Vascular Surgery in Japan: 2016 Annual Report by the Japanese Society for Vascular Surgery

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Objectives: This is an annual report indicating the number and early clinical results of annual vascular treatment performed by vascular surgeon in Japan in 2016, as analyzed by database management committee (DBC) members of the JSVS.

Materials and Methods: To survey the current status of vascular treatments performed by vascular surgeons in Japan, the DBC members of the JSVS analyzed the vascular treatment data provided by the National Clinical Database (NCD), including the number of treatments and early results such as operative and hospital mortality.

Results: In total 136,414 vascular treatments were registered by 1,070 institutions in 2016. This database is composed of 7 fields including treatment of aneurysms, chronic arterial occlusive disease, acute arterial occlusive disease, vascular injury, complication of previous vascular reconstruction, venous diseases, and other vascular treatments. The number of vascular treatments in each field was 21,653, 17,560, 4,983, 2,557, 846, 54,462 and 34,353, respectively. In the field of aneurysm treatment, 19,144 cases of abdominal aortic aneurysm (AAA) including common iliac aneurysm were registered, and 60.3% were treated by endovascular aneurysm repair (EVAR). Among AAA cases, 1,714 (9.4%) cases were registered as ruptured AAA. The operative mortality of ruptured and unruptured AAA was 15.7%, and 0.6%, respectively. 35.9% of ruptured AAA were treated by EVAR, and the EVAR ratio was gradually increasing, but the operative mortality of open repair and EVAR for ruptured AAA was 15.8%, and 15.3%, respectively. Regarding chronic arterial occlusive disease, open repair was performed in 9,303 cases, including 1,329 distal bypasses to the crural or pedal artery, whereas endovascular treatment (EVT) was performed in 8,257 cases. The EVT ratio was gradually increased at 47.0%. The number of varicose vein treatment tremendously increased to 52,639, and 68.5% of the cases were treated by endovenous laser ablations (EVLA). Regarding other vascular operations, 32,779 cases of vascular access operations and 1,411 lower limb amputation surgeries were included.

Conclusions: The number of vascular treatments increased since 2011, and the proportion of endovascular procedures increased in almost all field of vascular diseases, especially EVAR for AAA, EVT for chronic arterial occlusive disease, and EVLA for varicose veins. (This is a translation of Jpn J Vasc Surg 2021; 30: 23–41.)

Keywords: peripheral arterial disease, stent graft, endovascular treatment, aneurysm, venous surgery

Introduction

Since the launch of the National Clinical Database (NCD) in 2011, the Japanese Society for Vascular Surgery (JSVS) has registered patients undergoing surgical procedures, including tabulated vascular surgical procedures among patients registered in the NCD, and released annual reports on vascular surgical procedures in scientific conferences.1–9) This study reports the results of the tabulation of vascular surgical procedures registered in the NCD from January to December 2016 and the analysis by members of the JSVS database management committee.

Methods

Vascular surgery data were extracted at the request of the JSVS, an NCD member association, from among surgeries registered in the NCD in 2016. Data were tabulated and classified into seven categories. The members of the database management committee of the JSVS verified the data and analyzed the tabulated results. The categories were as follows: 1) treatment for aneurysms, 2) revascularization for chronic arterial occlusions, 3) revascularization for acute arterial occlusions, 4) treatment for vascular trauma, 5) surgery for vascular complications after revascularization, 6) venous surgery, and 7) other vascular
diseases and related surgeries.

The tabulation results presented include the number of patients who underwent differing surgical procedures, the etiology, operative mortality, in-hospital mortality, and materials used. Operative mortality is synonymous with surgery-related deaths and encompasses deaths within 30 days after surgery, including any deaths within 30 days after surgery regardless of cause or hospitalization status. In-hospital mortality refers to deaths that occurred during a period of continuous hospitalization after surgery, regardless of timing.

Although some numerical discrepancies exist in the tables presented, such as discrepancies in the sums under etiologies or materials used not being consistent with the total number of patients, the committee and the NCD carefully reviewed and concluded that the discrepancies were caused by one of the following four factors: 1) the selection of multiple choices, 2) blank entries when making selections, 3) omissions or erroneous entries by the party entering data, or 4) multiple types of materials being used or the treatment of multiple sites in a single surgical procedure. Since 2013, measures have been taken to prevent erroneous entries as much as possible by laying out or creating new options, and programs have been set up to make it possible to prevent omissions. Registration and tabulation methods that have changed since 2015 are presented in Table 1.

**Tabulation/Statistical Analysis Results**

The total number of patients with vascular surgeries registered in the NCD in 2016 was 136,414 (a 9.7% increase over the figure in the previous year), exceeding 130,000. These constituted 9.0% of the total number of surgeries registered in the NCD in 2016. In addition, vascular surgeries were registered by 1,070 institutions, indicating that 28.2% of institutions registered vascular surgeries. Of these 1,070 institutions, 471 (44.0%) were certified as vascular surgeons.

**Table 1** New items or changes in 2016 annual report

| New items                  | Table number | Status until 2015 |
|----------------------------|--------------|-------------------|
| Lower limb artery          |              |                   |
| Internal iliac             |              |                   |

1. Treatment for Aneurysms (Table 2-1 and 2-2)

1) Thoracic aortic aneurysms

Majority of thoracic aortic aneurysms are registered through the Japan Cardiovascular Surgery Database (JCVSD) by the JCVSD organization; however, some performed by vascular surgeons are tabulated in this vascular surgery database through the NCD (Table 2). Therefore, the registration of thoracic aortic aneurysm surgeries conducted across the entire country at present is fragmented, and it is not feasible to obtain an accurate image of the overall status. Thus, in the future, efforts should be made to obtain an overall view of thoracic aortic aneurysm surgeries performed nationwide through consultations with the JCVSD organization.

2) Abdominal aortic aneurysms (Table 2-1 and 2-2)

The total number of patients who underwent surgeries for abdominal aortic aneurysms (including iliac artery aneurysms) registered in the NCD in 2016 was 19,144, and the number continued to increase by approximately 1,000 per year at 16,694 in 2013, 17,973 in 2014, and 18,907 in 2015; however, the increase was slight this year. Furthermore, 7,691 patients (40.2%) underwent replacement surgeries, and 11,547 patients (60.3%) underwent stent grafting (endovascular aneurysm repair [EVAR] including hybrid surgeries), and the proportions have been increasing even after EVAR took over the majority in 2013 (52.9% in 2013, 55.7% in 2014, and 57.6% in 2015) (Fig. 1). The number of replacement surgeries remains almost unchanged, ranging from 7,000 to 8,000.

Among those requiring replacement surgeries, renal artery clamping was required for 1,354 patients (17.6%) and renal artery reconstruction for 308 patients (4.0%). With the use of EVAR becoming more mainstream, the incidence of pararenal abdominal aortic aneurysms requiring renal artery clamping has been slightly increasing from 15.4% in 2013 to 15.8% in 2014 and 16.6% in 2015.

Although these were treatment results in nonruptured patients, the operative mortality for replacement surgeries was 0.8% and the in-hospital mortality was 1.2%; the rates were 0.5% (p = 0.023) and 0.7% (p = 0.002), respectively, for EVAR (including special and hybrid procedures) (Fig. 2). The rates worsened in patients who underwent replacement surgeries with the addition of renal artery clamping and were 0.9% and 2.0%, respectively, and
### Table 2-1 Aortic aneurysm (continued)

| Region of aortic aneurysm | Treatment procedure | Graft materials<sup>7)</sup> |
|---------------------------|---------------------|-----------------------------|
|                           | Replacement         | Exclusion with bypass       | Stent graft | Hybrid<sup>6)</sup> | Polyester | ePTFE | Others |
|                           | Cases               | Y-graft | T-graft | Stent graft | Hybrid<sup>6)</sup> | Polyester | ePTFE | Others |
| Ascending aorta<sup>1)</sup> | 7                   | 0       | 0       | 0           | 17         | 3       | 52     | 7      | 6   |
| Aortic arch<sup>1)</sup>     | 20                  | 0       | 0       | 0           | 2          | 411     | 130    | 90     | 94  | 10 |
| Descending thoracic aorta<sup>1)</sup> | 36                  | 0       | 0       | 0           | 3          | 688     | 42     | 37     | 36  | 4  |
| Thoracoabdominal aorta<sup>1)</sup> | 51                  | 0       | 0       | 0           | 11         | 279     | 19     | 103    | 20  | 4  |
| Abdominal aortic aneurysm<sup>2)</sup> with renal artery reconstruction | 7,691               | 5,700   | 1,018   | 60          | 11,507     | 40      | 6,765  | 364    | 77  | 4  |
| Abdominal aortic aneurysm<sup>2)</sup> with renal artery clamping | 308                 | 237     | 37      | 5           | 8          | 4       | 286    | 15     | 4   |    |
|                           | 1,354               | 1,061   | 210     | 10          | 8          | 3       | 1,283  | 58     | 11  |    |

6) Debranch bypass surgery combined with two staged TEVAR is counted as one case of hybrid treatment.
7) Only for open surgery.
were 2.0% and 3.8%, respectively, with the additional reconstruction. Further, 1,794 patients had ruptures. The operative mortality was 15.7%, and in-hospital mortality was 19.2%. The results were similar to those in 2015 (16.0% and 19.9%, respectively). EVAR was performed in 653 patients (35.9%), and the proportion of patients with ruptures for whom EVAR is performed continues to increase (25.5% in 2013, 30.1% in 2014, and 33.9% in 2015) (Fig. 1). The operative mortality and in-hospital mortality for EVAR performed for patients with ruptures were 15.3% and 18.8%, respectively, which were almost the same as those in 2013 (15.8% and 18.2%, respectively), 2014 (17.1% and 20.3%, respectively), and 2015 (14.5% and 18.5%, respectively). Although there was a tendency for increases in EVAR performed for patients with ruptures, the results were stable. Even though there may be biases in the patient selection (EVAR may be selected for patients with general anatomical and hemodynamic advantages), the rates were no less than 15.8% and 19.2%, respectively, as seen for replacement surgery or slightly better (Fig. 3).

**3) Peripheral artery aneurysms (Table 2-3)**
The registration method was modified, and the item of internal iliac artery was added to the region of arteries of lower limbs. A total of 2,509 patients were registered; the male:female ratio was 1,843:666, with a higher incidence in males, and the breakdown of sites was 1,779 patients with sites in the lower limb arteries, 354 in the abdominal visceral arteries, 351 in the upper limb arteries, and 80 in the aortic arch branches. The inference was that 55 patients had simultaneous aneurysms at other sites. By artery, the breakdown was 42.5% for internal iliac arteries, 15.0% for femoral arteries, 9.5% for popliteal arteries, and 6.6% for brachial arteries. Details regarding internal iliac artery aneurysms were unilateral isolated in 41.5%, bilateral isolated in 14.0%, and simultaneous with ab-

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**Table 2-2 Abdominal aortic aneurysm mortality classified by treatment procedures**

| Procedure for aneurysm repair | Ruptured aneurysm | Non-ruptured aneurysm |
|-------------------------------|-------------------|-----------------------|
| Cases | 30-day mortality | Hospital mortality | Cases | 30-day mortality | Hospital mortality |
| Replacement | 1,146 | 181 | 220 | 6,458 | 53 | 79 |
| Exclusion with bypass | 21 | 2 | 4 | 39 | 1 | 2 |
| EVAR<sup>8)</sup> | 646 | 100 | 122 | 10,907 | 58 | 81 |
| Hybrid | 7 | 0 | 1 | 33 | 0 | 0 |

<sup>8)</sup> EVAR: endovascular aneurysm repair

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**Fig. 1** Treatment procedure for non-ruptured and ruptured abdominal aortic aneurysm (AAA). Comparing year 2011, 2012, 2013, 2014 and 2015, proportion of EVAR selection was gradually increased in 2016.

**Fig. 2** Early clinical results of non-ruptured AAA in year 2016 comparing with those in year 2011, 2012, 2013, 2014 and 2015. Regarding the statistical difference of mortality rates between open repair (replacement) and EVAR, see main text. EVAR: endovascular aneurysm repair.

**Fig. 3** Early clinical results of ruptured AAA in year 2016 comparing with those in year 2011, 2012, 2013, 2014 and 2015. Regarding the statistical difference of mortality rates between open repair (replacement) and EVAR, see main text.
| Aneurysm                      | Cases | Gender | Mortality | Ruptured aneurysm | Etiology | Treatment procedure | Graft material for open surgery |
|------------------------------|-------|--------|-----------|--------------------|----------|---------------------|-------------------------------|
|                              |       | Male | Female | 30-day mortality | Hospital mortality | Male | Female | 30-day mortality | Hospital mortality | Male | Female | 30-day mortality | Hospital mortality | Male | Female | 30-day mortality | Hospital mortality | Male | Female | 30-day mortality | Hospital mortality | Male | Female | 30-day mortality | Hospital mortality |
| Aortic arch branches         |       |      |         |                    |          |        |        |                    |          |        |        |                    |          |        |        |                    |          |        |        |                    |          |        |        |                    |          |
| Carotid                      | 15    | 9    | 6       | 0                  | 1        | 0      | 0      | 0                  | 0        | 5     | 0      | 2                  | 1        | 7     | 4      | 1                  | 3        | 5     | 2      | 1                  | 2        | 1     | 2      | 0                  |          |
| Vertebral                    | 1     | 1    | 0       | 0                  | 0        | 0      | 0      | 1                  | 0        | 0     | 0      | 0                  | 0        | 0     | 0      | 0                  | 0        | 0     | 0      | 0                  |          |
| Subclavian                   | 41    | 24   | 17      | 2                  | 3        | 0      | 0      | 0                  | 0        | 27    | 1      | 5                  | 1        | 7     | 8      | 2                  | 2        | 15    | 13     | 6                  | 7        | 3     | 1      | 0                  |          |
| Multiple in arch branches    | 0     | 0    | 0       | 0                  | 0        | 0      | 0      | 0                  | 0        | 0     | 0      | 0                  | 0        | 0     | 0      | 0                  | 0        | 0     | 0      | 0                  |          |
| Others                       | 23    | 13   | 10      | 2                  | 3        | 0      | 0      | 0                  | 0        | 7     | 1      | 4                  | 1        | 10    | 4      | 1                  | 8        | 8     | 4      | 3                  | 4        | 1     | 0      | 0                  |          |
| Upper limb artery            |       |      |         |                    |          |        |        |                    |          |        |        |                    |          |        |        |                    |          |        |        |                    |          |
| Axillary                     | 13    | 9    | 4       | 0                  | 1        | 0      | 0      | 11                 | 0        | 2     | 0      | 0                  | 10       | 2     | 1       | 0                  | 0        | 0     | 3      | 6                  | 3        | 0     |          |          |
| Brachial                     | 170   | 95   | 75      | 1                  | 3        | 2      | 0      | 0                  | 34       | 2     | 21     | 44                 | 69       | 35    | 8       | 84                 | 1        | 1     | 48      | 6                  | 11       | 24     | 1       |          |
| Forearm-hand                 | 128   | 74   | 54      | 1                  | 1        | 2      | 0      | 0                  | 45       | 1     | 17     | 33                 | 32       | 14    | 2       | 94                 | 0        | 0     | 25      | 2                  | 8        | 4      | 1       |          |
| Others                       | 40    | 23   | 17      | 1                  | 1        | 0      | 0      | 0                  | 15       | 0     | 6      | 7                  | 12       | 3     | 6       | 25                 | 0        | 2     | 4       | 1                  | 3        | 1     | 2       |          |
| Visceral artery              |       |      |         |                    |          |        |        |                    |          |        |        |                    |          |        |        |                    |          |        |        |                    |          |
| Celiac                       | 22    | 13   | 9       | 1                  | 1        | 3      | 1      | 1                  | 16       | 1     | 0      | 1                  | 4        | 3     | 4       | 7                  | 1        | 8     | 3       | 0                  | 1        | 5     | 0       |          |
| Hepatic                      | 14    | 7    | 7       | 0                  | 0        | 0      | 0      | 0                  | 10       | 0     | 0      | 0                  | 4        | 4     | 2       | 3                  | 0        | 4     | 1       | 0                  | 1        | 5     | 0       |          |
| Splenic                      | 81    | 35   | 46      | 0                  | 0        | 1      | 0      | 0                  | 73       | 1     | 1      | 1                  | 5        | 1     | 4       | 13                 | 0        | 61    | 5       | 0                  | 0        | 4     | 0       |          |
| Superior mesenteric          | 29    | 25   | 4       | 2                  | 3        | 1      | 0      | 0                  | 13       | 1     | 6      | 0                  | 9        | 6     | 2       | 8                  | 2        | 7     | 7       | 0                  | 2        | 5     | 0       |          |
| Renal                        | 64    | 32   | 32      | 0                  | 3        | 0      | 0      | 0                  | 59       | 1     | 0      | 1                  | 3        | 7     | 1       | 14                 | 5        | 30    | 11      | 1                  | 2        | 4     | 0       |          |
| Others                       | 144   | 110  | 34      | 2                  | 3        | 2      | 0      | 0                  | 118      | 0     | 7      | 1                  | 18       | 25    | 12      | 17                 | 52       | 55    | 6       | 27                  | 6        | 3     | 3       |          |
| Lower limb artery            |       |      |         |                    |          |        |        |                    |          |        |        |                    |          |        |        |                    |          |        |        |                    |          |
| Internal iliac               | 1,089 | 908  | 181     | 14                 | 16       | 6      | 0      | 0                  | 1,056    | 1     | 10     | 2                  | 20       | 146   | 9       | 108                 | 464      | 607   | 26      | 137                 | 21       | 0     | 2       |          |
| Femoral                      | 384   | 290  | 94      | 10                 | 18       | 2      | 0      | 0                  | 186      | 1     | 39     | 56                 | 102      | 142   | 18      | 142                 | 13       | 10    | 79      | 61                  | 85       | 19     | 2       |          |
| Popliteal                    | 244   | 176  | 68      | 2                  | 3        | 0      | 0      | 0                  | 222      | 0     | 1      | 6                  | 15       | 143   | 77      | 31                 | 0        | 1     | 7       | 20                  | 83       | 117    | 0       |          |
| Others                       | 62    | 43   | 19      | 0                  | 2        | 0      | 0      | 0                  | 43       | 0     | 6      | 4                  | 9        | 16    | 5       | 13                 | 18       | 5     | 7       | 8                  | 5        | 1     | 2       |          |
| Total                        | 2,509 | 1,843| 666     | 37                 | 60       | 18     | 1      | 1                  | 1,894    | 10    | 126    | 159                | 320      | 550   | 153     | 568                 | 558      | 802   | 231     | 268                 | 234      | 197    | 9       |          |

9) Including TAO, Takayasu aortitis, collagen disease related vasculitis, Behcet disease, fibromuscular dysplasia.

Abbreviations: Y-graft: Y-shape artificial graft; T-graft: straight artificial graft; Polyester: polyester artificial graft such as Dacron graft; ePTFE: expanded polytetrafluoroethylene graft
Table 3 Reconstruction for chronic arterial occlusive diseases

Table 3-1 Arterial reconstruction for aortic arches

| Arterial branches | Cases | Male | Female | Mortality | Back ground | Biology | Revascularization procedures | Graft materials (mm) | Previous reconstruction | Revision reason |
|-------------------|-------|------|--------|-----------|-------------|---------|------------------------------|----------------------|-----------------------|------------------|
| Carotid artery    | 289   | 228  | 61     | 17        | 17          | 4       | 11                           | 0                    | 0                     | 2487             |
| Vertebral artery  | 14    | 11   | 3      | 1         | 9           | 4       | 0                            | 0                    | 0                     | 0                |
| Subclavian artery | 580   | 448  | 132    | 16        | 16          | 87      | 0                            | 0                    | 0                     | 1258             |
| Multiple lesions  | 85    | 69   | 4      | 12        | 4           | 0       | 1                            | 0                    | 0                     | 0                |
| Accurate           | 140   | 104  | 36     | 3         | 8           | 99      | 1                            | 0                    | 0                     | 1023             |
| Celiac/Superior   | 124   | 94   | 30     | 3         | 1           | 78      | 0                            | 0                    | 0                     | 0                |
| Renal artery      | 130   | 93   | 37     | 0         | 1           | 84      | 0                            | 0                    | 0                     | 1                |
| Others             | 0     | 0    | 0      | 0         | 0           | 0       | 0                            | 0                    | 0                     | 0                |
| Total             | 1,102 | 844  | 258    | 34        | 139         | 412     | 1                            | 5                    | 11                    | 75               |

10) Bypass surgery combined with endovascular treatment is counted in both bypass category (Table 3-2) and endovascular category (Table 3-5).
11) Including TAO, Takayasu arteritis, Connective tissue disease related vasculitis, Behcet disease, Fibromuscular dysplasia.
12) Including percutaneous transluminal angioplasty (PTA), silent, and other endovascular means such as catheter atherectomy.
13) Only for open surgery.

14) Only for open surgery.

CEA: Carotid endarterectomy
ePTFE: Expanded polytetrafluoroethylene
eVT: Embolization of the true lumen
PTA: Percutaneous transluminal angioplasty
EVT: Embolization of the true lumen
DE: Distal embolus
GV: Graft failure
AR: Aortic regurgitation
LV: Left ventricular failure
RT: Right heart failure
TV: Tricuspid valve regurgitation
MV: Mitral valve regurgitation
VAD: Ventricular assist device
PA: Pulmonary artery
ST: Sternal wound infection
Other: Other complications

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### Table 3-2  Arterial reconstruction for chronic lower limb ischemia

| From aorta to lower limb arterial systems | Gender | 30-day mortality | Etiology | Graft materials | Previous reconstruction | Revision reason |
|------------------------------------------|--------|------------------|----------|----------------|--------------------------|----------------|
|                                          |        | Cases            |          |                |                          |                |
|                                          | Male   | Female           | Dialysis cases | ASO | TAO | Vasculitis | Others | Polyester | ePTFE | Autogenous veins | Others | None | Once | Twice | Three times and more | Underclear | Stent graft-caused stenosis/occlusion | Host artery stenosis/occlusion | Graft stenosis | Graft occlusion | EVT stenosis | EVT occlusion | Poor symptom recovery | Poor symptom recovery |
| Anterior aortic bypass                   | 32     | 35               | 17       | 7              | 43              | 0              | 1      | 3          | 30    | 17             | 6      | 2    | 40    | 8     | 2             | 2      | 0            | 0            | 0             | 0             | 0             |
| Inferior aortic reconstruction (suprarenal clamp) | 36     | 33               | 5        | 0              | 1               | 36             | 0      | 2          | 38    | 1              | 0      | 0    | 35    | 2     | 0             | 1      | 0            | 0            | 0             | 0             | 0             |
| Aorto-femoral bypass                    | 519    | 406              | 113      | 6              | 33              | 498            | 1      | 0          | 12    | 372             | 19    | 25     | 432   | 57    | 17              | 13    | 0            | 14           | 11             | 26             | 12            |
| Femoropopliteal (above the knee) bypass | 1,024  | 1,201            | 423      | 28             | 265             | 1,006          | 2      | 2          | 11    | 244             | 1,129  | 338  | 4,186 | 283   | 94              | 74    | 199          | 135          | 34             | 198            | 75            |
| Femoropopliteal (below the knee) bypass | 752    | 522              | 230      | 17             | 186             | 733            | 3      | 3          | 13    | 41              | 341   | 422  | 402   | 172   | 55              | 55    | 8            | 42           | 17             | 93             | 21            |
| Femorocrural (pedal) bypass(16)         | 1,339  | 974              | 355      | 20             | 523             | 1,287          | 17     | 13         | 12    | 37              | 144   | 1,105 | 49    | 775   | 317             | 106   | 11           | 96           | 17             | 110            | 8              |
| Others                                  | 111    | 87               | 24       | 2              | 26              | 105            | 1      | 0          | 3     | 44              | 53    | 25    | 1      | 66    | 23              | 9     | 12           | 17           | 4              | 11             | 7             |
| Total                                   | 4,217  | 3,097            | 1,120    | 65             | 968             | 4,105          | 26     | 18         | 3     | 54              | 741   | 1,730 | 1,868 | 3,830 | 823             | 252   | 30           | 268          | 74             | 328            | 128           |

15) Including aorto-iliac bypass or ilio-femoral bypass.
16) Including popliteal-crural (or pedal) bypass.

### Table 3-3  Extra-anatomical bypass(17)

| Extra-anatomical bypass | Gender | 30-day mortality | Dialysis cases | Etiology | Graft materials | Previous reconstruction | Revision reason |
|-------------------------|--------|------------------|----------------|----------|----------------|--------------------------|----------------|
|                         |        | Cases            |                | ASO      | TAO | Others | Polyester | ePTFE | Autogenous veins | Others | None | Once | Twice | Three times and more | Underclear | Stent graft-caused stenosis/occlusion | Host artery stenosis/occlusion | Graft stenosis | Graft occlusion | EVT stenosis | EVT occlusion | Poor symptom recovery | Poor symptom recovery |
| Carotid-subclavian bypass| 297    | 236              | 61             | 14       | 14            | 8             | 0      | 5          | 89    | 214             | 3      | 4    | 292  | 4     | 1             | 0      | 0            | 0            | 0             | 0             | 0            |
| Axillo-axillary bypass   | 366    | 280              | 86             | 16       | 22            | 27             | 0      | 14         | 308  | 106             | 2      | 1    | 358  | 6     | 0             | 1      | 1            | 0            | 0             | 2             | 2            |
| Axillo-femoral bypass    | 305    | 219              | 86             | 5        | 36            | 28              | 18     | 14         | 106  | 242             | 19     | 14   | 242  | 39    | 14            | 0      | 0            | 5            | 7              | 19             | 6            |
| Femorofemoral crossover bypass | 798 | 635              | 163            | 8        | 72            | 758            | 1      | 33         | 203  | 619             | 56    | 56    | 6      | 130   | 24            | 22     | 3            | 27           | 7              | 51             | 14            |
| Others                   | 98     | 77               | 21             | 1        | 13            | 91             | 0      | 6          | 40    | 60              | 5     | 8    | 2      | 68    | 9             | 2     | 2            | 2            | 5              | 9              | 1             |
| Total                    | 1,697  | 1,320            | 377            | 36       | 144           | 1145           | 2      | 74         | 463  | 1,206          | 84    | 37   | 1,415 | 193   | 48            | 35     | 6            | 35           | 19             | 81             | 23            |

17) Cases underwent extraanatomical bypass because of graft infection should not be included this category. Those cases are listed in vascular complication (Table 6).
18) A case underwent axillo-femoral-femoral crossover bypass is counted as one case. A case combined with additional contralateral side of axillo-femoral bypass as second staged surgery is counted as 2 cases.
### Table 3-4  Thromboendarterectomy\(^{19}\) for chronic lower limb ischemia

| Thromboendarterectomy | Gender | Mortality | Dialysis cases | Etiology | Previous reconstruction | Revision reason |
|-----------------------|--------|-----------|----------------|----------|-------------------------|-----------------|
|                       | Cases  | Male | Female | 30-day mortality | ASO | TAO | Others | None | Once | Twice | Three times and more | Unclear | Host artery stenosis/occlusion | Graft stenosis | Graft occlusion | EVT stenosis | EVT occlusion | Stent graft-caused stenosis/occlusion | Poor symptom recovery | Other |
| Aorto-iliac lesion    | 62     | 42   | 20     | 2               | 13   | 0   | 1     | 54   | 7   | 1     | 0                     | 0       | 2               | 2               | 0               | 3         | 0               | 2               | 0         |
| Femoro-popliteal lesion | 1,040 | 744 | 296     | 11              | 278  | 1,021 | 15  | 4               | 800  | 162 | 45    | 27                  | 6       | 90              | 14              | 23              | 34        | 23              | 1               | 35          | 29     |
| Others\(^{20}\)       | 546    | 411  | 135     | 16              | 140  | 510  | 5    | 27              | 314  | 132 | 44    | 54                  | 2       | 33              | 45              | 31              | 14        | 22              | 3               | 21          | 64     |
| Total                 | 1,611 | 1,169 | 442     | 28              | 415  | 1,554 | 20   | 32              | 1,146 | 291 | 87    | 79                  | 8       | 119             | 58              | 54              | 47        | 46              | 4               | 57          | 90     |

19) Including patch plasty.  
20) Including reconstruction, thrombolysis and others.

### Table 3-5  Endovascular treatment for chronic lower limb ischemia\(^{23}\)

| Endovascular treatment | Gender | Mortality | Dialysis cases | Etiology | Previous reconstruction | Revision reason |
|------------------------|--------|-----------|----------------|----------|-------------------------|-----------------|
|                        | Cases  | Male | Female | 30-day mortality | ASO | TAO | Others | None | Once | Twice | Three times and more | Unclear | Host artery stenosis/occlusion | Graft stenosis | Graft occlusion | EVT stenosis | EVT occlusion | Stent graft-caused stenosis/occlusion | Poor symptom recovery | Other |
| Aorto-iliac lesion\(^{21}\) | 3,504 | 2,812 | 692     | 26              | 56   | 476  | 3,430 | 1      | 52   | 2,759 | 463                  | 140     | 124             | 18              | 18              | 31         | 184            | 67               | 45          | 39        | 61    |
| Femoro-popliteal lesion\(^{21}\) | 3,689 | 2,545 | 1,144   | 41              | 94   | 1,030 | 3,683 | 3      | 23   | 2,174 | 800                  | 275     | 415             | 25              | 70              | 41        | 457            | 152             | 44          | 91        | 87    |
| Infrapopliteal-ankle lesion\(^{21}\) | 2,115 | 1,413 | 702     | 41              | 84   | 973  | 2,074 | 17     | 23   | 1,133 | 480                  | 179     | 305             | 18              | 26              | 48        | 258            | 157             | 11          | 93        | 47    |
| Others                 | 153    | 114   | 39      | 4               | 6    | 75   | 145   | 1      | 7    | 29    | 39                   | 28      | 57              | 0               | 14              | 67        | 18             | 7               | 5           | 82        | 219   |
| Total (number of regions underwent EVT)\(^{21}\) | 8,257 | 6,027 | 2,230   | 96              | 199  | 2,149 | 8,116 | 21     | 98   | 5,353 | 1,562                | 542     | 747             | 53              | 873             | 314       | 153            | 759             | 337         | 89        | 207   |
| Total (number of limbs underwent EVT)\(^{22}\) | 7,118 | 5,222 | 1,896   | 80              | 160  | 1,765 | 6,985 | 20     | 91   | 4,653 | 1,350                | 464     | 606             | 45              | 734             | 268       | 134            | 634             | 272         | 76        | 189   |

21) When endovascular treatment performed for multiple regions, the case should be counted in each regions (If a case underwent endovascular treatment in both aorto-iliac and femoro-popliteal region, this case can be counted one in aorto-iliac, and one in femoro-popliteal region).  
22) Counting the patients number not treated regions. When a case underwent endovascular treatment in multiple region, the case is counted as one case.

Abbreviations: ASO: arteriosclerosis obliterans; TAO: thromboangiitis obliterans (Buerger’s disease); CAS: carotid artery stenting; CEA: carotid endarterectomy; PTA: percutaneous transluminal angioplasty; EVT: endovascular treatment; IIA: internal iliac artery
Considering the increase in bypass surgeries thought to be associated with debranching mentioned above, the number of debranching associated with TEVAR seems to have substantially increased. Bypass surgeries for aortic arch branches thought to be related to these debranching procedures has been increasing year by year, which may be a manifestation of increased stent graft placement for anatomically complex aortic arch aneurysms (Table 3-6).

2) Anatomical bypass (Table 3-2), extra-anatomical bypass (Table 3-3), and endovascular treatment (Table 3-5) for the aorta to arteries of the lower limb region

Aortic-iliac artery region: The number of patients who underwent anatomical bypass surgeries for aortic-iliac artery region lesions was 640 in 2015 and 609 in 2016, with no changes in the breakdown, including the number of patients and graft materials used. Extra-anatomical revascularization procedures represented by axillary-femoral artery bypass and femoral-femoral artery bypass slightly decreased from 372 and 825 patients, respectively, in 2015 to 305 and 798 patients, respectively, in 2016, likely due to increases in endovascular treatment in this region (Fig. 4A). The rate of previous revascularization was 17% for anatomical bypasses versus 22% for extra-anatomical bypasses. The decrease in anatomical reconstruction was smaller than the increase in endovascular treatment, and the actual number of revascularization procedures in this region seemed to be slightly increasing.

Superficial femoral artery region: Femoral-above-knee popliteal artery bypasses decreased by 10% from 1,810 patients in 2015 to 1,624 in 2016. The number of patients who underwent endovascular treatment increased by 460, exceeding the decrease in the number of patients who underwent bypass surgeries (Fig. 4B). A past history of revascularization was reported in 28% of patients. Expanded polytetrafluoroethylene (ePTFE) was used as a graft in 70% of the patients and autologous veins in 20%, with no significant differences from the case in the previous year.

Revascularization below the knee joint: In 2015, 726 patients underwent femoral-below the knee popliteal bypasses and 1,194 patients underwent femoral-crural/pedal artery bypasses. Furthermore, 752 patients underwent femoral-below the knee popliteal artery bypasses,

### Table 3-6 Debranch for TEVAR or EVAR

| Debranch for TEVAR or EVAR                                                                 | Cases |
|------------------------------------------------------------------------------------------|-------|
| Ascending aorta-brachiocephalic-left common carotid (-left subclavian) arterial bypass   | 34    |
| Right axillar-left common carotid (-left axillary) arterial bypass                       | 284   |
| Right common carotid-left common carotid (-left subclavian) arterial bypass             | 325   |
| Left common carotid-left subclavian arterial bypass or transposition                    | 33    |
| Right axillar (subclavian)-left axillar (subclavian) arterial bypass                     |       |
| Abdominal aorta (iliac) (-celiac)-superior mesenteric-renal arterial bypass             |       |

The annual trends of the number of arterial reconstructions in aorto-iliac (A), femoro-popliteal (B), and crural/pedal region (C), comparing open repair and endovascular treatment. Ao-F: aorto-femoral; Ax-F: axillo-femoral; F-F: femoro-femoral crossover; EVT: endovascular treatment; FPAK: femoro-popliteal (above the knee); FPBK: femoro-popliteal (below the knee); SFA: superficial femoral artery; EA: endarterectomy.

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and 1,329 patients underwent femoral-crural/pedal artery bypasses in 2016. The number of patients who underwent femoral-crural/pedal artery bypasses increased by 11% from that in 2015 (Fig. 4C). The proportion of patients undergoing dialysis who underwent crural artery bypasses was 39%, unchanged from the previous year, and remained the same in 2014. This suggested that patients who underwent dialysis constituted approximately 40% of patients who had severe ischemic limbs. Autologous veins were used in 90% of the grafts.

**Thromboendarterectomy (Table 3-4):** The number of patients who underwent thromboendarterectomy for lower limb arteries in the femoropopliteal region increased from 960 in 2015 to 1,040 in 2016 (Fig. 4B). The number of patients who underwent other types of surgery increased from 476 in 2015 to 546 since other items were listed as including replacements. Femoral arterectomies with grafts were also included in this category in a large number of patients, and treatments for common femoral artery lesions difficult to deal with by endovascular treatment remained unchanged in comparison with those in the preceding year.

**Endovascular treatment (Table 3-5):** The total number of patients undergoing endovascular treatment increased by approximately 11%, (700 patients) from 2015, and 25% of this increase was for dialysis patients. The number of endovascular therapies increased compared with the number of surgical revascularization procedures (bypass, thromboendarterectomy) and almost equaled compared with the number in 2015. Endovascular therapies for occlusive arterial disease have rapidly expanded, and surgical revascularization procedures and endovascular therapies have been equally performed. Among these, the region of the lower limb artery considerably increased from 1,803 patients in 2015 to 2,115 patients in 2016, with a rate of increase of 17%; the region of the femoropopliteal artery increased by 17%, and the region of the iliac artery increased by 6% (Figs. 4A, 4B, 4C).

The data were compared with those in the NCD-based Japanese nationwide registry of patients undergoing endovascular therapy (J-EVT) published on the website of the Japanese Association of Cardiovascular Intervention and Therapeutics (CVIT). Endovascular treatment of the aortic-iliac region in cardiology departments was performed in 7,587 patients in 2016. Furthermore, 5,216 patients underwent anatomical/extra-anatomical revascularization and endovascular treatment performed by vascular surgeons, constituting 40.0% of the total, which was lower than 46.0% in 2014. In 2016, 13,666 patients reportedly underwent endovascular treatment of the superficial femoral artery in J-EVT. Moreover, 5,313 patients underwent both femoral-above-the-knee popliteal artery bypasses and endovascular treatment by vascular surgeons, constituting

| Table 4 | Revascularization for acute arterial occlusive disease |  |
| --- | --- | --- |
| Gender | 30-day mortality | Hospital mortality |
| Male | Female | 24) Cases with non-traumatic acute arterial occlusion are listed in this table. Please see Table 5-1 for acute arterial occlusion by trauma. | 25) Cases with acute worsening occlusion of chronic arterial occlusive disease are excluded. Treatment for those cases are listed in Table 3. |
| Carotid artery | 13 | 12 | Carotid artery |
| Subclavian artery | 49 | 46 | Subclavian artery |
| Axillary artery | 86 | 46 | Axillary artery |
| Brachial artery | 679 | 328 | Brachial artery |
| Celiac/superior mesenteric artery | 120 | 70 | Celiac/superior mesenteric artery |
| Renal artery | 30 | 20 | Renal artery |
| Abdominal aorta-iliac artery | 824 | 577 | Abdominal aorta-iliac artery |
| Femoro-popliteal artery | 2,833 | 1,796 | Femoro-popliteal artery |
| Crural artery | 941 | 594 | Crural artery |
| Pedal artery | 57 | 35 | Pedal artery |
| Others | 291 | 166 | Others |
| Total | 4,983 | 3,087 | Total |

23) Cases with non-traumatic acute arterial occlusion are listed in this table. Please see Table 5-1 for acute arterial occlusion by trauma.
24) Cases with acute worsening occlusion of chronic arterial occlusive disease are excluded. Treatment for those cases are listed in Table 3.
27.9% of the total, a 10% decrease from the number in 2014. In 2016, 6,943 patients underwent endovascular treatment in lower limb artery regions in J-EVT; 4,196 underwent femoral-below the knee popliteal artery bypasses, femoral-crural/pedal artery bypasses, and endovascular treatment by vascular surgeons, constituting 37.4% of the total number of patients, a 5.9% decrease from the number in 2014.

3. Revascularization for Acute Arterial Occlusions (Table 4)

Except for vascular trauma, 4,983 patients were reported to have acute arterial occlusions, and patients with sites in peripheral vessels below the abdominal aorta constituted approximately 80% of the total. The etiology was thrombosis in 60% and embolism in 40% of the patients. Further, 5,923 patients were classified by site of occlusion; thus, 940 patients (16%) had occlusions at multiple sites, which was almost the same as the numbers in the previous years. In addition, 74 patients underwent percutaneous transluminal angioplasty (PTA) ± stenting was 15%, almost the same as the number in the previous year. The rate of endovascular therapy (PTA ± stenting, thrombolysis) was 26% in the abdominal aortic-iliac artery region and 15% in the femoropopliteal region, both of which were almost the same as those in the previous year.

The proportion of patients overall who underwent percutaneous transluminal angioplasty (PTA) ± stenting was 15%, almost the same as the number in the previous year. The rate of endovascular therapy (PTA ± stenting, thrombolysis) was 26% in the abdominal aortic-iliac artery region and 15% in the femoropopliteal region, both of which were almost the same as those in the previous year. The rate of artificial graft use in bypass surgery was 69% (69% in the previous year) in the femoropopliteal region and 44% (55% in the previous year) in crural arteries, indicating a slight decreasing trend in the crural artery region.

The operative/in-hospital mortality was 11%/14% (12%/15% in the previous year) for the abdominal aortic-iliac artery region, 7%/9% (9%/11% in the previous year) for the femoropopliteal arteries, 10%/12% (9%/13% in the previous year) for crural arteries, and 4%/7% (20%/27% in the previous year) for pedal arteries. These figures indicated that as usual, the prognosis was obviously poor than that for elective revascularization. The reported mortality for pedal arterial occlusions markedly increased in the previous year (2015) but clearly decreased this year. Further, 120 occlusions were reported in the celiac artery or superior mesenteric artery, and the prognosis was poor with a 20% operative mortality and 25% inhospital mortality, with the rate of endovascular treatment being 26% (19% in the previous year), indicating a slight increase in tendency.

4. Treatment for Vascular Trauma (Table 5)

The location of vascular trauma, cause of injury, type of surgical procedure, and type of blood vessel used as a graft in the NCD registration data in 2016 are presented in Table 5. Further, 2,557 patients had arterial/venous trauma. The most common cause of vascular trauma was iatrogenic in 1,831 patients (71%), followed by traffic accident in 137 (5%) and work-related in 117 (4%). The most common site of vascular injury was the arteries of the lower limbs in 1,300 patients (50%), followed by the arteries of the upper limbs in 277 patients (10%) and the abdominal-iliac arteries in 257 patients (10%). Surgical procedures were registered for 2,685 patients. Of these, 1,557 patients (58%) underwent direct suture repair, 302 patients (11%) underwent ligation, and 286 patients (10%) underwent endovascular treatment (Fig. 5A). Vascular grafts were used in 324 patients, and approximately 48% of the grafts were autologous.

1) Iatrogenic vascular trauma (Fig. 5B)

Looking at 1,862 sites of iatrogenic vascular trauma in 1,831 patients by site, arteries of the lower limbs constituted the highest proportion (1,018 patients, 54%). This was followed by arteries of the upper limbs (310 patients, 16%), constituting 71% of the combined upper and lower limbs. Most of these lesions were considered to be complications of intravascular catheter examinations or puncture site complications associated with treatment.

2) Traffic accidents (Fig. 5C)

The most common site from traffic accidents in 137 patients (151 sites) was the upper or lower limb arteries in 47 patients (31%). The second most common was the abdominal aorta and iliac arteries (35 patients, 23%), followed by the descending aorta and thoracoabdominal aorta (25 patients, 16%) and the visceral arteries (16 patients, 10%). Blood vessels in the limbs close to the body surface are susceptible to direct external force and injury; however, unlike other causes, thoracic and abdominal aortic injuries in regions protected by the thorax and abdominal wall are common in traffic accidents. This is considered to be due to high-energy trauma with rapid deceleration such as collision.

3) Work-related (Fig. 5D)

Accidents at work such as falls from high places and machinery-related injuries were assumed, and 119 lesions in 117 patients were registered. As expected, arteries in the limbs, which are also close to the body surface and subject to external force, constituted 63% (75 patients).
### Table 5-1 Arterial trauma

| Injured artery                     | Cases | Gender | Mortality | Cause of trauma | Procedure | Status of injured artery | Prosthesis |
|-----------------------------------|-------|--------|-----------|-----------------|-----------|--------------------------|------------|
| Male | Female | 30-day mortality | Hospital mortality | Traffic accident | Labor accident | Iatrogenic | Others | Direct closure | Patch plasty | Replacement | Bypass | Endo-vascular | Ligation | Others | Obstruction/stenosis | Bleeding without specification | GI fistula | Non-GI fistula | Pseudoaneurysm | Autogenous vessel | Polyester ePTFE | Others |
|-----------------------------------|-------|--------|-----------|-----------------|-----------|--------------------------|------------|
| Carotid artery                    | 40    | 28     | 12        | 6               | 10        | 3                       | 1          | 24              | 12          | 15          | 1         | 5         | 15        | 1         | 2          | 3          | 19          | 1         | 2         | 6         | 10         | 3         | 4         | 1         | 1           |
| Subclavian artery                 | 51    | 37     | 14        | 2               | 3         | 9                       | 1          | 30              | 11          | 19          | 2         | 3         | 5         | 14        | 4         | 6          | 9          | 19          | 0         | 3         | 8         | 15         | 1         | 5         | 4         | 0           |
| Axillary artery                   | 20    | 12     | 8         | 2               | 2         | 2                       | 0          | 16              | 2           | 9           | 3         | 2         | 2         | 5         | 2         | 2          | 3           | 7          | 0         | 1         | 8         | 3         | 2         | 2         | 0           |
| Brachial artery                   | 321   | 206    | 115       | 8               | 13        | 4                       | 18         | 264             | 35          | 241         | 3         | 5         | 12        | 12        | 37        | 21         | 25          | 57          | 0         | 5         | 199        | 45         | 16        | 1         | 4         | 0           |
| Descending aorta (thoracoabdominal) | 60    | 49     | 11        | 10              | 11        | 2                       | 14         | 19              | 1           | 10          | 0         | 2         | 2         | 35        | 3         | 11         | 4           | 27          | 3         | 8         | 17         | 5          | 0         | 2         | 2         | 0           |
| Celiac/superior mesenteric artery | 54    | 39     | 15        | 4               | 5         | 10                      | 3           | 31              | 10          | 16          | 0         | 0         | 0         | 6         | 25        | 8          | 2           | 8          | 26        | 4         | 1         | 10        | 6          | 3         | 0         | 2         | 0           |
| Renal artery                      | 15    | 11     | 4         | 3               | 3         | 6                       | 1           | 5               | 3           | 2           | 1         | 1         | 1         | 11        | 1         | 1          | 1           | 11          | 0         | 2         | 0         | 1          | 0         | 2         | 2         | 0           |
| Abdominal aorta-iliaic artery     | 257   | 128    | 129       | 29              | 38        | 35                      | 10          | 163             | 49          | 58          | 9         | 30        | 38        | 116       | 11         | 12         | 43          | 127        | 10        | 11        | 26        | 49         | 7         | 40        | 31        | 3           |
| Femoro-popliteal artery           | 1246  | 798    | 448       | 169             | 208       | 23                      | 28          | 991             | 204         | 944         | 45        | 32        | 73        | 36        | 82         | 85         | 126          | 274        | 0         | 20        | 410       | 459        | 92        | 19        | 36        | 6           |
| Crural artery                     | 54    | 40     | 14        | 2               | 2         | 9                       | 8           | 27              | 10          | 24          | 2         | 3         | 12        | 4         | 9          | 3           | 16          | 17         | 1         | 0         | 16        | 6          | 16        | 1         | 1         | 0           |
| Others                            | 292   | 199    | 93        | 27              | 31        | 16                      | 27          | 166             | 83          | 129         | 4         | 4         | 8         | 29        | 92         | 45         | 30           | 141        | 2         | 9         | 55        | 67         | 11        | 1         | 1         | 3           |
| Total                             | 2357  | 1513   | 844       | 252             | 316       | 128                     | 97          | 1702            | 430         | 1453        | 437       | 67        | 78        | 150       | 284       | 249       | 186         | 252         | 705       | 21        | 60        | 746       | 656        | 145       | 69        | 76        | 12          |

28) Iatrogenic pseudoaneurysm in endovascular treatment is listed in Table 5-1.
29) Including arterial dissection.
30) Without GI fistula or non-GI fistula.
Cases with vessel injury involving both vein and accompanying artery are listed in Table 5-1. Abbreviation; GI: gastro-intestinal
4) Summary
Vascular traumas registered in the 2016 NCD database were reviewed. Although the number of registered patients slightly increased compared with the number in 2015, no major differences were observed in the cause of trauma, site of trauma, type of vascular graft, and treatment method.

5. Surgery for Vascular Complications after Revascularization (Table 6)
The number of patients registered with sites in the thoracic to thoracoabdominal aortic region was as low as those reported up to 2014, and the number of revascularization complications in this region could not be evaluated.

1) Vascular graft infections (Table 6-1)
As vascular graft infection, 526 cases were registered. 50.4% of which were the other region, including the arch branching and upper limb artery. In this region, the most prevalent condition of infection is the cutaneous fistula of vascular grafts. Many of which were inferred to be infection in the shunts for dialysis. 25.5% of graft infection were femoro-distal artery. The overall operative mortality was 8.4%, and in-hospital mortality was 14.3%.

2) Anastomotic aneurysms (noninfectious) (Table 6-2)
Further, 144 patients with anastomotic aneurysms were registered. By region, the femoral artery was the most common, followed by the abdominal aorta and axillary-upper limb arteries, which were similar to those in 2015. Femoral arteries were mainly repaired by replacement,
Table 6-1  Graft infection

| Position of infected graft          | Cases | 30-day mortality | Hospital mortality | Sepsis | Graft-GI fistula(32) | Graft-skin fistula(32) | Others | In-situ replacement | Extra-anatomical bypass | Others | Polyester | ePTFE | Autogenous vessel | Cryo-preserved homograft | Others |
|------------------------------------|-------|------------------|--------------------|--------|---------------------|----------------------|--------|---------------------|------------------------|--------|------------|-------|-------------------|------------------------|--------|
| Descending thoracic aorta          | 4     | 0                | 3                  | 2      | 1                   | 0                    | 1      | 1                   | 0                      | 2      | 2          | 0     | 0                 | 0                     | 0      |
| Thoracoabdominal aorta             | 7     | 0                | 1                  | 3      | 2                   | 2                    | 0      | 4                   | 0                      | 1      | 5          | 1     | 0                 | 0                     | 0      |
| Abdominal aorta-iliac artery       | 74    | 9                | 23                 | 29     | 31                  | 3                    | 23     | 29                  | 0                      | 31     | 33         | 12    | 4                 | 0                     | 3      |
| Abdominal aorta-femoral artery     | 42    | 3                | 5                  | 9      | 7                   | 10                   | 19     | 9                   | 0                      | 19     | 12         | 7     | 9                 | 0                     | 0      |
| Femoro-distal artery               | 134   | 18               | 23                 | 43     | 1                   | 53                   | 44     | 25                  | 0                      | 89     | 10         | 34    | 30                | 0                     | 7      |
| Others(31)                         | 265   | 14               | 20                 | 57     | 5                   | 91                   | 124    | 23                  | 0                      | 209    | 23         | 61    | 26                | 0                     | 10     |
| Total                              | 526   | 44               | 75                 | 143    | 47                  | 159                  | 211    | 91                  | 0                      | 351    | 85         | 115   | 69                | 0                     | 20     |

31) Cases with graft infection involving aortic arch branch or upper limb artery are listed on this column.
32) Including anastomotic disruption.
Abbreviation; GI: gastrointestinal

Table 6-2  Anastomotic aneurysm(33)

| Location of anastomotic aneurysm | Cases | 30-day mortality | Degenerative | Takayasu arteritis(34) | Other vasculitis(35) | Infection | Others | Replacement | Exclusion and bypass | Stent graft | Others | Polyester | ePTFE | Autogenous vessel | Cryo-preserved homograft | Others |
|----------------------------------|-------|------------------|--------------|------------------------|---------------------|-----------|--------|-------------|----------------------|-------------|--------|-----------|-------|-------------------|------------------------|--------|
| Aortic arch branch               | 10    | 0                | 3            | 0                      | 0                   | 0         | 7      | 1           | 0                    | 4           | 5      | 0         | 3     | 1                 | 1                     | 1      |
| Upper limb artery including axillar artery | 24    | 0                | 7            | 0                      | 0                   | 2         | 15     | 3           | 2                    | 1           | 18     | 1         | 7     | 4                 | 0                     | 0      |
| Thoracic aorta                   | 12    | 1                | 1            | 0                      | 0                   | 1         | 10     | 3           | 1                    | 2           | 6      | 2         | 1     | 0                 | 2                     | 0      |
| Splanchnic artery                | 1     | 0                | 0            | 1                      | 0                   | 0         | 0      | 1           | 0                    | 0           | 0      | 0         | 1     | 1                 | 0                     | 0      |
| Renal artery                     | 0     | 0                | 0            | 0                      | 0                   | 0         | 0      | 0           | 0                    | 0           | 0      | 0         | 0     | 0                 | 0                     | 0      |
| Abdominal aorta                  | 25    | 1                | 17           | 0                      | 0                   | 1         | 7      | 4           | 0                    | 17          | 4      | 16        | 2     | 0                 | 1                     | 1      |
| Iliac artery                     | 15    | 1                | 7            | 1                      | 0                   | 1         | 6      | 5           | 0                    | 5           | 5      | 7         | 5     | 1                 | 2                     | 1      |
| Femoral artery                   | 46    | 1                | 24           | 1                      | 0                   | 4         | 17     | 16          | 2                    | 0           | 29     | 10        | 10    | 2                 | 3                     | 3      |
| Popliteal or more distal lower limb artery | 15    | 1                | 7            | 0                      | 0                   | 2         | 6      | 4           | 2                    | 0           | 9      | 0         | 4     | 5                 | 1                     | 1      |
| Total                            | 144   | 5                | 64           | 2                      | 0                   | 10        | 68     | 35          | 7                    | 28          | 75     | 35        | 31    | 13                | 10                    | 10     |

33) Cases with infected pseudoaneurysm located at the anastomotic site to the artificial graft are listed in Table 6-1.
34) Including the atherosclerotic aneurysm.
35) Including TAO, collagen disease, Behcet disease, and fibromuscular dysplasia.
and abdominal aortas were repaired by stent graft endo-vascular repair.

3) Autologous vascular graft aneurysms (Table 6-3)

Autologous vascular graft aneurysms were registered in upper limb arteries in 23 patients and lower limb arteries in 32 patients, but not in the abdominal splanchnic arteries.

4) Vascular graft deterioration (Table 6-4)

The number of patients for whom operations for artificial vascular graft deterioration were reported was 110. There were 52 in 2014 and 97 in 2015, indicating increases. The number of reports by initial surgical procedure (2014→2015→2016) was 19 patients undergoing replacement→29 patients→40 patients, 19 patients undergoing bypass surgeries→46 patients→49 patients, and 3 patients undergoing stent grafting→6→12 patients. Although deterioration of artificial blood vessels was reported for both polyester and ePTFE, the rate of deterioration could not be calculated because the population parameter was unknown.

6. Venous Surgery (Table 7)

1) Varicose veins of lower limbs (Table 7-1)

The number of varicose vein surgeries of the lower limbs has been increasing since 2011, with a highest record of 52,639 patients in 2016. Stripping procedures (± sclerotherapy) and high ligation procedures were less frequent, and endovenous laser ablation (EVLA) (± sclerotherapy) increased to 36,036 patients (68.5%) (Fig. 6). In Japan, 1,470 nm lasers and radiofrequency catheters were covered by health insurance in 2014. In the present record, radiofrequency ablation may have been registered in other procedures. Nonetheless, endovascular ablation was performed in more patients and was the first-line treatment for varicose veins of lower limbs.10)

2) Deep vein thrombosis of the lower limbs (including deep vein stenosis and occlusion) (Table 7-2)

A total of 469 patients who underwent surgery for deep vein thrombosis (DVT) of the lower limbs were registered. Majority, 267 patients (56.9%), underwent inferior vena cava filter placement, and 135 patients (28.8%) underwent filter removal. The rate of filter placement slightly decreased compared with 58.6% in 2015. Endovascular treatment of catheter-directed thrombolysis (CDT) was performed in 37 patients (7.9%), and endovascular treatment for stenosis was performed in 20 patients (4.3%), the same as that in the previous year; however, thrombectomy decreased from 64 patients in 2015 to 37 patients (7.9%).

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**Table 6-3** Autogenous graft aneurysm

| Revascularization area | Cases | Mortality | Repair procedure |
|------------------------|-------|-----------|-----------------|
|                        |       | 30-day mortality | Replacement | Bypass | Others |
| Visceral artery        | 0     | 0          | 0              | 0      | 0      |
| Upper limb artery      | 23    | 0          | 5              | 3      | 15     |
| Lower limb artery      | 32    | 0          | 11             | 8      | 14     |
| Others                 | 11    | 0          | 1              | 2      | 8      |
| Total                  | 66    | 0          | 17             | 13     | 37     |

**Table 6-4** Graft degeneration

| Revascularization               | Cases | Mortality | Initial revascularization procedure | Degenerative material | Repair procedure | Graft material |
|--------------------------------|-------|-----------|------------------------------------|-----------------------|-----------------|---------------|
|                                |       | 30-day mortality | Replacement | Bypass | Others Polyester ePTFE Others | Replacement | Stent graft | Others Polyester ePTFE Others |
| Descending thoracic aorta      | 3     | 2          | 1 | 1 | 0 | 2 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| Thoracoabdominal aorta         | 4     | 1          | 3 | 1 | 1 | 0 | 3 | 0 | 1 | 1 | 2 | 0 | 1 | 1 | 1 |
| Abdominal aorta-femoral artery | 20    | 0          | 7 | 10 | 3 | 1 | 10 | 7 | 3 | 2 | 9 | 3 | 1 | 5 | 5 | 10 | 1 |
| Femoro-popliteal artery        | 20    | 1          | 2 | 15 | 0 | 5 | 5 | 16 | 1 | 4 | 7 | 0 | 1 | 9 | 3 | 9 | 6 |
| Others                         | 66    | 2          | 28 | 24 | 7 | 11 | 14 | 32 | 21 | 12 | 24 | 3 | 1 | 31 | 5 | 26 | 16 |
| Total                          | 110   | 4          | 40 | 49 | 12 | 17 | 32 | 55 | 25 | 19 | 40 | 8 | 3 | 47 | 15 | 46 | 23 |
3) Upper limb and cervical vein stenosis and occlusion (Table 7-3)

The number of surgeries reported was 148, a slight increase from the number in 2015. Endovascular treatment was mostly performed to resolve venous stenosis in 87 patients (58.8%).

4) Vena cava reconstruction (Table 7-4)

The number of patients undergoing surgeries decreased to 67 patients from 75 in 2015, and the proportion of venous reconstruction surgeries for the inferior vena cava to that for the superior vena cava was similar to that in 2015. The most common etiology was tumors in 57 patients (85.1%), and only 1 operative and in-hospital death were reported each (1.5%). Surgical results were more favorable than those in 2015.

5) Budd-Chiari syndrome (Table 7-5)

Only 1 patient each underwent shunt surgery and percutaneous shunt creation, and the number of registered patients was extremely small as in 2015.

6) Other (Table 7-6)

There were 17 patients with deep vein aneurysm plication and suturing, and 3 patients underwent splanchnic vein aneurysm surgeries, indicating that the disease was rare as was the case in 2015.

7. Other Vascular Diseases and Related Surgeries (Table 8)

Only vascular access surgery significantly increased in 2016 compared with that in 2015.

1) Popliteal artery entrapment syndrome and cystic adventitial disease (CAD) (Table 8-1 and 8-2)

Although these were rare diseases from the start, the number of CAD did not change in 2016 compared with that in 2015, but that of popliteal artery entrapment syndrome decreased significantly.

2) Thoracic outlet syndrome (Table 8-3)

The number has remained almost the same over the past several years, and the disease continues to be rare.

3) Vascular access surgery (Table 8-4)

Although there is a tendency for increases every year, the speed of increase is accelerating, with an increase to 4,700 patients from the last year.

4) Surgical treatment for lymphedema (Table 8-5)

Although the number of surgeries significantly decreased from the previous year, there seems to be large fluctuations in the numbers.

5) Sympathectomy (Table 8-6)

In 2016, the number of patients was 33, with the level remaining almost unchanged.

6) Upper limb and lower limb amputation (Table 8-7 and 8-8)

Upper limb amputation remained unchanged this year;
however, leg amputations showed a decreasing trend from an increasing trend, and there is a need to observe the future course.

### Table 7-2  Deep vein thrombosis (including venous stenosis or obstruction)

| Deep vein thrombosis treatment          | Cases | Male | Female | 30-day mortality |
|------------------------------------------|-------|------|--------|------------------|
| Thrombectomy                             | 41    | 20   | 21     | 0                |
| Catheter-directed thrombolysis           | 37    | 16   | 21     | 0                |
| Bypass (peripheral venous reconstruction)| 3     | 1    | 2      | 0                |
| IVC filter insertion                     | 267   | 112  | 155    | 2                |
| IVC filter retrieval                     | 135   | 59   | 76     | 0                |
| Direct surgery of stenosis               | 6     | 1    | 5      | 0                |
| Endoluminal treatment of stenosis        | 20    | 12   | 8      | 2                |
| Others                                   | 6     | 5    | 1      | 0                |
| Total                                    | 469   | 207  | 262    | 4                |

38) Including the catheter-directed thrombolysis using hydrodynamic thrombectomy catheter. 
39) Including temporary IVC filter. 
40) Including obstruction.

### Table 7-3  Upper limb vein stenosis or obstruction

| Treatment of vein stenosis (obstruction) | Cases | Male | Female | 30-day mortality |
|------------------------------------------|-------|------|--------|------------------|
| Thrombectomy                             | 44    | 25   | 19     | 0                |
| Catheter-directed thrombolysis           | 4     | 3    | 1      | 0                |
| Bypass                                   | 9     | 6    | 3      | 0                |
| SVC filter insertion                     | 2     | 2    | 0      | 0                |
| Direct surgery of stenosis               | 5     | 2    | 3      | 0                |
| Endoluminal treatment of stenosis        | 87    | 55   | 32     | 1                |
| Others                                   | 14    | 9    | 5      | 0                |
| Total                                    | 148   | 91   | 57     | 1                |

41) Including the catheter-directed thrombolysis using hydrodynamic thrombectomy catheter. 
42) Including temporary IVC filter.

### Table 7-4  Vena cava reconstruction

| Vena cava reconstruction | Cases | 30-day mortality | Hospital mortality | Etiology | Treatment procedures | Material for open surgery |
|---------------------------|-------|------------------|--------------------|----------|---------------------|---------------------------|
|                           |       | Tumor | Thrombus | Others | Patch | Bypass | Replacement | PTA + stent | Others | Autogenous vessel | Polyester | ePTFE | Others |
| SVC reconstruction        | 16    | 0     | 11       | 3      | 2    | 3       | 6           | 5          | 3      | 0         | 0         | 11     | 1       |
| IVC reconstruction        | 51    | 0     | 46       | 1      | 4    | 12      | 1           | 10         | 2      | 26        | 10        | 3      | 9       |
| Total                     | 67    | 0     | 57       | 4      | 6    | 15      | 7           | 15         | 5      | 26        | 10        | 3      | 20      |

Abbreviations: IVC: inferior vena cava; SVC: superior vena cava

### Table 7-5  Budd-Chiari syndrome

| Treatment                  | Cases | Gender | 30-day mortality | Hospital mortality | Material for open surgery |
|----------------------------|-------|--------|------------------|--------------------|---------------------------|
|                            |       | Male   | Female           |                    | Polyester | ePTFE | Autogenous vessel | Others |
| Shunting                   | 1     | 0      | 1                | 0                  | 0         | 0     | 0             | 0      |
| Percutaneous shunting      | 1     | 1      | 0                | 0                  | 0         | 0     | 0             | 1      |
| Surgical recanalization    | 0     | 0      | 0                | 0                  | 0         | 0     | 0             | 0      |
| Total                      | 2     | 1      | 1                | 0                  | 0         | 0     | 0             | 1      |

### Conclusion

Annual reports of vascular surgery have been released every year since 2011, when the registration into NCD started, and an overall view of vascular surgeries in 2016
was clarified. This article provides a glimpse into the current status of vascular surgeries in Japan, in which details regarding surgeries are changing over time.

One of the major purposes of participating in the NCD is to improve the quality of medical care using NCD data. Limiting the data entry to essential items is essential to facilitate the entry of data considering the busy schedule of medical care. Despite this, the number of items to enter in order to improve the evaluation of the quality of medical care is essential.

### Table 7-6 Other surgery

| Treatment                                    | Cases | Gender | 30-day mortality | Hospital mortality | Material for open surgery |
|----------------------------------------------|-------|--------|------------------|--------------------|--------------------------|
| Plication of deep venous aneurysm<sup>43)</sup> | 17    | 8      | 9                | 1                  | 0                        |
| Plication of abdominal venous aneurysm        | 3     | 0      | 3                | 1                  | 0                        |
| Others                                        | 1,117 | 552    | 565              | 52                 | 95                       |
| Total                                         | 1,137 | 560    | 577              | 54                 | 96                       |

<sup>43)</sup> Including patch plasty.

### Table 8 Other vascular diseases

#### Table 8-1 Popliteal artery entrapment syndrome

| Treatment                      | Cases | 30-day mortality |
|--------------------------------|-------|------------------|
| Myotomy                       | 9     | 0                |
| Revascularization             | 19    | 0                |
| Total                         | 28    | 0                |

#### Table 8-2 Adventitial cystic disease

| Treatment                             | Cases | 30-day mortality |
|---------------------------------------|-------|------------------|
| Cyst excision± patch plasty           | 22    | 1                |
| Replacement                           | 13    | 0                |
| Bypass                                | 5     | 0                |
| Total                                 | 37    | 1                |

#### Table 8-3 Throracic outlet syndrome (TOS)

| Treatment                             | Cases | Male | Female | 30-day mortality | Type of TOS<sup>44)</sup> |
|---------------------------------------|-------|------|--------|------------------|---------------------------|
| Rib resection<sup>45)</sup>           | 2     | 0    | 2      | 0                | Neurogenic 6            |
| Rib resection + scaleneotomy          | 12    | 9    | 3      | 0                | Venous 2                |
| Bypass                                | 4     | 4    | 0      | 0                | Arterial 4              |
| Total                                 | 14    | 9    | 5      | 0                |                           |

<sup>44)</sup> In the case with mixture type, the type having the most significant impact on the clinical symptom is listed. But, if the impacts are similar, multiple response is allowed.

<sup>45)</sup> Including cervical rib.

#### Table 8-4 Vascular access operation

| Treatment                                                      | Cases | 30-day mortality |
|---------------------------------------------------------------|-------|------------------|
| Arteriovenous access creation by autogenous material           | 14,533| 134              |
| Arteriovenous access creation by artificial material<sup>46)</sup> | 3,320 | 42               |
| Open surgery for access repair                                 | 2,801 | 34               |
| Endovascular access repair                                    | 11,120| 46               |
| Arterial transposition                                         | 503   | 11               |
| Arteriovenous access aneurysm repair                           | 502   | 7                |
| Total                                                         | 32,779| 274              |

<sup>46)</sup> Including cases with access repair using artificial graft.

#### Table 8-5 Surgery for lymphedema

| Treatment             | Cases | Male | Female | 30-day mortality |
|-----------------------|-------|------|--------|------------------|
| Lymphovenous anastomosis | 0     | 0    | 0      | 0                |
| Lymph drainage operation | 3     | 2    | 1      | 0                |
| Resection             | 36    | 23   | 13     | 0                |
| Total                 | 39    | 25   | 14     | 0                |
care is increasing every year. Fortunately, the rate of mortality is too low for vascular surgeries, except for major vascular surgeries to be used as an evaluation index. The future goal is to add a function into the NCD to allow the comparison of quality of risk-adjusted vascular surgical practice at each institution with national standards. In 2018, the JSVS started a nationwide multicenter observational study of treatment options between open surgery and endovascular stent grafting for ruptured abdominal aortic aneurysms. As a model study, a retrospective study of treatment and prognosis for infected abdominal aortic aneurysm and common iliac artery aneurysm was conducted. Furthermore, in 2019, a retrospective study of surgical procedures and prognosis for popliteal artery entrapment syndrome was conducted to address these issues. In particular, the retrospective study on the treatment and prognosis of infected abdominal aortic aneurysms and common iliac artery aneurysm was accepted for publication in the British Journal of Surgery and will be published. In addition, a public offering of new research topics in the field of vascular surgery using NCD data has been started. Since 2018, an analysis of factors affecting surgical methods and prognoses for infection of artificial vascular/stent grafts in the abdominal aortic region; an analysis of the effects of malignant neoplasms on the prognoses of patients with arteriosclerosis obliterans and severe lower limb ischemia; and an analysis of the onset of wound complications after bypass surgery for ischemic limbs have been started. In 2019, a multicenter observational study on medical institution cooperation in emergency care for aortic and peripheral artery emergency care and the results of bypass surgery for collagen disease- and vasculitis-related critical limb ischemia in Japan has also been started. Site visits were started in 2018 to improve the reliability of the data. Due to the COVID-19 pandemic in 2020, remote audits over the web are being considered. The aim is to continue developing the vascular surgery database on NCD with the members, and the sincere hope is that this database will help provide high-quality medical care to patients suffering from vascular diseases.

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**Ethical Review**

Vascular surgery data registered in the NCD are analyzed and disclosed after opt-out procedures were conducted. Furthermore, the vascular surgery annual report was approved by the Institutional Review Board of Kansai Medical University Hospital on April 6, 2020 (Reference No. 2019276).

**Appendix**

Team responsible for analyzing the 2014 annual report as follows; Database Management Committee of the Japanese Society for Vascular Surgery: Nobuya Zempo

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**Table 8-6 Sympathectomy**

| Sympathectomy        | Cases | 30-day mortality |
|----------------------|-------|------------------|
| Thoracic sympathectomy | 23    | 0                |
| Lumbar sympathectomy  | 10    | 0                |
| Total                | 33    | 0                |

**Table 8-7 Amputation of upper limb**

| Amputation level | Cases | 30-day mortality |
|------------------|-------|------------------|
| Digit            | 17    | 0                |
| Forearm/upper arm| 2     | 0                |
| Total            | 19    | 0                |

**Table 8-8 Amputation of lower limb**

| Etiology          | Cases | 30-day mortality |
|-------------------|-------|------------------|
| ASO               | 68    | 12               |
| DM-ASO            | 290   | 12               |
| TAO               | 30    | 12               |
| Others            | 4      | 12               |
| Total             | 1,411 | 58               |

47) Amputations not due to ischemia are not included.

Abbreviations; ASO: arteriosclerosis obliterans; DM-ASO: diabetic ASO; TAO: thromboangiitis obliterans (Buerger’s disease)
Database Management Committee, NCD Vascular Surgery Analysis Team

(Chairman), Nobuyoshi Azuma (Vice-chairman), Yukio Obitsu (Vice-chairman), Yoshinori Inoue, Jin Okazaki, Hideaki Obara, Hiroto Satokawa, Kunihiro Shigematsu, Ikuo Sugimoto, Hiroshi Banno, Naoki Fujimura, Akihiro Hosaka, Shinsuke Mii, Noriyasu Morikage, Terutoshi Yamaoka, Tetsuro Miyata (Observer), Kimihiro Komori (Chief director of the Japanese Society for Vascular Surgery)

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Conflicts of Interest

None of the authors or co-authors have any conflict of interest to declare.

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