Predicting Aneurysmal Dilatation after Type B Aortic Dissection

Progressive aortic aneurysmal dilatation is well-recognised after Stanford Type B aortic dissection, and may lead to delayed rupture and death. There is still a lack of well-defined variables which can reliably predict late aortic dilatation.

The International Registry of Acute Aortic Dissection (IRAD) showed an in-hospital mortality of 8.9% in patients with acute type B dissection mainly from aortic rupture and neurological complications. The long-term prognosis was heterogeneous, with 48–82% surviving to 5 years. Poor blood pressure control, a patent false lumen, and an aortic diameter ≥40 mm on admission were found to be independent risk factors associated with late events. Some authorities suggested that an initial false lumen diameter ≥22 mm predicted late aneurysm development.

There are no studies to state specifically which drugs are most effective in controlling hypertension. Beta-blockers are effective in the acute phase as they reduce the rate of increase of aortic pressure in systole. They also reduce blood pressure peaks from acute exertion or emotion in chronic cases. A heart rate of less than sixty beats per minute was found to be associated with less aortic events and interventions. Angiotensin-converting enzyme inhibitors are also effective in reducing late aortic events.

Studies on patients with Marfan syndrome have shown that angiotensin II-receptor blockers may decrease the rate of aortic-root dilatation. A study of patients with aortic aneurysms and aortic dissection showed aneurysm enlargement in 41% despite well-controlled brachial blood pressure. Central aortic systolic pressure and aortic augmentation index were significantly higher with aneurysm expansion, and could be considered as surrogate prognostic markers. The aortic augmentation index is the ratio of the ejection pressure from the heart and the reflection pressure from the arterial system measured by an echo-tracking probe at the carotid artery. Elevated left ventricular afterload caused by the double lumen aorta and a narrowed true lumen may lead to progressive aneurysmal dilatation. Aortic dilatation in Marfan patients was associated with raised aortic augmentation index and central pulse pressure using applanation tonometry.

Dilatation in a dissected aorta is multifactorial and determined by intra-luminal pressure, turbulent flow pattern, and wall shear stress. Computational simulations of blood flow in patient-specific models have shown highly turbulent re-circulating flow with high wall shear stress leading to aortic dilatation, and the presence of an inadequate outflow in the false lumen increases diastolic pressure and wall stress promoting the risk of dilatation. Anatomically the site of the primary entry tear may cause different patterns of propagation: if the tear occurs at the convexity of the aortic arch, retrograde type A dissection is less common compared with tears at the concavity. The degree of spiral flow may also influence aneurysm growth. False lumen patency and the location and size of secondary distal tears may also determine late dilatation.

The INvestigation of STEnt Grafts in Aortic Dissection (INSTEAD) trial compared best medical therapy versus best medical therapy with stent graft in patients with chronic dissection. False lumen thrombosis was enhanced in 91.3% after stent graft placement, and the true lumen diameter increased at the expense of the false lumen. Although this favourable aortic remodelling with stent grafts did not lead to improved two-year survival rates, it may reduce the risk of dilatation and rupture in the long-term. The Acute uncomplicated type B Dissection Stent-grafting OR Best Medical Treatment (ADSORB) Study randomizing acute dissection treated with best medical therapy with and without stent grafts has just finished recruiting. The endpoint in this study is false lumen thrombosis, and published results are still pending. This trial should help to answer the question as to whether early intervention in uncomplicated dissection reduces the risk of late rupture.

Many studies have shown that patency of the false lumen is a strong independent risk factor for dissection-related events in the long-term. The survival rate with complete thrombosis of the false lumen is better compared with patent false lumens. The presence of contrast in the false lumen was the only significant risk factor associated with increase in aortic diameter in both univariate and multivariate analyses in one series. A large maximal false lumen area in the acute phase and branch-vessel...
involvement were associated with early and late adverse outcomes. Interestingly, IRAD data has shown that partial thrombosis of the false lumen was a significant independent predictor of post-discharge mortality. It was postulated that the thrombus at the distal false lumen would impede outflow, increasing the mean intra-luminal pressure causing aneurysmal expansion and rupture. Another hypothesis was that the thrombus in the false lumen may promote local inflammation and augment wall weakening. Multi-variate regression analysis has shown that a maximum aortic diameter of ≥40 mm and a patent false lumen were significant predictors of persistent aortic enlargement. Others suggest that a patent false lumen or a diameter ≥45 mm (or both) during the first two weeks are risk factors for enlargement of the dissecting aorta.

Computed tomography (CT) is widely available and is able to acquire large 3-dimensional volumes with high spatial resolution, making it the ideal imaging modality for aortic dissection in the emergency setting. Magnetic resonance imaging (MRI) is able to combine the 3-dimensional anatomical and functional information in a single acquisition and may provide a method for risk stratification of individuals once the acute episode has settled. The risk of contrast-nephropathy and ionizing irradiation is decreased compared to CTs. Traditional MRI has been hampered by long scan times, but these have now been dramatically reduced by advanced data reconstruction algorithms resulting in a reduction in scan time by more than eight times. Flow-sensitised MRI can demonstrate the position and contribution of (primary and secondary) entry tears and the amount and direction of flow in both the true and false lumen, and in future may be able to predict aortic expansion. Images acquired in a single time frame in the cardiac cycle may not illustrate the complex dynamic changes in the dimensions of the true and false aortic lumens with systole and diastole, and may cause errors in device sizing and distinguishing dynamic from static obstruction. ECG-gated CT is able to provide additional dynamic information, but the temporal resolution is inferior to MRI. Gadolinium-based contrast agents used in MRI are less nephrotoxic and the recent introduction of blood pool contrast media has demonstrated that current MRI and CT imaging protocols over-estimate the amount of false lumen thrombus by five to six times and therefore studies using this parameter may be misleading. The current generation of thoracic aortic devices are made of nitinol and these are compatible with the magnetic field and do not degrade the images with artefact. A standardised imaging protocol for aortic dissection would use CT with contrast in the acute setting for diagnosis and assessment of aortic wall integrity and visceral perfusion, with MRI as the main imaging modality for follow up: these patients are frequently young and will require multiple surveillance scans. False lumen thrombosis and device placement can be accurately assessed with MRI, and these haemodynamic parameters may be used for patient-specific risk stratification and tailoring the frequency and timing of future surveillance scans.

Recently, aortic dissection detection risk assessment guidelines have been drawn up by the American Heart Association and American College of Cardiology based on a number of risk categories: high-risk predisposing conditions, high-risk pain features, high-risk examination features. Standardised protocols will be available to guide vascular specialists in determining the rationale for, modality of, and intervals for surveillance for medically-treated patients with Type B aortic dissection. Patients with connective tissue diseases such as Marfan syndrome require long-term surveillance, as their aortae continue to dilate in medically-treated cases even with coverage of the primary entry tear and false lumen thrombosis. Further aortic haemodynamic and clinical studies will hopefully identify a subset of ‘higher-risk’ patients with acute uncomplicated dissections who may benefit from early intervention. Patients with aortic dissection should be managed by a multi-disciplinary team in aortic centres where all diagnostic and therapeutic skills are readily available.

References


Y.C. Chan*
Division of Vascular & Endovascular Surgery, Department of Surgery, University of Hong Kong Medical Centre, South Wing, 14th Floor K Block, Queen Mary Hospital, Pokfulam Road, Hong Kong

R.E. Clough
P.R. Taylor
Department of Vascular Surgery & Division of Imaging Sciences, NIHR Comprehensive Biomedical Research Centre of Guy’s & St Thomas’ NHS Foundation Trust and King’s College London, King’s Health Partners, United Kingdom

*Corresponding author. Tel.: +852 2855 4969; fax: +852 2855 4967.
E-mail address: yccchan88@hkucc.hku.hk

Submitted 20 March 2011
Accepted 30 May 2011