Intravascular Ultrasound

Number: 0382

Policy

*Please see amendment for Pennsylvania Medicaid at the end of this CPB.

I. Aetna considers intravascular ultrasound (IVUS) medically necessary for any of the following situations:

   A. As a clinical decision-making tool to evaluate the need for an intracoronary interventional procedure in a symptomatic member whose angiogram shows 50 to 70% stenosis(es); or

   B. As a conclusive study to assess suspected left main stem coronary artery disease not revealed by coronary angiography; or

   C. As a guidance for placement of vena caval filter; or

   D. As a method for both guidance of placement of endoluminal devices and immediate assessment of the results of intracoronary interventional procedures (i.e., angioplasty, atherectomy, stenting), including those performed on coronary grafts; or

   E. As a method for evaluation of cardiac allograft vasculopathy in post-cardiac transplantation recipients; or

   F. Diagnosis of iliac vein compression syndrome (May-Thurner syndrome) of the left lower extremity.

Policy History

Last Review 04/13/2017
Effective: 02/01/2000
Next Review: 04/12/2018

Review History

Definitions

Additional Information

Clinical Policy Bulletin Notes
II. Aetna considers the clinical application of IVUS experimental and investigational in screening for coronary artery disease, diagnosing coronary vulnerable plaques, and its use in other coronary procedures because its effectiveness for these indications has not been established.

III. Aetna considers the clinical application of IVUS experimental and investigational for diagnosis of aortic dissection, during endovascular interventions of failing hemodialysis access grafts, evaluation of chronic venous obstruction/venous stenting, evaluation of carotid artery stenosis, and stenting of non-coronary arteries, and other non-coronary vascular (i.e., including veins) procedures (other than those listed above) because its use for these indications has not been validated by clinical studies.

See also CPB 0520 - Magnetic Resonance Imaging of the Cardiovascular System - Cardiac MRI.

**Background**

Angiography is limited in determining the anatomic severity of coronary artery stenoses because it represents only a projectional image of the vessel lumen without providing any information concerning vascular wall architecture. Catheter-based intravascular ultrasound (IVUS) has been developed in the last few years to provide this unique perspective for viewing vascular disease and the effects of intervention. As a complement to the information provided by coronary angiography, it has the unique ability to study vessel wall morphology in vivo, accurately displaying the details of vessel structure and tissue characterization by providing such critical information as the presence and degree of calcified plaque, quantifying luminal dimensions, and characterizing the composition of stenotic lesions into soft plaque, hard plaque, calcification, and type of thrombus.

Although these devices have only been available for a relatively short time, an array of studies demonstrating numerous diagnostic and therapeutic applications in interventional cardiology have been reported. The maturity of the technology is such that IVUS currently has a place as a clinical decision-making tool in patients with symptoms and intermediate lesions, as a
provisional study to assess left main stem disease suspected but not disclosed by coronary angiography, and as a method for both guidance of endoluminal devices and immediate assessment of the results of therapeutic techniques, including balloon angioplasty, atherectomy, and intravascular stent deployment.

More research is needed to answer some important questions regarding the whole array of potential applications of IVUS. Newer developments under scrutiny include combined devices, looking-forward ultrasound, high-frequency probes, imaging wires, tissue characterization and three dimensional (3-D) technology.

Its use in peripheral vascular disease remains as a research tool for investigation of blood vessel compliance, dynamic changes in the vessel wall caused by disease or pharmacologic intervention, and elucidation of the morphologic changes associated with the natural history of atherosclerosis. It has not been proven that changes in treatment made based on the results of intravascular ultrasound improve health outcomes in patients with non-coronary vascular diseases.

Intravascular ultrasound has been used as a guidance for placement of inferior vena cava filters. Ashley et al (2001) reported that IVUS is a more accurate method of localizing the renal veins and measuring vena cava diameter for placement of vena cava filters than contrast venography. Mathews et al (2003) noted that imaging of the vena cava prior to the insertion of an inferior vena cava (IVC) filter is mandatory to assess IVC diameter and patency, delineate anatomy and venous anomalies, and to direct filter placement for appropriate deployment and avoidance of complications. The standard imaging technique is vena cavography, although alternative methods to evaluate the IVC include carbon dioxide venography, trans-abdominal duplex ultrasound, and IVUS.

Wellons et al (2004) stated that reports have demonstrated the benefit of prophylactic inferior vena cava filter (IVCF) placement to prevent pulmonary embolism. This study evaluated the potential for the bedside placement of a removable IVCF under
"real-time" IVUS guidance. A total of 20 trauma patients underwent intensive care unit placement of a removable IVCF with IVUS guidance. All patients had ultrasonography of the femoral veins after placement to rule out post-procedure femoral vein thrombosis and radiographs to identify filter location.

Nineteen of 20 IVCFs were placed at approximately the L2 level as verified by radiography. One patient had a large IVC (34 mm) and underwent bilateral common iliac IVCF placement under IVUS. Within 3 weeks of placement, 12 IVCFs were retrieved. Of the remaining 8 patients, 6 had indications for permanent implantation, 2 had contralateral deep venous thrombosis, and 1 had ipsilateral deep venous thrombosis. The authors concluded that bedside insertion of a removable IVCF with IVUS guidance and its removal are simple, safe, and accurate.

Passman et al (2005) stated that bedside placement of ICVF by using either trans-abdominal duplex ultrasonography or IVUS has been shown to be safe and effective. The authors reviewed techniques for bedside filter placement with trans-abdominal duplex ultrasonography, IVUS with dual venous access, and IVUS with single venous access. They noted that trans-abdominal duplex ultrasonography and IVUS remain their preferred techniques for filter placement when feasible, especially in critically ill and immobilized patients.

de Ribamar Costa et al (2007) stated that in the drug-eluting stent (DES) era, stent expansion remains an important predictor of re-stenosis and sub-acute thrombosis. Compliance charts are developed to predict final minimum stent diameter (MSD) and area (MSA). The objectives of the study were 2-fold: (i) to evaluate DES expansion by comparing IVUS-measured MSD and MSA against the values predicted by compliance charts and (ii) to compare each DES against its bare-metal stent (BMS) equivalent. These researchers enrolled 200 patients with de novo coronary lesions treated with single, greater than 2.5-mm Cypher (Cordis, Johnson & Johnson, Miami Lakes, FL) (sirolimus-eluting stent [SES], n = 133) or Taxus (Boston Scientific, Natick, MA) (paclitaxel-eluting stent [PES], n = 67) stent under IVUS guidance without another post-dilation balloon. They used a comparison cohort of 65 equivalent BMS (Express 2 [Boston Scientific], n = 37; Bx
Velocity [Cordis, Johnson & Johnson, n = 28) deployed under similar conditions. The DES achieved only 75 % +/- 10 % of predicted MSD and 66 % +/- 17 % of predicted MSA; this was similar for SES and PES. Furthermore, 24 % of SES and 28 % of PES did not achieve a final MSA of 5 mm(2), a consistent predictor of DES failure. The SES achieved 75 % +/- 10 % of predicted MSA versus 75 % +/- 9 % for Bx Velocity (p = 0.9). The PES achieved 79.9 % +/- 14 % of predicted MSA versus 79 % +/- 10 % for Express 2 (p = 0.8). Lesion morphology, arc and length of calcium, stent diameter and length, and implantation pressures did not affect expansion. The authors concluded that compliance charts fail to predict final MSD and MSA. A considerable percentage of DES does not achieve minimum standards of stent expansion. The SES and PES achieve similar expansion to their BMS platform, indicating that the polymer coating does not affect DES expansion in vivo. However, stent expansion can not be predicted from pre-intervention IVUS lesion assessment.

The randomized TAXUS II trial evaluates the polymer-based paclitaxel-eluting Taxus stent in slow- and moderate-release formulations. Tsuchida et al (2007) examined the consistency between angiographic and IVUS outcomes of late lumen loss (late loss) and neointimal growth to measure restenotic plaque load in Taxus and BMS. Serial angiographic and IVUS analyses were available in 155 event-free patients (BMS, n = 74; Taxus stent, n = 81) after the procedure, at 6 months, and at 2 years. For this sub-analysis, quantitative coronary angiographic (QCA) and IVUS measurements were used to derive late loss and neointimal volume. From after the procedure to 6 months, QCA and IVUS showed matching results for the 2 groups with significant decreases in late loss and neointimal volume in the Taxus versus the control group. From 6 months to 2 years, QCA and IVUS measurements also showed results similar to those in the control group, demonstrating neointimal compaction over time. However, in the Taxus group, QCA late loss showed a non-significant decrease from 6 months to 2 years, whereas IVUS neointimal volume increased. The authors concluded that although QCA and IVUS results were similar over the first 6 months, long-term assessment of changes in re-stenotic plaque load showed discrepant findings for the Taxus stent. These
findings suggest the need for critical re-evaluation of current end points and the use of more precise techniques to detect lumen and stent boundaries.

Hoffmann and colleagues (2008) stated that the impact of incomplete stent apposition (ISA) after drug-eluting stent implantation determined by IVUS on late clinical events is not well-defined. These researchers assessed the clinical impact of ISA after sirolimus-eluting stent (SES) placement during a follow-up period of 4 years. Intravascular ultrasound at angiographic follow-up was available in 325 patients (SES, n = 180; BMS, n = 145); IVUS images were reviewed for the presence of ISA defined as one or more unapposed stent struts. Frequency, predictors and clinical sequel of ISA at follow-up after SES and BMS implantation were determined. Incomplete stent apposition at follow-up was more common after SES (n = 45 (25 %)) than after BMS (n = 12 (8.3 %), p < 0.001). Canadian Cardiology Society class III or IV angina at stent implantation (odds ratio (OR) = 4.69, 95 % confidence interval [CI]: 2.15 to 10.23, p < 0.001) and absence of diabetes (OR = 3.42, 95 % CI: 1.05 to 11.1, p = 0.041) were predictors of ISA at follow-up after SES placement. Rate of myocardial infarction tended to be slightly higher for ISA than for non-ISA patients. When only SES patients were considered, major adverse cardiac event free survival at 4 years was identical for those with and without ISA at follow-up (11.1 % versus 16.3 %, p = 0.48). The authors concluded that ISA at follow-up is more common after SES implantation than after BMS implantation. Considering the current very sensitive IVUS definition, ISA appears to be an IVUS finding without significant impact on the incidence of major adverse cardiac events even during long-term follow-up.

Garcia-Garcia et al (2008) stated that detection of coronary vulnerable plaques in vivo is essential for studying their natural history and assessing potential treatment modalities and, therefore, may have an important impact on the prevention of acute myocardial infarction and death. Currently, conventional grayscale IVUS, IVUS-virtual histology (IVUS-VH) and palpography data are being collected with the same catheter during the same pullback. A combination of this catheter with either
thermography capability or additional imaging, such as optical coherence tomography or spectroscopy, would be an exciting development. Intravascular magnetic resonance imaging also holds much promise. To date, none of the techniques described above has been sufficiently validated and, most importantly, their predictive value for adverse cardiac events remains elusive. The authors noted that very rigorous and well-designed studies are needed for defining the role of each diagnostic modality. In this regard, Ibanez and colleagues (2009) consider IVUS as an investigational technique for the visualization as well as the compositional characterization of atheromatous plaques.

Clementi et al (2009) noted that plaque reduction with the use of pioglitazone and statin combination therapy has been observed in carotid plaque. These researchers examined the effect of combination therapy with statins and pioglitazone on coronary plaque regression and composition with the use of IVUS and IVUS-VH. These investigators analyzed 29 plaques in 25 diabetic patients with angiographic evidence of non-significant coronary lesions with IVUS-VH. Patients were treated with 80 mg of atorvastatin and 30 mg of pioglitazone daily for 6 months. After 6 months of therapy, IVUS-VH of each lesion was re-acquired. Mean elastic external membrane volume was significantly reduced between baseline and follow-up (343.0 mm versus 320.5 mm; p < 0.05) as was mean total atheroma volume (179.3 mm versus 166.6 mm; p < 0.05). Change in total atheroma volume showed a 6.3 % mean reduction. Areas of fibrous tissue, fibro-lipidic tissue and calcium decreased over the 6 months of follow-up, although not significantly. On the other hand, the necrotic core increased from 9 % to 14 % (p < 0.05). The authors concluded that these findings demonstrated that atorvastatin/pioglitazone association is able to induce significant regression of coronary atherosclerosis, acting on plaque composition. Moreover, they noted that their findings are preliminary results and will be confirmed in an ongoing randomized placebo-controlled multi-center trial.

An assessment prepared for the Agency for Healthcare Research and Quality (Lau et al, 2004) concluded that currently, neither IVUS nor other imaging technologies can reliably
identify vulnerable plaque prospectively, i.e., before rupture.

Konig et al (2008a) noted that cardiac allograft vasculopathy (CAV) is the major limitation in survival of patients following heart transplantation. Cardiac allograft vasculopathy is angiographically silent in the early phase after operation. Intravascular ultrasound is a more sensitive method to detect the early stages of CAV and provides information about its development. Recent IVUS studies demonstrated a rapid progression of CAV within the 1st year after transplantation as a predictor of morbidity and mortality. These investigators evaluated the plaque composition of early atherosclerosis in transplant patients by radiofrequency (RF) analysis. Coronary angiography and IVUS with Virtual Histology (VH) software were used to assess 18 patients early after heart transplantation (1.71 +/- 0.47 months). The plaque composition was determined by IVUS radiofrequency data analysis. Tissue maps were reconstructed from RF data using VH-IVUS software. The VH-IVUS acquisition was performed with standardized IVUS and the VH-IVUS console. Coronary angiography did not show any wall irregularities; IVUS demonstrated donor-transmitted atherosclerosis in 6 of 18 patients (33.33 %). The incidence, amount of plaque burden, and plaque composition was significantly related to donor age. By VH-IVUS analysis, the plaque composition consisted mainly of fibrotic tissue. The authors concluded that donor-transmitted coronary atherosclerosis is present early after heart transplantation and can not be detected by coronary angiography; VH-IVUS gives detailed information about the plaque distribution and the plaque composition.

Konig and associates (2008b) stated that the survival of heart transplant recipients is limited by CAV. Intravascular ultrasound and IVUS-derived RF plaque composition analysis (IVUS-RF) provide further information about the process of coronary atherosclerosis. These researchers assessed the time-dependent differences in disease progression in patients with CAV. A total of 56 patients were divided into 3 groups according to time interval after transplantation: (i) Group I: 1 to 3 months (n =18); (ii) Group II: 1 to 5 years (n = 20); and (iii) Group III: 5 to 15 years (n = 18). IVUS-RF revealed time-dependent increases in all plaque
components. The largest increase was shown for fibrotic, fibro-fatty and necrotic tissue between Groups I and II. Dense calcium area increased uniformly in all groups. IVUS-RF-derived plaque type analysis revealed predominantly fibrotic plaques in all groups with a decrease of frequency over time. Fibro-lipidic and fibrotic-calcific plaques increased uniformly. High-risk lesions, such as thick-cap fibro-atheromas (FAs), increased in Groups I and II and decreased in Group III. Thin-cap FAs were detected only in Group III. The authors concluded that IVUS-RF, as compared with gray-scale IVUS, provides better detailed information regarding the development of CAV by plaque morphology and composition analysis in different stages after heart transplantation. Serial IVUS-RF analysis in these patients may improve the stratification of heart transplant recipients.

Hernandez et al (2009) characterized graft coronary artery disease by means of VH-IVUS at different time-points of follow-up and correlated plaque composition with clinical factors. These investigators included 67 patients (mean age of 7.6 +/- 5.7 years post-heart transplant (HTx); and IVUS gray-scale evaluation was performed on all patients. VH-IVUS analysis was done in those patients showing intimal thickening greater than 0.5 mm at the 3 more significant lesions (3 cross-sections for each) of the left anterior descending artery. VH-IVUS analysis was obtained on 58 patients (86.5 %). They found a significant correlation between time of HTx and IVUS gray-scale parameters (plaque area and plaque burden), with both increasing over time. They also found a significant correlation between time and VH-IVUS-derived plaque components, necrotic core and calcium, which increased with time, and fibrous and fibro-fatty components, both decreased at follow-up. VH-IVUS results were also related to donor age and cardiovascular risk factors. The authors observed a time-related change in VH-IVUS-derived plaque composition. Necrotic core and calcium, typical atheromatous components, become more prevalent with time after HTx, especially when influenced by cardiovascular risk factors. The presence of a necrotic core in the early stages was linked to older donor age.

Raichlin et al (2009a) investigated tissue characterization of the coronary allograft atherosclerotic plaque with VH-IVUS imaging to
assess the presence and predictors of vessel wall inflammation and its significance in CAV progression. A total of 86 patients with CAV underwent VH-IVUS examination of the left anterior descending coronary artery 3.61 +/- 3.04 years following cardiac transplantation. Based on the VH-IVUS plaque characteristics, coronary allograft plaque was divided on VH-IVUS-derived "inflammatory" (VHD-IP) (necrotic core and dense calcium greater than or equal to 30 %) and "non-inflammatory" plaque (VHD-NIP) (necrotic core and dense calcium less than 30 %). Total rejection scores were calculated based on the 2004 International Society of Heart and Lung Transplantation rejection grading system. Overall, the mean percentage of fibrous, fibro-fatty, dense calcified, and necrotic core plaques in a mean length of 62.3 +/- 17.4 mm of the left anterior descending coronary artery were 50 +/- 17 %, 16 +/- 11 %, 15 +/- 11 %, and 18 +/- 9 %, respectively. Patients with a 6-month total rejection score greater than 0.3 had significantly higher incidence of VHD-IP than those with a 6-month total rejection score less than or equal to 0.3 (69 % versus 33 %, p = 0.011). The presence of VHD-IP at baseline was associated with a significant increase in plaque volume (2.42 +/- 1.78 mm(3)/mm versus -0.11 +/- 1.65 mm(3)/mm, p = 0.010), plaque index (7 +/- 9 % versus 0 +/- 8 %, p = 0.04), and re-modeling index (1.24 +/- 0.44 versus 1.09 +/- 0.36, p = 0.030) during 12 months of follow-up when compared with the presence of VHD-NIP at baseline and during follow-up. The authors concluded that the presence of VHD-IP as assessed by VH-IVUS is associated with early recurrent rejection and with higher subsequent progression of CAV. A VH-IVUS assessment may add important information in the evaluation of transplant recipients.

Raichlin et al (2009b) investigated the role of cellular rejection in CAV development. The study comprised 252 cardiac transplant recipients (mean age of 49.02 +/- 17.05 years; mean follow-up of 7.61 +/- 4.49 years). Total rejection score (TRS) based on the 2004 International Society of Heart and Lung Transplantation R grading system (0R = 0, 1R = 1, 2R = 2, 3R = 3) and any rejection score (ARS; calculated as OR = 0, 1R = 1, 2R = 1; 3R = 1, or the number of rejections of any grade) were normalized for the total number of biopsy specimens. Cardiac allograft vasculopathy was defined as coronary stenosis of 40 % or more and/or distal
pruning of secondary side branches. A total of 32 patients had undergone 3-dimensional IVUS at baseline and with VH-IVUS at 24 months. In uni-variate analysis, 6-month TRS (hazard ratio [HR], 1.9; 95 % CI: 0.99 to 3.90, p = 0.05) and ARS (HR, 2.22; 95 % CI: 1.01 to 4.95; p = 0.047) were associated with increased risk of CAV. In multi-variate analysis, 6-month TRS (HR, 2.84; 95 % CI: 1.44 to 6.91, p = 0.02) was significantly associated with increased risk of CAV onset. The 12- and 24-month rejection scores were not risk factors for the onset of CAV. By Kaplan-Meier analysis, 6-month TRS exceeding 0.3 was associated with a significantly shorter time to CAV onset (p = 0.018). There was direct correlation (r = 0.44, p = 0.012) between TRS at 6 months and the percentage of necrotic core shown by VH-IVUS at 24 months. The authors concluded that recurrent cellular rejection has a cumulative effect on the onset of CAV. The mechanism may be due to increased inflammation resulting in increased plaque burden suggesting a relationship between the immune basis of cellular rejection and CAV.

Sarno and colleagues (2009) used VH-IVUS to characterize plaque burden and tissue composition over time in heart transplant recipients. These researchers recruited patients undergoing heart transplantation in 4 centers in Europe and the U.S. between 2004 and 2006. They used IVUS to obtain morphological plaque measurements and to perform virtual histology in the left anterior descending coronary artery. Data were characterized according to the duration between transplantation and IVUS assessment: less than or equal to 24, greater than 24 to 60, greater than 60 to 120 and greater than 120 to 192 months. They assessed vessels from 152 patients (mean age of 58 +/- 12 years) a mean of 70 +/- 53 months (range of 1 week to 16 years) after transplantation. Plaque burden of greater than 40 % was observed in 26 % of vessels analyzed, with increases from baseline being seen in all time categories. If assessed greater than 24 months after transplantation, necrotic core and dense calcified volumes were significantly greater than at baseline (p = 0.0005 and p = 0.01, respectively). Time since heart transplantation and donor age and recipient age were independent predictive factors of increased necrotic core content. Necrotic core volume greater than 2.01 mm(3), diabetes
mellitus, donor age older than 40 years, follow-up from transplantation longer than 5 years and recipient age older than 58 years were associated with the need for re-vascularization. The authors concluded that in CAV, plaque burden and composition change over time and seem to affect clinical outcome. This relationship might facilitate identification of high-risk patients in whom the value of more aggressive medical therapy should be tested.

Diethrich and colleagues (2007) determined the diagnostic accuracy of virtual histology IVUS imaging (VH IVUS) of carotid plaque and assessed the feasibility of VH IVUS to identify plaque with embolic potential in patients undergoing carotid artery stenting (CAS). A total of 30 patients (17 men; mean age of 74 +/- 7 years) were entered non-randomly into a single-center, prospective, 2-arm study following FDA and Institutional Review Board approval. In the 1st arm, 15 patients underwent VH IVUS examination of carotid plaque with a cerebral protection device immediately followed by carotid endarterectomy (CEA). A comparison of "virtual" with true histology was then performed, classifying plaque type by VH IVUS and histopathology in a blinded study. In the 2nd arm, 15 patients undergoing CAS had a preliminary VH IVUS scan performed with cerebral protection. Debris collected from the filter following stenting was examined histologically and compared with the VH IVUS data. The diagnostic accuracy of VH IVUS to agree with true histology in different carotid plaque types was 99.4 % in thin-cap fibroatheroma, 96.1 % for calcified thin-cap fibroatheroma, 85.9 % in fibroatheroma, 85.5 % for fibrocalcific, 83.4 % in pathological intimal thickening, and 72.4 % for calcified fibroatheroma. Filter debris was captured in 2 patients prior to CEA and in 4 patients undergoing CAS for restenosis; VH IVUS classification of plaque composition was consistent with the histological evaluation of filter fragments. Calcified nodules projecting into the carotid artery lumen were associated with a higher incidence of previous neurological symptoms (66.7 % versus 33.3 %, p < 0.05), while patients on aspirin has significantly less necrotic lipid core plaque detected by VH IVUS than patients not taking aspirin (6.4 % +/- 4.7 % versus 9.7 % +/- 2.8 %, p < 0.05). The authors concluded that these findings showed a strong correlation between VH IVUS
plaque characterization and the true histological examination of the plaque following endarterectomy, particularly in "vulnerable" plaque types. The feasibility study to examine VH IVUS data and the filter debris histology in CAS patients supports a larger prospective study.

Mokin et al (2013) noted that IVUS is an important diagnostic tool in many interventions, particularly coronary and carotid artery angioplasty and stenting. In contrast, its application in the management of diseases of the cerebral venous system remains an unexplored territory. These investigators reported the findings of 3 patients in whom IVUS was used during angiography for the evaluation of venous flow obstruction secondary to venous sinus thrombosis, venous sinus stenosis, and a transverse sinus mass lesion, respectively. In addition, these researchers reviewed current literature to summarize previous experience, focusing on the advantages and limitations of IVUS technology in interventional cardiology, carotid artery disease, and venous disease. In all 3 cases, IVUS was used without any complications and provided critical information that guided further management of these distinct diseases. Intravascular US helped diagnose the presence of intraluminal thrombus, severe stenosis, and a mass lesion in the transverse sinuses and also helped assess the response to angioplasty of the stenotic regions. The authors concluded that IVUS is a promising tool that has potential to improve diagnostic accuracy and to guide the management of several diseases of the cerebral venous system.

Hitchner et al (2014) stated that the clinical use of IVUS in carotid intervention is not well characterized. These investigators evaluated the role of IVUS in carotid plaque characterization and determine whether it could be predictive of procedure-related microemboli. From July 2010, patients with severe carotid stenosis who underwent elective carotid stenting procedures were prospectively enrolled. Intravascular US evaluation was performed before stent placement. Patient demographics, co-morbidities, and pre-operative images were recorded. Comparison of pre- and post-operative diffusion-weighted magnetic resonance images was used to identify the number of procedure-related microemboli. Intravascular US-derived
minimal lumen diameter and vessel wall plaque characteristics were collected. Uni-variate and multi-variate logistic regressions were used to search for associations between IVUS-derived virtual histology (VH) data and incidence of microemboli. A total of 38 high-risk patients receiving carotid stenting were enrolled. Among them, 25 patients had type I aortic arches and 17 of the patients were symptomatic (pre-operative stroke or transient ischemic attack). Virtual histology IVUS data did not show strong associations with microemboli, however, a trend was found between the area of fibrous tissue and median or more incidence of microemboli ($p = 0.099$). Intravascular US-defined vessel diameter maximum was associated with median or more incidence of microemboli ($p = 0.042$). In addition, median or more incidence of microemboli showed trends with proximal common carotid artery calcification ($p = 0.056$) and with being over the age of 80 ($p = 0.06$). Contralateral carotid occlusion or high-grade stenosis was associated with post-operative contralateral microemboli ($p = 0.036$). The authors concluded that they demonstrated that peri-procedural carotid IVUS is clinically feasible. Moreover, they stated that VH IVUS may be helpful in better understanding plaque morphology and determining optimal stent placement. However, its use in predicting microembolization remains limited.

Witzenbichler et al (2014) examined if IVUS guidance is associated with improved clinical outcomes after DES implantation in an unrestricted patient population. Assessment of Dual Antiplatelet Therapy With Drug-Eluting Stents (ADAPT-DES) was a prospective, multi-center, non-randomized "all-comers" study of 8,583 consecutive patients at 11 international centers designed to determine the frequency, timing, and correlates of stent thrombosis and adverse clinical events after DES. Propensity-adjusted multi-variable analysis was performed to examine the relationship between IVUS guidance and 1-year outcomes. IVUS was utilized in 3,349 patients (39 %), and larger- diameter devices, longer stents, and/or higher inflation pressures were used in 74 % of IVUS-guided cases. IVUS guidance compared with angiography guidance was associated with reduced 1-year rates of definite/probable stent thrombosis (0.6 % [18 events] versus 1.0 % [53 events]; adjusted HR, 0.40; 95 % CI:
0.21 to 0.73; p = 0.003), myocardial infarction (MI) (2.5 % versus 3.7 %; adjusted HR, 0.66; 95 % CI: 0.49 to 0.88; p = 0.004), and composite adjudicated major adverse cardiac events (i.e., cardiac death, MI, or stent thrombosis) (3.1 % versus 4.7 %; adjusted HR, 0.70; 95 % CI: 0.55 to 0.88; p = 0.002). The benefits of IVUS were especially evident in patients with acute coronary syndromes (ACS) and complex lesions, although significant reductions in major adverse cardiac events were present in all patient subgroups those with including stable angina and single-vessel disease. The authors concluded that in ADAPT-DES, the largest study of IVUS use to-date, IVUS guidance was associated with a reduction in stent thrombosis, MI, and major adverse cardiac events within 1 year after DES implantation.

Ahn et al (2014) stated that there are conflicting data regarding the benefit of IVUS-guided percutaneous coronary intervention (PCI) over angiography-guided PCI. Since the last meta-analysis was published, several new studies have been reported. These researchers performed a comprehensive meta-analysis to evaluate the clinical impact of IVUS-guided PCI with DES compared with conventional angiography-guided PCI. This meta-analysis included 26,503 patients from 3 randomized and 14 observational studies; 12,499 patients underwent IVUS-guided PCI and 14,004 underwent angiography-guided PCI. Main outcome measures were total mortality, MI, stent thrombosis, and target lesion revascularization (TLR). IVUS-guided PCI was significantly associated with more stents, longer stents, and larger stents. Regarding clinical outcomes, IVUS-guided PCI was associated with a significantly lower risk of TLR (OR 0.81, 95 % CI: 1.66 to 1.00, p = 0.046). In addition, the risk of death (OR 0.61, 95 % CI: 0.48 to 0.79, p < 0.001), MI (OR 0.57, 95 % CI: 0.44 to 0.75, p < 0.001), and stent thrombosis (OR 0.59, 95 % CI: 0.47 to 0.75, p < 0.001) were also decreased. The authors concluded that the findings of this meta-analysis demonstrated that IVUS-guided PCI was associated with lower risk of death, MI, TLR, and stent thrombosis after DES implantation.

May-Thurner syndrome (MTS), also known as the iliac vein compression syndrome, is a rare condition in which compression of the common venous outflow tract of the left lower extremity
may cause discomfort, swelling, pain or deep venous thrombosis (DVT) in the iliofemoral vein. May-Thurner syndrome should be considered in patients who have no other obvious reason for hypercoagulability and who present with left lower extremity thrombosis. Venography will demonstrate the classical syndrome when causing deep venous thrombosis. Intravascular ultrasound can detect nonthrombotic iliac vein lesions in symptomatic patients.

Hong et al (2015) examined if the long-term clinical outcomes with IVUS-guided drug-eluting stent implantation are superior to those with angiography-guided implantation in patients with long coronary lesions. The Impact of Intravascular Ultrasound Guidance on Outcomes of Xience Prime Stents in Long Lesions (IVUS-XPL) randomized, multi-center trial was conducted in 1,400 patients with long coronary lesions (implanted stent greater than or equal to 28 mm in length) between October 2010 and July 2014 at 20 centers in Korea. Patients were randomly assigned to receive IVUS-guided (n = 700) or angiography-guided (n = 700) everolimus-eluting stent implantation. Primary outcome measure was the composite of major adverse cardiac events, including cardiac death, target lesion-related MI, or ischemia-driven TLR at 1 year, analyzed by intention-to-treat. Overall, 1-year follow-up was complete in 1,323 patients (94.5 %). Major adverse cardiac events at 1 year occurred in 19 patients (2.9 %) undergoing IVUS-guided and in 39 patients (5.8 %) undergoing angiography-guided stent implantation (absolute difference, -2.97 % [95 % CI: -5.14 % to -0.79 %]) (HR, 0.48 [95 % CI: 0.28 to 0.83], p = 0.007). The difference was driven by a lower risk of ischemia-driven TLR in patients undergoing IVUS-guided (17 [2.5 %]) compared with angiography-guided (33 [5.0 %]) stent implantation (HR, 0.51 [95 % CI: 0.28 to 0.91], p = 0.02). Cardiac death and target lesion-related MI were not significantly different between the 2 groups. For cardiac death, there were 3 patients (0.4 %) in the IVUS-guided group and 5 patients (0.7 %) in the angiography-guided group (HR, 0.60 [95 % CI: 0.14 to 2.52], p = 0.48). Target lesion-related MI occurred in 1 patient (0.1 %) in the angiography-guided stent implantation group (p = 0.32). The authors concluded that among patients requiring long coronary stent implantation, the use of IVUS-guided everolimus-eluting stent
implantation, compared with angiography-guided stent implantation, resulted in a significantly lower rate of the composite of major adverse cardiac events at 1 year. These differences were primarily due to lower risk of TLR.

In reviewing the afore-mention study, Meyer (2015) noted that “Despite strikingly low adverse event rates with drug-eluting stent placement, intravascular ultrasound–guided stent implantation yielded modest benefits over angiography-guided implantation”. The editorial comment stated that “Although these findings show that everolimus-eluting stents are safe and effective in patients with long coronary lesions, IVUS-guided stent implantation yielded a relatively small absolute reduction in coronary events (2.9 %) over angiography-guided stent implantation -- a difference primarily related to fewer TLRs. Considering this modest advantage (as well as the higher costs of IVUS-guided implantation), IVUS should be used only for selected lesions”.

Diagnosis of Aortic Dissection:

The diagnosis of aortic dissection is generally made non-invasively using computed tomography (CT), magnetic resonance imaging (MRI), or trans-esophageal echocardiography (TEE).

On behalf of the American College of Emergency Physicians, Diercks et al (2015) stated that in adult patients with suspected non-traumatic thoracic aortic dissection, emergency physicians may use CT angiogram (CTA) to exclude thoracic aortic dissection because it has accuracy similar to that of magnetic resonance angiogram (MRA) and TEE. It did not mention IVUS.
Furthermore, an UpToDate review on “Clinical features and diagnosis of acute aortic dissection” (Manning and Black, 2016) does not mention IVUS as a diagnostic tool.

**Diagnosing Functionally Significant Non-Left Main Coronary Artery Disease and Determining Whether or Not To Proceed With the PCI of Intermediate Non-Left Main Coronary Artery Stenosis:**

Jang and colleagues (2016) noted that IVUS-guided PCI frequently results in unnecessary stenting due to the low positive predictive value of IVUS-derived minimal lumen area (MLA) for identification of functionally significant coronary stenosis. In a meta-analysis, these investigators appraised the diagnostic accuracy of IVUS-derived MLA compared with the fractional flow reserve (FFR) to assess intermediate coronary stenosis. These investigators searched Medline and Cochrane databases for studies using IVUS and FFR methods to establish the best MLA cut-off values to predict significant non-left main coronary artery stenosis. Summary estimates were obtained using a random-effects model. The 17 studies used in this analysis enrolled 3,920 patients with 4,267 lesions. The weighted overall mean MLA cut-off value was 2.58 mm². The pooled MLA sensitivity that predicted functionally significant coronary stenosis was 0.75 (CI: 0.72 to 0.77) and the specificity was 0.66 (CI: 0.64 to 0.68). The positive likelihood ratio (LR) was 2.33 (CI: 2.06 to 2.63) and LR (-) was 0.33 (CI: 0.26 to 0.42). The pooled diagnostic OR (DOR) was 7.53 (CI: 5.26 to 10.76) and the area under the summary receiver operating characteristic curve (ROC) for all the trials was 0.782 with a Q point of 0.720. Meta-regression analysis demonstrated that an FFR cut-off point of 0.75 was associated with a 4 times higher diagnostic accuracy compared to that of 0.80 (relative DOR: 3.92; 95 % CI: 1.25 to 12.34). The authors concluded that IVUS-derived MLA has limited diagnostic accuracy in predicting functionally significant coronary artery disease and cannot be used alone to make the decision whether or not to proceed with the PCI of intermediate non-left main coronary artery stenosis.

This study had several drawbacks: (i) the majority of studies included in this analysis were observational studies from different cohorts with no randomized controlled trials (RCTs). This caused
the findings to have insufficient power, (ii) the proportion of the involved coronary arteries and extent of coronary diseases were different across the included studies. It was not possible to suggest the diagnostic performance of IVUS-MLA according to the lesion location, (iii) the researchers could not perform separate subgroup analyses of all coronary arteries and their location (proximal-, mid-, distal-) because very few studies presented such data, (iv) these investigators could not differentiate patients presenting with stable angina and acute coronary syndrome, despite differences in clinical significance of IVUS-derived MLA and FFR, (v) the IVUS criteria to discriminate the functional significance of lesions in different locations were applied differently across studies, and (vi) the authors did not take into account the plaque composition that can affect clinical outcomes.

_During Endovascular Interventions of Failing Hemodialysis Access Grafts:_

Ross and colleagues (2016) noted that arterio-venous (AV) access graft complications represent a serious complication in patients undergoing hemodialysis. Angiography is one method of visualizing them. However, angiography is not always an effective means of detecting lesions that occur in this context. Intravascular ultrasound is an adjunct modality used to identify stenoses responsible for failing access by identifying multiple stenoses, including those that are most severe. In a pilot, single-center randomized study, these researchers examined the value of IVUS in patients with failing AV access grafts by comparing digital subtraction angiography (DSA) alone with DSA followed by IVUS. They compared IVUS with DSA in patients with failing hemodialysis access grafts. It consisted of 100 randomized hemodialysis patients presenting with failing AV access who were being considered for endovascular intervention. Interventions in the control group were guided by DSA alone, whereas interventions in the test group were guided by DSA followed by IVUS. Patients were observed for 6 months after intervention. The primary end-point was the time in days to AV access graft failure after the index intervention, expressed as median and interquartile range (IQR). Secondary analyses included influence of DSA and IVUS on index procedure decision-making and
percentage of patients with AV access graft re-interventions or discontinuation through 3 and 6 months. Median time to first AV graft re-intervention or discontinuation was 61 days in the test group and 30 days in the control group (p = 0.16), with analysis limited to patients who experienced re-intervention or discontinuation (n = 59). Intravascular US resulted in a change in treatment plan in 76% (44/58) of patients, with no treatment change after IVUS in 24% (14/58) of patients. At 6 months, approximately 35% of patients in both the control and test groups remained free from re-interventions (p = 0.88). At 6 months, approximately 75% of patients in the control group and 80% of patients in the test group remained free from AV graft discontinuation or abandonment (p = 0.45). The authors concluded that the findings of this pilot study suggested that addition of IVUS to standard angiography during endovascular interventions of failing hemodialysis access grafts holds potential to extend the time to the first re-intervention. The data supported the design and execution of an adequately powered randomized trial with longer follow-up to reliably discern the clinical benefit of IVUS as an addition to standard angiography in the setting of failing AV access grafts.

**CPT Codes / HCPCS Codes / ICD-10 Codes**

Information in the [brackets] below has been added for clarification purposes. Codes requiring a 7th character are represented by "+":

<table>
<thead>
<tr>
<th>CPT codes covered if selection criteria are met:</th>
</tr>
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<tbody>
<tr>
<td>37252</td>
</tr>
<tr>
<td>37253</td>
</tr>
<tr>
<td>+92978</td>
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<tr>
<td>+92979</td>
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</tbody>
</table>
Other CPT codes related to the CPB:

0075T - 0076T
Transcatheter placement of extracranial vertebral artery stent(s), including radiologic supervision and interpretation, open or percutaneous

33500 - 33530
Surgery for coronary artery anomalies, endoscopy, venous grafting only for coronary artery bypass, and combined arterial-venous grafting for coronary bypass

33533 - 33536
Coronary artery bypass, using arterial graft(s)

33548
Surgical ventricular restoration procedure, includes prosthetic patch, when performed (eg, ventricular remodeling, SVR, SAVER, DOR procedures)

+ 33572
Coronary endarterectomy, open, any method, of left anterior descending, circumflex, or right coronary artery performed in conjunction with coronary artery bypass graft procedure

35450
Transluminal balloon angioplasty, open; renal or other visceral artery

35452
aortic

35458
brachiocephalic trunk or branches, each vessel

35460
venous

35471
Transluminal balloon angioplasty, percutaneous; renal or visceral artery

35472
aortic

35475
brachiocephalic trunk or branches, each vessel

35476
venous

37191 - 37193
Insertion, repositioning or retrieval (removal) of intravascular vena cava filter, endovascular approach including vascular access, vessel selection, and radiological supervision and interpretation, intraprocedural roadmapping, and imaging guidance (ultrasound and fluoroscopy), when performed

37215 - 37216
Transcatheter placement of intravascular stent(s), cervical carotid artery, open or percutaneous, including angioplasty, when performed, and radiological supervision and interpretation
Transcatheter placement of intravascular stent(s), intrathoracic common carotid artery or innominate artery by retrograde treatment, open ipsilateral cervical carotid artery exposure, including angioplasty, when performed, and radiological supervision and interpretation

Transcatheter placement of intravascular stent(s), intrathoracic common carotid artery or innominate artery, open or percutaneous antegrade approach, including angioplasty, when performed, and radiological supervision and interpretation

Revascularization, endovascular, open or percutaneous; iliac artery

femoral, popliteal artery(s)

tibial, peroneal artery

Transcatheter placement of an intravascular stent(s) (except lower extremity, cervical carotid, extracranial vertebral or intrathoracic carotid, intracranial, or coronary), open or percutaneous, including radiological supervision and interpretation and including all angioplasty within the same vessel, when performed; initial artery

each additional artery (List separately in addition to code for primary procedure)

Transcatheter placement of an intravascular stent(s), open or percutaneous, including radiological supervision and interpretation and including angioplasty within the same vessel, when performed; initial vein

each additional vein (List separately in addition to code for primary procedure)

Balloon angioplasty, intracranial (eg, atherosclerotic stenosis), percutaneous
61635 Transcatheter placement of intravascular stent(s), intracranial (eg, atherosclerotic stenosis), including balloon angioplasty, if performed

75962 Transluminal balloon angioplasty, peripheral artery other than cervical carotid, renal or other visceral artery, iliac or lower extremity, radiological supervision and interpretation

+ 75964 Transluminal balloon angioplasty, each additional peripheral artery other than cervical carotid, renal or other visceral artery, iliac or lower extremity, radiological supervision and interpretation (list separately in addition to code for primary procedure)

75966 Transluminal balloon angioplasty, renal or other visceral artery, radiological supervision and interpretation

+ 75968 Transluminal balloon angioplasty, each additional visceral artery, radiological supervision and interpretation (List separately in addition to code for primary procedure)

+ 92973 Percutaneous transluminal coronary thrombectomy (List separately in addition to code for primary procedure)

92997 - 92998 Percutaneous transluminal pulmonary artery balloon angioplasty

Other HCPCS codes related to the CPB:

C1753 Catheter, intravascular ultrasound

C1880 Vena cava filter

ICD-10 codes covered if selection criteria are met:

I20.0 - I25.9 Ischemic heart diseases

I65.21 - I65.29 Occlusion and stenosis of carotid artery [chronic venous obstruction/venous stenting]

I87.1 Compression of vein [chronic venous obstruction/venous stenting]

T86.290 Cardiac allograft vasculopathy

Z98.61 Coronary angioplasty status
ICD-10 codes not covered for indications listed in the CPB:

I71.00 - Dissection of aorta
I71.03

The above policy is based on the following references:


Technology Assessment at the German Institute for Medical Documentation and Information (DAHTA) (DIMDI); 2003.


57. Regar E, Weissman NJ, Muhlestein JB. Intravascular ultrasound, optical coherence tomography, and angioscopy of coronary circulation. UpToDate [online serial]. Waltham, MA: UpToDate; reviewed February 2015.


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