Brachial artery catheterization to facilitate endovascular grafting of abdominal aortic aneurysm: Safety and rationale

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Purpose: Endovascular treatment of abdominal aortic aneurysms (AAAs) is a technically demanding procedure that is based on the complexity and multiplicity of steps and the guidewire and catheter manipulations required. Brachial artery catheterization is an adjunctive technique that can facilitate the placement of an endoluminal prosthesis.

Methods: Brachial access was used during endoluminal AAA repair in 79 of 103 consecutive patients with a modular-design stent-graft prosthesis at two institutions.

Results: Left brachial access facilitated (1) angiography to guide juxtarenal device deployment, (2) antegrade contralateral limb access, (3) device delivery through disadvantaged iliac arteries by means of a brachial femoral wire, (4) access to renal arteries when necessary, and (5) catheter exchanges and a reduction in fluoroscopic positional changes. Complications included one puncture-site pseudoaneurysm, seven hematomas, and 29 patients with extensive ecchymosis. The length of stay was not prolonged in any case. There were no embolic, oculocerebral, or ischemic upper extremity events.

Conclusions: Brachial artery catheterization, as an adjunctive technique to endoluminal AAA repair, offers noteworthy technical advantages with few, but self-limiting complications. (J Vasc Surg 2000;32:1137-41.)

Endovascular exclusion is a technique that promises to revolutionize the treatment of abdominal aortic aneurysms (AAAs).1,2 Numerous stent grafts have been designed for this purpose; many are currently undergoing late-phase clinical testing, with two devices already approved by the Food and Drug Administration. Currently, the modular bifurcated configuration appears to be the predominant design choice.3-5 The implant procedure is a technically demanding intervention that involves sequential performance of multiple surgical and endovascular maneuvers. Retrograde femoral access and transluminal delivery of the device to the aorta, precise deployment with secure placement at the proximal (aortic neck) attachment site, and guidewire crossing of the short contralateral leg are examples of critical steps where adjunctive techniques may help to avoid potential problems and maximize technical success. Brachial artery catheterization is one such adjunct that is has been used frequently in our practice. In this report, we seek to evaluate the safety and efficacy of “access from the top” with a brachial catheter/wire to facilitate endovascular grafting of AAA.

METHODS

Of 103 consecutive patients with AAA treated at two institutions that were collaborating in the Phase II clinical trial of the Talent modular stent-graft system (World Medical, Medtronic AVE, Santa Rosa, Calif), 79 prostheses were placed with adjunctive brachial artery catheterization. Access was achieved by percutaneous puncture of the left brachial artery at the antecubital fossa with the use of a 21-gauge micropuncture set (0.018-in wire and 5F catheter). Subsequent exchange for a 0.035-in guidewire allowed placement of a 5F introducer sheath that
was sutured to the skin, followed by systemic anticoagulation with heparin. A floppy-tip guidewire was introduced retrograde to the aortic arch and antegrade through the descending thoracic aorta to the upper abdominal aorta, all under fluoroscopic guidance. Steering the guidewire with a directional catheter at the top of the arch was necessary in 49 (70%) of 79 cases to avoid passage into the ascending aorta and arch branches. A pigtail catheter was passed over the wire to the T12 level, properly flushed with heparinized saline solution, and left in place for subsequent use. With left brachial artery catheterization completed, the access was used to perform or facilitate the following steps of the endovascular grafting procedure:

1. Contrast angiography of the abdominal aorta defines the anatomy of the renal arteries and proximal attachment site (juxtarenal aorta). The angiogram was obtained after the main device sheath had been introduced transfemorally to the L1-L2 level. Device deployment can proceed immediately after the initial angiogram without image position changes.

2. Antegrade guidewire access across the short contralateral leg is easily achieved with this approach. An extra-stiff 300-cm Wholey or 450-cm hydrophilic wire (Microvasive, Natick, Mass) is used. Occasionally, a 120-cm long, 5F directional selective catheter (multipurpose, hockey-stick) is necessary to redirect the wire into the contralateral short leg (Fig 1). The wire can be advanced antegrade into the aneurysm sac and through the iliac artery to the level of the access site in the exposed femoral artery, allowing extraction through a transverse arteriotomy. When a puncture-sheath approach is used for contralateral limb deployment, extraction of the wire necessitates the use of a snare device. At this juncture, the wire is “pulled” caudally from the common femoral artery, establishing brachial-femoral access. Deployment of the contralateral limb can be performed over this brachial-femoral wire; a 300-cm length is the minimum necessary for such a technique. Difficult access situations and tortuous iliac arteries may need tensing of the guidewire, with potential for injury of the aortic arch and origin of the left subclavian artery from a “cheese-cutting” effect. This can be pre-
vented by placing a catheter over the wire to the level of the descending aorta every time brachial-femoral access is used (Fig 2).

3. Brachial artery access helps overcome technical difficulties related to tortuous aortoiliac anatomy:
   a. Tortuous (but soft) iliac arteries can be “straightened” with the use of brachial-femoral access as described (“body-flossing”).
   b. Unanticipated problems with the delivery of the main sheath to the aorta can be overcome by “conversion” of the femoral retrograde guidewire into a brachial-femoral wire through the introduction of a 6F snare wire-loop device from the left brachial artery. The snare is used to capture and stabilize the transfemoral wire to facilitate tracking and advancement of the delivery sheath to the desired location (Figs 3 and 4).

4. Provide an avenue to catheterize the renal arteries for guidance of juxtarenal deployment and “protection” from possible coverage.

5. Minimize catheter exchanges and positional changes.

**RESULTS**

Adjunctive left brachial artery catheterization was used in 79 of the 103 AAA procedures that were reviewed. It was unsuccessfully attempted in two additional cases, failing where the brachial artery could not be cannulated. In one of the 79 cases, the brachial approach failed to overcome access-related difficulties. Complications included one puncture-site pseudoaneurysm in a postoperatively anticoagulated patient that resolved spontaneously within 4 months. Seven patients had arm hematomas, and extensive ecchymoses occurred in 29 others. No oculocerebral events or upper extremity ischemic sequelae were encountered.

**DISCUSSION**

Endovascular grafting of AAAs is a technically difficult procedure that necessitates refined catheter skills and judgment. Anatomic challenges with luminal access, delivery conduit, and attachment sites can seriously compromise or complicate an otherwise manageable endoluminal intervention.

Although it offers an option for the performance of several technical steps of the intervention, brachial artery catheterization does enhance procedural capabilities over more standard approaches. It can rescue situations where a technically successful stent-graft implant would not be otherwise possible. This applies particularly to the ability to straighten tortuous iliac arteries, which enables retrograde translu-
terminal delivery of the device with a brachial-femoral technique. Similarly, guidewire access across the short contralateral leg can be achieved expeditiously with the transbrachial antegrade approach. Also, with repetitive contrast injections during juxtarenal deployment, proximal deployment can be performed with reduced catheter exchanges or repositioning of the image intensifier. This is critical with disadvantaged (ie, short, noncylindrical) necks.\(^6\)

Previously anticipated vertebral-basilar and ocular embolic events are the principal concerns. The incidence of such complications (in the setting of brachial artery catheterization for noncerebrovascular/noncardiac intervention) is unknown and largely undocumented in the literature. We are aware of anecdotal reports of visual disturbances including blindness and vertebral-basilar strokes, but the precise mechanisms and prevalence of such events cannot be elucidated from currently available information (B. R. Hopkinson, oral communication, Feb 1999). Pericatheter formation of thrombi and platelet aggregates that may dislodge and embolize through the ipsilateral vertebral artery may explain some of these phenomena. The recommended approach calls for induction of systemic anticoagulation with heparin as soon as successful brachial artery puncture has been achieved and before retrograde catheter manipulations have been initiated to minimize all such occurrences. Other potential complications include arterial dissection and thrombosis related to puncture-site or sheath-insertion injury to the vessel wall. Complications of brachial artery catheterization for cardiac and noncardiac intervention have been documented.\(^8\)\(^-\)\(^11\)

Local entry-site complications after transbrachial heart catheterization have varied from 1% to 5% in diagnostic procedures and 1% to 5% after therapeutic intervention. Brachial artery occlusion after percutaneous placement of a 7F sheath has been reported to occur in 1.3% of cases. It is theorized that female patients may be more prone to such complications because of small arterial size. Using a fine needle (21 g) approach for percutaneous puncture and limiting sheath size to 5F may help avoid this problem. Careful assessment of brachial pulse is important. Absent or weak pulsations, brachial pressure differential, or other evidence of possible proximal arterial stenosis or occlusion contraindicates brachial artery catheterization.

“Blind” retrograde advancement of guidewire and catheter can also lead to arrhythmia or ventricular perforation from intracardiac entry. The latter can be easily prevented by insisting on continuous fluoroscopic visualization and guidance. Cardiac monitoring is likewise mandatory. Hemostasis at puncture site is another area of concern. With experience, major hematomas and pseudoaneurysms could be reduced by puncturing the brachial artery at the antecubital fossa where the vessel is relatively fixed and superficial, and secure compression against the humerus can be achieved. The sheath should not be removed until normal coagulability has been restored (activating clotting time < 180 seconds). In spite of these precautions, ecchymoses and small hematomas still occur relatively frequently.

Caution should be exercised when applying tension on a brachial-femoral guidewire. A catheter should always be placed over the wire to protect the arch and proximal subclavian artery from the cheese-cutting effect of a tensed, rigid wire going across the aortosubclavian junction. Catastrophic complications could occur from disregard of this critical point. The additional precaution of applying only the minimum tension needed to facilitate retrograde transfemoral tracking of the device is also recommended.

Catheterization of the right brachial artery was not performed in any case during the experience herein reported. It is theoretically undesirable because of the potential complications related to invasion of other supra-aortic vessels with the crossing of the flow path to the carotid artery.

The technique of left brachial artery catheterization has proved helpful. It emerges as an important technical resource that should be available to surgical and interventional teams performing endoluminal repair of AAAs. The anecdotal fear of potential serious complications was unsubstantiated.

REFERENCES


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