Impact of Surgical Stroke on the Early and Late Outcomes After Thoracic Aortic Operations

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Background. **Thoracic aortic operations still remain associated with substantial risks of death and neurologic injury. This study investigated the impact of surgical stroke on the early and late outcomes, focusing on the physical status and quality of life (QOL).**

Methods. **From 1986 to 2008, 500 patients (aged 63 ± 13 years) underwent open thoracic aortic repair for root and ascending (31%), arch (39%), extended arch (10%), and descending and thoracoabdominal (19%) aneurysms. Brain protection consisted of retrograde cerebral perfusion (52%), antegrade cerebral perfusion (29%), and simple deep hypothermic circulatory arrest (19%). Surgical stroke was defined as a neurologic deficit persisting more than 72 hours after the operation. QOL was assessed with the Short-Form 36 Health Survey Questionnaire 5.9 ± 4.2 years after the operation.**

Results. **Stroke occurred in 10.3% of patients. Hospital mortality was 21% in the stroke group and 2.7% in the nonstroke group ($p < 0.001$). At hospital discharge, 76% of survivors in the stroke group had permanent neurologic deficits (PNDs), with sustained tracheostomy in 39%, tube feeding in 46%, and gastrostomy in 14%, and 89% required transfer to other facilities. PND was an independent risk factor for late death (hazard ratio, 2.29; 95% confidence interval, 1.04 to 4.62; $p = 0.041$) in a multivariate analysis. The physical component of the QOL score was worse in the PND group (51% vs 100%; $p = 0.039$), whereas the mental component was similar in both groups (14% vs 14%).**

Conclusions. **Surgical stroke is associated with high hospital mortality and PNDs that decrease late survival and the physical component score of the QOL survey.**

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Despite remarkable improvements in surgical technique and brain protection methods, surgical thoracic aortic repair remains an invasive procedure associated with substantial risks of death and permanent neurologic injury. Stroke during thoracic aortic operations could be regarded as a procedure-related adverse outcome triggered during the operation, so we termed this a "surgical stroke." We believe the surgeon has the responsibility to fully understand the early and late outcomes after surgical stoke. However, previous publications have been focused mostly on the risk factors for surgical stroke such as the patient demographics or brain protection techniques [1–3]. Surgical stroke is known to be an independent risk factor for early death [4]. However, the impact of surgical stroke on the long-term results remains unclear.

Very few reports are available concerning the impact of surgical stroke on early and late outcomes, including the patient's physical status and quality of life (QOL), as well as the mortality of the affected patients. The aim of this study was to investigate the impact of surgical stroke on the early and late outcomes after thoracic aortic operations, focusing on physical status and QOL.

Patients and Methods

The Nagoya University Graduate School of Medicine Institutional Review Board approved this study, and individual patient consent for this study was obtained.

Patients

We retrospectively analyzed the data for 500 consecutive thoracic aortic operations performed from 1986 to 2008 at our institute. Patient characteristics are summarized in Table 1. The patients were 70% male, with a mean age of 63 ± 13 years. Aneurysms due to dissection were noted in 32% of patients, and those due to atherosclerosis comprised the remaining 68%. Twenty percent of the operations were performed as emergency or urgent procedures. The cerebral protection technique was applied with antegrade cerebral perfusion (ACP) in 29%, retrograde cerebral perfusion (RCP) in 52%, and simple deep hypothermic circulatory arrest (DHCA) in 19%. A concomitant cardiac procedure was performed in 26% of the patients. The intraoperative data are listed in Table 2. The replaced segments of the aorta were the ascending to

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Abbreviations and Acronyms

ACC = aortic clamping time
ACP = antegrade cerebral perfusion
CI = confidence interval
CPB = cardiopulmonary bypass
DHCA = deep hypothermic circulatory arrest
HR = hazard ratio
ICU = intensive care unit
IQR = interquartile range
MCS = Mental Component Summary
PCS = Physical Component Summary
PND = permanent neurologic deficit
QOL = quality of life
RCP = retrograde cerebral perfusion
SD = standard deviation
SF-36 = Short Form 36 Health Survey Questionnaire
TND = transient neurologic dysfunction

the root in 31%, the arch in 39%, an extended arch in 11%, or the descending and thoracoabdominal aortae in 9%.

Surgical stroke was defined as a newly developed neurologic deficit within 24 hours after surgery that persisted more than 72 hours, with a new focal lesion of the brain detected by computed tomography scanning or magnetic resonance imaging. To avoid including postoperative strokes, the onset of neurologic symptoms was limited to those that occurred within 24 hours postoperatively. In elective cases, preoperative head computed tomography or magnetic resonance imaging scans, or both, were conducted in all patients as a reference. If we could not confirm whether the lesion was new postoperatively, magnetic resonance imaging was conducted to determine whether any new infarctions had occurred. Cases of surgical death, which was defined as death within 72 hours after the operation, and transient ischemic attack, which had symptoms that recovered within 72 hours, were excluded from the cases of surgical stroke.

Table 1. Baseline Patient Characteristics

Variable	Result
Age, mean ± SD y	63 ± 13
Male, %	71
Emergency/urgent, %	21
Redo, %	17
Marfan, %	7
Type of aneurysm, %	
Dissection	32
Atherosclerosis	68
Concomitant operation, %	26
Smoking, %	44
Diabetes, %	12
Hypertension, %	74
Hyperlipidemia, %	31
Renal failure, %	6.7
COPD, %	14

COPD = chronic obstructive pulmonary disease; SD = standard deviation.

Table 2. Operative-Related Data

Variable	Result
Range of replacement, %	
Ascending root	31
Arch	39
Extended arch	11
Descending thoracoabdominal	9
Approach, %	
Median sternotomy	67
L-shaped thoracotomy[a]	5
Left thoracotomy	16
Thoracoabdominal incision[b]	12
Cerebral protection techniques, %	
ACP	29
RCP	52
DHCA	19
CPB time, mean ± SD min	221 ± 88
ACC time, mean ± SD min	100 ± 68
ICU stay, mean (IQR) days	2 (1–5)[c]

[a] L-shaped thoracotomy means the combination of an upper partial sternotomy and anterolateral thoracotomy. [b] The thoracoabdominal incision is made usually through the fifth or sixth intercostal space and is extended pararectally, with retroperitoneal entry into the aorta. [c] The values were expressed as the median (interquartile range).

ACC = aortic clamping time; ACP = antegrade cerebral perfusion; CPB = cardiopulmonary bypass time; DHCA = deep hypothermic circulatory arrest; ICU = intensive care unit; IQR = interquartile range; RCP = retrograde cerebral perfusion; SD = standard deviation.

A permanent neurologic deficit (PND) was defined as a surgical stroke in a patient whose neurologic symptoms persisted until hospital discharge. An extended arch aneurysm was defined as an aneurysm located in the aortic arch that extended to the distal portion near the pulmonary hilum, where we could not perform a distal anastomosis via a standard median sternotomy. Data from the patients' hospital records were obtained from our departmental registry. The mean postoperative follow-up was 76 ± 58 months (range, 1 to 294 months).

QOL Analysis

The long-term QOL was measured by the Japanese version of the Short-Form 36 (SF-36) Health Survey Questionnaire, a self-reported questionnaire used to evaluate health-related QOL [5, 6]. The SF-36 consists of 36 questions that measure the 8 scale profiles of functional health, including physical functioning, role limitations due to physical problems, bodily pain, social functioning, general health perceptions, vitality, role limitations due to emotional problems, and mental health. Two summary measures, the physical component summary (PCS) and mental component summary (MCS), are calculated from the 8 scales and can be compared with an age-matched and gender-matched Japanese standard population of healthy individuals. A significant