Bacteriology of the Buttonhole Cannulation Tract in Hemodialysis Patients: A Prospective Cohort Study

Line Dahlstrøm Christensen, Mai-Britt Skadborg, Agnete H. Mortensen, Carsten Mortensen, Jens K. Møller, Lars Lemming, Irene Høgsberg, Steffen E. Petersen, and Niels H. Buus

Background: The buttonhole cannulation technique for arteriovenous fistulas is widely used, but has been associated with an increased rate of vascular access–related infections. We describe the frequency and type of bacterial colonization of the buttonhole tract over time and associated clinical infections.

Study Design: A prospective observational cohort study with 9 months of follow-up.

Setting & Participants: 84 in-center hemodialysis patients using the buttonhole cannulation technique at 2 Danish dialysis centers.

Outcomes: Bacterial growth from the buttonhole tract and dialysis cannula tip and clinically important infections during follow-up.

Measurements: On 3 occasions 1 month apart, cultures before dialysis (from the skin surrounding the buttonhole before disinfection and from the cannulation tract after disinfection and scab removal) and the cannula tip after dialysis. Patients with positive cultures from the buttonhole tract or cannula tip had repeat cultures within 1 week, along with blood cultures.

Results: Growth from the cannulation tract and/or cannula tip at each of the 3 monthly sets of cultures was found in 18%, 20%, and 17% of patients, respectively. 38% of patients had at least 1 positive culture from the buttonhole tract. Sustained growth was detected in 11% of patients, whereas asymptomatic bacteremia was seen in 30% of those with positive buttonhole cultures. Staphylococci species were the most common pathogens (*Staphylococcus aureus*, 25%; and *Staphylococcus epidermidis*, 41%). Colonization-positive buttonholes had more localized redness and slightly more tenderness. During follow-up, significantly more access-related infections were diagnosed among those with positive buttonhole cultures ($P < 0.001$).

Limitations: No comparison to area puncture cannulation technique. Blood cultures were obtained only from patients with positive buttonhole bacteriology.

Conclusions: Transient or sustained colonization of the buttonhole tract by staphylococci and asymptomatic bacteremia is common in hemodialysis patients, implying a substantial risk for access-related infections among patients using a buttonhole cannulation technique. These findings suggest the possible value of surveillance of buttonhole colonization.

Complete author and article information provided before references.

Correspondence to L.D. Christensen (linedahlstrom@gmail.com)

Am J Kidney Dis. XX(XX):1-9. Published online Month X, 2018.

doi: 10.1053/j.ajkd.2018.01.055

The arteriovenous fistula (AVF) is the recommended vascular access for hemodialysis patients due to a lower overall complication rate,[1,2] but cannulation of an AVF can be associated with difficulties. Buttonhole cannulation, first described in 1979,[3] is an alternative to the "rope-ladder" or "area cannulation" techniques and is increasingly used. It is believed that buttonhole cannulation decreases the rate of problematic cannulations, patient discomfort, hematoma formation, and access failure while also facilitating patient self-cannulation.[4-6] However, the technique is highly debated[7-9] because it may be associated with an increased rate of infectious complications, and prior claims of benefit have not been consistently observed.[5,10-13]

A randomized study found increased risk for bacteremia and localized infection with buttonhole cannulation,[5,12] whereas another trial found similar risks for infectious complications using buttonhole and rope-ladder techniques.[14] A number of recent observational studies also report a higher incidence of local infections, especially with *Staphylococcus aureus*, potentially leading to severe systemic infections such as endocarditis.[10,15] These findings are supported by observations from Labriola et al,[16] who described an increased infection rate after implementation of buttonhole cannulation, although a significant decrease was seen following re-education of the dialysis staff, demonstrating the importance of thorough skin disinfection prior to cannulation.

A prospective study examined how skin flora and the disinfection technique influence the risk for infection and found that *S aureus* colonization and poor hygiene are major risk factors.[17] However, very little is known about the actual bacterial flora in the buttonhole cannulation tract. A small pilot study from our department found positive buttonhole cultures in 2 of 22 patients.[18] However, the frequency of bacterial colonization and whether bacterial growth is a permanent or transient phenomenon are unknown. We therefore conducted a prospective systematic evaluation of bacterial colonization in the cannulation tract using repeated cultures from buttonholes during a 3-month period with follow-up of clinically relevant infections.

Methods

This is a prospective observational cohort study with 9 months of follow-up performed at hemodialysis units at

Aarhus University Hospital (AUH) and Lillebaelt Hospital Fredericia (LHF) in Denmark. The Committees on Biomedical Research Ethics for Central Denmark and Southern Denmark Regions approved the study, and all participants gave written informed consent.

Patients

At the time of inclusion, AUH had 105 patients treated with in-center maintenance hemodialysis. Of these, 98 had native AVFs; 48 used 2 buttonholes for cannulation, while 4 used 1 buttonhole site in combination with either the area or rope-ladder technique. LHF had 109 patients receiving hemodialysis. Of these, 83 had AVFs; 52 used 2 buttonholes for cannulation, while 1 patient used 1 buttonhole site in combination with the rope-ladder technique. No patients had more than 2 active buttonholes. Patients received dialysis on average 3 times a week.

At AUH, all patients using buttonholes were invited to participate in the study. At LHF, 46 patients were invited (by mistake, 7 patients were not asked). Exclusion criteria or reasons for exiting the study before the end of follow-up included death, dementia, change in dialysis modality, kidney transplantation, or abandoning of the buttonholes. If only 1 buttonhole was abandoned, the patient continued in the study with the remaining buttonhole.

Buttonhole Cannulation Procedure

Buttonholes had been established in the traditional way by a limited group of experienced "cannulators," usually only 2 per patient. Sharp needles were used during the first 2 weeks (6-10 cannulations) to establish the buttonhole tract, after which blunt needles were preferred and cannulation was not limited to selected nurses. The needles used during the study period were blunt Buttonhole Fistula Needles (Bionic) 14 gauge (14G), 15G, or 16G or Biohole Dialysis Cath (Nipro) 14G or 15G. The arterial and venous cannulation sites were disinfected for 30 seconds with chlorhexidine–alcohol 70% before the scab was gently removed from the buttonhole (Fig 1A). Each site was disinfected again twice for 30 seconds before cannulation. Cannulation was performed at the prescribed angle into the fibrous tract, and as soon as blood flashback was observed, the angle was decreased and the needle was taped. No topical antibiotic prophylaxis was used. In cases of self-cannulation, a nurse performed the disinfection procedure and collected the samples. If clinical signs of infection were observed, the buttonhole was not used and the fistula was cannulated elsewhere.

Collection of Samples

On 3 occasions 1 month apart, swabs before dialysis and cannula tips following dialysis were obtained and cultured. To investigate superficial skin colonization, swabs were collected from the scab surface and the surrounding skin at the arterial and venous buttonhole site before disinfection. After disinfection and just before cannulation, a thin cotton swab was gently rotated in the superficial part of the buttonhole tract and placed in Stuarts transport medium (Fig 1B). After dialysis, the cannula tip was cut off with a sterile wire cutter and placed ino a sterile tube (Fig 1C). In cases in which the buttonhole was not used for cannulation due to signs of infection, a swab was still collected. In

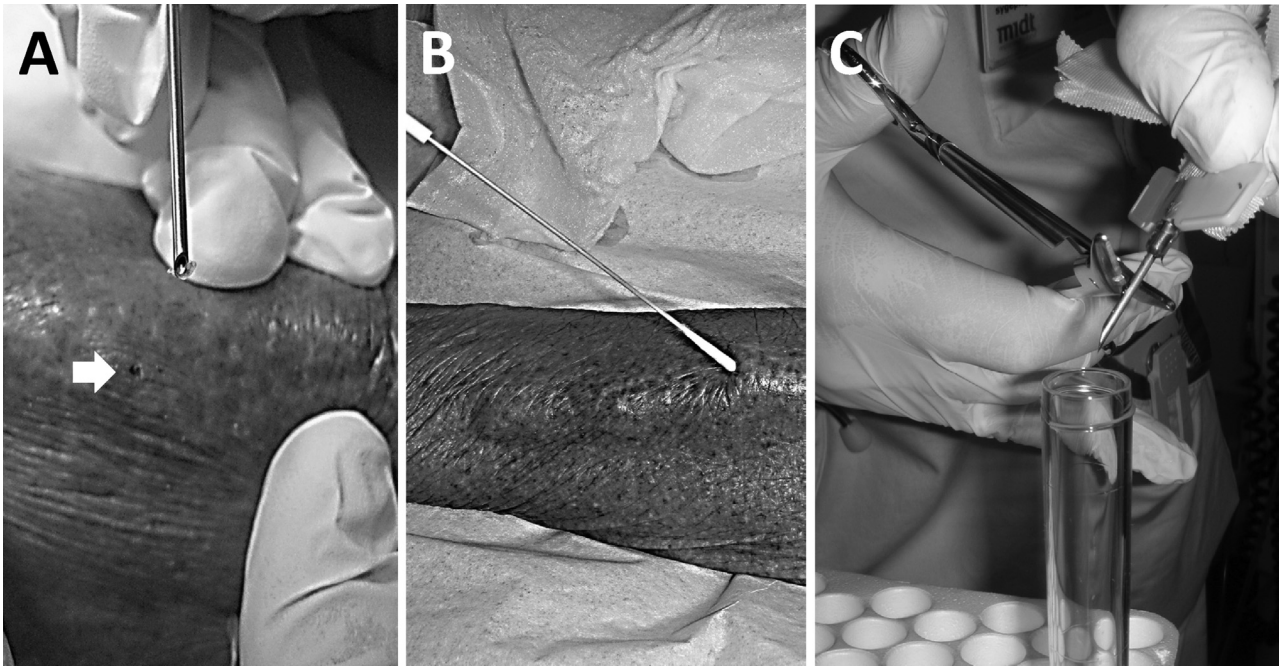

Figure 1. (A) The buttonhole (arrow) after removal of the tiny scab seen on the cannula tip. (B) The swab sample from the superficial buttonhole opening. (C) Cutting the cannula tip directly into the sterile tube.