includes a large randomized controlled trial (another randomized controlled trial reported results, but most trial enrollees overlapped with those in the larger trial) and uncontrolled studies. The relevant outcomes are overall survival, symptoms, quality of life, hospitalizations, resource utilization, and treatment-related morbidity. The randomized controlled trial, the Surgical Treatment of Ischemic Heart Failure trial, did not report significant improvements in quality of life outcomes for patients undergoing SVR as an adjunct to standard coronary artery bypass grafting surgery. Several uncontrolled studies have suggested that SVR can improve hemodynamic functioning in selected patients with ischemic cardiomyopathy; however, these studies are considered lower quality evidence. The evidence is insufficient to determine the effects of the technology on health outcomes.

**Background**

Surgical ventricular restoration (SVR) is also known as surgical anterior ventricular endocardial restoration, left ventricular reconstructive surgery, endoventricular circular plasty, or the Dor procedure. Named after the surgeon who pioneered the expansion of techniques for ventricular reconstruction and is credited with treating heart failure patients with SVR and coronary artery bypass grafting.

SVR is usually performed after coronary artery bypass grafting and may precede or be followed by mitral valve repair or replacement and other procedures such as endocardectomy and cryoablation for treatment of ventricular tachycardia. A key difference between SVR and ventriculectomy (ie, for aneurysm removal) is that, in SVR, circular “purse string” suturing is used around the border of the aneurysmal scar tissue. Tightening of this suture is believed to isolate the akinetic or dyskinetic scar, bring the healthy portion of the ventricular walls together, and restore a more normal ventricular contour. If the defect is large (ie, an opening >3 cm), the ventricle may also be reconstructed using patches of autologous or artificial material to maintain the desired ventricular volume and contour during closure of the ventriculotomy. In addition, SVR is distinct from partial left ventriculectomy (ie, the Batista procedure; see evidence review 7.01.66), which does not attempt specifically to resect akinetic segments and restore ventricular contour.

**Regulatory Status**

The U.S. Food and Drug Administration regulates the marketing of devices used as intracardiac patches through the 510(k) clearance process. These devices are Class II and are identified as polypropylene, polyethylene terephthalate, or polytetrafluoroethylene patch or pledget placed in the heart that is used to repair septal defects, for patch grafting, to repair tissue, and to buttress sutures. Biological tissue may also be a component of the patches. In 2004, the CorRestore™ Patch System (Somanetics; acquired by Medtronic) was cleared for marketing by the U.S. Food and Drug Administration for use “as an intracardiac patch for cardiac reconstruction and repair.” The device consists of an oval tissue
patch made from glutaraldehyde-fixed bovine pericardium. It is identical to other marketed bovine pericardial patches, except that it incorporates an integral suture bolster in the shape of a ring that is used along with ventricular sizing devices to restore the normal ventricular contour. Food and Drug Administration product code: DXZ.

**Rationale**
This evidence review was created in September 2005 and has been updated regularly with searches of the MEDLINE database. The most recent literature update was performed through December 6, 2018.

Evidence reviews assess the clinical evidence to determine whether the use of technology improves the net health outcome. Broadly defined, health outcomes are the length of life, quality of life (QOL), and ability to function—including benefits and harms. Every clinical condition has specific outcomes that are important to patients and managing the course of that condition. Validated outcome measures are necessary to ascertain whether a condition improves or worsens; and whether the magnitude of that change is clinically significant. The net health outcome is a balance of benefits and harms.

To assess whether the evidence is sufficient to draw conclusions about the net health outcome of technology, two domains are examined: the relevance, and quality and credibility. To be relevant, studies must represent one or more intended clinical use of the technology in the intended population and compare an effective and appropriate alternative at a comparable intensity. For some conditions, the alternative will be supportive care or surveillance. The quality and credibility of the evidence depend on study design and conduct, minimizing bias and confounding that can generate incorrect findings. The randomized controlled trial (RCT) is preferred to assess efficacy; however, in some circumstances, nonrandomized studies may be adequate. RCTs are rarely large enough or long enough to capture less common adverse events and long-term effects. Other types of studies can be used for these purposes and to assess generalizability to broader clinical populations and settings of clinical practice.

**Surgical ventricular restoration**

**Clinical Context and Therapy Purpose**
The purpose of SVR as an adjunct to standard coronary artery bypass grafting (CABG) is to provide a treatment option that is an alternative to or an improvement on existing therapies, such as coronary artery bypass grafting, in patients with ischemic dilated cardiomyopathy.

The question addressed in this evidence review is: does SVR as an adjunct to standard CABG improve the net health outcome for individuals with ischemic dilated cardiomyopathy?

The following PICOTS were used to select literature to inform this review.
**Patients**
The relevant population of interest are individuals with ischemic dilated cardiomyopathy.

**Interventions**
The therapy being considered is SVR as an adjunct to standard CABG.

**Comparators**
The main comparator of interest is CABG alone.

**Outcomes**
The general outcomes of interest are overall survival, symptoms, QOL, hospitalizations, resource utilization, and treatment-related morbidity. Symptoms of ischemic dilated cardiomyopathy may include heart palpitations, angina, edema, shortness of breath, dizziness or syncope, and fatigue.

**Timing**
The existing literature, particularly the Surgical Treatment of Ischemic Heart Failure (STICH) trial and its subsequent subgroup analyses, that evaluate SVR as an adjunct to standard CABG as a treatment for ischemic dilated cardiomyopathy has varying lengths of follow-up, 4 months to 19 years. While studies described below all reported at least one outcome of interest, longer follow-up was necessary to fully observe outcomes. Therefore, long-term follow-up is considered necessary to demonstrate efficacy.

**Setting**
Patients with ischemic dilated cardiomyopathy are preoperatively managed by cardiologists and primary care providers in both outpatient and inpatient settings. SVR is performed by cardiovascular surgeons.

**Study Selection Criteria**
Methodologically credible studies were selected using the following principles:

a. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;

b. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.

c. To assess long-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.

d. Studies with duplicative or overlapping populations were excluded.

**Randomized Controlled Trials**
In 2002, the international STICH trial was initiated to compare medical therapy with CABG and/or SVR for patients with heart failure and coronary heart disease (NCT00023595). This trial was sponsored by the National Heart, Lung, and Blood Institute. Results of the STICH trial were published in 2009 (see Tables 1 and 2). This unblinded trial was performed at 127 clinical sites in 26 countries. The
STICH trial tested two hypotheses, examining the effect of (1) medical therapy vs medical therapy plus CABG and (2) medical therapy plus CABG vs medical therapy plus CABG and SVR. Focusing on testing of the second hypothesis, a total of 1000 patients with coronary artery disease and an ejection fraction of 35% or less were randomized to CABG alone (n=499) or CABG plus SVR (n=501) (see Table 2). The primary outcome was a composite of death from any cause and hospitalization for cardiac reasons.

Table 1. Summary of Key RCT Characteristics

<table>
<thead>
<tr>
<th>Author; Study</th>
<th>Countries</th>
<th>Sites</th>
<th>Dates</th>
<th>Participantsa</th>
<th>Active</th>
<th>Comparator</th>
</tr>
</thead>
</table>
| Jones et al (2009); STICH | U.S., Canada, South America, Europe, Asia | 127 | 2002-2007 | - Patients with CAD treatable with CABG, and LVEF £35%  
- Exclusion for recent MI, need for AV replacement, planned PCI, or life expectancy <3 y | Medical therapy + CABG | Medical therapy + CABG + SVR |

AV: aortic valve; CAD: coronary artery disease; CABG: coronary artery bypass grafting; LVEF: left ventricular ejection fraction; MI: myocardial infarction; PCI: percutaneous coronary intervention; RCT: randomized controlled trial; SVR: surgical ventricular restoration.

a Key eligibility criteria.

Table 2. Summary of Key RCT Results

<table>
<thead>
<tr>
<th>Study</th>
<th>Primary Outcomes</th>
<th>Secondary Outcomes</th>
<th>Death From Any Cause at 30 days (ITT)</th>
<th>Acute MI</th>
<th>Stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Death From Any Cause</td>
<td>Hospitalization for Cardiac Causes</td>
<td>Hospitalization for Any Cause</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jones et al (2009)</td>
<td>CABG (n=499)</td>
<td>141 (28)</td>
<td>211 (42)</td>
<td>272 (55)</td>
<td>25 (5)</td>
</tr>
<tr>
<td></td>
<td>CABG + SVR</td>
<td>138 (28)</td>
<td>204 (41)</td>
<td>268 (53)</td>
<td>26 (5)</td>
</tr>
<tr>
<td>Study</td>
<td>Population(^a)</td>
<td>Intervention(^b)</td>
<td>Comparator(^c)</td>
<td>Outcomes(^d)</td>
<td>Follow-Up(^e)</td>
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<tr>
<td>Jones et al (2009)(^1); STICH</td>
<td></td>
<td>2. Volume studies were not conducted for 66% of trial participants</td>
<td></td>
<td>6. The STICH trial’s 300 surgically treated patients in 12 centers had 6% mortality (range 3%–12%); much higher than the 1% mortality reported in 1978 of 1000 patients from the Cleveland Clinic</td>
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</tbody>
</table>

The evidence gaps stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.

\(^a\)Population key: 1. Intended use population unclear; 2. Clinical context is unclear; 3. Study population is unclear; 4. Study population not representative of intended use.

\(^b\)Intervention key: 1. Not clearly defined; 2. Version used unclear; 3. Delivery not similar intensity as comparator; 4. Not the intervention of interest.

<table>
<thead>
<tr>
<th>(n=501)</th>
<th>HR (95% CI)</th>
<th>p</th>
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<tbody>
<tr>
<td></td>
<td>1.00 (0.79 to 1.26)</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>0.97 (0.83 to 1.18)</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>0.98 (0.83 to 1.16)</td>
<td>0.82</td>
</tr>
<tr>
<td></td>
<td>1.01 (0.54 to 1.87)</td>
<td>0.88</td>
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<tr>
<td></td>
<td>0.77 (0.45 to 1.32)</td>
<td>0.96</td>
</tr>
<tr>
<td></td>
<td>0.77 (0.45 to 1.32)</td>
<td>0.35</td>
</tr>
</tbody>
</table>

Values are n (%) unless otherwise indicated.

CABG: coronary artery bypass grafting; CI: confidence interval; HR: hazard ratio; MI: myocardial infarction; RCT: randomized controlled trial; SVR: surgical ventricular restoration.

The purpose of the gaps tables (see Tables 3 and 4) is to display notable gaps identified in each study. This information is synthesized as a summary of the body of evidence following each table and provides the conclusions on the sufficiency of the evidence supporting the position statement.
 Comparator key: 1. Not clearly defined; 2. Not standard or optimal; 3. Delivery not similar intensity as intervention; 4. Not delivered effectively.


Table 4. Study Design and Conduct Gaps

<table>
<thead>
<tr>
<th>Study</th>
<th>Allocation</th>
<th>Blinding</th>
<th>Selective Reporting</th>
<th>Follow-Up</th>
<th>Power</th>
<th>Statistical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jones et al (2009)(^1); STICH</td>
<td>1,3. physicians and surgeons caring for patients were aware of the treatment received.</td>
<td>2. The STICH trial reports the intervention successful despite the higher mortality rate than other non-participating centers (</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

The evidence gaps stated in this table are those notable in the current review; this is not a comprehensive gaps assessment.


While SVR reduced the end-systolic volume index by 19% compared with 6% with CABG alone, there was no difference between groups in the primary outcome. Cardiac symptoms and exercise tolerance also improved to similar degrees between groups. Other secondary outcomes, such as stroke, myocardial infarction, and subsequent procedures, did not differ between groups. Subgroup analyses did not reveal any patient groups that benefited from SVR significantly more than the entire group.

STICH investigators subsequently conducted additional analyses to identify patient groups that might have improved outcomes with CABG plus SVR over CABG alone. A 2014 analysis evaluated whether, in the STICH trial, myocardial viability was
associated with patient outcomes. A total of 267 patients underwent single-photon emission computed tomography viability studies, and 191 were found to have myocardial viability. The investigators found no significant interaction between myocardial viability status and treatment group for the outcomes mortality (p=0.36) or mortality plus cardiac hospitalization (p=0.55).

Subgroup analyses published in 2013 did not find significantly improved outcomes in patients with better preoperative left ventricular function, using measures such as left ventricular ejection fraction, end-systolic volume index, and/or end-diastolic volume index. A 2015 subgroup analysis found that patients with moderate-to-severe preoperative right ventricular dysfunction had worse outcomes when they underwent SVR plus CABG than CABG alone. In an analysis adjusting for other prognostic factors, the interaction between right ventricular function and treatment group was statistically significant for all-cause mortality (p=0.022). A 2017 subgroup analysis found that left ventricular end-systemic volume index was the most important predictor of mortality following CABG or CABG plus SVR; the study also established that mortality following SVR was not predicted by left ventricular regional dysfunction. Because subgroup analyses were performed post hoc, they are considered hypothesis generating, and findings would need to be confirmed in prospective trials. In 2018, a subgroup analysis investigated the association of sex (gender) and the long-term benefit of CABG plus medical therapy vs medical therapy on all-cause mortality, cardiovascular mortality, the composite of death or hospitalization, or surgical deaths in the STICH cohort to compare for gender-related interactions. The analyses found no association between sex and outcomes, recommending that gender should not influence CABG treatment decisions.

A separate 2009 publication from the STICH trial reported on QOL outcomes. The main QOL outcome measurement tool used was the Kansas City Cardiomyopathy Questionnaire, which is a 23-item scale that assesses the effect of heart failure symptoms on QOL. Secondary QOL measures included the Seattle Angina Questionnaire, the 12-Item Short-Form Health Survey, the Center for Epidemiologic Studies Depression Scale, the Cardiac Self-Efficacy Questionnaire, and the EuroQoL 5-D. The questionnaires were administered at baseline and 4, 12, 24, and 36 months postrandomization. Available numbers of patients at each time point were 991, 897, 828, 751, and 669, respectively. Scores on the Kansas City Cardiomyopathy Questionnaire QOL measures improved for both groups to a similar degree; there was no incremental benefit for the SVR group compared with the CABG alone group. Similarly, there were no group differences noted on any of the secondary QOL measures.

A second RCT was published by Marchenko et al (2011). Performed in Russia, this study randomized 236 patients with ischemic heart failure to CABG alone or CABG plus SVR. The authors noted that “most” of the patients in the trial were also included in the STICH trial. Mean follow-up was 31 months. Outcome measures reported were perioperative mortality and survival at 1-, 2-, and 3-year follow-ups. Perioperative mortality was 5.8% in the CABG alone group compared with 3.5% in the CABG plus SVR group (p=NS). Survival at 1 and 3 years was
95% and 78%, respectively, in the CABG plus SVR group, compared with 83% and 78%, respectively, in the CABG alone group (statistical comparisons not reported). There were reductions in New York Heart Association functional and angina classes for both groups after surgery, but between-group statistical testing was not reported. For example, mean New York Heart Association functional class decreased in the CABG plus SVR group from 3.1 at baseline to 2.2 at 3 years, compared with a decrease in the CABG alone group from 2.9 to 2.4.

**Section Summary: Randomized Controlled Trials**

Two RCTs have examined SVR for the treatment of ischemic dilated cardiomyopathy—the large multicenter National Heart, Lung, and Blood Institute-sponsored STICH trial and a smaller single-center Russian study that included patients enrolled in STICH. The STICH trial failed to demonstrate benefit from SVR. Overlap in the patients reported in the second trial limits any implications of its results.

**Nonrandomized Trials**

Tables 5 and 6, below, summarize the characteristics and results of key nonrandomized trials and observational studies (n=6), including five cohort studies and one comparative review comparing SVR to other surgical interventions in multiple populations. The studies range in size (n=731) and duration of follow-up (n>22 years). The studies, as a whole, show some clinical improvements when SVR is utilized in the target patient population as a surgical intervention.

**Table 5. Summary of Key Nonrandomized Trial Characteristics**

<table>
<thead>
<tr>
<th>Study</th>
<th>Study Type</th>
<th>Country</th>
<th>Date(s)</th>
<th>Participants</th>
<th>Treatment 1</th>
<th>Treatment 2</th>
<th>Treatment 3</th>
<th>Treatment 4</th>
<th>Follow-Up</th>
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</thead>
<tbody>
<tr>
<td>Athanasuleas (2001)⁹</td>
<td>Cohort</td>
<td>US, Monaco, Italy</td>
<td>1998-2000</td>
<td>who underwent SVR after anterior myocardial infarction with or without concomitant procedures (n=662)</td>
<td>SVR+ CABG (n=609)</td>
<td>SVR+ Mitral Repair (n=146)</td>
<td>SVR+ Mitral Replacement (n=20)</td>
<td></td>
<td>3-years</td>
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<tr>
<td>Athanasuleas (2001)¹⁰</td>
<td>Cohort</td>
<td>US, Monaco, Italy</td>
<td>1998-1999</td>
<td>who underwent SVR after anterior myocardial infarction with or without concomitant</td>
<td>SVR+ CABG (n=391)</td>
<td>SVR+ Mitral Repair (n=97)</td>
<td>SVR+ Mitral Replacement (n=18)</td>
<td></td>
<td>18-months</td>
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<tr>
<td>Cohort</td>
<td>Location</td>
<td>Year Range</td>
<td>Patients</td>
<td>Procedures</td>
<td></td>
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<tr>
<td>Mickleborough (2004)</td>
<td>CA</td>
<td>1983-2002</td>
<td>n=285</td>
<td>SVR+ CABG (n=63), SVR+ arrhythmia ablation (n=17), SVR+ mitral repair (n=9), SVR+ mitral replacement (n=9)</td>
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<tr>
<td>Bolooki (2003)</td>
<td>US</td>
<td>1997-2000</td>
<td>n=157</td>
<td>Radial aneurysm resection + linear closure (n=65), Septal dyskinesia reinforced with patch septoplasty (n=70), Ventrilotomy closure + intracavitary oval patch (n=22)</td>
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<tr>
<td>Sartipy (2005)</td>
<td>Sweeden</td>
<td>1994-2004</td>
<td>n=101</td>
<td>SVR+ CABG (n=99), SVR+ arrhythmia ablation (n=53), SVR+ mitral valve procedure (n=29)</td>
<td></td>
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<tr>
<td>Study</td>
<td>In-hospital mortality</td>
<td>Increase in post-operative ejection fraction</td>
<td>Decrease in left ventricular end systolic volume index</td>
<td>Survival rate (post-op year)</td>
<td>Freedom from hospitalization</td>
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<tr>
<td>Athanasuleas (2001)(^9)</td>
<td>7.7%</td>
<td>10.3% (p&lt;0.05)</td>
<td>109 ± 71 to 69 ± 42 ml/m(^2) (p &lt; 0.005)</td>
<td>89.4% (3)</td>
<td>88.7% (3)</td>
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<td>Athanasuleas (2001)(^10)</td>
<td>6.6%</td>
<td>29 ± 10.4 to 39 ± 12.4%</td>
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<td>89.2% (18-months)</td>
<td>N</td>
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<tr>
<td>Mickleborough (2004)(^11)</td>
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<tr>
<td>Total (n=285)</td>
<td>2.8%</td>
<td>10% (p&lt;.000)</td>
<td>1.3 classes/patient for 140 patients</td>
<td>82%</td>
<td>62%</td>
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<tr>
<td>Sartipy (2005)(^13)</td>
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<tr>
<td>SVR via Dor procedure for Class III or IV HF (n=101)</td>
<td>7.9% (early-mortality) measured, within 30 days_</td>
<td>6%</td>
<td>-</td>
<td>65%</td>
<td>-</td>
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<tr>
<td>Bolooki (2003)</td>
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The Reconstructive Endoventricular Surgery, returning Torsion Original Radius Elliptical Shape to the LV (RESTORE) Group is an international group of cardiologists and surgeons from 13 centers that investigated SVR in more than 1000 patients with ischemic cardiomyopathy following anterior infarction. Athanasuleas et al (2001), from the RESTORE Group, reported on early and 3-year outcomes in 662 patients who underwent SVR following anterior myocardial infarction between 1998 and 2000. In addition to SVR, patients concomitantly underwent CABG (92%), mitral repair (22%), and mitral replacement (3%). The authors reported that overall mortality during hospitalization was 7.7%; postoperative ejection fractions increased from 29.7% to 40.0% (p<0.05). The survival rate and freedom from hospitalization for heart failure at 3 years was 89.4% and 88.7%, respectively. In a separate 2001 publication on 439 patients from the RESTORE Group, Athanasuleas et al (2001) reported that outcomes improved in younger patients, those with higher ejection fractions, and those not needing mitral valve replacement.

Mickleborough et al (2004) reported on 285 patients who underwent SVR by a single surgeon for class III or IV heart failure, angina, or ventricular tachyarrhythmia during the period of 1983 to 2002. In addition to SVR, patients concomitantly underwent CABG (93%), patch septoplasty (22%), arrhythmia ablation (41%), mitral repair (3%), and mitral replacement (3%). SVR was performed on the beating heart in 7% of patients. The authors reported hospital mortality of 2.8%; postoperative ejection fractions increased 10% from 24% (p<0.0001), and symptom class in 140 patients improved 1.3 functional classes per patient. Patients were followed for up to 19 years (mean, 63 months), and overall actutimes survival was reported as 92%, 82%, and 62% at 1, 5, and 10
years, respectively. The authors suggested wall-thinning should be used as a criterion for patient selection.

Bolooki et al (2003) reported on 157 patients who underwent SVR by a single surgeon for class III or IV heart failure, angina, ventricular tachyarrhythmia, or myocardial infarction using 3 surgical methods from 1979 to 2000. SVR procedures consisted of radical aneurysm resection and linear closure (n=65), septal dyskinesia reinforced with patch septoplasty (n=70), or ventriculotomy closure with an intracavitary oval patch (n=22). The authors reported hospital mortality of 16%. Mean preoperative ejection fraction was 28%. Patients were followed for up to 22 years, and overall actutimes survival was reported as 53%, 30%, and 18% at 5, 10, and 15 years, respectively. The authors found factors improving long-term survival included SVR with intraventricular patch repair and an ejection fraction of 26% or greater preoperatively.

Sartipy et al (2005) reported on 101 patients who underwent SVR using the Dor procedure at a single-center for class III or IV heart failure, angina, and ventricular tachyarrhythmia from 1994 to 2004. In addition to SVR, patients concomitantly underwent CABG (98%), arrhythmia ablation (52%), and mitral valve procedure (29%). The authors reported early mortality (within 30 days of surgery) was 7.9%; left ventricular ejection fraction increased from 27% to 33% postoperatively. Patients were followed for a median of 4.4 years, and overall actutimes survival was reported as 88%, 79%, and 65% at 1, 3, and 5 years, respectively.

Hernandez et al (2006) reported on the contemporary performance of SVR based on data from the Society of Thoracic Surgeons' database. From 2002 to 2004, 731 patients underwent procedures at 141 hospitals. The operative mortality was 9.3%; combined death or major complications occurred in 33.5%. Tulner et al (2006) reported on 6-month follow-up for 21 patients with ischemic dilated cardiomyopathy who underwent SVR and bypass grafting; some also had valve annuloplasty. Improvement in a number of clinical variables was noted, including decreased left ventricular dyssynchrony, reduced tricuspid regurgitation, and improved ejection fraction (27%-36%).

In a number of reports, SVR has been performed in conjunction with additional cardiac procedures. For example, Tulner et al (2007) reported on 6-month outcomes for 33 patients with class III or IV heart failure who underwent SVR and/or restrictive mitral annuloplasty. Operative mortality was 3%, and additional in-hospital mortality was 9%. QOL scores improved, as did 6-minute walking distance (248-422 meters). Williams et al (2007) retrospectively reviewed outcomes following SVR in a series of 34 patients with New York Heart Association class IV heart failure and 44 patients with class II or III heart failure who had surgery between 2002 and 2005. There were three operative deaths in each group. While symptoms improved in both groups, there was a trend toward reduced survival at 32 months in those with class IV (68%) vs class II or III disease (88%). A 2009 nonrandomized comparative study from Europe involving patients with coronary artery disease who underwent CABG or CABG plus
SVR reported an ejection fraction of 30% to 40%. In this nonrandomized study, the authors concluded that patients in whom SVR was possible experienced more perioperative complications but had improved early and midterm outcomes. Ohira et al (2017) reported on 44 consecutive patients who underwent a modified SVR procedure, many done in conjunction with CABG (93%) or mitral valve repair or replacement (58%). Operative mortality was 11%. Patients demonstrated improvements in ejection fraction as well as end-systolic left ventricular volume index after the procedure.

**Section Summary: Nonrandomized trials**
While these and similar uncontrolled studies have shown some clinical improvements following surgery plus SVR, the nonrandomized nature of these studies limits the ability to draw conclusions. Controlled trials are needed to compare SVR outcomes with other alternatives.

**Summary of Evidence**
For individuals who have ischemic dilated cardiomyopathy who receive SVR as an adjunct to CABG, the evidence includes a large RCT (another RCT reported results, but most trial enrollees overlapped with those in the larger trial) and uncontrolled studies. The relevant outcomes are overall survival, symptoms, QOL, hospitalizations, resource utilization, and treatment-related morbidity. The RCT and the STICH trial did not report significant improvements in QOL outcomes for patients undergoing SVR as an adjunct to standard CABG surgery. Several uncontrolled studies have suggested that SVR can improve hemodynamic functioning in selected patients with ischemic cardiomyopathy; however, these studies are considered lower quality evidence. The evidence is insufficient to determine the effects of the technology on health outcomes.

**SUPPLEMENTAL INFORMATION**

**Practice Guidelines and Position Statement**

**European Society of Cardiology and European Association for Cardio-Thoracic Surgery**
The European Society of Cardiology and the European Association for Cardio-Thoracic Surgery (2018) developed joint guidelines on myocardial revascularization. The guidelines indicate that surgical ventricular restoration during coronary artery bypass grafting may be considered in selected patients treated in centers with the requisite expertise.

**U.S. Preventive Services Task Force Recommendations**
Not applicable.

**Medicare National Coverage**
There is no national coverage determination. In the absence of a national coverage determination, coverage decisions are left to the discretion of local Medicare carriers.
Ongoing and Unpublished Clinical Trials
A search of ClinicalTrials.gov in December 2018 did not identify any ongoing or unpublished trials that would likely influence this review.

REFERENCES

Billing Coding/Physician Documentation Information

33548 Surgical ventricular restoration procedure, includes prosthetic patch, when performed (e.g., ventricular remodeling, SVR, SAVER, DOR procedure)

ICD10 Codes:
Investigational for all diagnoses
I25.3 Aneurysm of heart
I25.5 Ischemic cardiomyopathy
I42.0 Dilated cardiomyopathy

Additional Policy Key Words
N/A

Policy Implementation/Update Information

3/1/06 New policy added to the Surgery section. Considered investigational.
9/1/06 No policy statement changes.
3/1/07 No policy statement changes.
9/1/07 No policy statement changes.
3/1/08 No policy statement changes.
9/1/08 No policy statement changes.
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3/1/16  No policy statement changes.
9/1/16  No policy statement changes.
3/1/17  No policy statement changes.
9/1/17  Minor edits; deleted “or postinfarction left ventricular aneurysm” from the policy statement.
3/1/18  No policy statement changes.
9/1/18  No policy statement changes.
3/1/19  No policy statement changes.
9/1/19  No policy statement changes.
3/1/20  No policy statement changes.

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