REVIEW ARTICLE

A Review of Atherectomy in Peripheral Arterial Disease

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ABSTRACT

Atherectomy involves exciting technology and offers expanded treatment options for PAD. Data are scant so far in most lower extremity territories to support its use over other interventions, but newer results are promising. There is still a financial benefit to choosing atherectomy in the outpatient setting that likely drives much of its popularity among interventionalists. Atherectomy is an exciting technology for peripheral vascular intervention. Its use has greatly increased over the last decade. Data on its superiority to angioplasty or angioplasty with stenting are scant. Here, we review atherectomy techniques and principles along with results and controversy surrounding its use.

Key words: Angiography, atherectomy, endovascular, peripheral

INTRODUCTION

Peripheral arterial disease (PAD) affects millions worldwide. Roughly 12–15 million Americans suffer from PAD and as many as 200 million are affected worldwide.[1,2] Given how many patients suffer from PAD, the cost of treatment and care is considerable. In the United States in 2014, Medicare expenditures alone exceeded $22 billion for diagnoses related to PAD.[3] Many treatments are available for PAD including lifestyle modification, medications, exercise programs, endovascular interventions, endarterectomy, and open surgical bypass. As in many other fields, there has been a move toward less invasive intervention over the past 20 years.[4,5] Many peripheral vascular lesions are amenable to various treatment options. There are a several guidelines that offer recommendations for treating different lesions in PAD.[6-8] However, there is still not a gold standard treatment for all peripheral vascular lesions.[9]

Peripheral vascular intervention is occurring with increasing frequency and is being performed more often in the outpatient setting, either in hospitals or office-based practices that have angiography capabilities.[10] Atherectomy is one technique for treating PAD whose use in the outpatient setting has skyrocketed in the last decade. In 2008, Medicare issued a payment ruling that increased the non-facility payment for atherectomy for PAD. The final ruling in 2011 cemented the reimbursement for non-facility atherectomy.[11] Since 2011, there has been a notable increase in outpatient atherectomy procedures.[12] Despite the increasing use of atherectomy for treating PAD, there have been a few controlled trials comparing it to other endovascular interventions. A Cochrane review went so far as to declare that there was no evidence of the superiority of atherectomy over angioplasty.[13] Here, we review the use of atherectomy in PAD, the technology involved, and the results.

ATHERECTOMY PRINCIPLES

Stenting has been shown to be superior to angioplasty alone in many lower extremity lesions, especially longer lesions, and those that are densely calcified.[14] Not all lower extremity lesions are amenable to stenting. Rarely it is advisable to place a stent in the common femoral artery, and stents in arteries over joint spaces may be more susceptible to fracture or occlusion.[9] The appeal of atherectomy has been to offer

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treatment in areas where stents are not feasible and to debulk atherosclerotic lesions to allow lower insufflation pressures during angioplasty.[15-17]

ATHERECTOMY TECHNOLOGY

Several different atherectomy technologies are available and all work in slightly different ways. These include rotational atherectomy, directional atherectomy, orbital atherectomy, and laser atherectomy.

Rotational atherectomy uses a high-speed concentric spinning blade to cut atheroma.[9] Approved rotational atherectomy systems include Rotablator (Boston Scientific/Scimed), the Phoenix atherectomy catheter (Volcano Corporation), and the Pathway Jetstream atherectomy system (Boston Scientific). These devices offer various sized heads to accommodate lower extremity vessels from the iliac arteries through the tibial arteries. Not all devices are approved for each vessel. Because these devices work over the wire, they can be used in conjunction with a distal embolic protection device (filter). However, the use of filters in these settings may be off label. The Phoenix atherectomy catheter is a dual lumen catheter that shaves plaque with its rotating distal tip while capturing the dislodged plaque into its own catheter.

Orbital atherectomy devices utilize an eccentric rotating crown. The speed of the device can be varied to alter the width of the orbit of the rotating crown. Orbital atherectomy devices include the Diamondback Systems (Cardiovascular Systems, Inc.). The debris generated is believed to be sufficiently small (smaller than a red blood cell) to allow it to pass through the capillary system rather than cause symptomatic distal embolization.[15] The device works best on calcific lesions but may be less effective on soft plaque and is not indicated for in-stent restenosis. The Diamondback System may be especially effective in modifying plaque to improve vessel compliance for angioplasty, which may result in a longer freedom from reintervention and greater cost-effectiveness.[18] A cadaver study demonstrated that vessels treated by orbital atherectomy had an increased drug uptake when treated after atherectomy by drug-coated balloon (DCB) angioplasty.[19]

Directional atherectomy is a process of removing plaque from arterial walls in a controlled and directional fashion. The plaque is removed and captured in a portion of the atherectomy device. Approved devices include the SilverHawk (Medtronic/Covidien), TurboHawk (Medtronic/Covidien), HawkOne (Medtronic/Covidien), and Pantheris (Avinger) devices. These devices can be used with either calcified or soft lesions. They must be directed under visual guidance toward the area of plaque. Despite the plaque capturing technology, distal embolization remains a concern and these devices are frequently used with a distal filter.[20] Directional atherectomy can be used to debulk atherosclerotic lesions as well as prepare vessels for angioplasty or DCB angioplasty.[21] The Pantheris uses Lumivascular technology to visualize the layers of the arterial wall and plaque morphology. This may prevent the injury of the elastic lamina that is hypothesized to result in earlier restenosis.[22]

Laser atherectomy uses a xenon chloride laser operating at a pulsed 308-nanometer wavelength.[23] Currently approved systems include the excimer laser system from Spectranetics. This device uses ultraviolet laser light in a process referred to as "photoablation" of plaque.[24] While most of the debris generated during laser atherectomy is small enough to pass through the capillary system (smaller than 10 μ), macroparticle distal embolization is still a concern and filters are often employed during laser atherectomy. The Spectranetics system is also approved for the treatment of in-stent restenosis.

Indications

The primary indication for atherectomy is debulking of atherosclerotic disease or vessel preparation for angioplasty when stenting is not planned. The advent of paclitaxel-coated balloons (Lutonix from Bard, IN.PACT from Medtronic) for peripheral use is a promising area for atherectomy. *In vitro* and *in vivo* studies demonstrate better absorption of paclitaxel into the arterial tissue and more durable results after vessel preparation by atherectomy.[21,25-27] Areas where stents are not recommended, such as the common femoral and mobile portions of the superficial femoral or popliteal arteries are commonly targeted with this technique.

Infrapopliteal lesions are another area frequently targeted with atherectomy. Vessel preparation before angioplasty may reduce the required inflation pressures during angioplasty, thus reducing this risk of dissection. Atherectomy may also help debulk lesions in infrapopliteal vessels unlikely to respond well to angioplasty alone.[23,28,29]

The excimer laser is the only atherectomy device approved for use in the United States for treating in-stent restenosis. There have been favorable results in its use compared to angioplasty alone.[30] Orbital and rotational atherectomy systems are occasionally used off label for in-stent restenosis. Directional atherectomy devices are less often used in this manner as there is a concern for the cutting mechanism becoming lodged in the stent struts. However, some groups have had success with the technique.[31,32]

RESULTS

The Cochrane review provides some of the most rigorous outcome data for atherectomy.[13] This review looked at the available studies comparing atherectomy to balloon angioplasty. In cases treated with atherectomy, there tended to

be fewer dissections and needs for bailout stenting. There was also a lower required inflation pressure during angioplasty. Atherectomy also showed a lower overall mortality, however, that may have been influenced by the relatively high mortality noted in one study in the angioplasty arm.[16]

Furthermore, noted in the Cochrane review was the higher embolization rate with atherectomy.[13] Most importantly, there was no benefit in primary patency for atherectomy over angioplasty. Other studies have failed to demonstrate a difference in clinical outcomes with atherectomy use but have noted higher costs.[16,33,34]

There is also some data that the complications associated with atherectomy may lead to worse outcomes. Mukherjee *et al*. looked at outpatient atherectomy in claudicants. Their study found a higher rate of recent intervention than with other forms of endovascular intervention and also noted a higher rate of major amputation (proximal to ankle).[35]

Controversies

Few would argue that atherectomy is a valuable adjunct in lower extremity intervention. The degree of its benefit and how widely applicable it may be is more debatable. There are little data showing a clear benefit of atherectomy with angioplasty over angioplasty alone.[36] The use of drug-coated balloons after atherectomy is showing promise but how much better it might be over drug-coated balloon angioplasty alone is also not clear nor is how long any apparent benefit might endure. There is scant if any data thus far that in suitable territories, atherectomy followed by balloon angioplasty is superior to angioplasty with stenting.[36] However, the reimbursement for atherectomy and angioplasty far exceeds that of stenting with angioplasty. The reimbursement "bonus" for atherectomy is the cloud looming over its head and raises questions regarding the motivation for the growth of atherectomy in the past 5–10 years.[10,36]

Atherectomy is clearly not a superior intervention in most lower extremity applications. Moreover, it is not technically any easier than angioplasty alone or stenting with angioplasty. The cost of disposables and/or implants with atherectomy and angioplasty is no less expensive than stenting with angioplasty. Hence, why are so many interventionalists choosing atherectomy, especially in non-facility settings? Unfortunately, the financial benefit of atherectomy may answer the question since there seems to be no other explanation.

Summary

Atherectomy involves exciting technology and offers expanded treatment options for PAD. Data are scant so far in most lower extremity territories to support its use over other interventions, but newer results are promising. There is still a financial benefit to choosing atherectomy in the outpatient setting that likely drives much of its popularity among interventionalists.

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