Initial experience with the buttonhole technique in a Brazilian hemodialysis center

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The present study was conducted at the Instituto do Rim de Marília/Santa Casa de Misericórdia de Marília, Marília, São Paulo.

We declare no conflict of interest.

Abstract

Introduction: The most commonly used technique of arteriovenous fistula cannulation for hemodialysis is the rope-ladder technique with alternation of the cannulation site. An alternative technique, the buttonhole (BH) technique, has become popular because its constant cannulation sites are advantageous for patients with special characteristics. **Objective:** To assess the initial experience of our service with the BH technique and determine its usefulness. **Patients and Methods:** Twenty-one patients with short, tortuous, painful fistulae of difficult cannulation were submitted to the BH technique for the first time using appropriate needles. **Results:** Neither bleeding nor hematoma were observed during or after hemodialysis. Some patients (15%) reported little or no pain. Two (9.5%) arteriovenous fistulae were lost, and 47.6% of the patients developed fistula clotting at some point in the study, both situations related to change in cannulators. One patient had a paravertebral abscess, possibly originating from the arteriovenous fistula. **Discussion and Conclusion:** The advantages of reducing pain, miscannulation, and hematoma incidence were counterbalanced by an increased risk of infection and loss of vascular access, due to noncompliance with the technique or involvement of more than one cannulator. The BH technique is useful for selected patients.

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

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Introduction

The rope-ladder (RL) technique is the traditional vascular access cannulation technique for hemodialysis in Brazil. That technique consists in alternating cannulation sites to prevent the formation of aneurysms and stenoses due to repetitive trauma to the vascular wall.[1-7] More recently, the adoption of an alternative technique in which the cannulation site is constant, the buttonhole (BH) technique, has been encouraged in our country. Unlike the first technique, the BH technique tends not to damage the endothelium, because it uses a blunt needle inserted through a previously formed track. The BH technique, described by Twardowsky *et al*. in 1977, was used initially for patients with short arteriovenous fistula (AVF) lengths and severe pain due to alternate cannulations and, later, for self-cannulation of patients undergoing home hemodialysis. [7-15] Currently, the introduction of daily hemodialysis and the consequent increase in the number of cannulations per week can represent an additional indication for the BH technique, although some studies have shown that a greater number of cannulations per week does not necessarily relate to a reduction in vascular access survival.[9]

Aiming at assessing the usefulness and efficacy of the BH technique in daily clinical practice, a protocol for creating and cannulating AVF according to the BH technique has been introduced in our service.

Materials and Methods

The present observational and prospective study was conducted from 11/17/2008 to 05/17/2009. Of the 164 patients participating in the program of regular

hemodialysis at the Santa Casa de Misericórdia de Marília, in the state of São Paulo, 21 patients were selected to this study as follows: nine (42.9%) patients with very short or tortuous or aneurysm-related AVF; eight (30.1%) patients with difficult cannulation and tendency towards hematoma formation; and four (19.0%) patients reporting severe pain when cannulated. Patients with the following characteristics were not admitted to the study: vascular prosthesis; increased venous pressure due to AVF stenosis; poor personal hygiene; cutaneous infections; and fistulae with skin instability during cannulation that could jeopardize track formation.[15]

The study protocol was approved by the Committee on Ethics and Research involving human beings of the Medical School of Marília, under protocol number 537/08. All patients selected agreed to participate in the study after signing an informed written consent. The characteristics of the patients selected are shown in Table 1.

Only one patient started hemodialysis according to the BH technique while the others (by the time they entered the study) had already undergone cannulation according to the RL technique for a mean time period of 24 months (patients with very short or tortuous AVF or difficult cannulation) or of 60 months (patients with very painful AVF). The anatomical locations of the AVF are shown in Table 2.

Three nurses specialized in nephrology and with mean 10-year experience with the RL technique were assigned for track formation according to the BH technique. The tunnel tracks were formed by using sharp needles with backeye in accordance with Ball's description.[11] Each nurse always cannulated the same patient in an attempt to avoid imperfections in track formation due to different angles at each cannulation. Insertion angles were measured with the aid of a plastic protractor. Damaged skin areas; areas with hematomas; and cannulation of an intraaneurysm thrombus were avoided. Only one pair of tracks per AVF was created, and no anesthetic agent was ever used.[16] The pairs of tracks were always formed following the direction of blood flow, so that the arterial track was never cannulated in the opposite flow direction. After track formation, estimated to occur between the eighth and twelfth cannulation, initial cannulation with blunt needles and backeye was performed by the same nurse who had formed the tracks. After ensuring that cannulations were functioning perfectly, those nurses trained nurse assistants for the procedure.

Skin preparation for cannulation was performed by using saline solution to aid with the removal of the crust formed in the previous cannulation, followed by topical application of 70% ethyl alcohol according to the following technique:

1. Application of a gauze dressing soaked in saline solution for two minutes, followed by application of 70% ethyl alcohol;
2. Removal of the crust by use of sterile, nontraumatic, sharp-tip forceps;
3. Reapplication of 70% ethyl alcohol;
4. Natural drying;
5. Tourniquet application;
6. Vascular access cannulation.

Removal of the crust with the aid of the cannulation needle itself or other needles or cutting instruments were not allowed in order to prevent skin trauma, crust fragmentation, and track contamination. All patients were instructed not to remove the crust by themselves before arriving at the dialysis unit.[17]

The following parameters were recorded: blood flow according to vascular access type (radiocephalic, ulnar, brachiocephalic, brachiobasilic); bleeding during and after hemodialysis; compression time required for the vascular access; pain intensity measured according to a subjective pain scale from 0 to 10 (0 = no pain; 10 = extreme pain) for each site; infections; hematomas; preparation time for cannulation; difficulty in performing cannulation according to a scale (easy, moderate, difficult); venous and arterial blood pressure at a 200 mL/minute blood flow.

The mean dose of heparin was 128 ± 21.4 IU/kg, 50% being administered as bolus in the priming solution and the remaining by use of an infusion pump until the last half hour of the hemodialysis session (Table 1).

Statistical analyses comprised the Chi-square test, and a significance value of $p < 0.05$ was adopted.

Results

The 21 patients studied underwent a total of 2,946 cannulations, and 16 completed the observation period, totaling 152 cannulations each. Two patients (undergoing 100 and 38 cannulations each) left the study because of death not related to vascular access. Two other patients (144 and 142 cannulations each) left the study because of vascular access loss related to complications of the BH technique (one because of thrombophlebitis and another because of thrombophlebitis with infection, both related to trauma of the vascular wall). One patient with 90 cannulations left the study because of kidney transplantation.

Table 1 General characteristics of the selected patients

Pt	Age (years)	Sex (M/F)	CC (Y/N)	HD/T (years)	AVF/T (mounths)	Heparin (IU/kg)	Tab (Y/N)	PAa (Y/N)	Reuse (times)	UD
1	56	M		4	48	150	N	Y	19	DM
2	50	F	N	14	36	125	N	N	18	SAH
3	63	M		4	60	136	N	Y	16	DM
4	41	M		2	2	85	N	Y	16	SAH
5	55	M		5	60	121	N	N	18	CGN
6	56	M		1.5	36	129	N	N	18	CTIN
7	64	F	N	2	36	122	Y	N	15	SAH
8	45	M		5	48	116	N	N	18	CGN
9	40	M		11	136	120	Y	N	19	CGN
10	39	F	Y	7	24	131	Y	Y	13	SAH
11	47	F	N	5	36	197	Y	N	18	ADPKD
12	57	F	N	2	36	115	N	Y	10	ADPKD
13	52	F	N	4	48	112	Y	Y	18	DM
14	63	F	N	3	24	98	N	N	19	SAH
15	68	F	N	4	60	128	N	N	10	DM
16	57	M		2	60	139	Y	Y	15	SAH
17	45	M		5	60	142	N	N	18	CGN
18	63	M		6	24	130	N	N	18	DM
19	40	F	N	1	24	134	N	Y	18	CGN
20	51	M		2	24	134	N	N	18	DM
21	51	F	N	8	72	125	N	N	12	DM
	52.5 ± 8.8 mean	52.4 / 47,6 %	10.0 / 90,0 %	4.6 ± 3.2 mean	45.4 ± 27 mean	128 ± 21.4 mean	28,6 / 71.4 %	38.1 / 61.9 %	16.4 ± 2.9 mean	

PAa = platelet antiaggregating agent; CC = contraceptive; UD = underlying disease; DM = diabetes mellitus; ADPKD = autosomal dominant polycystic kidney disease; CGN = chronic glomerulonephritis; SAH = systemic arterial hypertension; kg = kilogram; M = male; F = female; N = No; CTIN = chronic tubulo-interstitial nephritis; Pt = patient; Y = Yes; Tab = Tobacco use; AVF/T = time with arteriovenous fistula; HD/T = time in hemodialysis; IU = international units.

Table 2 Anatomical location of the AVF

AVF	n	%
Radiocephalic	10	47.6%
Brachiocephalic	9	42.9%
Ulnar	1	4.8%
Brachiobasilic	1	4.8%

AVF = arteriovenous fistula; n = absolute number.

The mean preparation time for cannulation comprised two minutes for crust humidification, one minute for crust removal, and one minute for AVF cannulation adding up to four minutes.

The mean number of cannulations reported in the literature for track formation is eight to ten for nondiabetic patients and 12 for diabetic patients.[7-9,15,18] During track formation, perfect insertion of blunt needles was not feasible between the eighth and twelfth cannulation. Thus, the use of blunt needles was reprogrammed from the thirteenth cannulation on, regardless of the etiology of the chronic kidney disease.

Cannulation was considered easy with both blunt and sharp needles for all patients. However, out of a total of 42 cannulation sites, resistance to insertion of the blunt needle was observed in nine sites (21.4%), but such resistance did not relate to patient's age, type of disease, cannulator, type of fistula, and clot formation.

The pain intensity reported at the beginning of the study was minimum or even absent in 15% of the patients (Table 3). Throughout the study, that percentage progressively increased (Figure 1).

A minimum blood flow of 300 mL/minute was obtained in all AVF, regardless of their anatomical locations. The mean venous and arterial blood pressures observed at 200 mL/minute blood flow were 100 mmHg and 150 mmHg, respectively.

The mean compression time for hemostasis was two minutes. No patient showed hematomas or bleeding during or after dialysis in the observation period. However, ten patients (47.6%) developed fistula clotting at some point in the study and that did not relate to gender [relative risk (RR) 0.63; confidence interval (CI) 0.21-1.52; p = 0.39), contraceptive use (6/10 with clots, one using contraceptive), tobacco use (RR 1.4; 95% CI: 0.35-5.56; p = 0.66), platelet antiaggregating agent use (RR: 1.8; 95% CI: 0.58-5.78 p = 0.39), nor to the number of times dialyzers were reused. For all those patients, the clots developed after changing the cannulator, and only two patients were on a heparin dose below the mean.

Infection was observed in two patients (9.5%): one had direct infection from the fistula and the other had sepsis due to coagulase-negative *Staphylococcus* spp., with a paravertebral abscess possibly related to hematogenous inoculation via AVF.

Discussion

The experience with the BH technique provided some information to the medical and nurse team.

The time for preparation and vascular access cannulation did not delay the process, because while skin was being prepared, the nurses were busy cannulating other patients at the same dialysis shift.

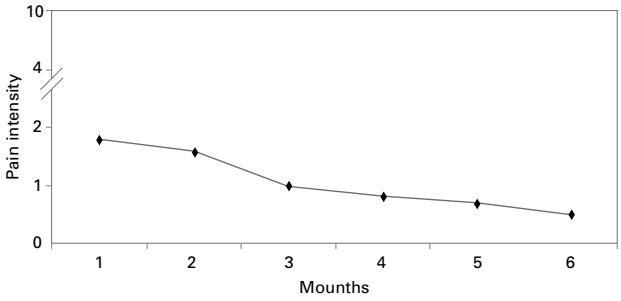
Unlike what is reported in the literature, neither hemorrhage during or after dialysis, nor an increase in compression time for hemostasis were observed even considering that the observation period may not have been sufficiently long for that.[9,18,19] In addition, the heparin dose used may not have been large enough for the manifestation of those hemorrhagic events.

Table 3 Pain intensity when using the BH technique

Pain scale		%
0	(no pain)	15
1		80
2		4
3		1
4 to 10		0

BH: *buttonhole*.

Figure 1. Evolution of pain over time at cannulation by use of the BH technique.



Scale from 0 (no pain) to 10 (maximum pain). From the fourth month on, statistical significance is achieved.

However, in our service, we have not found a high incidence of fistula clotting when using the RL technique, or of clotting in extracorporeal systems, suggesting that the mean heparinization dose was adequate.

Miscannulation and consequent hematoma formation, known to increase morbidity and decrease AVF survival, were rarely observed.[8,11,14,18,20-27]

In addition, partial and even complete elimination of pain was observed in some patients with longer AVF use. Some patients were so satisfied with the technique that they even asked not to go back to the RL technique.[7,9-11,14,27]

The loss of two accesses (9.5%) due to complications was considered high, as was the occurrence of clots in 47.6% of the patients. However, such intercurrences resulted mainly from the change in cannulator and did not relate to the use of tobacco, contraceptives, and platelet antiaggregating agents, nor to any difficulty in tunnel track formation.[19] Although track formation and subsequent cannulations were performed by the same nurse, the moment of changing the cannulator was critical for the process and should be optimized to minimize vascular access loss. Currently, the increasing number of patients undergoing hemodialysis and the different shifts of the nurse teams necessarily result in a single patient being cared for by more than one cannulator, making it into a potential limitation of the technique. Ideally, cannulation should be always performed by the same person; however, if more than one person should be required, that number should be minimized to reduce access loss.

As reported in the literature, regarding the risks of infection, such as endocarditis and sepsis,[9,15,18,19,28] our case of paravertebral abscess due to the possible hematogenous dissemination from the vascular access emphasizes the need for reinforced surveillance regarding antisepsis by the health care team.

In addition to the lack of a control group undergoing the RL technique, further limitations to this study include the fact that almost all fistulae have been previously cannulated according to the RL technique and already had special characteristics by the time the study began.[7,9,14,29] Furthermore, that was the first time the BH technique was used in our service and the cannulator-dependent factor should not be underestimated because the nurses were highly skilled, but only in the RL technique. In addition, it is worth stressing the small number of patients and short period of observation, limiting the analytical power of the study.

Conclusion

From our point of view, the buttonhole technique can be useful for some vascular accesses with special characteristics, mainly the short, very tortuous, and deep ones. It is also useful for minimizing the pain of hypersensitive patients, as long as observing a rigid protocol of track formation, antisepsis, and maintenance of a limited number of cannulators used to a certain vascular access.

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