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A systematic approach to improve the outcomes of type A aortic dissection

Hidefumi Nishida, MD,[a] Minoru Tabata, MD, MPH,[a,b] Toshihiro Fukui, MD,[a,c] Yasunori Sato, PhD,[d] Hajime Kin, MD,[a] and Shuichiro Takanashi, MD[a]

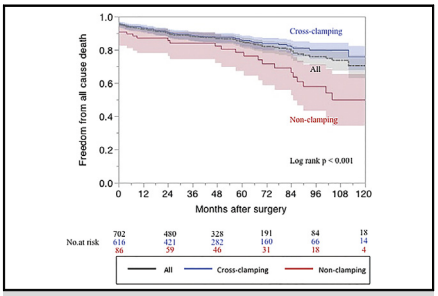
ABSTRACT

Objectives: The aims of this study are to evaluate the outcomes and trends of contemporary emergency surgery for acute type A aortic dissection on the basis of a systematic approach and to assess the impact of temporary aortic crossclamping during systemic cooling on early and late outcomes.

Methods: We retrospectively reviewed 702 consecutive patients who underwent emergency surgery for acute type A aortic dissection between March 2004 and May 2015. Our clinical protocol includes rapid transfer to the operating room, quick establishment of cardiopulmonary bypass, temporary aortic crossclamping during cooling, primary entry resection, and open distal anastomosis. We analyzed the perioperative data, survival, freedom from aortic reinterventions, and impact of aortic crossclamping on early and late outcomes.

Results: The median time from hospital arrival to cardiopulmonary bypass establishment was 115 minutes and has decreased over the last decade (trend test $P < .001$). We perfused the femoral artery in 615 patients (87.6%), placed aortic crossclamping in 616 patients (87.7%), and performed open distal anastomosis in all patients. The operative mortality was 5.4% (38/702), and the incidence of stroke was 10.8% (76/702). The 7-year overall survival and freedom from aortic reinterventions were 80.4% and 87.5%, respectively. Compared with the non-clamping group, the crossclamping group had a shorter operation time, similar operative mortality, incidence of stroke, and freedom from aortic reinterventions.

Conclusions: Emergency surgery for acute type A aortic dissection based on our systematic approach demonstrated excellent early and late outcomes. The temporary aortic crossclamping during cooling decreased the operation time without increasing early and late adverse events. (J Thorac Cardiovasc Surg 2017;154:89-96)



Long-term survival after emergency surgery for ATAAD.

Central Message

Emergency surgery for ATAAD based on our systematic approach demonstrated excellent early and late outcomes.

Perspective

Our findings increase surgeons' awareness of the importance of a systematic approach to emergency surgery for ATAAD, which may contribute to an improvement in surgical outcomes of ATAAD. The spread of temporary aortic crossclamping during systemic cooling may shorten the average operation time without increasing adverse events.

See Editorial Commentary page 97.

Despite recent advances in surgical techniques and perioperative management, the surgical mortality of acute type A aortic dissection (ATAAD) remains high (12.7% to 29.8%).[1-5]

To improve surgical outcomes, various techniques have been developed over time.[6] The current consensus about the surgical technique for ATAAD recommends open distal anastomosis with hypothermic circulatory arrest.[7-9] However, it is not clearly understood whether temporary aortic crossclamping during systemic cooling affects surgical outcomes or not.

The aims of this study are to evaluate the outcomes and trends of emergency surgery for ATAAD in a Japanese high-volume aortic center and to assess the impact of temporary aortic crossclamping on early and late outcomes.

Scanning this QR code will take you to supplemental table and video for this article.

From the [a]Department of Cardiovascular Surgery, Sakakibara Heart Institute; [b]Department of Cardiovascular Surgery, Tokyo Bay Urayasu-Ichikawa Medical Center, Tokyo; [c]Department of Cardiovascular Surgery, Kumamoto University, Kumamoto; and [d]Department of Global Clinical Research, Graduate School of Medicine, Chiba University, Chiba, Japan.

Received for publication July 13, 2016; revisions received Jan 23, 2017; accepted for publication March 9, 2017; available ahead of print April 14, 2017.

Address for reprints: Minoru Tabata, MD, MPH, Department of Cardiovascular Surgery, Tokyo Bay Urayasu-Ichikawa Medical Center, 3-4-32 Todaijima, Urayasu-Shi, Chiba 279-0001, Japan (E-mail: mtabata@post.harvard.edu).

0022-5223/$36.00

http://dx.doi.org/10.1016/j.jtcvs.2017.03.050

Abbreviations and Acronyms

ATAAD = acute type A aortic dissection
CT = computed tomography
CPB = cardiopulmonary bypass
FA = femoral artery
OR = operating room
TEE = transesophageal echocardiography

MATERIALS AND METHODS

Patients and Study Design

Between March 2004 and May 2015, 702 consecutive patients underwent emergency surgical aortic repair of ATAAD at Sakakibara Heart Institute. The diagnosis of ATAAD was made with computed tomography (CT) in all patients. ATAAD was defined as any nontraumatic dissection involving the ascending aorta presenting within 14 days from symptom onset.

This is a retrospective cohort study. First, we assessed the time from hospital arrival to establishment of cardiopulmonary bypass (CPB) (door-to-CPB time), operative procedural details, operative mortality, incidence of postoperative complications, long-term mortality, and aortic reinterventions. We also assessed the trend of door-to-CPB time and operative mortality over a decade. In the door-to-CPB time analysis, we excluded 1 patient who developed ATAAD during hospitalization for Stanford type B aortic dissection.

Second, we divided our 702 cases into 2 groups, the aortic crossclamping group and the nonclamping group, and compared early and late outcomes. We also evaluated the impact of aortic crossclamping on incidence of stroke and aortic reinterventions using multivariable analyses. For comparison of operation time, isolated ascending aortic or hemiarch replacement cases were exclusively included to adjust the bias of operative procedures. We included cases in which we crossclamped the aorta and aborted the clamping with any reasons in the crossclamping group.

The institutional review board of our institution approved this study and waived the requirement for informed consent. All data were collected prospectively and reviewed retrospectively from each patient's medical chart during regular visits to the outpatients' clinic or by telephone interview. The latest follow-up was conducted between June 2014 and May 2015. The mean follow-up period was 47.5 $\pm$ 36.0 months after surgery.

Definitions

Emergency surgery was defined as operation within 24 hours after the diagnosis. Preoperative shock was defined as an unstable preoperative condition with at least 1 of the following factors: systolic blood pressure less than 80 mm Hg, requirement of inotropes, pericardial drainage, or cardiopulmonary resuscitation. Cerebral malperfusion was defined as newly developed neurologic deficits with cervical arterial dissection on CT images. Myocardial malperfusion was defined as new electrocardiogram change indicating myocardial ischemia, elevated myocardial enzymes, and coronary arterial dissection on echocardiography or CT images. Lower-limb malperfusion was defined as newly developed lower-limb ischemia with symptoms and corroborative CT images. Mesenteric malperfusion was defined as newly developed acute abdomen associated with a dissected superior mesenteric artery on CT images. Operative mortality was defined as any death within 30 days after surgery or before discharge. Stroke was defined as the presence of new neurologic dysfunction lasting for more than 24 hours. High-risk patients were defined as patients with at least 1 of the following factors: age 80 years or older, preoperative shock, previous cardiac surgery, and any organ malperfusion.[5,10,11]

Diagnosis and Surgical Protocols

Our systematic protocol includes rapid transfer to the operating room (OR), quick establishment of CPB mainly with femoral arterial cannulation, temporary aortic crossclamping during cooling, primary entry resection, and open distal anastomosis.

When the diagnosis has been made at a transferring hospital, we start setting up the OR before the patient's arrival and transfer the patient to the OR as soon as possible after arrival. Even for undiagnosed patients, we start preparing the OR except for opening the sterile instruments and CPB circuits before arrival if the reported patient's condition is likely to be ATAAD. Then, we quickly transfer the patient to the CT suite and perform contrast-enhanced scans after arrival. As soon as the diagnosis of ATAAD is made, we continue setting up the OR and stabilize the patient in the intensive care unit until the OR is ready to accept the patient.

All operations are performed through a median sternotomy. The femoral artery (FA) is primarily selected as a cannulation site unless the CT findings show malperfusion of bilateral legs or shaggy aorta.[12] For quick establishment of CPB, the sternotomy and dissection of the FA are performed simultaneously. We routinely scan the true lumen of the aorta by transesophageal echocardiography (TEE) as soon as CPB is established. If the true lumen collapses, we stop CPB and switch the cannulation site to the left ventricular apex. We use the EZS21A cannula (Edwards Lifesciences, LCC, Irvine, Calif) for left ventricle apex perfusion. When preoperative CT shows bilateral lower limbs malperfusion or shaggy aorta, we cannulate the left ventricular apex or right axillary artery instead of the FA. In this series, the ascending aorta was cannulated in a few cases with unclear reasons. We cannulated the right atrium for systemic venous drainage and right upper pulmonary vein for left ventricle vent.

After establishment of CPB, the patients are cooled down to 25°C for circulatory arrest. During systemic cooling, we usually crossclamp the aorta, open the proximal ascending aorta, administer retrograde and selective cardioplegia, and repair the aortic root. At the moment of crossclamping, we temporarily stop perfusion, decrease the pressure of aorta to zero, and clamp the aorta very slowly to minimize the pressurization of the false lumen. At the same time, an anesthesiologist temporarily compresses the bilateral carotid arteries to avoid incidental cerebral thrombosis. Needless to say, we do not clamp the aorta when we cannulate the left ventricular apex. We carefully monitor the blood pressure of the bilateral radial arteries, bilateral cerebral oxygen saturation, and TEE findings after crossclamping. If any sign of malperfusion is found, we unclamp the aorta or change the clamping site proximally. We did not crossclamp the aorta in 86 patients. The reasons why we did not crossclamp included systemic perfusion from the left ventricular apex (60 cases), severe adhesion around the ascending aorta (12 cases), large thrombosis in the ascending aortic false lumen (6 cases), on-pump beating coronary artery bypass grafting performed during cooling (4 cases), large entry in ascending aorta (3 cases), and distal ascending aortic rupture (1 case).

In supracommissural aortic repair, the dissected aortic root is repaired with BioGlue (Cryolife Inc, Kennesaw, Ga) and double strips at the level of the sinotubular junction. At the core temperature of 25°C, systemic circulation is arrested. In ascending aortic or hemiarch replacement, the distal end of the aorta is reinforced with double felt strips and open distal anastomosis is performed with retrograde cerebral perfusion. After distal anastomosis, systemic perfusion is resumed through the branch of the prosthesis and the proximal anastomosis is performed during rewarming (Video 1). In total arch replacement, open distal anastomosis is performed with selective antegrade cerebral perfusion. We use the MERA balloon catheter 12F cannula (MERA, Inc, Tokyo, Japan). The details of our total arch replacement have been reported.[13] We perform total arch replacement when the entry is located in the aortic arch or the distal aortic arch is dilated (>45 mm).[14] We perform aortic root operations when at least 1 of the following conditions exist: intimal tear in the aortic root, extensive involvement of coronary arteries, aortic root rupture, and aortic root diameter 45 mm or greater.[15]