Objective analysis of midterm outcomes of conventional and hybrid aortic arch repair by propensity-score matching

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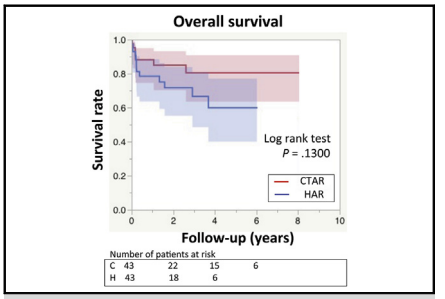
ABSTRACT

Objective: The aim of this study is to evaluate the objective outcomes of conventional total aortic arch repair (CTAR) and hybrid arch repair by using propensity-score matching to reduce selection bias.

Methods: Between January 2006 and April 2016, 470 consecutive patients underwent isolated aortic arch repair (excluding hemiarch or partial arch reconstruction, and cases with concomitant cardiac surgeries) at a single cardiovascular institute. We categorized 337 total aortic arch repair with antegrade cerebral perfusion under circulatory arrest as the CTAR group and 58 hybrid aortic arch repair (HAR) with thoracic endovascular aortic repair as the HAR group. Seventy-five patients with scheduled and staged thoracic endovascular aortic repair after total aortic arch repair with elephant trunk were excluded. Then, we compared early and midterm outcomes between the propensity-matched group (43 CTAR vs HAR pairs).

Results: There were no significant differences in 30-day and operative deaths between the CTAR and HAR groups (4.7% [2/43] vs 7.0% [3/43]; $P = .4142$ and 11.6% [5/43] vs 16.3% [7/43]; $P = .5637$). Although there were no significant differences in the incidences of other major complications, permanent stroke was observed more frequently in the HAR group (0% [0/43] vs 11.6% [5/43]; $P = .0064$) compared with the CTAR group. Matching analysis, however, revealed an equivalent 5-year survival rate between the CTAR and HAR groups (80.5% vs 59.9%; $P = .1300$).

Conclusions: Matching analysis revealed a significantly greater incidence of stroke in the HAR group but equivalent midterm outcomes in the hybrid group compared with the CTAR group. (J Thorac Cardiovasc Surg 2017;154:100-6)



Matched analysis reveals equivalent survival rate between conventional and hybrid groups.

Central Message

Matching analysis revealed equivalent midterm outcomes in the hybrid arch repair groups compared with the conventional arch repair group.

Perspective

Matching analysis revealed a significantly greater incidence of postoperative stroke but equivalent midterm outcomes in the hybrid arch repair group compared with the conventional arch repair group. In a high-risk population, hybrid approaches have the potential to be alternatives to a conventional approach. Further development, however, is required for hybrid repair to become a superior option.

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Conventional surgical total aortic arch repair (CTAR) with the use of antegrade cerebral perfusion under moderate hypothermia is an established procedure with excellent 5-year survival reported to be 70% to 90%.[1-6] CTAR, however, is not necessarily an optimal strategy, especially for high-risk patients, considering the invasiveness of surgery. Therefore, hybrid aortic arch repair (HAR) with thoracic endovascular aortic repair (TEVAR) has been introduced in the last decade for patients with comorbidities and frailties.[7-16] The safety of hybrid TEVAR securing enough proximal landing zone and requiring supra-aortic rerouting bypass is still, however, controversial. We previously reported satisfactory midterm outcomes of CTAR (7-year survival = 90.1%), compared with HAR with TEVAR, but the preoperative patient background in that report was significantly different because hybrid approaches had

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Scanning this QR code will take you to supplemental figures, table and a video for the article.

Abbreviations and Acronyms
CTAR = conventional surgical total aortic arch repair
HAR = hybrid aortic arch repair
PTFE = polytetrafluoroethylene
TEVAR = thoracic endovascular aortic repair

been used for high-risk patients.[17] Patient background makes it difficult to evaluate the veritable superiority in outcomes, and there are still limited studies regarding risk-adjusted comparison between conventional and hybrid approaches.[18,19] The aim of this study is to evaluate the objective outcomes of CTAR and HAR by the use of propensity-score matching to reduce selection bias.

PATIENTS AND METHODS

Between January 2006 and April 2016, 470 consecutive patients underwent isolated aortic arch repair (excluding hemiarch or partial arch reconstruction, and cases with concomitant cardiac surgeries) at the Sakakibara Heart Institute of Okayama in Japan. In the present study, 75 patients with staged and scheduled TEVAR after reconstruction of arch vessels with elephant trunk for extended lesion were excluded, because this procedure is a useful option for extended lesion but controversial as a hybrid option. Of those remaining, CTAR with antegrade cerebral perfusion under moderate hypothermia was performed for 337 patients and debranching with TEVAR (including 1, 2, and total rerouting) in 58 patients, including 4 patients with chimney technique for zone 0. The patients with an isolated lesion at the descending aorta were not included in the group. Patients who underwent debranching with TEVAR and chimney technique were categorized as HAR group to aortic arch lesion.

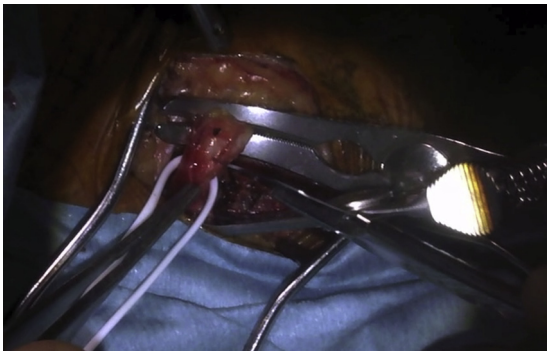
In our institute, conventional open repair basically was considered as the first choice. We also selected the respective hybrid approaches for high-risk patients, based on the patient frailty, anatomically broad lesion, and aortic shagginess. This study is a retrospective risk-adjusted comparison of early and midterm clinical outcomes between CTAR and respective hybrid approaches with propensity-score matching. The project was approved by the institutional review board of the Sakakibara Heart Institute of Okayama, on April 1, 2016. Since it has been reported previously, the respective surgical technique is summarized here briefly.[17]

Conventional TAR (n = 337)

After systemic cooling to a bladder temperature of 25°C on cardiopulmonary bypass by the use of unilateral femoral artery perfusion and bicaval drainages, antegrade cerebral perfusion was established by inserting 14-18 Fr balloon catheters into the 3 aortic arch vessels under circulatory arrest. The brachiocephalic artery was clamped to perfuse the right-sided hemisphere in case the right axillary artery also was chosen for arterial cannulation. The aortic arch was transected at the level distal to the aneurysmal end and reconstructed with the use of either the stepwise technique or direct distal anastomosis.[5] Finally, antegrade systemic perfusion through the rim of the graft was resumed, and 3 cerebral vessels and proximal aorta were reconstructed step-by-step (Video 1).

Debranching With TEVAR (n = 54)

For the single debranching technique, a left carotid-left axillary artery bypass with an 8-mm polytetrafluoroethylene (PTFE) graft was performed for zone 2 proximal landing (n = 23), and the double debranching technique, composed of the right axillary-left common carotid and the left axillary bypass with an 8-mm PTFE T-shape graft, was performed for zone 1 proximal landing (n = 17). The left subclavian artery was embolized routinely for the prevention of persistent type II endoleak after debranching TEVAR. For the total debranching technique, type I hybrid arch repair, which was reported previously by Bavaria and colleagues,[10] was adopted (n = 14). With regard to device selection, Zenith TX2 (Cook Inc, Bloomington, Ind), Gore TAG or Conformable TAG (W. L. Gore and Associates, Flagstaff, Ariz), and Relay Plus (Bolton Medical Inc, Sunrise, Fla) were used in 12, 26, 15, and 1 patients, respectively.



VIDEO 1. Initial-stage arch repair at the proximal site of aneurysm lesion as another option. During systemic cooling under cardiopulmonary bypass using the unilateral femoral (18 Fr) and right axillary arteries (12 Fr), and bicaval cannulations, the neck vessels were taped. Then, Gelweave Siena 4 branch Plexus graft (Vascutek, Inchinnan, Scotland, UK) was trimmed with a 7-cm elephant trunk, and radiopaque marker was placed at the distal edge of the graft. The ascending aorta was clamped, and antegrade cardioplegia was administered. After systemic cooling was achieved to bladder temperature of 25°C, the brachiocephalic artery was clamped to perfuse the right-sided hemisphere, and antegrade cerebral perfusion was established by inserting 14-18 Fr balloon catheters under circulatory arrest. The aortic arch was transected at the proximal end of the aneurysm and reconstructed using elephant trunk anastomosis placed between the left carotid and left subclavian artery. Then, resuming antegrade systemic perfusion through the rim of the graft, proximal anastomosis was performed and myocardial perfusion resumed. The cerebral vessels were reconstructed step-by-step. Video available at: http://www.jtcvsonline.org/article/S0022-5223(17)30192-7/addons.

Endovascular Chimney Technique (n = 4)

In the patients requiring zone 0 landing, single-stent chimney technique was performed, considering the risk of sternotomy. After a right carotid-left carotid artery bypass with a 7-mm PTFE graft, a chimney graft was deployed in the innominate artery and TEVAR was performed through the femoral artery. The left subclavian artery was embolized routinely for the prevention of persistent type II endoleak and revascularized to the left carotid artery.

Statistical Analysis

Continuous data are presented as mean ± standard deviation and were analyzed by the use of 2-tailed *t*-tests or compared with a Mann-Whitney *U* test for independent data, as appropriate. Categorical variables are given as a count and percentage of patients and compared using the χ^2 or Fisher exact test. The survival rate between groups was compared with the Kaplan-Meier model and log-rank test. A *P* value of < .05 was considered significant. All data were analyzed with the Statistical Analysis Systems software JMP 12.0 (SAS Institute Inc, Cary, NC). We also performed propensity-score matching using a 1:1 nearest-available matching algorithm with a ± 0.1 caliper and no