

Should Buttonhole Cannulation of Arteriovenous Fistulas be Used? PRO

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Introduction

Successful cannulation of arteriovenous fistulas (AVFs) is a key priority to maintain the vascular access for hemodialysis, prevent vascular access-related morbidity, and avoid discomfort associated with AVF needling. Contrary to the rope ladder method of AVF cannulation, in the constant site or buttonhole technique, blunt needles are inserted at the same sites at each session, with the same angle of cannulation and depth, in a fibrous track between the skin and the vessel, created previously with repetitive punctures at the same spot with a sharp needle. Importantly, whereas the rope ladder technique allows skin healing before the following cannulation, the buttonhole technique requires the laborious withdrawal of the scab formed at the puncture site at each hemodialysis session, before performing puncture. This step is critical and requires a rigorous disinfection protocol (1,2).

Possible benefits of buttonhole cannulation over the standard rope ladder technique have been claimed on the basis of small-sized, potentially biased observational studies, most of them retrospective, with relatively short follow-up periods. Only five randomized controlled trials with a small sample size have been published (3–7). They show inconclusive or even conflicting results concerning several outcomes, such as AVF survival and intervention rates (3,4). Of note, there has been concern about the potential of buttonhole to increase the risk of AVF-related infections, as reported not only in some observational studies (8–12) but also in four out of the five randomized controlled trials comparing buttonhole with the standard technique of cannulation (4–7).

However, the quality of evidence concerning the potential benefits and risks of buttonhole is low (13). Infectious risk might have been overestimated due to a number of factors related to the technique itself, and the experience and vigilance of the cannulator teams (14). Furthermore, the long-term effect of a number of strategies proposed recently to prevent infections (14,15) has not been assessed in adequately designed trials. Therefore, the debate is far from being over.

In this review, we provide a critical view on the available publications discussing the potential benefits and concerns regarding the buttonhole cannulation technique, and explain why we think that the evidence

to recommend definitively abandoning it is, as yet, grossly insufficient.

Buttonhole Cannulation Technique and AVF-Related Infections: An Overestimated Risk?

Despite more than two decades of buttonhole use across countries, only five randomized controlled trials comparing buttonhole with standard cannulation (rope ladder and area) techniques have been published (3–7), three of them which had a small *n* (56–80 patients) and a very short follow-up period (3–6 months) (5–7). All but one (7) included only in-center hemodialysis patients. An increased incidence of local infections with buttonhole needling was documented in these three small trials (one infection in 37 and 22 patients, over 3- and 6-month follow-up periods, respectively (5,6), and four infections in 34 patients during 6-month follow-up (7). Similarly, in a Canadian randomized controlled trial both local and systemic infections were increased with buttonhole needling compared with standard technique in 140 in-center hemodialysis patients over 18 months of follow-up ($P < 0.001$) (4). However, the fifth randomized controlled trial, conducted in the United Kingdom and including 140 in-center hemodialysis patients, found no difference in infection rate with buttonhole in comparison with standard needling (two local infections and two with bacteremia, respectively) over 1-year follow-up (3). Of note, polycarbonate pegs (BioHole Stick; Nipro Corp.) were used between treatments for creation of the buttonhole tract during the first six hemodialysis sessions, and both the patient and the cannulating nurse used a mask during the cannulation procedure.

Before recommending the impulsive abandonment of buttonhole cannulation, some nuances in the interpretation of the current data should be underlined. First of all, the increased infection rates associated with buttonhole shown in four out of five randomized controlled trials were extremely variable, probably because none of the trials were designed with infections as a primary endpoint. This might lead to an overestimation of the infectious risk. Nevertheless, because infections were not prespecified as main endpoints, rigorous monitoring and aseptic protocols may not have been fully respected, and the observed variability

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could thus reflect inconstant adherence to the appropriate hygiene rules required for proper cannulation. Whatever the explanation, the observed infection rates show how dramatic the outcome could be if providers do not proceed with extreme caution, and emphasize the crucial importance of a rigorous and constant quality program of staff education and re-education regarding strict adherence to the buttonhole procedure. Indeed, we previously documented a dramatic increase in the incidence of infectious events after conversion to buttonhole in our busy in-center hemodialysis unit (10). Intensive nurse re-education regarding strict adherence to the hygiene rules for the buttonhole procedure led to a drop in septic complications. After new increases in infection rates, especially during holiday periods when vascular access coordinators were less available, the implementation of additional procedural changes to strengthen the hygiene protocol, together with the intensification of regular audits, achieved a level of virtually zero incidence of AVF-related infections over almost 2 years (Labriola, unpublished data). This highlights that AVF-related infections can be controlled and reduced to minimal levels through constant surveillance and the strong reinforcement of the aseptic protocol.

Second, a number of strategies have been proposed to decrease the infectious risk through different mechanisms, *i.e.* allowing easier creation of a unique buttonhole track (polycarbonate peg), preventing *Staphylococcus aureus* colonization of the buttonhole sites (face masks for both patient and cannulator, and mupirocin ointment at the buttonhole sites), or facilitating scab removal (special dressings on the buttonhole sites, soaking scabs with antibacterial soap, and a change of buttonhole sites in cases of bulging deformities or hypertrophic scabs) (2,14). Studies investigating their effect are scarce and have had short follow-up periods. However, as documented in the British randomized controlled trial using both polycarbonate pegs and masks (3), there have been no reported systemic infections in hemodialysis units using at least one of these approaches (11,15).

Third, some settings or patient characteristics could favor buttonhole use. In our satellite self-care hemodialysis unit (162 patients), buttonhole cannulation (1998–2012) was not associated with a higher incidence of infection in comparison with the rope ladder technique used during the previous study period (1990–1997) (16). Thus, in this specific population closely supervised by the nursing team for cannulation, buttonhole appears to be a safe technique.

Potential Advantages of Buttonhole Cannulation on Other AVF Outcomes: The Absence of Clear Evidence Is Not Evidence of Absence

Long-Term Patency and Intervention Rates

Both of the biggest randomized controlled trials have shown conflicting results. In the Canadian randomized controlled trial by MacRae *et al.*, (4) median access survival was similar for both cannulation groups (about 17 months). In contrast, Vaux *et al.* (3) did not observe any AVF failure in the buttonhole group, after a 1-year follow up period, in comparison with 14% of AVF failure in the control group [median time to AVF failure 268 days (interquartile range 143–292)]. Furthermore, although in the Canadian trial no difference in primary patency was demonstrated for

buttonhole compared with usual practice technique (4), this outcome was significantly better in the buttonhole group in the study by Vaux *et al.* (3) (74% versus 49%; $P=0.02$).

Aneurysms

Only two randomized controlled trials have assessed this important outcome. Struthers *et al.* (6) found that the transverse diameter of AVF cannulated with buttonhole remained unchanged after a follow-up period of 6 months, whereas the rope ladder AVFs increased in size by 30% ($P<0.01$), equivalent to an absolute rise of 5 mm. Similarly, Vaux *et al.* (3) observed new aneurysms in 4% of patients using buttonhole in comparison with 17% of patients using the usual technique. Moreover, significant enlargement of preexisting aneurysms occurred less frequently in the buttonhole group compared with the standard cannulation group (23% versus 67%, respectively).

Cannulation-Related Pain

Although some previous observational reports showed reduced cannulation pain (8,17), this benefit could not be demonstrated by the two biggest randomized controlled trials (3,4) including only in-center hemodialysis patients. In the British study, 8 of 70 buttonhole patients abandoned buttonhole due to pain (3). However, the fact that their subsequent pain scores were been excluded from analysis warrants caution when interpreting results.

Bleeding Time after Needle Removal

One small randomized controlled trial found a shorter time until hemostasis in patients with AVF punctured with the buttonhole technique compared with the control technique (5), whereas no significant difference for this outcome was documented in the four other randomized controlled trials (3,4,6,7).

Hematoma

Conflicting results also exist for this outcome, with two randomized controlled trials reporting less hematoma occurrence in buttonhole patients in comparison with rope ladder (6) or standard (18) cannulation, and a third randomized controlled trial documenting four hematomas in the buttonhole group and none in the usual care group after a 6-month follow-up period ($P=0.03$) (7).

The Current Evidence is too Scanty to Justify the Complete Abandon of Buttonhole Technique

In our opinion, it would be premature to discourage the use of the buttonhole needling technique in the absence of long-term, well designed randomized controlled trials. As suggested recently (14), this would frustrate efforts to better assess the safety and the potential advantages of this technique, and thus deprive many patients of its possible benefits. Additionally, many variations in cannulation technique exist among published studies, and many descriptions of the procedure are incomplete and unclear (13), which makes the interpretation of the data difficult.

In fact, there are many questions that remain open. Is the lack of survival benefit attributable to the increased risk of infectious complications (19)? If infections can be prevented,

Table 1. Necessary conditions in hemodialysis units using the buttonhole technique of cannulation

Condition
Clear standardization of the buttonhole technique Constant and strict adherence to aseptic protocols for buttonhole cannulation Rigorous and continuous monitoring of AVF-related infections Regular audits/surveillance concerning respect to hygiene protocols Regular training and retraining of staff and self-cannulating patients Availability of vascular access coordinator(s) or reference nurse(s), teaching the buttonhole technique and aseptic protocols, and ensuring regular supervision of the cannulation by the nurses and self-cannulating patients Antimicrobial cream prophylaxis on each buttonhole site after needle removal Written informed consent advising patients of potentially increased infection risk Avoidance of buttonhole in busy, in-center hemodialysis units with many rotating/part-time nurses
AVF, arteriovenous fistula.

will AVF last longer? What is the actual long-term effect of the recently proposed modifications to the buttonhole technique on infectious risk, the intervention rate, and, eventually, AVF survival? Moreover, due to the fact that AVF loss is a competing event when an AVF-related infection occurs, a competing risk model should be used to discriminate between potential benefits of buttonhole (*i.e.* better access survival) and its related complications (*i.e.* infections). However, this model can be performed only in large cohorts (16).

Another important point is represented by the different populations of hemodialysis patients in whom buttonhole is implemented (in-center versus low-care units versus home hemodialysis patients). Among the five randomized controlled trials, only one included home hemodialysis patients (7). Recently, an attempt to conduct a randomized controlled trial assessing the benefits and risks of the buttonhole and rope ladder techniques in patients in training for home hemodialysis in seven Canadian hemodialysis units could not include enough participants to draw statistically valid conclusions ($n=14$) (20). Admittedly, some observational, short-term trials performed in home hemodialysis patients have also documented an increased risk of infections with buttonhole compared with the rope ladder technique (11,21). However, the use of one of the refinements of the buttonhole technique (mupirocin ointment on each buttonhole site after needle removal) led to virtually no episodes of bacteremia after its implementation in this population (11). Needless to say, the lower perceived difficulty in needling offered by the buttonhole technique regarding the success of the sticks and the integrity preservation of the track (which is more likely to be obtained in self-cannulators) make buttonhole especially appropriate for patients dialyzed in low-care units or at home, especially those with frequent missed sticks, or suffering from cannulating stress or needle phobia. We agree that buttonhole may be not suitable in some busy in-center units with many rotating (or part-time) nurses or lacking a vascular access coordinator. But in our

experience, the documented infectious peaks could be managed with a careful and individualized approach, and strict attention paid to adherence to the aseptic protocol (10,22).

Finally, the absence of reduction in cannulation-related pain observed with buttonhole cannulation in both of the largest randomized controlled trials (3,4) could be explained by the fact that both studies included only in-center hemodialysis patients performing hemodialysis thrice weekly. The interdialytic interval was thus long enough to enable some degree of healing at the sites, with larger scabs more difficult to remove and leading subsequent discomfort during the procedure. With more frequent hemodialysis sessions, AVF needling might be easier (14).

In conclusion, debate on the clinical benefits and safety of buttonhole continues. Current published evidence is not sufficiently conclusive to recommend either the complete discontinuation of buttonhole or its widespread implementation. Impulsive abandonment of this technique for fear of infections without understanding their pathogenesis and predicting factors, which could be modified, would be reckless. Nevertheless, units considering a switch to buttonhole should be warned that it is a very demanding technique that requires a strict adherence to aseptic protocols, and rigorous education and constant retraining of staff, and self-cannulating patients. The implementation of careful and regular monitoring of infection rates is crucial. Patients should be informed regarding the potentially increased infectious risk associated with buttonhole (Table 1). Long-term, large-scale national trials are urgently needed in order to identify patients who could really benefit from this technique. As recently recommended by the European Best Renal Practices (13), we think that, on the basis of our current knowledge, both the rope ladder or buttonhole techniques can be used to cannulate patients with AVF, according to center expertise, AVF characteristics, and patient preference.

Author Contributions

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References

- Atkar RK, MacRae JM: The buttonhole technique for fistula cannulation: Pros and cons. *Curr Opin Nephrol Hypertens* 22: 629–636, 2013
- Labriola L, Jadoul M: Moderator's View: Buttonhole cannulation of arteriovenous fistulae: Great caution is warranted. *Nephrol Dial Transplant* 31: 530–533, 2016
- Vaux E, King J, Lloyd S, Moore J, Bailey L, Reading I, Naik R: Effect of buttonhole cannulation with a polycarbonate PEG on in-center hemodialysis fistula outcomes: A randomized controlled trial. *Am J Kidney Dis* 62: 81–88, 2013
- MacRae JM, Ahmed SB, Hemmelgarn BR; Alberta Kidney Disease Network: Arteriovenous fistula survival and needling technique: Long-term results from a randomized buttonhole trial. *Am J Kidney Dis* 63: 636–642, 2014

5. Toma S, Shinzato T, Fukui H, Nakai S, Miwa M, Takai I, Maeda K: A timesaving method to create a fixed puncture route for the buttonhole technique. *Nephrol Dial Transplant* 18: 2118–2121, 2003
6. Struthers J, Allan A, Peel RK, Lambie SH: Buttonhole needling of arteriovenous fistulae: A randomized controlled trial. *ASAIO J* 56: 319–322, 2010
7. Chow J, Rayment G, San Miguel S, Gilbert M: A randomised controlled trial of buttonhole cannulation for the prevention of fistula access complications. *J Ren Care* 37: 85–93, 2011
8. Verhallen AM, Kooistra MP, van Jaarsveld BC: Cannulating in haemodialysis: Rope-ladder or buttonhole technique? *Nephrol Dial Transplant* 22: 2601–2604, 2007
9. van Loon MM, Goovaerts T, Kessels AG, van der Sande FM, Tordoir JH: Buttonhole needling of haemodialysis arteriovenous fistulae results in less complications and interventions compared to the rope-ladder technique. *Nephrol Dial Transplant* 25: 225–230, 2010
10. Labriola L, Crott R, Desmet C, André G, Jadoul M: Infectious complications following conversion to buttonhole cannulation of native arteriovenous fistulas: A quality improvement report. *Am J Kidney Dis* 57: 442–448, 2011
11. Nesrallah GE, Cuerden M, Wong JH, Pierratos A: Staphylococcus aureus bacteremia and buttonhole cannulation: Long-term safety and efficacy of mupirocin prophylaxis. *Clin J Am Soc Nephrol* 5: 1047–1053, 2010
12. Glerup R, Svensson M, Jensen JD, Christensen JH: Staphylococcus aureus bacteremia risk in hemodialysis patients using the buttonhole cannulation technique: A prospective Multicenter study. *Kidney Med* 1: 263–270, 2019
13. Gallieni M, Hollenbeck M, Inston N, Kumwenda M, Powell S, Tordoir J, Al Shakarchi J, Berger P, Bolignano D, Cassidy D, Chan TY, Dhondt A, Drechsler C, Ecder T, Finocchiaro P, Haller M, Hanko J, Heye S, Ibeas J, Jemcov T, Kershaw S, Khawaja A, Labriola L, Lomonte C, Malovrh M, Marti I, Monros A, Matthew S, McGrogan D, Meyer T, Mikros S, Nistor I, Planken N, Roca-Tey R, Ross R, Troxler M, van der Veer S, Vanholder R, Vermassen F, Welander G, Wilmsink T, Koobasi M, Fox J, Van Biesen W, Nagler E: Clinical practice guideline on peri- and postoperative care of arteriovenous fistulas and grafts for haemodialysis in adults. *Nephrol Dial Transplant* 34[Suppl 2]: ii1–ii42, 2019
14. Nesrallah GE: Pro: Buttonhole cannulation of arteriovenous fistulae. *Nephrol Dial Transplant* 31: 520–523, 2016
15. Sato S, Shinzato T, Sakai N, Ohkuri K, Sasaki M, Nakai S, Toma S: Deformity of buttonhole entry site Causes higher frequency of vascular access-related infection. *Contrib Nephrol* 186: 48–56, 2015
16. Béchade C, Goovaerts T, Cougnet P, Labriola L, Jadoul M, Goffin E: Buttonhole cannulation is not associated with more AVF infections in a low-care satellite dialysis unit: A long-term longitudinal study. *PLoS One* 10: e0142256, 2015
17. Hashmi A, Cheema MQ, Moss AH: Hemodialysis patients' experience with and attitudes toward the buttonhole technique for arteriovenous fistula cannulation. *Clin Nephrol* 74: 346–350, 2010
18. MacRae JM, Ahmed SB, Atkar R, Hemmelgarn BR: A randomized trial comparing buttonhole with rope ladder needling in conventional hemodialysis patients. *Clin J Am Soc Nephrol* 7: 1632–1638, 2012
19. Garg N, Kumar N: Buttonhole cannulation: The jury is still out. *Am J Kidney Dis* 64: 658, 2014
20. Huang SS, MacRae J, Ross D, Imtiaz R, Hollingsworth B, Nesrallah GE, Copland MA, McFarlane PA, Chan CT, Zimmerman D: Buttonhole versus stepladder cannulation for home hemodialysis: A Multicenter, randomized, pilot trial. *Clin J Am Soc Nephrol* 14: 403–410, 2019
21. Muir CA, Kotwal SS, Hawley CM, Polkinghorne K, Gallagher MP, Snelling P, Jardine MJ: Buttonhole cannulation and clinical outcomes in a home hemodialysis cohort and systematic review. *Clin J Am Soc Nephrol* 9: 110–119, 2014
22. Robb ME: The one thing clear about buttonholes, is that nothing is clear about buttonholes. *Kidney 360* 1: 1–2, 2020

See related debate, “Should Buttonhole Cannulation of Arteriovenous Fistulas Be Used? CON” and commentary, “Should Buttonhole Cannulation of Arteriovenous Fistulas Be Used? Moderator Commentary” on pages 322–325 and 326–329, respectively.