Reconsideration of the Transradial Approach for PCI

The transradial approach for PCI eliminates access site bleeding complications, which may pose the largest risk to patients undergoing PCI in the modern era.

BY RONALD P. CAPUTO, MD, FACC, FSCAI

Since the introduction of elective percutaneous coronary revascularization (PCI), there have been significant advancements in technique, strategy, anticoagulant regimens, and equipment. These advancements have resulted in improved outcomes, as well as a change in the spectrum of complications encountered. Compared to today's standards, the early experience with PCI was associated with a high incidence of cardiac complications. Between 1979 and 1982, the National Heart, Lung, and Blood Institute (NHLBI) reported a death rate of 1.1% for elective PCI.[1] Acute vessel closure was a major concern, resulting in a high incidence of Q-wave myocardial infarction (4.8%) and emergency coronary artery bypass surgery (6%). Today, more predictable, acute results are achieved, as reflected in the low incidence of acute Q-wave myocardial infarction (.05%) and emergent coronary bypass surgery (.2%).[2]

Despite this impressive evolution in coronary revascularization, complications related to femoral arterial access remain essentially unchanged. In fact, with an incidence of approximately 5%, major bleeding related to femoral arterial access may now pose the most significant risk to patients undergoing PCI. Kinnaird et al[3] studied almost 10,000 patients undergoing PCI and reported a strong association between the occurrence of a bleeding complication and in-hospital mortality. Patients without a bleeding complication had an in-hospital mortality rate of .6%, which is a dramatic contrast to the 7.5% incidence for patients with a major TIMI bleed. Multivariable analysis of these data demonstrated that major hemorrhage was associated with a greater risk for 1-year mortality than even myocardial infarction (odds ratio, 3.53 vs 2.59).[3] Rao et al examined 24,112 patients undergoing

Figure 1. Positioning of the arm for radial artery catheterization.

PCI for the indication of acute coronary syndrome from the PARAGON B, PURSUIT, and GUSTO IIb studies. The meta-analysis reported that transfusion-related bleeding was associated with a nearly fourfold increase in 30-day death.[4] Anemia after the procedure has also been associated with adverse PCI outcomes.[5] The REPLACE II study revealed a significant association between bleeding complications and poor outcomes after PCI, and recently, the Acuity trial reinforced the adverse impact of post-PCI bleeding on outcomes, demonstrating a significant increase in 30-day mortality rates after a major bleed (7.3% vs 1.2%; P<.0001). Mortality was found to be further increased at 1 year (8.8% vs 1.2%; $P<.0001$).[6,7]

After PCI, manual compression remains the standard method for femoral arterial sheath removal worldwide. Despite the development of femoral arterial closure devices, manual compression is still utilized in approximately 65% to 70% of cases.[8] Although the use of femoral access closure devices has demonstrated benefit in terms of patient comfort and improved patient turnover, there have been no convincing data to suggest that these devices decrease the incidence of bleeding compared to manual compression. In fact, bleeding related to failure of a femoral access closure device is associated with poor outcomes, as reported in REPLACE II and by Moscucci, who reported that such bleeding was associated with an increased risk of death (2.4% vs .2%) and myocardial infarction (13% vs 3%).[9,10]

Figure 2. Sheath removal after radial artery catheterization: the TR Band (Terumo Interventional Systems, Somerset, NJ).

The most significant innovation leading to decreased bleeding complications with PCI is the use of radial artery access. First reported by Campeau in 1989, this technique was pioneered by Kiemeneij et al, who published a randomized study in 1997 comparing the femoral, brachial, and transradial approaches.[11,12] In this study, there was a similar success rate for PCI performed by the radial approach compared to the femoral approach (91.7% vs 90.7%; P=NS), but there was a significantly lower rate of vascular complications (0% vs 2%; $P=.03$).[12] These findings were reinforced by Mann et al, who published the first large US radial access PCI experience. In this randomized study (n=142), the transradial approach was associated with equivalent PCI success rates (96% vs 96%; P=NS) and a lower incidence of access site complications (0% vs 4%; $P<.01$) compared to the femoral approach. The transradial approach was also associated with lower procedure-related costs ($20,476 vs $23,389; $P<.01$).[13] A meta-analysis of 12 studies (n=3224) comparing the radial to the femoral approach demonstrated a significant benefit with the former approach in regard to access site complications (.3% vs 2.8%; $P<.001$).[14]

Other benefits to the radial approach include an upper-extremity arterial access option for patients with severe aortoiliac disease; early/immediate patient ambulation, which is associated with increased patient comfort; expedited room turnover, both in the catheterization laboratory and for hospital beds; the option for uninterrupted delivery of antiplatelet/anticoagulant drugs; and patient preference for the radial approach; leading to practice development/enhancement. Several of these benefits were actually quantified in one study by Cooper et al.[15]

Despite these advantages and the widespread adoption of transradial catheterization in other countries, it is estimated that this approach is utilized in only 7% of PCI procedures in the US.[16] Reasons for this are varied, but a major deterrent is lack of exposure during formal fellowship training and a dearth of postgraduate training opportunities.

When initiating a transradial PCI program, it is important to consider the three main groups of staff involved: physicians, catheterization laboratory nurses and technicians, and recovery unit personnel. Each group has different training objectives, and the overall success of the program requires proficiency in each area. Physicians must become comfortable and proficient with preprocedure patient evaluation, arterial access, catheter manipulation, and equipment selection. Lab personnel must become familiar with patient preparation, nuances in equipment, and sheath removal. The recovery areas need to learn how to care for radial artery access sites, the various methods of arterial compression utilized, and postprocedure evaluation/discharge instructions.

There are four main components to the procedure: patient preparation, arterial access, navigation of the catheter to the aortic root and proper catheter positioning, and postprocedure care.

PATIENT PREPARATION

Patient preparation is relatively straightforward. Preprocedure evaluation should include identification of the size, quality, and location of the radial pulse. Documentation of a normal Allen's test is suggested. The patient is positioned on the catheterization table with an armboard extending from the right side, which is preferably hinged to allow lateral motion toward and away from the table. The right arm is extended palm upward with a roll of gauze, rolled up washcloth, etc. underneath (Figure

1). Sterile drapes are applied. The left radial approach can also be used and is especially helpful for selective angiography of the left internal mammary artery. For the left radial approach, following sheath insertion, the arm can be positioned across the patient's torso so that the operator can work from the usual side of the table.

New transradial operators should consider using sedation/analgesia and concurrent preparation of the femoral site until proficient in radial access. The former helps with patient comfort in cases where multiple attempts at radial access are needed. The latter allows for an efficient "bail-out" strategy in the event that radial access fails and will prevent prolonged procedure times.

ARTERIAL ACCESS

Once needle access into the radial artery has been achieved, the next critical step is advancing a small guidewire of appropriate size proximally. It is critical to evaluate the tactile feedback from the wire because early resistance indicates that the wire is not in the center of the lumen. Further wire advancement against resistance could result in dissection or perforation. In the case of resistance, the wire should be withdrawn and the needle repositioned before further wire advancement. Resistance encountered further upstream can be caused by entry of the wire into a side branch, a severe bend in the artery, or severe spasm. Strategies to overcome this problem can be based on information derived from limited angiography performed through the needle or a 4-F dilator and would include the use of a steerable wire and/or administration of a vasodilator.

When selecting an arterial sheath, optimal features for the radial approach are a highly tapered tip and a hydrophilic coating. The recently available Glidesheath (Terumo) is a good example of a sheath with these features. Sheaths 4 F in diameter are acceptable for diagnostic imaging; however, the vast majority of radial arteries are large enough to accommodate the 6-F sheaths usually required for PCI. It should be noted that large radial arteries can easily accept 7-F diameter sheaths, which are sometimes required for special procedures. Contrary to the femoral approach, sheath length must also be considered. Many interventionists feel that a short-length (10 cm) sheath is very adequate, but a longer sheath (21 to 25 cm) extending to the brachial artery is preferred by operators who feel enhanced catheter manipulation. Many operators routinely administer an antispasm "cocktail" after sheath insertion—usually nitroglycerine (.2 to .4 µg) and/or a calcium channel blocker (diltiazem 500 µg, verapamil 250 to 500 µg).

CATHETER NAVIGATION AND POSITION

Navigation of the catheter to the aortic root may be facilitated by advancement over a wire. Tortuous, calcified subclavian/innominate arteries are sometimes encountered, often in obese, elderly, or hypertensive patients. The concurrent use of a deep breath hold and catheter manipulation over a shapable/steerable wire will usually overcome this problem. The choice of optimal catheters from the right radial approach is important.

In regard to PCI, it is helpful to adapt the working space to the radial approach, which is easily accomplished either by swiveling the arm board placing the arm immediately adjacent to the body, or by placing a small table or Mayo stand between the arm board and the catheterization table. Guiding catheter selection is similar to the femoral approach for left coronary lesions, but occasionally a KIMNY (Boston Scientific Corporation, Natick, MA), Tiger II (Terumo), or an AL-2 (Cordis Corporation, a Johnson & Johnson company, Warren, NJ) is helpful. Selection of a guiding catheter is the critical first equipment decision. For right coronary interventions, AL0.75 (Boston Scientific) and hockey stick guiding catheters provide excellent support. It should be remembered that guide support for right coronary artery interventions is often superior from the right upper-extremity approach compared to the femoral approach as the guide catheter backs up directly against the opposite side of the aorta. Given the working space, short guidewires (180 to 200 cm) and rapid exchange platforms for balloons and stents are most suitable. However, procedures that mandate a long-wire or over-the-wire system (rotational atherectomy) can certainly be performed.

POSTPROCEDURE CARE

Hemostasis can be applied in many ways after sheath removal. Although a gauze "bullet" and a dialysis HemoBand (HemoBand Corp., Portland, OR) are very effective, there are several specially designed devices that are gaining popularity. The TR Band (Terumo) is the most recently introduced and allows direct visualization of the access site and automatic, gradual release of pressure (Figure 2). Regardless of the method of compression utilized, complete obliteration of the radial pulse is contraindicated, and gradual release of pressure over 1 to 1.5 hours is usually sufficient. After sheath removal, radial and ulnar pulses should be measured every 15 minutes with concurrent documentation of the color, warmth, and sensation of the hand. Once hemostasis is achieved, a light compression dressing is applied. Patients are instructed to avoid strenuous lifting or overuse of the wrist for 3 or 4 days and to call if they experience any coldness, numbness, or significant pain.

The incidence of acute or subacute radial artery occlusion after transradial PCI is approximately 6%. Half of these radial arteries will spontaneously recanalize, yielding a 3% incidence of permanent occlusion. Anecdotal evidence suggests that systemic anticoagulation is associated with higher rates of long-term radial artery patency.

CONCLUSION

Through the utilization of the principles outlined in this article and the accumulation of experience, it has been demonstrated that even the most complex PCI procedures can be successfully performed by the radial approach. Because the benefits of this approach are numerous, the safety conferred by a lack of significant access site bleeding compels interventional cardiologists in the US to seriously reconsider transradial PCI. ■

Ronald P. Caputo, MD, FACC, FSCAI, is from SJH Cardiology Associates, in Syracuse, New York. He has disclosed that he is a paid consultant to Boston Scientific, Terumo, Cordis, and Medtronic. Dr. Caputo may be reached at caputo331@msn.com.

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