Kidney Medicine

Is It Time to Abandon Buttonhole Cannulation of Arteriovenous Fistulas?

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Successful dialysis with an arteriovenous fistula (AVF) requires repeated cannulation with 2 large-bore needles at least thrice weekly to deliver blood flow sufficiently high to ensure an adequate dialysis dose. Due to variations in vascular anatomy, cannulation of an AVF can be more challenging than that of an arteriovenous graft (AVG), resulting in more frequent complications of cannulation.[1,2] Mis-cannulation is particularly common with new AVFs using the conventional rope ladder technique. A prospective study of 120 hemodialysis Dutch patients with an AVF observed that 51% had a mis-cannulation episode in one of the first 3 dialysis sessions using the AVF, and 91% had at least 1 mis-cannulation during follow-up.[1] The risk for mis-cannulation was doubled if the AVF length available for cannulation was <10 cm. In contrast, mis-cannulations were rarely observed in patients with forearm AVGs. Major needle infiltration of an AVF may lead to inability to complete a dialysis session, additional diagnostic procedures, percutaneous or surgical interventions, AVF thrombosis, or prolonged catheter dependence.[2]

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The buttonhole cannulation technique purportedly reduces the risk for needle infiltrations of the AVF by creating subcutaneous channels from the skin to the AVF lumen, thereby providing a "road map" for repeated cannulation. The AVF is cannulated using blunt dialysis needles that are inserted through these channels, thereby eliminating uncertainty about the optimal cannulation sites, angle of cannulation, and distance from the skin to the AVF lumen. It has also been proposed that the buttonhole cannulation technique is easier for the nurses to use, produces less pain, and prolongs AVF patency (Table 1). Owing to these theoretical advantages, the buttonhole AVF cannulation technique was widely promoted by the Fistula First Breakthrough Initiative in its first few years.[3] However, more recent studies from the past decade have tempered enthusiasm for the buttonhole technique.

After each dialysis session, a scab forms over the buttonhole exit site. This scab is frequently colonized with bacteria, most commonly *Staphylococcus* species.[4] It can serve as the nidus of an infection that could be introduced into the bloodstream unless the scab is removed before AVF cannulation. The standard antisepsis protocol for the conventional rope ladder cannulation technique consists of scrubbing the skin with chlorhexidine before cannulating the AVF. This protocol must be modified when using buttonhole cannulation, beginning with application of chlorhexidine or a similar antiseptic to the skin, followed by removal of the scab at the exit site and repeat application of the antiseptic at the buttonhole site before proceeding with cannulation. If the scab is not removed completely before cannulation, bacteria colonizing the scab may be introduced into the AVF, potentially causing a local AVF infection or even bacteremia with its associated risk for a metastatic infection.

Nesrallah et al[5] reported in 2010 a cluster of *Staphylococcus aureus* bacteremia in a cohort of hemodialysis patients with AVFs using the buttonhole cannulation technique. This initial observation has subsequently been confirmed by a number of short-term studies. A meta-analysis of 14 publications, including 4 randomized clinical trials, 7 observational studies comparing infection rates before and after cannulation technique changes, and 3 observational studies comparing dialysis units with different cannulation practices yielded remarkably consistent findings for each study type: buttonhole AVF cannulation was associated with a 3-fold greater incidence of AVF infection.[6] Collectively, these reports established that infectious complications of buttonhole cannulation are not theoretical, but rather a scary reality.

In the current issue of *Kidney Medicine*, a large, prospective, long-term, observational study from Denmark reported by Glerup et al[7] provides further evidence supporting a substantially increased risk for *S aureus* bacteremia in patients with a buttonhole AVF cannulation technique as compared to conventional cannulation.

The investigators prospectively followed up 286 hemodialysis patients from 5 Danish units who were using an AVF. The overall duration of follow-up was an impressive 803 patient-years, representing the largest prospective multicenter cohort study comparing the 2 cannulation techniques. Half of the patients underwent buttonhole cannulation, and the rest used conventional cannulation. About three-fourths of each cannulation group had diabetes, and ~75% in each group had a forearm AVF. Approximately 40% of patients in each group had a nasal swab positive for *S aureus*.

During a prospective 5-year follow-up period, *S aureus* bacteremia related to the AVF occurred 43 times in the buttonhole technique group versus 5 times in the group using conventional cannulation. The adjusted risk for *S aureus* bacteremia was more than 8-fold greater in the buttonhole group. Patients in the buttonhole cannulation group also had an 8-fold greater number of hospital days for treatment of *S aureus* bacteremia. Alarmingly, many of these patients developed major systemic complications. A metastatic *S aureus* infection was observed in 8 of the

Table 1. Potential Advantages of Buttonhole Cannulation of AVFs

Potential Advantage	Clinical Observation in RCTs[9,13]
Reduce pain with cannulation	No difference in pain level between buttonhole and rope ladder cannulation
Ease of cannulation	Nurses thought buttonhole cannulation was more challenging technically
Reduce frequency of infiltration	Lower frequency of infiltration with buttonhole cannulation
Prolong AVF patency	No difference in AVF survival between buttonhole and rope ladder cannulation

Abbreviations: AVF, arteriovenous fistula; RCT, randomized controlled trial.

buttonhole patients versus 1 in those with conventional cannulation. Similarly, *S aureus* endocarditis occurred in 12 patients with buttonhole technique versus 2 using conventional AVF cannulation.

Meticulous aseptic technique should theoretically abolish the risk for *S aureus* AVF infection and bacteremia in patients using buttonhole cannulation, but it clearly does not. Even in European and Canadian dialysis units with a lower (3-4:1) patient to nurse ratio and low staff turnover, the problem persists. For example, a large Belgian observational study observed a 4-fold increase in the frequency of bacteremia when the dialysis unit protocol was switched from rope ladder to buttonhole cannulation.[8] Intensive educational workshops subsequently decreased this complication. Similarly, a Canadian randomized controlled trial of 140 hemodialysis patients with an AVF reported a 2-fold greater risk for AVF infection in patients allocated to buttonhole versus rope ladder cannulation.[9] Remarkably, most of the dialysis nurses in the study by Glerup et al had 10 to 30 years of experience as dialysis nurses. Such individuals are exceedingly rare in the United States. It is likely that the risk for bacteremia would be even higher in US hemodialysis units, which are characterized by a high (8-12:1) patient to nurse ratio and frequent staff turnover.

Why might the risk for bacteremia persist despite use of an appropriate antiseptic technique? One possibility is that over time, there is a natural tendency of the cannulator to take shortcuts and omit the critical step of removing the scab. A second explanation is that the scab is not always entirely removed, and there is a residual nidus of infection that is introduced during cannulation.

One major advantage of AVFs over AVGs is that the former have lower risk for access infection.[10] For example, in a large series of 322 patients with brachiocephalic AVFs and 289 with AVGs, the annual frequency of access infection was 0.7% versus 9.7%, respectively.[11] In other words, it appears that use of the buttonhole abolishes the lower propensity of AVFs for infection. As a recent editorial asked: "Have we denigrated our 'gold standard' fistula to the status of a catheter with this buttonhole technique"?[12(p 1549)]

Given the overwhelming evidence associating buttonhole cannulation with AVF infections and bacteremia, is there any role for the continued use of this technique in dialysis patients with an AVF? Theoretically, the risk should be minimal among home hemodialysis patients who have a highly motivated and stable dialysis partner (essentially 1:1 nursing). However, even in this ideal population, buttonhole cannulation has been associated with increased risk for AVF infection and bacteremia. For example, a recent Australian study followed up 90 home hemodialysis patients and documented a 4-fold higher incidence of AVF infections in those using buttonhole cannulation as compared to conventional cannulation.[6] Perhaps the only acceptable candidate for buttonhole cannulation is a patient with a very short AVF, such that this technique is required to achieve effective dialysis. The use of topical mupirocin prophylaxis may reduce the risk for AVF infection in such patients.[5] Alternatively, placement of an AVG may be a better choice.

What about the other purported advantages of buttonhole cannulation over standard cannulation (Table 1)? A Canadian randomized controlled trial confirmed that the buttonhole technique reduced the risk for AVF infiltration by 33%. However, it did not reduce pain at the cannulation site. Moreover, the nurses found buttonhole cannulation to be more technically challenging.[9] Finally, this technique did not prolong AVF survival.[13]

The experience with buttonhole cannulation of AVFs provides a cautionary tale. Here was a technique that seemed to offer obvious advantages and was enthusiastically adopted worldwide before being studied closely. However, subsequent studies have demonstrated that it can cause substantial harm to dialysis patients. This experience teaches us that before any medical technique is widely adopted, it should be subjected to objective comparison with the current standard.

ARTICLE INFORMATION

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