Arteriovenous fistula cannulation by buttonhole technique using dull needle

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This study was conducted at the Institute of Nephrology of Taubaté, city of Taubaté, São Paulo state.

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Abstract

Introduction: Cannulation of arteriovenous fistula (AVF) may be performed by the following techniques: area puncture, rope ladder, or buttonhole. The ideal technique has not yet been established. **Objective:** To assess the complications and difficulties of introducing the buttonhole (BH) technique for cannulation of AVF created with a native vein in a dialysis unit. **Methods:** Sixteen patients (mean age, 57 ± 14 years) undergoing hemodialysis for 63 ± 38 months were changed to BH AVF cannulation. In the phase of track formation cannulations were performed with sharp needles and, in the maintenance phase, with blunt needles. In both phases, patients were assessed for pain intensity on a 0 to 10 scale. **Results:** The number of HD sessions required for the track formation was 9.5 ± 1.5 and the number of sessions during the maintenance phase was 29.7 ± 0.8 per patient. During the 152 HD for the track formation, no significant complications occurred. During the 475 HD sessions using the BH technique and a blunt needle, the complications were as follows: resistance to cannulation (7.6%); cannulation using a sharp needle due to cannulator choice (5.7%); change from a blunt to a sharp needle during cannulation (4.2%); and local bleeding (0.8%). One patient required antibiotic therapy. The median pain intensity reported by the patients was four during the track formation, and two during cannulation with a blunt needle. The Kt/V values before and after changing the cannulation technique did not differ (1.48 ± 0.27 and 1.48 ± 0.23). **Conclusion:** The introduction of the BH technique with a blunt needle is technically easy, has few complications, reduces pain, and does not induce change in dialysis dose.

Keywords: dialysis; arteriovenous fistula; vascular fistula; peripheral catheterization

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Introduction

The ideal arteriovenous fistula (AVF) cannulation technique for patients undergoing chronic hemodialysis (HD) has not yet been established.[1,2] Repeated cannulations in circumscribed areas of AVF (area puncture technique) have been associated with aneurysmal dilatation in the sites of needle insertion and stenoses in adjacent areas. Such dilations and stenoses tend to progress and may affect the vascular access survival. When the cannulations are distributed along the entire extension of the vascular access (alternating punctures), small dilations tend to appear along their length, but without the development of aneurysmal dilatations.

More recently, the buttonhole technique has been introduced. In that method, after track formation, the needles are inserted in the AVF always in the orifice of the previous cannulation. Track formation requires variable time and depends on the ability of the cannulator, who should insert the needle always in the same site and with the same angulation. However, track formation involves several techniques and the ideal method has not been completely established.

This study describes the difficulties and complications for implementing the buttonhole AVF cannulation technique by using a blunt needle after track formation with a sharp needle at our dialysis service.

Material and Methods

Sixteen patients (mean age, 57 ± 14 years; eight males) undergoing HD for 63 ± 38 months were selected for AVF cannulation by use of the buttonhole technique. All patients had AVF created with the

cephalic vein, and five (31.2%) patients had diabetes mellitus. Their mean body mass index (BMI) was 23.4 ± 2.9 kg/m^2.

During track formation, the cannulations were always performed by the same nurse, using a 16G sharp needle (Nipro do Brasil, Brazil). Sites of AVF with aneurysmal dilatations were not selected for the track formation. After rigorous asepsis of the AVF with 0.5% chlorhexidine, if necessary, the crust of the previous cannulation was removed with the tip of a needle, which was then inserted in the fistula always following the same angulation. According to the protocol, the mean time predicted for track formation was nine HD sessions; however, the cannulator could reduce or increase that time based on his/her personal impression.

After the track formation, the patient began to be cannulated with a 16G blunt needle (Nipro do Brasil, Brazil), following the same instructions of the track formation phase. During the phase of buttonhole cannulation with a blunt needle, the cannulator was allowed to use a sharp needle for AVF cannulation depending on the resistance observed in the cannulation of the previous dialysis session. In addition, after beginning cannulation with a blunt needle, the cannulator could change to a sharp needle if a high resistance to needle insertion was observed. Such cannulations with a sharp needle were performed aiming at reestablishing the track with the least possible trauma. According to the protocol, the time established for using and assessing the buttonhole technique was 30 consecutive HD sessions. The complications observed by the cannulator were recorded on a specific sheet right after AVF cannulation.

During the track formation phase with a sharp needle and buttonhole cannulation with a blunt needle, the intensity of pain during fistula cannulation was assessed by use of a visual-numerical scale from 0 to 10. To enhance the patient's understanding and standardize the answer, the following was explained to the patient: a score from 0 to < 1 indicated no pain; between ≥ 1 and < 3, very little pain; between ≥ 3 and < 5, mild pain; between ≥ 5 and < 7, severe pain; between ≥ 7 and < 9, very severe pain; and from ≥ 9 to 10, unbearable pain. During the track formation phase, the pain scale was applied every three HD sessions, and, during the buttonhole phase, every five HD sessions.

All patients underwent three HD sessions per week, with a length of 3.5 to 4.0 hours. The treatment duration was individualized according to the urea kinetics model. During dialyses, blood flow ranged from 350 to 400 mL/min and the dialysate flow was 500 mL/min. The dialysate concentrations of sodium, potassium, calcium and bicarbonate were 137, 1.0, 3.0, and 36 mEq/L, respectively. The dialysate contained glucose at the concentration of 100 mg/dL. The dialysis filter used was high-flow polysulfone (Hemoflow HF80 series, Fresenius Medical Care - Germany). During the study, the dialysis prescription was not altered.

The HD dose was assessed by use of Kt/V according to the National Kidney Foundation recommendations.[3] The Kt/V values are the mean of the two months preceding buttonhole cannulation and the mean of the two (n = 6) or three (n = 10) months during buttonhole cannulation.

The results are shown like mean ± SD or median and 25 and 75 percentiles. The differences between the means were assessed by use of the paired Student *t* test. The significance level adopted was 5%. The software used for statistical analysis was GraphPad Prism, version 4.0 for Windows (GraphPad Software, San Diego, California USA).

Finally, all patients provided written informed consent, and the study protocol was approved by the Committee on Ethics of the institution.

Results

The mean number of HD sessions for track formation was 9.5 ± 1.5 sessions/patient. One patient required six HD sessions, ten patients required nine HD sessions, two patients required ten HD sessions, and three patients required 12 HD sessions. During the 152 sessions for track formation with a sharp needle, three patients had four bleeding episodes around the cannulation site during dialysis, and two patients had a bleeding episode in the cannulation site after dialysis.

The mean number of HD sessions using the buttonhole cannulation technique with a blunt needle was 29.7 ± 0.8 sessions/patient. One patient underwent 27 sessions, two patients underwent 29 sessions, and 13 patients reached the goal established in the protocol, 30 HD sessions. During the 475 HD sessions with the buttonhole cannulation, the following complications were observed: resistance in at least one of the cannulation needles in 36 HD sessions (7.6%); the cannulator changed to a sharp needle before beginning cannulation in at least one of the cannulations in 27 HD sessions (5.7%); change, during cannulation, from a blunt to a sharp needle in at least one of the cannulations in 20 HD sessions (4.2%); bleeding around

the needle in four HD sessions (0.8%). One patient received prophylactic antibiotic therapy because of hyperemia at the buttonhole cannulation site.

During the track formation phase with a sharp needle, the median of the pain intensity index was 4, and 2 and 4 were the 25 and 75 percentiles, respectively. During the buttonhole cannulation phase with a blunt needle, the median of the pain intensity index was 2, and 0 and 4 were the 25 and 75 percentiles, respectively (Figure 1).

Figure 2 shows the AVF cannulation sites in two patients in the buttonhole cannulation phase with a blunt needle.

Finally, the Kt/V values before and after changing the cannulation technique were not statistically different (1.48 ± 0.27 versus 1.45 ± 0.23, respectively).

Discussion

So far, there is no universally accepted method for AVF cannulation. Most authors recommend changing the cannulation site every dialysis session. This would allow better healing of the cannulation wound and reduce complications, such as hematoma, dilatation, stenosis, infection, and pseudoaneurysm formation.

The constant site AVF cannulation technique was described by Twardowski *et al.* in 1977, in an article in Polish.[4] Two years later, the same group published a new study comparing the different sites cannulation technique with the constant site cannulation technique.[5] In that study, 16 patients were assessed during six months, and the cannulations were performed with sharp needles. The authors concluded that needle insertion in the same site was easier, faster, and less painful for the patient. In addition, it was associated with fewer complications, such as miscannulation and hematomas, and the frequency of local infection was not higher than that observed with the different sites cannulation technique.

Despite the favorable results reported by Twardowski *et al.*, the technique did not thrive until home HD and daily HD programs became more frequent. From then on, the new interest in the buttonhole technique resulted in its development and improvement.[6-9]

The wider use of the buttonhole technique allowed the recognition of some fundamental aspects for its success, the most important of which seems to be the track formation by a single professional skilled in AVF cannulation. The technique has been boosted with the introduction of blunt needles. As such needles are less sharp and cause less trauma, a reduction in

Figure 1. Intensity of pain during a buttonhole arteriovenous fistula cannulation with a sharp needle to the track formation and with a blunt needle to the technique maintenance.

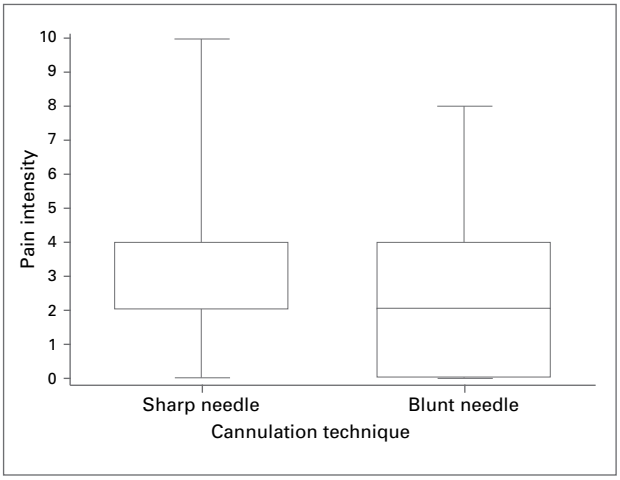
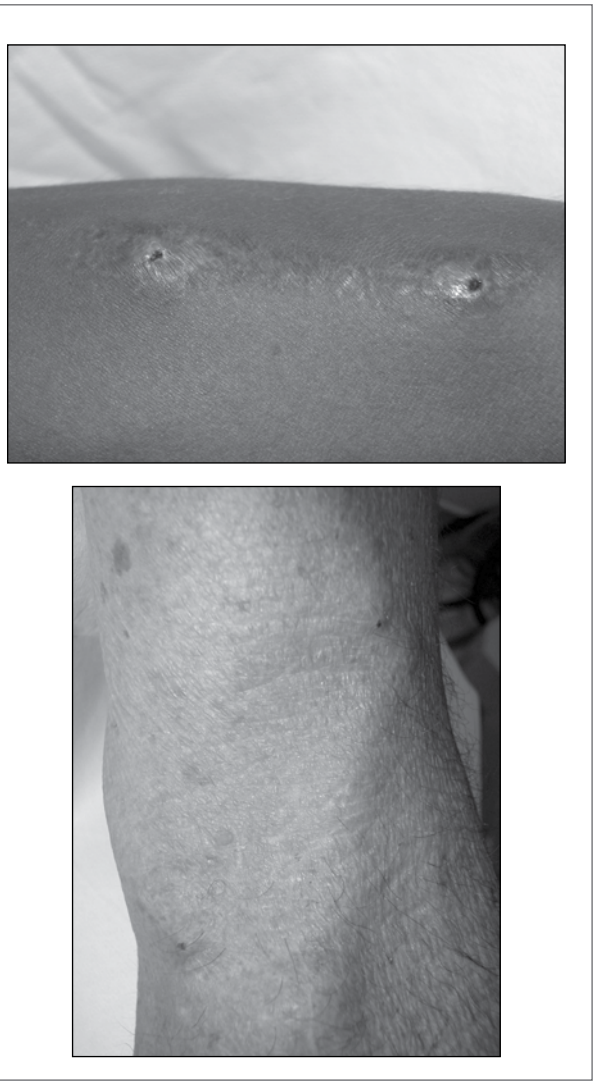


Figure 2. Puncture orifice of two arteriovenous fistulae in the maintenance phase of the buttonhole cannulation with a blunt needle.



the appearance of lacerations and of multiple tracks occurs, thus decreasing the risk of bleeding around the needles during HD sessions.[6] From that point on the new technique has gained more interest and acceptance.

Because the track formation is one of the most important aspects of the buttonhole technique, Toma *et al.* have described a method that uses a polycarbonate device to maintain the track permeability between cannulations[10]. However, the experience with the buttonhole cannulation method has shown that such a device is not necessary, because the success of the technique is more strongly dependent on the track formation by a single cannulator.

On average, track formation takes three to four weeks.[9] From that point on, other cannulators can perform the procedure, and the major requirement is the maintenance of the track through needle insertion always at the same penetration angle.

This study describes our experience during the introduction of the buttonhole cannulation technique in our dialysis unit. Initially, three nursing professionals were selected for track formation with sharp needles. In that phase, each cannulator was responsible for cannulating the same patient.

As described in other studies involving patients undergoing HD three times a week,[9] in our study, the mean time for track formation was nine HD sessions. After that, the cannulators began exchanging experience between themselves, and, after knowing the exact angle of needle insertion, they could take turns in cannulating the patients participating in the study.

Our results have shown that, during the phase of the track formation and maintenance, no serious complications occurred. However, our study had no control group for comparisons. One of the greatest barriers to overcome was that cannulations with blunt needles sometimes require greater force for needle insertion. Although the patients reported no pain, that generated anxiety in the cannulators, who, sometimes initiated cannulation with a sharp needle or changed from a blunt to a sharp needle during the procedure. The objective was to reestablish the track.

Another aspect that deserved consideration in our study was the way of manipulating the crust of the previous cannulation. Considering that our patients undergo dialysis three times a week, the crusts were often eliminated in the time interval between HD sessions or were easily removed during the process of AVF asepsis. When that did not occur, the nursing professional removed the crust with the tip of the cannulation needle, after rigorous and long asepsis with 0.5% chlorhexidine. Only one patient developed hyperemia in the cannulation site in the buttonhole phase. Nevertheless, the technique was not interrupted.

In accordance with the results of other studies,[5,9] we observed that the intensity of pain caused by buttonhole cannulation was lower than that observed in cannulation with a sharp needle in the track formation phase. Because of the lack of a control group, comparisons with the area puncture technique or rope-ladder technique could not be performed. However, after the end of the study, some patients asked to continue with the buttonhole cannulation technique. The major reason for some patients returning to the traditional AVF cannulation techniques was the delay in starting cannulation with the buttonhole technique, because of the reduced number of professionals trained for the procedure. This caused discomfort to patients, but can be modified by introducing a new concept in the dialysis unit.

One aspect approached in our study but not in others was that, with adequate choice of cannulation sites, the buttonhole technique does not imply a variation in the dialysis dose quantified by Kt/V. It is worth emphasizing that the buttonhole cannulation technique does not correct blood flow problems in the vascular access. Thus, the recommendations for the other AVF cannulation techniques remain valid when using the buttonhole technique.

Finally, our study was not performed to analyze possible limitations of the buttonhole cannulation technique, but the experience acquired allows us to infer occasional restrictions to the use of that cannulation method. The buttonhole technique can be difficult in excessively obese patients, because of the thickness of their adipose tissue and depth of their vascular access. On the other hand, in excessively undernourished patients, the lack of adipose tissue can increase vein mobility, jeopardizing the track maintenance. In our study, we faced no difficulties associated with obesity and malnutrition, because those conditions were considered at the time of patients' selection for the study.

If the buttonhole cannulation technique should be used in a recently formed AVF, or in fistulae with longer time of use, is yet to be established. In our opinion, for candidates to that type of cannulation, the earlier the beginning of the technique, the better, because the zones of fibrosis in the skin, in the subcutaneous tissue, and in the venous wall will be smaller and the possibility of forming an adequate track, greater. We believe that for long-term AVF, when changing to the buttonhole technique, regions of the fistula with no

aneurysmal dilatations should be sought. In our study, despite the long use of AVF, that difficulty was not found, because that was one of the criteria for choosing the site for the track formation. We believe that, during AVF cannulation in a dilatation zone, the intensity of compression for venous engorgement can misalign the track, jeopardizing the maintenance of the technique.

In conclusion, our results show that for selected patients, changing from AVF cannulation to the buttonhole technique is easy, safe, and is associated with a reduction in pain during cannulation. Further studies are required to confirm and expand our observations.

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