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Cerebral Embolic Protection During Transcatheter Aortic Valve Replacement Significantly Reduces Death and Stroke Compared With Unprotected Procedures

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ABSTRACT

OBJECTIVES The aim of this study was to evaluate the impact of cerebral embolic protection on stroke-free survival in patients undergoing transcatheter aortic valve replacement (TAVR).

BACKGROUND Imaging data on cerebral embolic protection devices have demonstrated a significant reduction in number and volume of cerebral lesions.

METHODS A total of 802 consecutive patients were enrolled. The Sentinel cerebral embolic protection device (Claret Medical Inc., Santa Rosa, California) was used in 34.9% (n = 280) of consecutive patients. In 65.1% (n = 522) of patients TAVR was performed in the identical setting except without cerebral embolic protection. Neurological follow-up was done within 7 days post-procedure. The primary endpoint was a composite of all-cause mortality or all-stroke according to Valve Academic Research Consortium-2 criteria within 7 days. Propensity score matching was performed to account for possible confounders.

RESULTS Both filters of the device were successfully positioned in 280 of 305 (91.8%) consecutive patients. With use of cerebral embolic protection rate of disabling and nondisabling stroke was significantly reduced from 4.6% to 1.4% (p = 0.03; odds ratio: 0.29, 95% confidence interval: 0.10 to 0.93) in the propensity-matched population (n = 560). The primary endpoint occurred significantly less frequently, with 2.1% (n = 6 of 280) in the protected group compared with 6.8% (n = 19 of 280) in the control group (p = 0.01; odds ratio: 0.30; 95% confidence interval: 0.12 to 0.77). In multivariable analysis Society of Thoracic Surgeons score for mortality (p = 0.02) and TAVR without protection (p = 0.02) were independent predictors for the primary endpoint.

CONCLUSIONS In patients undergoing TAVR use of a cerebral embolic protection device demonstrated a significant higher rate of stroke-free survival compared with unprotected TAVR. (J Am Coll Cardiol Intv 2017;10:2297–303)

Transcatheter aortic valve replacement (TAVR) has been shown to be superior to surgical aortic valve replacement in patients at high and intermediate surgical risk (1,2). Cerebral ischemic events after TAVR have been identified as an independent predictor of morbidity and mortality with an up to 9-fold increase in risk (3,4). Although with new-generation TAVR devices stroke rates are declining (2,5), the risk of stroke is still high with 5.5% after 30 days in transfemoral TAVR patients treated in the randomized PARTNER (Placement of Aortic Transcatheter Valves)-2 trial (2). Risk of thromboembolic events has been shown to be highest during valve implantation procedures (6–9). Protecting the brain from embolic burden has become a major issue. The first data on cerebral embolic protection

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ABBREVIATIONS AND ACRONYMS

CI = confidence interval

MRI = magnetic resonance imaging

NNT = number needed to treat

OR = odds ratio

STS = Society of Thoracic Surgeons

TAVR = transcatheter aortic valve replacement

VARC-2 = Valve Academic Research Consortium-2

devices demonstrated in small populations a reduction in number and volume of new ischemic brain lesions on diffusion-weighted magnetic resonance imaging (MRI) and a trend toward less neurological impairment compared with unprotected procedures (10–16). The randomized Sentinel trial recently demonstrated an absolute 3.6% reduction of stroke within 30 days correlating to a 42% reduction of new lesion volumes on MRI in protected territories (17).

We evaluated in an all-comer prospective study the impact of cerebral embolic protection with the Claret Sentinel device (Claret Medical Inc., Santa Rosa, California) on stroke-free survival in patients undergoing transfemoral TAVR compared with TAVR patients treated without cerebral embolic protection.

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METHODS

PATIENT SELECTION. Patients were prospectively enrolled and underwent diagnostic evaluation with routine laboratory testing, medical history with current medication, Society of Thoracic Surgeons (STS) score, New York Heart Association functional class, electrocardiography, echocardiography, heart catheterization, and multislice computed tomography analyzed with a dedicated software (3mensio software, Pie Medical Imaging, Maastricht, the Netherlands) (18,19). Left ventricular outflow tract calcification was assessed according to Barbanti et al. (20). Valve calcification was graded according to Rosenhek et al. (21). The decision for transcatheter approach was done in the interdisciplinary heart team. TAVR procedures were performed via the transfemoral approach in a hybrid catheterization lab as described elsewhere (18,19). Since 2016 the protection device was used consecutively in all patients except if there was no vascular access or there were rare anatomic situations clearly not allowing the positioning of both filters. Patients with valve-in-valve procedures were excluded, otherwise there were no exclusion criteria representing an all-comers TAVR population. Aortic arch, brachiocephalic trunk, and carotid artery anatomy in multislice computed tomography were visually analyzed. Periprocedural complications, and in hospital clinical outcomes were assessed according to the Valve Academic Research Consortium-2 (VARC-2) criteria (22). The study was approved by the ethics committee of the University of Ulm and conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all patients (NCT02162069).

EMBOLIC PROTECTION DEVICE. The Sentinel device is a dual filter-based embolic protection device inserted through a 6-F sheath introduced via the right radial, ulnar, or brachial artery (**Figure 1**). The proximal filter consists of a radiopaque nitinol frame with a 140-μm pore polyurethane filter and is positioned in the brachiocephalic trunk. The second filter is delivered to the left common carotid artery. The Sentinel system was inserted prior to passage of the aortic arch with any device. The inserted filters cover all brain areas supplied by the right vertebral and carotid artery and the left carotid artery. The left vertebral artery remains unprotected. All cerebral protection devices were inserted by experienced operators trained in TAVR, radial access, coronary, and carotid interventions (23). The protection device was not used in case of left common carotid artery stenosis, atypical insertion of the right subclavian artery, or atypical anatomy, which would not allow sufficient positioning of the filters.

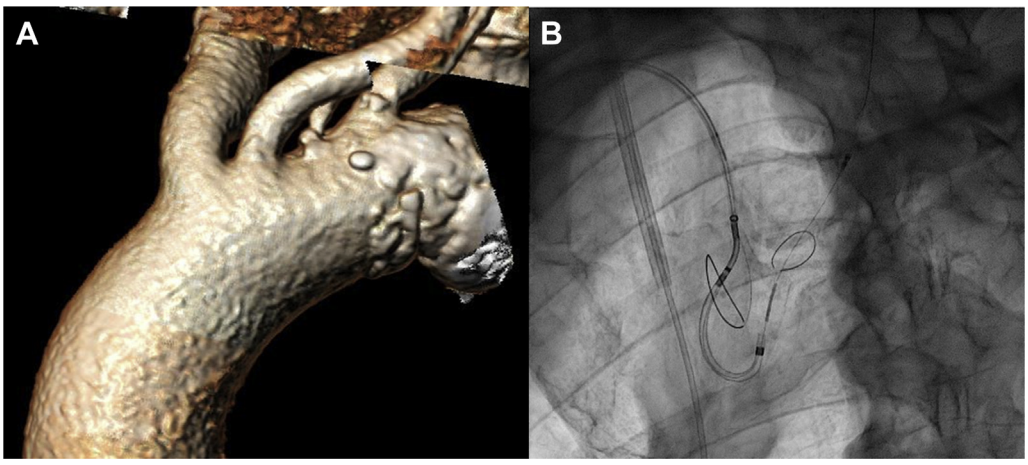
PROCEDURE. Procedures were performed transfemorally with local anesthesia under conscious sedation in the hybrid catheterization laboratory. Anticoagulation during the TAVR procedure was done with unfractionated heparin. All patients were on aspirin before the procedure. Clopidogrel was continued when indicated (e.g., after previous coronary stent implantation). Oral anticoagulation was discontinued prior to the procedure and restarted after TAVR in patients with atrial fibrillation. The Sentinel embolic protection device was introduced after insertion of the TAVR delivery sheath prior to passage of the aortic arch with any device. Operators, used TAVR devices, vascular access, hybrid catheterization labs and technical settings were identical in patients with and without protection.

All patients underwent neurological assessment by a neurologist. There was no change in neurological assessment between the protected and unprotected patient population. In case of neurological impairment, cerebral computed tomography or MRI was performed and analyzed by a neuroradiologist and neurologist. Stroke was defined according to VARC-2 criteria.

STUDY ENDPOINTS. The primary composite endpoint was all-cause mortality or all stroke according to VARC-2 criteria within 7 days. Secondary endpoint was technical success of the device, defined as successful insertion and deployment of both filters at intended position.

STATISTICAL ANALYSIS. Categorical parameters are presented as counts and percentages and were

FIGURE 1 The Sentinel Cerebral Embolic Protection Device



(A) Evaluation of aortic arch anatomy in multislice computed tomography. **(B)** The Claret Sentinel embolic protection device (Claret Medical Inc., Santa Rosa, California) is a dual filter-based protection device. The proximal filter is positioned in the brachiocephalic trunk, the distal filter is placed in the left carotid artery. The flexible radiopaque filter frames expand to the vessel wall after unsheathing. Fluoroscopic control with both filters properly deployed.

compared by the Pearson chi-square test and the Fisher exact test as appropriate. Continuous variables are presented as mean ± SD. The outcome of patients with cerebral embolic protection was compared with patients without protection. Groups were compared with the 2-sample *t* test or Mann-Whitney *U* test. Post-procedural 7-day outcome was analyzed according to the VARC-2 criteria, including all-cause mortality, major vascular complications, ischemic stroke (disabling and nondisabling), bleeding complications according to Bleeding Academic Research Consortium criteria, and acute kidney injury. To account for possible confounders in the unmatched patient population, adjusted measures of effect were calculated. Adjustment was done for age, sex, STS score for mortality, diabetes, chronic renal insufficiency, coronary artery disease, history of coronary artery bypass grafting, history of stroke, atrial fibrillation, carotid artery stenosis, peripheral artery disease, and left ventricular ejection fraction and valve type. Multivariable analyses using stepwise forward regression were performed to evaluate independent predictors for the primary endpoint in the total study group. The following variables were included for multivariable analysis: sex, diabetes mellitus, valve calcification, atrial fibrillation, STS score for mortality, and use of cerebral protection device. To account for differences between the 2 nonrandomized groups, we performed propensity score analysis based on an optimal matching attempt (SAS version 9.4, SAS Institute, Heidelberg, Germany). Matching was done for STS score, atrial fibrillation, aortic cusp calcification, left ventricular outflow tract calcification, valve type, carotid artery stenosis, peripheral vascular disease, sex, diabetes mellitus, and renal insufficiency. A p value <0.05 was considered to be statistically significant, and tests were 2-sided. Statistical analysis was performed using Statistica release 10 (StatSoft, Tulsa, Oklahoma).

RESULTS

PATIENTS BASELINE CHARACTERISTICS. From 2014 to 2016 a total of 802 consecutive patients were enrolled. The Sentinel cerebral embolic protection device was consecutively used in 280 (34.9%) patients. In 522 (65.1%) patients, TAVR was done without cerebral embolic protection. Patient baseline characteristics and aortic valve parameters were similar between groups (Online Table 1). Procedural data were similar between groups (Online Table 2). In the propensity score-matched population patients' baseline and procedural data did not differ between groups (**Tables 1 and 2**).

SENTINEL DEVICE PERFORMANCE. The Sentinel device was successfully positioned in 280 of 305 (91.8%) patients, with proximal and distal filter in the intended anatomic position. In 1 patient, placement of the distal filter was not performed due to common left carotid artery stenosis, and in 24 cases, the device was not used. In 18 of the 24 patients, right radial or ulnar artery access was impossible due to heavily calcified or

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TABLE 1 Patient Baseline Characteristics: Propensity-Matched Population

	No Cerebral Embolic Protection (n = 280)	Cerebral Embolic Protection (n = 280)	p Value
Age, yrs	80.9 ± 6.4	80.6 ± 6.0	0.79
Female	154 (55.0)	152 (54.3)	0.87
STS score for mortality	6.9 ± 5.0	6.2 ± 4.2	0.10
Diabetes mellitus	82 (29.3)	84 (30.0)	0.79
Chronic renal failure	83 (29.6)	81 (28.9)	0.85
Coronary artery disease	171 (61.1)	166 (59.3)	0.67
History of cardiac surgery	36 (12.9)	24 (8.6)	0.11
History of stroke/intracerebral bleeding	38 (13.6)	26 (9.3)	0.11
Atrial fibrillation	103 (36.8)	100 (35.7)	0.59
Permanent pacemaker	25 (8.9)	27 (9.6)	0.43
Carotid artery stenosis	20 (7.1)	17 (6.1)	0.59
Peripheral vascular disease	19 (6.8)	18 (6.4)	0.86
LVEF <35%	33 (11.8)	20 (7.1)	0.10
Single antiplatelet therapy	171 (61.1)	166 (59.3)	0.67
Dual antiplatelet therapy	58 (20.7)	44 (15.7)	0.13
Oral anticoagulation	85 (30.4)	91 (32.5)	0.59
INR	1.13 ± 0.33	1.13 ± 0.22	0.72
Platelet count, × 10^9/l	202 ± 74	206 ± 68	0.41
Aortic annulus diameter by computed tomography			
Area-derived diameter, mm	24.5 ± 2.4	24.6 ± 2.4	0.46
Area, mm^2	474 ± 92	480 ± 95	0.46
Perimeter, mm	78.7 ± 7.6	78.8 ± 7.7	0.87
Severe aortic cusp calcification	244 (87.1)	245 (87.5)	0.89
LVOT calcification Barbanti 2/3	108 (38.6)	98 (35.0)	0.38

Values are mean ± SD or n (%).

INR = international normalized ratio; LVEF = left ventricular ejection fraction; LVOT = left ventricular outflow tract; STS = Society of Thoracic Surgeons.

TABLE 2 Procedural Data: Propensity-Matched Population

	No Cerebral Embolic Protection (n = 280)	Cerebral Embolic Protection (n = 280)	p Value
Valve size, mm	25.7 ± 2.1	26.3 ± 2.1	<0.01
Edwards Sapien 3*	185 (66.1)	146 (52.1)	<0.01
Boston Lotus†	70 (25.0)	87 (31.1)	0.11
Medtronic Evolut R‡	25 (8.9)	47 (16.8)	0.01
Activated clotting time, s	258 ± 39	261 ± 35	0.44
Pre-dilation	244 (87.1)	258 (92.1)	0.05
Post-dilation	1 (0.4)	3 (1.1)	0.65
Implantation >1 valve	0 (0)	0 (0)	1.0
Conversion to surgery	0 (0)	0 (0)	1.0
Immediate procedural mortality	4 (1.4)	1 (0.4)	0.18
Fluoroscopy time, min	19.1 ± 7.7	20.6 ± 7.1	0.02
Valve repositioning	36 (12.9)	41 (14.6)	0.54
Adjunctive PCI	4 (1.4)	6 (2.1)	0.52
Contrast amount, ml	87 ± 31	88 ± 31	0.69
Coronary obstruction	0 (0)	1 (0.4)	0.17
Annular rupture	0 (0)	1 (0.4)	0.17

Values are mean ± SD or n (%). *Edwards Lifesciences, Irvine, California. †Boston Scientific, Marlborough, Massachusetts. ‡Medtronic, Minneapolis, Minnesota.

PCI = percutaneous coronary intervention.

hypoplastic arteries at puncture side, and in 6 patients, anatomic variants did disable filter positioning. In 2017, brachial access was additionally used, increasing the rate of successful device placement to 96.3% (n = 26 of 27). There was no vascular access in 1 patient. One patient in whom cerebral protection was not used due to atypical insertion of the right subclavian artery suffered a cerebral ischemic event on day 1. Contrast amount was similar between protected and unprotected procedures. However, there was a significant increase in fluoroscopy time with use of the protection device (Table 2). Filters were visually analyzed regarding capturing of debris after removal of the protection device. Debris was seen in 85.1%.

OUTCOME. In the propensity matched population the primary endpoint, stroke-free survival, occurred significantly less frequently with 2.1% (n = 6 of 280) in the protected group compared with 6.8% (n = 19 of 280) in the unprotected group (p = 0.01; odds ratio [OR]: 0.30; 95% confidence interval [CI]: 0.12 to 0.77; absolute risk reduction 4.7%; number needed to treat [NNT] 21). With use of the Sentinel cerebral embolic protection device rate of disabling and nondisabling stroke was significantly reduced from 4.6% to 1.4% (p = 0.03; OR: 0.29; 95% CI: 0.10 to 0.93; absolute risk reduction 3.2%; NNT 31) compared with patients undergoing TAVR without cerebral protection (Table 3, for overall population see Online Table 3).

In patients undergoing protected TAVR, there were 1 disabling and 3 nondisabling strokes. The disabling stroke occurred within 24 h in the protected left parietal and temporal brain regions. Two nondisabling strokes occurred on day 1, 1 in the protected left parietal and temporal brain region and 1 in the unprotected left parieto-occipital brain region. One nondisabling stroke happened on day 4 in the potentially protected right posterior brain region supplied by the posterior cerebral artery. None of these events occurred during positioning or removal of the cerebral protection device. In addition, the SENTINEL endpoint, a combination of all-cause mortality, all stroke, and acute kidney injury stage 3, was significantly less frequent with use of the embolic protection device (7.9% vs. 2.1%; p = 0.01). The incidences of major vascular complications, major bleeding, and acute kidney injury were similar between groups (Table 3). In multivariable analysis only STS score for mortality (p = 0.02) and TAVR procedure without cerebral embolic protection (p = 0.02) were independent predictors for the occurrence of death or stroke, but not sex, diabetes, valve calcification, or atrial fibrillation. Procedure without use of a cerebral embolic protection device was the only independent predictor (p = 0.04) for the occurrence of stroke within

7 days, but not STS score for mortality, sex, diabetes, valve calcification, or atrial fibrillation. In addition, stroke was significantly lower with use of the protection device compared with unprotected procedures within 48 h (3.6% vs. 1.1%; p = 0.03; OR: 0.29; 95% CI: 0.10 to 0.93; NNT 31).

TABLE 3 Outcome: Propensity-Matched Population

	No Cerebral Embolic Protection (n = 280)	Cerebral Embolic Protection (n = 280)	OR (95% CI)	p Value
Mortality or stroke	19 (6.8)	6 (2.1)	0.30 (0.12–0.77)	0.01
Disabling and nondisabling stroke	13 (4.6)	4 (1.4)	0.29 (0.10–0.93)	0.03
Disabling	9 (3.2)	1 (0.4)	0.11 (0.01–0.86)	0.01
Nondisabling	4 (1.4)	3 (1.1)	0.75 (0.17–3.38)	0.70
Mortality	8 (2.9)	2 (0.7)	0.25 (0.05–1.20)	0.06
Acute kidney injury stage 2/3	4 (1.4)	3 (1.1)	0.64 (0.15–2.71)	0.54
Major vascular complications	10 (3.6)	5 (1.8)	0.64 (0.23–1.78)	0.19
Major bleeding	12 (4.3)	4 (1.4)	0.33 (0.11–1.05)	0.05
SENTINEL endpoint*	22 (7.9)	7 (2.1)	0.32 (0.14–0.77)	0.01

Values are n (%) unless otherwise indicated. *All-cause mortality, all stroke, acute kidney injury stage 3.

CI = confidence interval; OR = odds ratio; SENTINEL endpoint = all-cause mortality, all stroke, acute kidney injury stage 3.

DISCUSSION

We are able to demonstrate in a large-scale prospective all-comers TAVR trial a significantly lower rate of death and stroke for patients undergoing transfemoral TAVR with the Sentinel cerebral embolic protection device compared with patients receiving TAVR without protection. In addition, use of the Sentinel cerebral embolic protection device was associated with high technical success.

Cerebral ischemic events have been a major issue in TAVR, with a severe impact on morbidity and mortality (24–26). In the PARTNER-1 trial (27) transfemoral TAVR was associated with an increased risk of stroke (5.5% at 30 days) compared with the surgical approach (2.4%), limiting its future adoption in low-risk patients. With new-generation TAVR devices, disabling stroke rates have been reduced to 3.2% in PARTNER-2 trial at 30 days compared with 4.3% with surgical approach in intermediate-risk patients (2).

Cerebral ischemic lesions have been shown to be associated with a decline in neurological and neurocognitive function (28–30). With TAVR advancing to intermediate risk and younger patients preventing cerebral ischemic events and protecting the brain from embolic burden is crucial to improve overall TAVR outcome and prevent stroke related morbidity and mortality. Recent studies on cerebral embolic protection devices demonstrated a significant reduction in number and volume of cerebral lesions on diffusion weighted MRI post TAVR compared with unprotected procedures (10–16). A prospective randomized evaluation of the DEFLECT III (TriGuard™ HDH embolic DEFLECTion device during transcatheter aortic valve implantation) trial with 85 patients demonstrated a reduction of all stroke from 5.1% (n = 2 of 39) to 2.2% (n = 1 of 46) (p = 0.46; absolute risk reduction 2.9%) at 30 days with use of the Triguard embolic protection device (Keystone Heart Ltd., Caesarea, Israel) (10) and a greater freedom from new cerebral ischemic lesions. The randomized MISTRAL-C trial, using the Claret Sentinel device in 65 patients, revealed a significant reduction in multiple new brain lesions from 20% to 0% (p = 0.03) (11). The randomized CLEAN-TAVI (Claret Embolic Protection and TAVI) (12) trial with 100 patients also demonstrated a reduction in number (5 vs. 10; p = 0.009) and volume of new cerebral lesions (205 mm^3 vs. 472 mm^3; p = 0.009) on diffusion-weighted MRI following TAVR with use of the Claret Sentinel filter-based embolic protection device. We demonstrate in a large all-comer patient series of 280 protected TAVR patients compared with 522 unprotected TAVR patients a significant reduction of cerebral ischemic events and high technical success. In the propensity-matched population including 560 patients, there was a significant reduction in disabling and nondisabling stroke from 4.6% without protection to 1.4% with the Sentinel embolic protection device (p = 0.03). This represents an absolute risk reduction of 3.2%, which is similar to the 2.9% absolute risk reduction in DEFLECT III trial using the Triguard system and an absolute 3.6% reduction of stroke (p = 0.57) in the SENTINEL trial (17). In contrast to the SENTINEL trial our primary endpoint was defined earlier, within 7 days, which covers the periprocedural events as well as potential events triggered by device positioning. Furthermore, there was a significant reduction of cerebral ischemic events within the early periprocedural period of the first 48 h with use of the Sentinel protection device. A longer follow-up allows cofounders such as atrial fibrillation to dilute the results. However, even with use of the protection device, there were some strokes, which is predominantly explained by 2 reasons. First, brain regions supplied by the left vertebral artery, originating from the left subclavian artery, stay unprotected. Second, there is only 1 size of filter system available. Hence, complete sealing of the intended vessels after expansion of the proximal and distal filter might not be achieved in all aortic arch anatomies.

A recent large meta-analysis by Giustino et al. (31) included 5 randomized controlled trials on cerebral embolic protection devices. There were 376 patients randomized to embolic protection compared with 249

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unprotected patients. Absolute risk reduction of the combined endpoint stroke or death at longest follow-up was 4.4% ($p = 0.04$) with an NNT of 22. The present analysis including 560 patients with propensity score matching demonstrated an absolute risk reduction of stroke or death of 4.7% ($p = 0.01$) and an NNT of 21. In the meta-analysis, there was an absolute risk reduction of mortality of 2.28% ($p = 0.12$) with an NNT of 44 compared with 2.2% ($p = 0.06$) and an NNT of 45 in the present analysis. Use of a protection device was associated with an absolute risk reduction of 2.2% ($p = 0.02$) for stroke with an NNT of 46 in the meta-analysis. With use of the Sentinel protection device there was an absolute risk reduction of 3.2% ($p = 0.03$) with an NNT of 31 in our study. In contrast to DEFLECT III, CLEAN-TAVI (The Claret Embolic Protection and TAVI), and SENTINEL trials, there were no exclusion criteria in our study and patients were at a higher periprocedural risk, documented by a higher STS score. Looking at the other VARC-2 outcome measures, there was no significant difference in rate of major bleeding, major vascular complications, and acute kidney injury among groups because operators, TAVR devices used, and technical setting were otherwise identical. The SENTINEL endpoint including all death, all stroke, and acute kidney injury stage 3 was significantly lower in the protected group compared with the unprotected population (2.1% vs. 7.9%; $p = 0.01$). Nonrandomized data demonstrated a lower stroke rate for the Edwards Sapien 3 valve (1.4%) (Edwards Lifesciences, Irvine, California) in the SOURCE 3 (SAPIEN Aortic Bioprosthesis European Outcome) registry (32) compared with stroke rates known from the Boston Lotus (Boston Scientific, Marlborough, Massachusetts) (33) and Medtronic Evolut R (Medtronic, Minneapolis, Minnesota) (34). Hence, effect of cerebral embolic protection might have even been underestimated in our patient population where the implantation of the Edwards Sapien 3 valve was significantly more frequent in the unprotected group.

Technical success with the Sentinel device was high with 91.8% in a more complex and consecutive patient population compared with 92% in the CLEAN-TAVI trial, 93.3% in the SENTINEL trial, and 88.9% with the Triguard device in the DEFLECT III trial in selected patients. Including the right brachial artery access, technical success rate increased to 96.3%. There was no increase in contrast amount, but fluoroscopy time significantly increased by 1.5 min with use of the protection device versus 3 min in the SENTINEL trial.

In multivariate analyses, only STS score for mortality and the TAVR procedure without use of the cerebral embolic protection device were independent predictors for the primary endpoint. In addition, there are no safety issues with use of the protection device. Hence, cerebral embolic protection should become standard of the TAVR procedure, as there are no pre-procedural independent predictors identified for selection of patients at high risk for stroke.

STUDY LIMITATIONS. This was not a randomized controlled trial, although it is the largest published study to date comparing outcomes with the Sentinel cerebral embolic protection device with unprotected TAVR procedures in patients with severe aortic stenosis. To account for differences at baseline, propensity matching was performed, although there was no change in vascular preclosure, valve types, setting in the hybrid cath lab, or operators between groups, apart from the protection device.

CONCLUSIONS

In patients undergoing TAVR, use of a cerebral embolic protection device demonstrated a significantly higher rate of stroke-free survival compared with unprotected TAVR.

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PERSPECTIVES

WHAT IS KNOWN? Cerebral ischemic events after TAVR have been identified as an independent predictor of morbidity and mortality. Data on cerebral embolic protection devices demonstrated a reduction in number and volume of new ischemic brain lesions on diffusion-weighted MRI and a trend toward less neurological impairment compared with unprotected procedures.

WHAT IS NEW? This study includes the largest number of patients undergoing TAVR with cerebral embolic protection. Stroke-free survival was significantly higher with use of the Sentinel cerebral embolic protection device compared with a propensity score–matched population undergoing unprotected TAVR.

WHAT IS NEXT? Our data, supported by recently published data on cerebral embolic protection device focusing on brain imaging, provide strong evidence that protecting the brain from embolic burden during TAVR improves neurological outcome. Larger randomized controlled trials are needed to confirm these findings.

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APPENDIX For supplemental tables, please see the online version of this paper.