Endovascular Practice in Asia-Pacific

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The Asia-Pacific consists of countries with wide diversities in population, ethnicity, language, and clinical practice. With improvement in health care, many developed economies in the region have an aging population. The incidence and detection rates of occlusive and aneurysmal diseases are on the rise, although not yet approaching that in the United States.

The development of vascular surgery in Asia is slow, and most countries have only a small group of dedicated vascular surgeons. Peripheral vascular surgery is often practiced within the domain of general or cardiac surgery. With the rapid evolution of endovascular procedures, there is an increasing awareness to develop these technologies in Asia, but the task is made more difficult by the lack of a cohesive force, stern competition from other disciplines, and the difficulty in obtaining devices and training.

The growth of endovascular surgery, particularly endovascular stent grafts, is met with distinct variations in practice, device availability, regulations, and reimbursement among Asian countries. In those with matured economies and established funding structures such as Japan, government regulations and conservatism have hindered the introduction of industrial devices. On the other hand, developing worlds such as China have no strict regulation for devices, but the absence of reimbursement mechanism has restricted availability to only the more affluent. In others, the endovascular treatment option is simply not possible due to economic constraints. Culturally many patients are less receptive to pay for medical devices and consumables for conditions that they do not perceive as immediately life threatening—such as peripheral arterial disease and aneurysms. These factors are the main obstacles in the advancement of endovascular surgery in Asia.

To deliver an up-to-date and accurate summary of endovascular surgery in Asia is a grand task. I would attempt to describe the evolution and current practice of endovascular aortic aneurysm repair (EVAR) as representative of current developments in key countries including China, India, Japan, and Korea and the South East Asian states of Hong Kong, Singapore, Malaysia, Taiwan, Thailand, and to a lesser extent, Malaysia, Philippines, Indonesia, and Vietnam. For this purpose the Caucasian population of Oceania is not included. With a tremendous economic growth in the region, we expect that endovascular practice will evolve at an equally rapid pace, and information presented in this chapter may soon become obsolete.

Diversity

Maturity of Vascular Surgery as a Specialty

With modernization and changing dietary habits, we are witnessing an increase in the incidence of arterial pathologies, but peripheral vascular disease in Asia is still less prevalent than in the West. As a result vascular surgery as a specialty is not well developed in Asia. There is a proliferation of different practices based on patient access, equipment, and referral patterns. Many cardiologists and interventional

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radiologists participated in peripheral vascular work, particularly lower limb angioplasty and stenting.

Currently in many countries vascular surgery is practiced predominantly by general surgeons. In China, there is an increasing trend of specialization in major cities, and the Chinese Vascular Society comprise both dedicated vascular surgeons and general surgeons. Japan, Korea, and India have well-formed regional vascular surgery societies. Nevertheless many aortic aneurysm repairs are done by cardiovascular surgeons in these countries, while lower limb reconstructions are seldom performed. Primary amputation is still widely practiced. Most vascular surgeons work inside university practices, and vascular surgery in its current form as in the United States does not exist.

Training and certification requirements are also different. Local training institutions and facilities are very limited, and many vascular surgeons have sought additional overseas experience in reputed centers in the United States, Australia, or Europe as fellowships or short-term attachments. These surgeons form the backbone of the modern generation vascular surgeons in Asia and are often the pioneers in endovascular intervention.

Health Statistics

Due to the relative underdevelopment of vascular surgery, it is a universal phenomenon in Asia that there is no organized national database or health registry of peripheral vascular disease. Information is often gathered from local institution-based research data, and the overall disease prevalence is not known.

Economy and Health-Care Structure

Asia is also diversified in terms of wealth. There are regions that are considered developed, with healthcare systems on par with the West, such as Japan, Hong Kong, and Taiwan. In other, less developed countries endovascular surgery is still very much in its infancy due to the non-availability of infrastructure and resources. In some countries, expensive devices such as aortic endograft are realistically out of the general population's financial means. Most countries also have no universal health insurance, and the costs of devices have to be borne by the patients, which generally limits the accessibility of devices to the more affluent population.

Language

Each of the Asian countries speaks its own language, sometimes several languages and dialects, and English is not widely spoken even by physicians except perhaps in India, Hong Kong, and Singapore. When it comes to advanced endovascular procedures, international academic exchange, training, and proctorship, language barrier is an important concern. Very often the promulgation of a technology is left to a few English-speaking pioneers in the country.

Device Market

There are additional difficulties of making all devices available in Asia, particularly in the smaller countries. Most device companies regard Japan and China as their chief targets, the former due to its wealth and pricing structure, and the latter due to its economic growth and vast population. The degree of technical and product support in many countries in Asia is sadly at best haphazard and at worst non-existent. The uncertainties of government regulations, import restrictions, lack of good local training infrastructure, and domestic distribution issues have made many companies hesitant in moving into Asia. There are the additional legal concerns of patents and property rights and competition from domestic-manufactured devices. For the aortic endografts, only three industrial companies are currently having a real presence in Asia, namely Cook Medical (Bloomington IN), Gore (Flagstaff, AZ), and Medtronic (Santa Rosa, CA). In the smaller countries, access to new devices is often very limited due to the lack of company representation, knowledgeable sales personnel, and good technical support.

Government Regulations

Japan and Taiwan have FDA-type strict government regulations on the import and use of new medical

devices. Endografts have to undergo a rigorous clinical trial stage before approval can be granted. This has also resulted in a setback of several years before current generation devices are made available for use outside clinical trials. In many South East Asian countries, on the other hand, government regulations are less stringent, and any new devices are accepted as long as they have been marketed in a Western country and possess either a CE mark or FDA approval rating. Many branched and fenestrated devices are therefore made available also in Asia, notably Hong Kong and Singapore. With strict FDA regulations in the United States, some companies are already conducting their trials of new innovative devices in Asia.

Anatomy

Asians are generally smaller in stature and have smaller vessels. Superficial femoral artery diameters of 5–6 mm are common among women, and this has a negative impact on the results of angioplasty and stenting. The use of covered stents in the lower limbs is also not met with great success due to the inherent bulk of the graft. Likewise small access vessels have limited the application of endovascular aortic stent grafts. In our own experience half of the thoracic endografts implanted in women require the construction of an iliac conduit. Percutaneous stent graft insertion is seldom feasible, and this has also limited the adoption of endovascular aortic stent graft by interventional cardiologists in Asia.

The common iliac artery in Asians is often shorter and wider than their Western counterparts [1]. The average length of the common iliac artery is in the region of 25–30 mm, with diameters of 16–20 mm. Short and wide common iliacs result in two main issues: length of the main body and a lack of adequate distal seal. As a result planning for EVAR has to be more demanding and execution more accurate in Asians. Many abdominal stent grafts, originally designed according to Caucasian anatomy, were too long for Asians. Placement of the distal components had to be as close to the iliac bifurcation as possible to maximize seal. A three-component system such as the Zenith endograft (Cook Medical, Bloomington, IN) is popular. The main body can be introduced first without concern of the length of the ipsilateral leg, and the iliac components added at a second stage to achieve an accurate landing as close to the iliac bifurcation as possible. The Zenith graft also has a wide choice of body lengths and large diameter iliac extensions up to 24 mm to accommodate variations in Asian anatomy.

Preservation of the internal iliac arteries also is a challenge. Even with large diameter iliac extensions, more than 40% of our patients would need sacrifice of one internal iliac artery. The newer generation iliac bifurcation grafts have also found a good testing ground in this part of the world.

China

China has a population of 1.3 billion. There is, however, no national training body for vascular and endovascular surgery. Vascular surgery is not a popular specialty, but there are large individual hospitals and units in major cities dedicated to cardiovascular and peripheral vascular work. Over the last decade, there has been a tremendous development of health care in China, although most remain regional based. New hospitals with modern equipment, including state-of-the art CT scanners and interventional theaters, are being built at a fast pace.

Endovascular intervention is shared by many specialists who have access to patients and equipment. Peripheral and carotid angioplasty and stenting had proliferated but unregulated and is practiced by cardiologists, neurologists, radiologists, and vascular surgeons alike.

EVAR is largely carried out by surgeons in operating theatres. Currently more than 2,000 cases are performed annually in about 200 regional centers. Prominent leading centers in endovascular surgery are located mainly in Shanghai, Beijing, and Guangzhou. The Chinese have embraced the thoracic endovascular stent graft technology to treat aortic dissections, and several centers have accumulated experiences in excess of 200 implants, among the most experienced in the world. At the Department of Vascular Surgery at Fudan University in Shanghai, some 110 thoracic endovascular repairs (TEVAR) were performed for dissection in 2006, compared to 20 in 2000. Treating acute Type B dissection by TEVAR has become the standard first

choice procedure in China. There is a disproportionally large percentage of thoracic endograft implants compared with its abdominal counterpart – it is estimated that at least 60–75% of endografts in China are done for thoracic dissections. Although hypertension and smoking may be more prevalent in China, the high number of aortic dissections being treated in China may not actually reflect a high incidence of the disease, but a higher detection rate from emergency departments. EVAR comprises about half of TEVAR numbers in China, but with the rapid modernization of health-care systems and improved detection of abdominal aortic aneurysms (AAA), endovascular repair of AAA has been growing fast.

There is no strict license for devices, and a variety of foreign-manufactured stent grafts are available. The Medtronic Talent and Valiant grafts currently dominate the stent graft market, with the Cook Zenith coming second. These devices are often sold for prices in the region of US $20,000, and there is no national reimbursement system or medical insurance. Except in the military and some private companies, the patients are expected to pay for the device out of their own resources.

There are a number of domestically manufactured stent grafts which comprise about half of the total market. The Microport Hercules device (Microport Medical, Shanghai, China) is a thoracic stent graft made of polyester fabric sutured on nitinol stents, similar to the Talent design. It is available in diameters up to 44 mm and lengths from 40 to 160 cm and delivered through a 16–24 Fr sheath. The company also offers an abdominal bifurcated AEGIS graft (Microport Medical, Shanghai), consisting of an e-PTFE fabric supported by a cobalt–chromium–nickel–molybdenum–iron alloy (Conichrome) with suprarenal stents, similar to the Powerlink (Endologix Inc, Irving, CA) design, and comes in diameters from 20 to 38 mm. The Ankura (Lifetech Scientific Inc, Shenzhen, China) device consisted of an e-PTFE embedded non-suture stent graft with a suprarenal stent cone. These domestic devices are available for about two-thirds of the costs of a “Western” device and are attractive alternatives to patients. There is also a large market for domestically developed medical cardiovascular products, from balloons to peripheral, carotid, and intracranial stents, drug-eluting coronary stents, IVC filters, occluders, to endovascular stent grafts. There are plans for a central tendering system from the Beijing government, but at the time of writing the choice and pricing of devices are largely hospital administered.

A lot of innovative work has been done in China to adopt endografts in unconventional situations, such as Type A aortic dissections, and homemade branched devices for the aortic arch have also been developed [2]. The main issue about endovascular surgery in China is the adequacy of follow-up. Many patients who seek treatment in reputed centers are from rural areas and without means of further surveillance or communication. This alone poses a significant barrier to promulgating the many novel procedures currently done in China.

Vascular surgeons in China are currently doing more than 90% of EVAR, and it is expected that their role will continue to dominate in future.

Japan

Vascular surgery is also not well recognized and underdeveloped as a specialty in Japan. The entire country has only four professors of vascular surgery among 80 medical schools. Open surgery is largely done by cardiac surgeons, while carotid disease is managed by neurosurgeons. Few procedures such as carotid endarterectomy or distal bypasses were performed. Lower limb and renal angioplasty are less commonly done and largely in the hands of cardiologists. Although the Japanese Society for Vascular Surgery has almost 2,000 members, the majority are cardiothoracic surgeons who perform aneurysm repairs and lower limb procedures. Nevertheless it is estimated that 10,000 AAA repairs were done annually in Japan. Over 80% of EVAR currently is being performed by cardiovascular surgeons and the remaining by interventional radiologists and cardiologists.

The Minister of Health, Labor, and Welfare has a very strict process of licensing stent grafts, which has led to a delay of their commercial availability. In the last decade Japan has developed, by domestic manufacturers, a number of homemade thoracic endografts, with proprietary branch and fenestration arrangements. The Najuta stent graft was developed by the Tokyo Medical University, with custom-made Z stents covered with PTFE and containing fenestrations and sutured only at proximal and distal ends to allow for the aortic curvature [3]. Other designs include the

Matsui–Kitamura graft consisting of a nitinol stent spiral skeleton covered with Dacron and also curved to match the arch anatomy [4] and the branched abdominal and thoracic versions of the Inoue graft [5]. A few hundred of these devices have been implanted in Japan under research permits in several centers, but they are not widely available.

Japan has always been regarded as one of the largest market for cardiovascular devices in the world, second only to the United States, due to its health-care system and high pricing. There is no universal insurance, but once a device is registered, it is reimbursable by a health insurance company based on a fixed price controlled by the government and only if the patients are deemed at high risk unsuitable for open surgery. Currently an EVAR device costs about US $15,000 in Japan.

Three industry-made abdominal aortic stent grafts have been approved by the Minister of Health, Labor, and Welfare: the Zenith (Cook Medical, Bloomington, IN) in July 2006, Excluder (Gore & Associates, Flagstaff, AZ) in January 2007, and Powerlink (Endologix Inc, Irving, CA) in April 2008, 7 years behind the United States. The training requirements mandate the first two cases to be done in the presence of a proctor and the first ten under strict scrutiny. About 1,500 EVARs have since been performed in the first 2 years of launch, compared to only 100 in 2006. In early 2008 the Gore TAG device had been approved, and in the first 4 months some 300 TEVARs had been performed. It is anticipated that after the initial adoptive phase, there will be an explosive growth in the use of these devices in the next 1–2 years. The total number of endografts done to date in Japan approximates 2,000.

As of the time of writing the largest endovascular surgery unit had been established at the Jikei University in Tokyo, where approximately 300 aortic stent grafts were performed yearly. In the last 2 years, more than 360 EVARs were performed in this university, of which about 60% were Zenith and 40% Excluder implants. Current workload has increased to about 30 EVARs a month, and some 30 branched graft cases have been performed [6].

The Angioguard/Precise carotid stent was approved in 2007. Four Japanese centers have recently been recruited into the Cook Zilver PTX drug-eluting stent's trial. The situation is promising, and with better device access in future, it is foreseeable that there will be an endovascular revolution in Japan.

Korea

Similar to Japan, there are no large numbers of vascular surgeons in Korea, and interventional radiologists have traditionally dominated peripheral endovascular work. Surgeons and cardiologists are, however, showing an interest in endografts. Currently about 300 EVARs and 100 TEVARs have been performed in the country.

Reimbursement of the device is government controlled with a diagnosis-related group-based payment and the prices are generally lower. Registrations of foreign devices are relatively slow. Three industry-made endografts are currently approved in Korea – the Zenith (Cook Medical, Bloomington, IN), AneuRx (Medtronic, Santa Rosa, CA), and Excluder (Gore, Flagstaff, AZ).

Korea has developed a domestic thoracic endograft which had originated in 1997 with S&G Biotech, currently named SEAL. The graft is based on a percutaneous 12 Fr design with an outer Dacron fabric supported at both ends with nitniol stents and reinforced by a second stage inner lattice of bare nitinol stents [7]. The graft has been approved by the Korean FDA in March 2008 and is marketed mainly in Korea and also in Indonesia.

India

Despite its large population of more than 1.1 billion, vascular surgery is still in its developing phase in India. In 2008 it was estimated that there were only 70 full-time vascular surgeons in the country. Only 10 out of 24 medical schools in India have a vascular surgery unit, and only seven centers have a training program for 12 vascular trainees annually. There are about 5,000 arterial reconstructions per year, and most of the work is done by cardiac and general surgeons. There is no medical insurance, and patients with the financial means will have to pay for the consumables. Endovascular surgery has not been widely available to the general population, mainly due to the prohibitive costs of the devices, and the general public often prefers the less expensive open option. Availability of interventional facilities is another factor, as most are controlled by cardiologists and radiologists. As far as endografting is concerned at this time India remained a small market of 100–200 devices per year, and the

work is largely done by vascular surgeons and cardiologists working in private hospitals. Endovascular training is generally obtained overseas, but a company has established a training facility in New Delhi. Progress at present remains slow.

Hong Kong

Vascular surgery practice is mainly confined to two university hospitals, and the rest are performed by general surgeons. Following largely a British system, the territory provides affordable health care for all citizens, but expensive devices were not included and patients have to pay for endografts and stents. Insurance is picking up but still not popular among the aged.

There is an increasing interest of vascular surgeons to practice endovascular surgery, and many have obtained training overseas in United States and Australia. Nevertheless they face keen competition from cardiologists and some interventional radiologists for peripheral vascular work. Carotid angioplasty and stenting are not commonly done, and around 80 are done yearly in the region. In general, peripheral endovascular surgery is still not popular due to reluctance of the patients to undergo intervention and to pay for expensive devices. Endovascular stent graft remained at this time largely in the hands of surgeons, working in operating room setting either individually or in cooperation with radiologists.

Regulation of devices is not stringent, and any device with CE or FDA approval can be used in Hong Kong. The first EVAR was performed as early as 1997, and to date about 150–200 have been performed yearly, largely in three public hospitals. Currently at the largest vascular center at Queen Mary Hospital, the University of Hong Kong, approximately 60 aortic endografts are performed annually, accounting for 60–70% of all its aneurysm repairs.

The biggest obstacle to the endovascular program in Hong Kong is reimbursement. The Hospital Authority, which controls all funding to public hospitals, does not restrict the use of EVAR, but also does not provide financial support. After more than 10 years of regular usage, EVAR is still regarded as a new technology and remains unfunded. Most patients would have to be self-financed, with a small proportion of disadvantaged patients supported by meager charity grants.

Due to issues of representation and difficulty of technical support, only a few devices are currently available. The first endograft was the AneuRx (Medtronic, Santa Rosa, CA), which was later replaced by the Talent. The Zenith (Cook Inc, Bloomington, IN) graft became the market leader since its introduction in 2003, taking about 80% of share because of its range of diameters suited for Asian anatomy. There have been sporadic Excluder (Gore, Flagstaff, AZ) implants. In the thoracic market, the Zenith TX2 and Medtronics Valiant are the popular grafts.

Hong Kong has benefitted from a relative freedom in importing devices and has always enjoyed the latest grafts on the market (such as the Zenith FLEX and TX2 with Flexor sheaths, fenestrated grafts, and branched devices and the newer Medtronic Endurant). Due to the unique common iliac anatomy, we have come to the need to sacrifice one internal iliac artery in almost half of the patients with EVAR. This has prompted the introduction of a proprietary iliac bifurcated branched graft and later a bifurcated main body version in the territory.

With a relatively small population of 7 million, the endograft market has matured in Hong Kong, and the number will stay stable. The funding system has found a balance, and there is no apparent incentive in the health-care administration to advance this arrangement.

Singapore

Similar to Hong Kong, Singapore is a mature but smaller market. With a population of about 4.5 million, less than 100 endografts are performed in the country yearly, largely in cardiac laboratories or radiology suites in two public institutions. The work is shared between vascular surgeons, cardiologists, and radiologists. Singapore has a more mature specialty structure, and vascular surgery is better recognized in the region. There is a small government fund to support a small number of grafts, but most patients have to pay for the devices.

Taiwan

Vascular surgery only gained recognition as a specialty in the mid-2000s, when the Taiwan Society

for Vascular Surgery was established. Prior to this endovascular work was largely in the hands of cardiologists. There has been a significant volume of carotid and vertebral angioplasty and stenting done by the Division of Cardiology at the National University of Taiwan Hospital. EVAR development was late in Taiwan due to government regulations mandating a FDA-type trial before any devices can be registered for use. EVAR was formally approved only in July 2005 after a series of slow trials, and currently only the AneuRx (Medtronic, Santa Rosa, CA), Zenith TriFab (Cook Medical, Bloomington, IN), and Excluder (Gore, Flagstaff, AZ) endografts are on the market. EVAR is being performed largely by cardiovascular surgeons, with some 150 AAA and 100 TAAs and dissections per year. This is also a growing market, although most patients have to pay for the devices and no universal insurance coverage is in place.

Thoracic endografting was officially approved in November 2006 with the registration of the Zenith TX2 device. The current leading center in Taiwan is the Veterans General Hospital, where annually about 60 TEVAR and 50 EVARs are performed in the cardiothoracic department, many in combination with extracorporeal circulation or hybrid procedures. There has been a steady growth in endovascular stent grafts in other centers over the territory.

Thailand

Endovascular surgery has also proliferated significantly in Thailand in the last few years. Initially supported and reimbursed by the government, covering 80% of device costs, there has been a rapid growth of endovascular stent grafts, but at significant expenses to the government. Currently EVARs are mainly done by cardiothoracic surgeons in Bangkok.

Malaysia

EVAR and other endovascular surgery is limited to a very few private vascular surgeons who have the facilities and the patients to afford the devices. Currently this remains a very small market.

Philippines and Indonesia

These countries do not have a well-differentiated vascular surgery program and are also limited by device costs. There is really only a token number of cases performed each year, and the market is not looking at expanding in the near future.

In conclusion, endovascular surgery practice is very varied in Asia, but shows good promise in at least several countries. There is a universal phenomenon of under-recognition of vascular surgery, and limitation in facilities and reimbursement became the major obstacles for vascular surgeons. It is anticipated, however, that with increasing disease numbers and awareness we will see a continuing bloom of endovascular surgery in this part of the world.

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