Distal Radial Sheath Extension Technique to Reduce Operator Radiation Exposure and Promote Ergonomics for Cardiac Catheterization

Richard Casazza, MAS, RT(R)(CI)

Distal radial artery access has become commonplace for many cardiac catheterization laboratories in recent years. Originally described for cardiac catheterization by Dr. Ferdinand Kiemeneij for left extremity procedures to promote ergonomics, it has become one of the most fastidious access points studied in interventional cardiology.

Distal radial access offers low rates of radial artery occlusion, access-site crossover, hemostasis time, and access-site related complications. Its safety and feasibility have been well demonstrated.[1-3] Distal radial access has been shown with a higher crossover rate, most likely due to a learning curve and theoretically a smaller "window" to access than conventional radial artery access. Using ultrasound-guided access may obviate these obstacles. Shorter hemostasis times have been observed which can help with post-procedure workflow. Radial artery occlusion is one of the pitfalls of all radial artery access procedures. Although most are benign, limiting radial artery occlusion and preserving flow should be at the forefront of the radial operator's mind. One study showed that radial artery occlusion occurred in 4.8% (41/837) of patients undergoing standard radial access and in 0% (0/326) of patients undergoing a distal approach ($P<.0001$).[2] Distal radial access was associated with higher percentage of flow preservation (97.2% versus 78.5% in the transradial access group, $P<.0001$) and reduced time to hemostasis (147±99 minutes [min] versus 285±138 min, $P<.0001$).[2] These promising data should be considered when choosing between distal or conventional radial access. Some degree of common sense should also be used, as typically distal pulses that are not palpable despite the use of ultrasound guidance will be more difficult to access and thus distal radial access might be better avoided in these patients.

Distal Radial Sheath Extension Technique (Left Radial Access)

The distal radial sheath extension technique is used to optimize ergonomics and increase the distance between the operator and the primary scatter radiation source. The patient is prepped and draped in the usual fashion. The use of a Radial Access Sleeve (Tesslagra Design Solutions) is preferred to maximize sterility and provide ample material to clamp down to the body drape, which helps avoid the left arm drifting away from the operator. Using a 16 cm Slender sheath (Terumo), after access has been obtained in the distal radial artery, the sheath is advanced roughly 10-12 cm (Figure 1) leaving 4-6 cm outside the body. The sheath then is meticulously secured down with Tegaderm. The arm is then adducted onto the abdomen of the patient and the sleeve drape is secured with clamps (Figure 2A-B). With the sheath withdrawn, operators can work comfortably down the middle of the table, providing an excellent working platform for support. It also creates distance, albeit small, between themselves and the radiation source. This setup also allows operators to position the ceiling-mounted shield in a strategic location to optimize radiation reduction. Using a shield with a lead skirt attached in a "draping" fashion over the patient will maximize protection for the interventionalists (Figure 3).

Distal Radial Sheath Extension Technique (Right Radial Access)

Ideally, the right arm should be set up in a hyperadducted fashion, which will again remove the operator further from the radiation source. This setup also may offer better table-mounted shield protection from leakage radiation underneath the patient table. After access is obtained, a 16 cm Slender sheath is advanced, leaving 4-6 cm outside the body (Figure 4A). Hyperadduction can offer operators better shield positioning to maximize their radiation protection techniques. An abducted arm may induce the operator to position the shield laterally, which isn't the best location to effectively block scatter radiation. The procedural maneuver of hyperadduction, in and of itself, has shown to provide lower exposure to operators.[4] Utilizing a sheath extension technique in conjunction with hyperadduction can further radiation reductions. This technique also enhances ergonomics by providing a stable working platform for operators (Figure 4B).

Figure 1. Left distal radial access with 4-5 cm left outside the body.

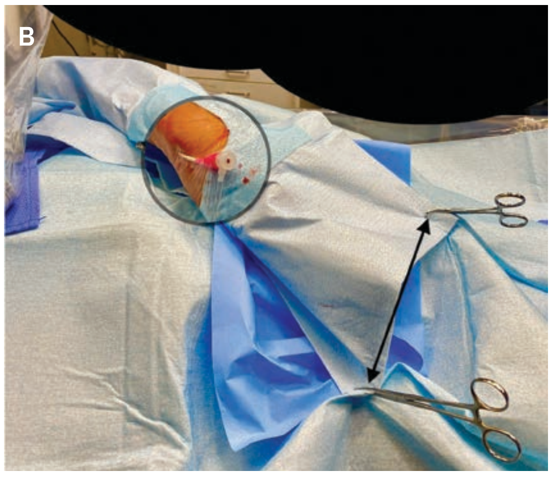

Figure 2A-B. (A) Proper arm placement with distal radial extension technique. (B) Radial Access Sleeve (Tesslagra Design Solutions) securely clamped.

Figure 3. **Lead skirt "draped" on patient for optimal radiation protection.**

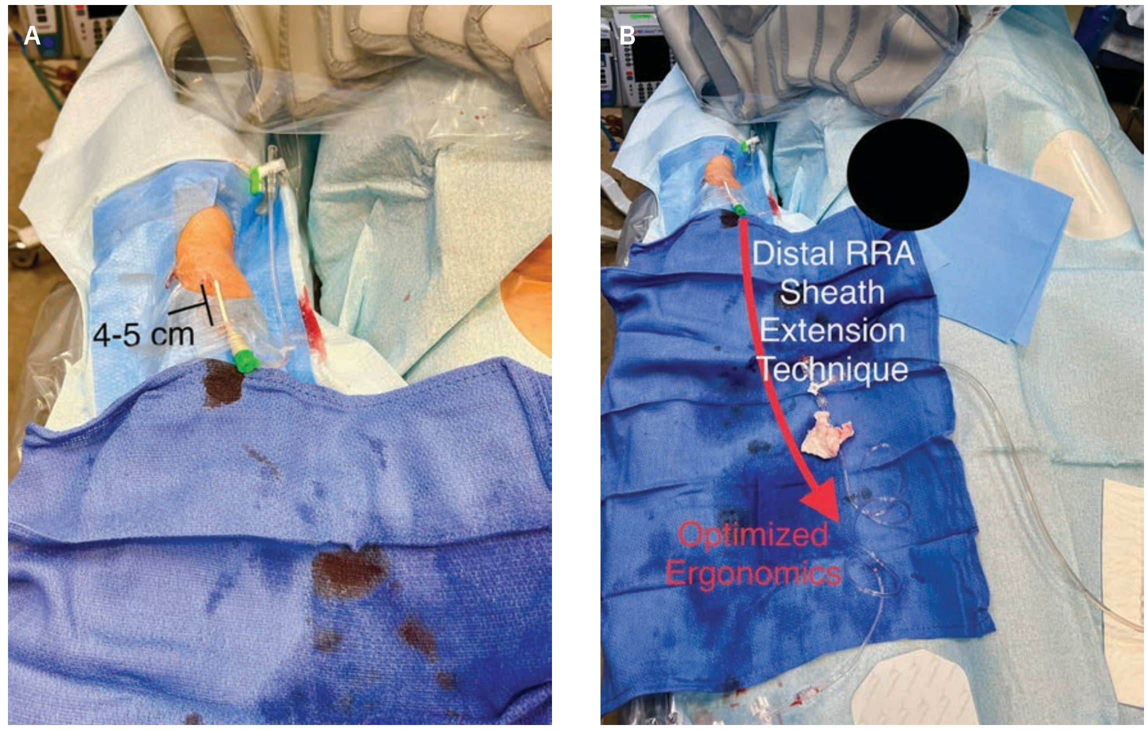

Figure 4A-B. **(A) Right distal radial access with 4-5 cm left outside body. (B) Ergonomic working platform with right distal radial access.**

Discussion

The utilization of sheath extension techniques is a simple way to create distance between the operator and radiation source. The three main tenants of radiation safety are time, distance, and shielding. The sheath extension technique discussed here primarily maximizes distance for operators by rule of the inverse square law. The radiation inverse square law specifies that the intensity of the radiation goes down by the square of the distance from the source. For instance, moving twice as far from the source, decreases the intensity of the radiation by a factor of four.[5] This is significant for interventional cardiologists who do fluoroscopic procedures, especially those who have a heavy cath/percutaneous coronary intervention workload. Routine sheath extension has the ability to reduce radiation-induced deterministic and stochastic effects. The distance created with sheath extension over several hundred — or thousands — of procedures can have a profound radiation reduction for operators over the course of a career. Small, incremental distances add up over time.

Radiation is the enemy that we can't see but is always there.

Optimal shield positioning also has significant radiation reduction implications. The use of the ceiling-mounted shielding can decrease the dose from the scatter radiation by 95% at the position of the performing physician.[6] It is of paramount importance to not only utilize this shield, but to place it in a position that most effectively protects against scatter radiation. Ideally it is close to the operator's left shoulder (if working from the right side of the table). Moving the shield after each projection to optimize protection (dynamic shield positioning) is an effective way to limit exposure. Shields that have a retrofitted lead skirt are also an important tool in protecting against scatter and have been proven to reduce operator radiation exposure significantly.[4]

Sheath extension techniques are not without their limitations. This technique is not dissimilar to the "Peekaboo" technique.[7] Patient selection is important. With taller patients and long-limbed patients, operators run the risk of running out of catheter due to length issues. Tortuosity can also "eat up" catheter length and should also be taken into account. With these patients, operators may wish to put the sheath in all the way or be prepared with 125 cm catheters to accommodate the technique.

Simple solutions and commonsense techniques can help operators reduce their exposure without sacrificing ergonomics. Radiation is the enemy that we can't see but is always there. Cath lab operators and personnel should remain vigilant in efforts around reducing exposure. ■

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Richard Casazza, MAS, RT(R)(CI)
Maimonides Medical Center, Brooklyn, New York

Disclosure: Richard Casazza reports he is Director of R&D for Tesslagra Design Solutions.

Richard Casazza, MAS, RT(R)(CI), can be contacted at all4ugq@aol.com