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ORIGINAL ARTICLE

Vascular access cannulation and haemostasis: a national observational study of French practices

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ABSTRACT

Background. We report the results of an observational study of arteriovenous fistula (AVF) cannulation and haemostasis practices in France.

Methods. The study (sponsored by Brothier Pharmaceutical Inc.) was conducted in 150 dialysis units. Data obtained from 150 supervisory nurses, 1538 nurses and 3588 patients with an AVF were analysed.

Results. The nurses reported using rope-ladder, area or buttonhole cannulation techniques in 68, 26 and 6% of cases, respectively. Metal needles were used most frequently (64%), with mainly a diameter of 15 G or 16 G. The needle was introduced with the bevel up in 56% of cases. Compression applied using dressings (in particular, pure calcium alginate dressings) was the method of choice for haemostasis of the puncture sites and was assessed as being strong by most of the nurses and very strong in cases of prolonged bleeding. Most (82%) of the patients reported the use of local anaesthetic before cannulation and 23% reported an allergic skin reaction to the anaesthetic. Bleeding of the puncture sites lasted for >10 min for 48% of the patients and it reappeared between two sessions for 29% of the patients. Whereas the nurses appeared to have a good understanding of AVF, more than half of the patients did not know how to care for it, with 55% requiring more information.

Conclusions. This study underlines the lack of national consensus concerning AVF cannulation practices. It suggests that haemostasis methods of the puncture sites can be improved and it highlights the need to improve patient knowledge.

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Keywords: arteriovenous fistula, cannulation, catheter, dialysis, haemodialysis, haemostasis, vascular access

INTRODUCTION

International guidelines state that a native arteriovenous fistula (AVF) is the method of choice for vascular access in haemodialysis [1]. Awareness campaigns have been conducted to increase the use of this type of vascular access, especially in the USA (e.g. Fistula First Breakthrough Initiative). According to the Renal Epidemiology and Information Network (REIN) registry, a native AVF is the method used for vascular access in 78% of patients in France [2]. The native AVF is associated with an increased survival of patients compared with central venous catheters or AVF grafts [3]. Furthermore, the risk of infection [4] and cost [5] of the native AVF are lower. Complications of native AVFs include thrombosis, stenosis, aneurysm and infection [6], possibly leading to the loss of vascular access. Between 15 and 30% of AVFs last for <1 year [7, 8]. Maintaining patency is essential and requires limiting trauma to the AVF during the cannulation and compression processes in haemodialysis sessions. While some guidelines are available for AVF cannulation, there are few related to compression or haemostasis. Moreover, there are no recent data on the AVF techniques used in haemodialysis units on a large scale.

Here we report data obtained in an observational study of native AVFs conducted nationwide in France with supervisory nurses, nurses and patients. This study investigated the practices of cannulation and haemostasis and also the knowledge of nurses and patients concerning maintenance of a reliable AVF.

MATERIALS AND METHODS

This observational study was sponsored by Brothier Pharmaceutical Inc. (Nanterre, France) and authorized by French regulatory institutions (National Commission for Data Protection and Liberties and Committee on the Processing of Research Information). The following three questionnaires were filled out anonymously: a 'supervisory nurse questionnaire' intended for supervisory nurses and concerned with the organization of the unit, the staff and training organized for nurses; a 'nurse questionnaire' intended for nurses and concerned with the AVF cannulation technique and the haemostasis technique used after needle withdrawal and a 'patient questionnaire' intended for patients and concerned with the history of their AVF and with their understanding of how to protect the AVF.

The study was conducted from November 2015 to June 2016 in 150 renal dialysis units. The units were selected by Brothier medical representatives according to a random schedule of the units they usually visit. Agreement of the head of each department to participate in the study was obtained. During a scheduled meeting in each unit, one supervisory nurse questionnaire and several nurse questionnaires were completed. During a second meeting, several patient questionnaires were given to the nurses for the inclusion of haemodialysis patients >18 years of age and who had a native AVF, were able to complete the questionnaire and had given their oral consent. Nurses were asked about their most-used practices and not practices per patient included in the study. The supervisory nurse sent all of the completed questionnaires to a contract research organization for data management and statistical analyses (Gecem, Montrouge, France).

Multiple answers given to single-choice questions and incoherent answers have been cleaned and pooled with missing data for the statistical analysis. All free texts were reviewed and classified in consultation with the scientific committee. SAS software (version 9.3; SAS Institute, Cary, NC, USA) was used for the data analysis. Descriptive analysis was used for quantitative variables (numbers of data collected, missing data, mean, standard deviation, median and range values) and for qualitative variables (numbers of data collected and missing data, number and percentage values for each type of response and percentages of the data collected).

RESULTS

All ($n = 150$) supervisory nurses in the 150 renal dialysis units responded to the questionnaires. The ratios of administrative status of renal dialysis units and types of renal dialysis units were close to the national data (Table 1) [9]. The units were distributed throughout France, with most (38%) being in the southeast and the fewest (2%) being in the southwest. A median of 19 nurses (range 4–56) in each unit treated a median of 93 patients (range 23–390) each week. The 1538 nurses who responded to the questionnaires had a median of 6 years of working experience in haemodialysis (range 0–41 years).

The AVF clinical examinations performed by a nurse during the session appeared to be standardized by using palpation, examination of the skin and previous puncture sites. The arm elevation test was never performed by 33.5% of nurses, was performed by 44% when there was an AVF abnormality and always by only 6.5% of nurses. Cannulation was most commonly performed using metal needles (in 64% of cases) or fistula catheters (in 35%) (Table 2). Needle sizes of 15 G and 16 G were the most common (Table 2) and >90% of nurses used needles with a bevel indicator. The rope-ladder technique was most frequently used by the nurses, followed by the area technique (Table 2). Multiple AVF cannulation techniques could be used in the same dialysis unit. The buttonhole technique was used, exclusively or not, in 13% of all participating units and exclusively by only 3.4% of all participating units. Cannulation with the bevel of the needle facing upwards was used by 56% of nurses. The nurses

Table 1. Characteristics of the renal dialysis units

Renal dialysis unit	Study data	National data[a]
Administrative status (%)		
Public unit	50.0	46.5
Private unit	31.0	36.5
Association unit[b]	19.0	17.0
Type of units (%)		
Haemodialysis centre[c]	51.0	47.0
Unit with medical supervision[d]	31.0	34.0
Self-care dialysis unit[e]	18.0	16.0

[a]Data from France [9].
[b]Declared in association by the law in France.
[c]Renal dialysis unit treating patients with multiple chronic diseases requiring the constant presence of a nephrologist during dialysis sessions.
[d]Renal dialysis unit treating patients requiring care from nurses (but not necessarily nephrologists) for all dialysis procedures.
[e]Renal dialysis unit treating patients trained in the dialysis procedures, with the presence of a nurse only required to monitor the dialysis session.

who performed cannulation with the bevel upwards were three times more likely to do a 180-degree needle rotation than were the nurses who performed cannulation with the bevel facing downward. The final position was with the bevel facing downward for 69% of nurses (Table 2). The needle placement in the direction of the blood flow (antegrade) for an arterial needle was preferred by 89% of nurses (Table 2).

The duration of bleeding after needle withdrawal was assessed at each session by 86% of nurses. The duration was reported on the dialysis sheet by 68% of nurses, with only 24% of them recording if there was an abnormality, the most frequent of which was an excessive bleeding duration.

In most cases compression was performed manually with a dressing (Table 3). The nurses could also use a gloved finger or mechanical compression devices such as bracelets, clips and tourniquets, with 19% and 27% of nurses using multiple methods if the bleeding lasted for up to 10 min and >10 min, respectively. For bleeding lasting up to 10 min, pure calcium alginate dressing (in particular Coalgan/CoalganH, Brothier Pharmaceutical Inc.) was used in 48% of cases while gauze was used in 47%. For bleeding lasting >10 min, 92% of nurses chose pure calcium alginate dressings (Table 4). For bleeding lasting up to 10 min, AVF compression force after needle withdrawal was considered by the nurses themselves as strong (77%) and very strong (1%). The proportion of nurses applying very strong pressure increased to 15% if the bleeding became prolonged. Most patients estimated the applied compression as being strong or very strong (Table 5). The compression was applied most often by the nurses or by patients and the nurses' involvement increased for bleeding exceeding 10 min. A high proportion of patients was asked to perform compression (Table 5). After compression, dressings were applied in 95.5% of patients across almost all of the units.

The three main signs indicating that AVF integrity was at risk as reported by nurses were thrill abnormalities, local signs of infection and problems with pressure and flow rate. An exclusive in-house training of nurses about vascular access was performed in 42% of the units, mostly by senior nurses. In the other units, this training was performed both in-house and by external contractors. Information to increase patient awareness of the need to protect their AVF was given regularly by 64% of nurses and occasionally by 35% of them.

There were 3588 patients included in 146 units, with a mean of 25 (standard deviation 16) patients per unit and 94% of the units including at least 10 patients. Most (61%) of the patients were male, with a median age of 70 years (range 18–97) and 38% were >75 years. The median duration of dialysis was 4 years (range 0–46). The AVF position was radial in 66% and brachial in 34%. The median longevity of the AVF was 3 years (range 0–44). For 27% of patients it was the second AVF, while 50% of patients reported that they underwent surgical revision of their AVF at least once. Daily treatment with anticoagulant or platelet antiaggregant was reported by 61% of patients.

Table 2. Puncture needles and techniques (most frequently used)

	N	1538
Needle type	Missing or deleted data ($n = 16$)[a]	39
	Rigid metal needles	964 (64.3)
	Blunt needles	12 (0.8)
	Fistula catheters	523 (34.9)
Needle size	Missing or deleted data ($n = 239$)[a]	244
	14 G	99 (7.6)
	15 G	472 (36.5)
	16 G	613 (47.4)
	17 G	109 (8.4)
	18 G	1 (0.1)
Technique	Missing or deleted data ($n = 74$)[a]	82
	Rope-ladder	984 (67.6)
	Area	384 (26.4)
	Buttonhole	88 (6.0)
Bevel position and rotation of needles[b]	Missing or deleted data ($n = 6$)[a]	9
	Upon introduction: upwards	797 (55.6)
	downwards	637 (44.4)
	Missing data	14
	180-degree rotation	614 (43.0)
	Missing data	22
	During dialysis: upwards	446 (31.4)
	downwards	975 (68.6)

Data are *n* (%) values.
[a]Deleted data that correspond to multiple replies given to a single-choice question:
[b]Nurses who only use fistula catheters were not included in the pooled data analysed for this question.

Table 3. Method of controlling bleeding reported by nurses

Method[a]	Bleeding ≤10 min	Bleeding >10 min
n	1538	1538
Missing data	9	20
Dressing	1356 (88.7)	1279 (84.3)
Gloved finger	299 (19.6)	523 (34.5)
Mechanical compression device	194 (12.7)	200 (13.2)

Data are *n* (%) values.
[a]Some nurses checked multiple responses.

Table 4. Dressings listed by nurses

	Bleeding ≤10 min	Bleeding >10 min
Dressing[a]		
n[b]	1356	1279
Missing data	113	70
Coalgan/Coalgan H (calcium alginate)	592 (47.7)	789 (65.3)
Gauze (cotton)	591 (47.5)	161 (13.3)
Algostéril (calcium alginate)	80 (6.4)	286 (23.7)
Iris (transparent microperforated adhesive strip)	40 (3.2)	58 (4.8)
Pushban (cellulose sponge pad on an adhesive strip)	27 (2.2)	54 (4.5)
Tipstop (lyophilised alginate onto a polyamide pad on adhesive film)	27 (2.2)	23 (1.9)
Kendall alginate (calcium alginate)	15 (1.2)	39 (3.2)
Pangen (collagen)	10 (0.8)	67 (5.5)
Surgicel (oxidised regenerated cellulose)	3 (0.2)	37 (3.1)
Other	49 (3.9)	89 (7.4)

Data are *n* (%) values.
[a]Free field: some nurses named multiple dressings.
[b]Nurses who indicated that they used the dressings.

Table 5. Compression forces and who applied them

	Nurse		
	Bleeding ≤10 min	Bleeding >10 min	Patient
n	1538	1538	
Compression force			
Missing or deleted data[a]	182	221	61
Very strong	17 (1.3)	200 (15.2)	274 (7.8)
Strong	1047 (77.2)	983 (74.6)	2372 (67.3)
Weak	291 (21.5)	131 (9.9)	859 (24.4)
None	1 (0.1)	3 (0.2)	22 (0.6)
Who applied the compression[b]			
Missing data	10	31	8
Nurse	920 (60.2)	1160 (77.0)	776 (21.7)
Patient	1141 (74.7)	689 (45.7)	2519 (70.4)
Nursing aide	365 (23.9)	457 (30.3)	113 (3.2)
Mechanical compression device	311 (20.4)	317 (21.0)	311 (8.7)

Data are *n* (%) values.
[a]Data deleted ($n = 141$ and 15 for bleeding ≤10 and >10 min, respectively) correspond to multiple responses given for this single-choice question.
[b]Nurses checked multiple responses.

Table 6. Characteristics of the bleeding at the puncture sites according to patients

n	3588
Bleeding ≥10 min after needle withdrawal	
Missing data	35
Always	1288 (36.2)
Often	596 (16.8)
Sometimes	760 (21.4)
Never	909 (25.6)
Bleeding at the puncture sites between two sessions	
Missing data	14
Never	2522 (70.6)
Sometimes	1000 (28.0)
Often	47 (1.3)
Always	5 (0.1)

Data are *n* (%) values.

Little or no apprehension about the cannulation was reported by 87% of patients. Eighty-two percent had already received local anaesthetics, of whom 24% stated that they experienced an allergic reaction to the anaesthetics. A substantial number of patients (36%) estimated that their bleeding lasts >10 min after needle withdrawal. However, they stated that the duration of bleeding from the AVF was either hardly (20%) or not at all (72%) a cause of anxiety (Table 6). Twenty-eight percent of patients indicated that they experienced bleeding from their AVF between two sessions (Table 6).

With respect to the knowledge of the patients, 59% were not aware of any sign indicating that the AVF was in jeopardy and 55% of patients declared that they did not perform any actions to protect their AVF (Table 7). However, 45% of patients stated that they wanted more information about their AVF.

DISCUSSION

The characteristics of this study population were similar to those reported in the REIN 2017 registry, for which the median age was 71 years [2]. These populations are therefore characterized by being elderly with a known fragility of their vascular access.

There is a dearth of epidemiological data in the literature on AVF cannulation methods. An international cross-sectional survey [10] conducted in 171 renal dialysis units, which included nearly 7000 patients (mean age 63 years) found that the area, rope-ladder and buttonhole techniques were used in 66, 28 and 6% of cases, respectively. In contrast, the rope-ladder technique was the most common in the present study. This difference may be explained by the data being collected in the present study using a questionnaire rather than *in situ*, and hence the nurses who understood the superiority of the rope-ladder technique would tend to overvalue this response. We also cannot exclude the presence of reporting bias. The buttonhole technique, which has advantages such as less pain during cannulation and a reduction in the formation of haematomas and aneurysms [1, 11, 12], was rarely reported in the present study, whereas other studies have found an increased risk of infection of the fistula [12, 13]. More recently, the European Renal Best Practice guideline has suggested using either a rope-ladder or a buttonhole technique [14].

Several observational studies have attempted to identify cannulation practices. A German study involving 158 dialysed patients (two-thirds via native fistula and one-third via arteriovenous graft) reported a greater use of fistula catheters (30% of patients) and needle sizes of 15 G and 16 G in 94% of patients [15]. The bevel was facing upwards in 82% of cases and the needle was rotated in 18% of cases and the nurses had >3 years of experience in cannulation techniques in 21% of cases [15]. Parisotto *et al.* [16] reported that the needles were inserted in the antegrade direction with the bevel upwards in 70% of cases, with the needle being rotated in slightly <50% of cases. In that study, the nurses chose to use 15 G or 16 G metal needles, with a bevel indicator in 70% of cases. The experience of the nurses in dialysis was similar to ours, with more than two-thirds of them having >5 years of experience. These previous observational studies confirm our results regarding the use of a variety of cannulation methods in terms of the needles used and their positioning. In French practice, needles between 15 G and 17 G are mostly used. A sufficient arterial blood flow rate can usually be obtained with needles of 16 G and larger [10], although increasing the needle size to obtain higher flow rates was found to increase the risk of thrombosis in the AVF [17]. We also found that

Table 7. Principal signs indicating that the fistula is in danger and actions to protect the fistula according to patients

What are the two main signs that warn you that your fistula is in danger?[a]	
Missing data	103
I don't know ('I don't know' box ticked or equivalent spontaneous phrase)	2066 (59.3)
Absence of or reduction in thrill (or vibrations, beats, etc.)	915 (26.3)
Pain	283 (8.1)
Bleeding	169 (4.8)
Poor instrumentation data (e.g. dialyser)	129 (3.7)
Redness	88 (2.5)
Swelling and oedema	76 (2.2)
Abnormal appearance of the fistula (e.g. colour, decrease in volume, scab, hardness)	72 (2.1)
Cannulation difficult or impossible	56 (1.6)
Inflammation and/or infection	51 (1.5)
Miscellaneous	48 (1.4)
Stenosis or signs of stenosis (e.g. throbbing fistula)	48 (1.4)
Haematoma	37 (1.1)
Blocked fistula (e.g. thrombosis)	26 (0.7)
Warmth	18 (0.5)
Arm problems (e.g. oedema, numbness)	13 (0.4)
Itching and allergy	10 (0.3)
No emptying when arm elevated	8 (0.2)
What do you do to protect your fistula on a daily basis?[a]	
Missing data	24
I do nothing ('I do nothing' box ticked or equivalent spontaneous phrase)	1941 (54.5)
Avoid carrying heavy weights	374 (10.5)
Keep the dialysis dressing on it or protect the fistula with a dressing/bandage	293 (8.2)
Protection wearing long-sleeved clothing/cuff	244 (6.8)
I protect myself from the sun	216 (6.1)
Keep it clean/disinfect it well	206 (5.8)
Avoid shocks	196 (5.5)
Be careful	154 (4.3)
Use moisturizing and/or healing products	118 (3.3)
Protection (e.g. long-sleeved clothing, gloves) during do-it-yourself projects, sports, gardening, housework, etc.	117 (3.3)
Avoid compressing the fistula (e.g. bending arms, pressing on the fistula, sleeping on the arm)	103 (2.9)
No wristwatch, bracelet or tight clothing worn on the fistula arm	102 (2.9)
Avoid making effort or sudden movements with the arm with the fistula	91 (2.6)
Avoid using the arm with the fistula	65 (1.8)
Check for thrill	58 (1.6)
Protect the fistula	45 (1.3)
Miscellaneous	41 (1.2)
Avoid scratching, grazing, rubbing and touching the fistula	37 (1.0)
Avoid medical measurements on the arm with the fistula (e.g. blood test, blood pressure)	32 (0.9)
Beware of cuts, scratches, bites, etc.	27 (0.8)
Avoid DIY, gardening, violent sport	26 (0.7)
Use of anti-inflammatories or similar products	21 (0.6)

Data are *n* (%) values. The various ways in which responses were expressed were pooled into themes of identical responses. Off-topic responses or those without a response were counted as missing data.

[a]Question with a free field enabling multiple responses.

most units used metal needles. Fistula catheters may be beneficial for reducing trauma, but their use is often discouraged due to their higher cost. A study of 33 patients found that using plastic fistula catheters reduced the number of haematomas during cannulation but did not increase the longevity of the AVF [18]. A recent guideline recommends using either sharp needles or plastic cannulas for cannulation [14].

A venous needle should be placed in the antegrade direction. In contrast, some authors recommend placing the arterial needle in the retrograde direction in order to reduce the risk of turbulence and recirculation [19]. However, a study that compared antegrade with retrograde direction of the arterial needle did not find any difference in dialysis dose [20], while Parisotto *et al.* [10] reported that the AVF survived for longer in the antegrade direction.

International guidelines do not give recommendations on bevel position or flipping of needles. A study involving 48 patients found greater pain severity and a larger hole left by the needle when the bevel was facing upwards [21], which appears to be confirmed by a study in 70 patients finding a lower risk of bleeding during cannulation when the bevel is facing downwards [22]. Modelling the flows and pressures did not reveal any relationship between the position of the bevel and dialysis dose [23].

Parisotto *et al.* [10] found that the area technique and the retrograde direction with the bevel downwards led to worse

survival. That study favoured using a tourniquet or manual compression to ease the cannulation. In contrast, a rope-ladder or buttonhole technique, using a needle with a bevel indicator, 180-degree needle rotation or introducing the venous needle first were associated with higher risks of immediate complications such as puncture failure, haematoma, infiltration and bleeding [16].

A lidocaine/prilocaine type of local anaesthetic when performing the puncture process is commonly used [24], but this can result in pruritus or a true allergy, especially when the anaesthetic is delivered using a patch. A study of 75 patients found that 8 (11%) exhibited positive reactions in allergy tests of this type of product [25]. In our study, 24% of patients reported allergic reactions to local anaesthetics, some of which could have been skin reactions.

Few studies have investigated haemostasis practices after needle withdrawal, whereas the recommendations have insisted that the applied pressure should be sufficient to stop the bleeding while not impairing blood flow [26]. The ideal duration of compression of an AVF should be 8–10 min [26]. A two-finger technique is recommended: one on the puncture site and the other opposite the site of entry of the needle in the vascular wall [26]. In our study, both the nurses and patients evaluated the compression force as being either strong or very strong in the majority of cases. The nurses increased the compression force if the bleeding was prolonged. It is difficult to know whether this force was excessive or not, because no data were available on the presence of thrill upstream and downstream of the compression or on the flow rate in the fistula during compression. Excessive and repeated compression of the AVF could cause thrombosis [27–29] and reduce the longevity of the AVF. Like accidental AVF compression during sleep, voluntarily applied compression could reduce the blood flow rate and thereby increase the risk of thrombosis [27]. A dialysis patient already has a higher risk of thrombosis due to the association of haemostasis disorders and lesions of the vascular endothelium because of repeated punctures.

Prolonged bleeding after dialysis is usually an early warning sign of stenosis. Many of our patients declared a bleeding time exceeding 10 min; however, reported bias cannot be excluded due to memory lapses or even the misinterpretation of events by patients, especially patients overestimating the time that they spent waiting. Accordingly, Tsai *et al.* [30] reported a mean bleeding duration of 14 min between disconnecting the dialysis machine and when bleeding stopped.

In our study, pure calcium alginate dressings from Brothier were used as often as gauze to obtain haemostasis. The occurrence of prolonged bleeding will increase the use of haemostatic dressings. Pure calcium alginate dressings are recognized for their haemostatic efficacy due to the release of calcium ions and were validated by the French Higher Health Authority (HAS) to stop bleeding in patients with or without congenital or acquired haemostasis disorders [31]. The haemostatic effect of these dressings has been demonstrated, but there is no published study in a haemodialysis setting. A randomized study found a reduction of the compression time after angiography when calcium alginate dressings were used compared with classical sheets, with haemostasis obtained in up to 10 min in 82% versus 67% of patients, respectively [32]. Nevertheless, there is no consensus on which dressings to use in haemodialysis.

One-quarter of our patients reported bleeding between two sessions outside the dialysis facility. These data are of concern because repeated bleeding of the AVF can increase the severity of anaemia [33] and the incidence of cardiovascular deaths [30]. Daily treatment with anticoagulants and/or antiplatelet agents, as reported by most of our patients, may contribute to the increased risk of bleeding in the haemodialysis patient population [34].

Lastly, the findings of this observational study emphasize the efforts required in AVF supervision. The simple arm elevation test was not applied systematically by the healthcare professionals even though AVF supervision was satisfactory and the nurses had a good understanding of AVF management and monitoring. Moreover, half of the patients were not aware of the signs indicating that their AVF was in danger and the actions required to protect it. These data expose deficiencies in the training and information given and remembered by patients, who should play an important role in managing their vascular access.

Our study has several limitations that the reader should bear in mind. In this observational study, data were collected via a questionnaire rather than locally, and there was no assessment of the quality of the answers. The selection process of the participating facilities may not have been purely random, as Brothier representatives identified the participating dialysis units, which might have resulted in overestimation of the use of pure calcium alginate dressings. On the other hand, the ratio of the characteristics of units and patients in this study was close to national data. Moreover, the population comprised a large representative sample of 1538 nurses in 150 units and 3588 patients, which constituted 8% of haemodialysis patients with AVFs throughout France [2].

This was the first nationwide observational study on AVF cannulation and haemostasis practices in France. This study was original due to data being collected from nurses and patients in parallel. Furthermore, compression force, the person who applied compression, knowledge about warning signs of the function of the AVF and actions for protecting it were never addressed in other studies.

This study underlines the lack of international consensus on the practices of AVF management and the room for improvement of the knowledge of the patients. This study also found a high proportion of patients experiencing long bleeding times as well as bleeding at home, which suggests that haemostatic practices still need to be optimized. Preserving a good-quality AVF must remain a priority in the care of haemodialysis patients, an ageing population with more fragile vessels and higher rates of cardiovascular outcomes [2, 35].

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AUTHORS' CONTRIBUTIONS

P.B. initiated and coordinated this study, oversaw the clinical aspects of the statistical analysis, contributed to the preparation of the final report, had the idea for the article and entrusted the writing of the manuscript to M.S. M.S. contributed to the final interpretation of the data and wrote the manuscript. L.M., G.J., B.G., D.B., J-M.C., T.H., F.L.R. and

P.B., members of the scientific committee of the study, contributed to the study design and the data interpretation, reviewed the manuscript and approved the final version.

CONFLICT OF INTEREST STATEMENT

All authors have completed the ICMJE uniform disclosure form at http://www.icmje.org/conflicts-of-interest/. M.S. reports personal fees from Brothier, personal fees and non-financial support from Fresenius Medical Care and Baxter, outside the submitted work. L.M. reports personal fees from Brothier, during the conduct of the study, and personal fees and non-financial support from Brothier, outside the submitted work. G.J. reports personal fees from Brothier, during the conduct of the study, and personal fees and non-financial support from Brothier, outside the submitted work. B.G. reports personal fees from Brothier, during the conduct of the study, and personal fees from Vifor Fresenius, outside the submitted work. D.B. reports personal fees and non-financial support from Brothier, outside the submitted work. J.-M.C. reports grants from Brothier and Physidia, outside the submitted work. T.H. reports personal fees from Brothier, during the conduct of the study. F.L.R. reports personal fees from Brothier, during the conduct of the study, and personal fees from Fresenius and non-financial support from Hemotech, outside the submitted work. P.B. reports non-financial support from BBraun and Vifor Fresenius, outside the submitted work.

REFERENCES

1. Schmidli J, Widmer MK, Basile C *et al* Editor's choice – vascular access: 2018 Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS). *Eur J Vasc Endovasc Surg* 2018; 55: 757–818
2. Biomédecine Ad. Rapport annuel 2017: Réseau Epidémiologie, Infomation, Néphrologie. Agence de Biomédecine: Réseau Epidémiologie et Infomation en Néphrologie; 2017: 382.
3. Dhingra RK, Young EW, Hulbert-Shearon TE *et al* Type of vascular access and mortality in U.S. hemodialysis patients. *Kidney Int* 2001; 60: 1443–1451
4. Ishani A, Collins AJ, Herzog CA *et al* Septicemia, access and cardiovascular disease in dialysis patients: the USRDS Wave 2 study. *Kidney Int* 2005; 68: 311–318
5. Xue H, Lacson E, Jr., Wang W *et al* Choice of vascular access among incident hemodialysis patients: a decision and cost-utility analysis. *Clin J Am Soc Nephrol* 2010; 5: 2289–2296.
6. Fokou M, Teyang A, Ashuntantang G *et al* Complications of arteriovenous fistula for hemodialysis: an 8-year study. *Ann Vasc Surg* 2012; 26: 680–684
7. Pisoni RL, Young EW, Dykstra DM *et al* Vascular access use in Europe and the United States: results from the DOPPS. *Kidney Int* 2002; 61: 305–316
8. Borzumati M, Funaro L, Mancini E *et al* Survival and complications of arteriovenous fistula dialysis access in an elderly population. *J Vasc Access* 2013; 14: 330–334
9. Cour des Comptes. Chapitre X L'insuffisance rénale chronique terminale: favoriser des prises en charge plus efficientes. *La sécurité sociale: Rapport sur l'application des lois de financement de la Sécurité sociale* 2015; 345–377.
10. Parisotto MT, Schoder VU, Miriunis C *et al* Cannulation technique influences arteriovenous fistula and graft survival. *Kidney Int* 2014; 86: 790–797
11. Struthers J, Allan A, Peel RK *et al* Buttonhole needling of arteriovenous fistulae: a randomized controlled trial. *ASAIO J* 2010; 56: 319–322
12. MacRae JM, Ahmed SB, Atkar R *et al* A randomized trial comparing buttonhole with rope ladder needling in conventional hemodialysis patients. *Clin J Am Soc Nephrol* 2012; 7: 1632–1638
13. Vascular Access 2006 Work Group. Clinical practice guidelines for vascular access. *Am J Kidney Dis* 2006; 48(Suppl 1): S248–273
14. Gallieni M, Hollenbeck M, Inston N *et al* Clinical practice guideline on peri- and postoperative care of arteriovenous fistulas and grafts for haemodialysis in adults. *Nephrol Dial Transplant* 2019; 34: ii1–ii42
15. van Loon MM, Kessel AGH, van der Sande FM *et al* Cannulation practice patterns in haemodialysis vascular access: predictors for unsuccessful cannulation. *J Ren Care* 2009; 35: 82–89
16. Parisotto MT, Pelliccia F, Grassmann A *et al* Elements of dialysis nursing practice associated with successful cannulation: result of an international survey. *J Vasc Access* 2017; 18: 114–119
17. Asano M, Thumma J, Oguchi K *et al* Vascular access care and treatment practices associated with outcomes of arteriovenous fistula: international comparisons from the Dialysis Outcomes and Practice Patterns Study. *Nephron Clin Pract* 2013; 124: 23–30
18. Marticorena RM, Dacouris N, Donnelly SM. Randomized pilot study to compare metal needles versus plastic cannulae in the development of complications in hemodialysis access. *J Vasc Access* 2018; 19: 272–282
19. MacRae JM, Dipchand C, Oliver M *et al* Arteriovenous access failure, stenosis, and thrombosis. *Can J Kidney Health Dis* 2016; 3: 205435811666912
20. Elias M, Nnang-Obada E, Charpentier B *et al* Impact of arteriovenous fistula cannulation on the quality of dialysis. *Hemodial Int* 2018; 22: 45–49
21. Crespo Montero R, Rivero Arellano F, Contreras Abad MD *et al* Pain degree and skin damage during arterio-venous fistula puncture. *EDTNA ERCA J* 2004; 30: 208–212
22. Gaspar LJ, Moreira NM, Moutinho AA *et al* Puncture of the arteriovenous fistula: bevel upward or bevel downward? *EDTNA ERCA J* 2003; 29: 104
23. Fulker D, Simmons A, Kabir K *et al* The hemodynamic effects of hemodialysis needle rotation and orientation in an idealized computational model. *Artif Org* 2016; 40: 185–189
24. Celik G, Ozbek O, Yilmaz M *et al* Vapocoolant spray vs lidocaine/prilocaine cream for reducing the pain of venipuncture in hemodialysis patients: a randomized, placebo-controlled, crossover study. *Int J Med Sci* 2011; 8: 623–627
25. Gaudy-Marqueste C, Jouhet C, Castelain M *et al* Contact allergies in haemodialysis patients: a prospective study of 75 patients. *Allergy* 2009; 64: 222–228
26. Matos J, Furlan A, Costa Pinto B et al. Needle removal and haemostasis. In: Parisotto M, Pancirova J (eds). *Vascular Access Cannulation and Care – A Nursing Best Practice Guide for Arteriovenous Fistula*. 1st edn. Madrid: Tomás Hermanos, 2014, 86–90
27. Abularrage CJ, Sidawy AN, Weiswasser JM *et al* Medical factors affecting patency of arteriovenous access. *Semin Vasc Surg* 2004; 17: 25–31

28. Schwab SJ, Harrington JT, Singh A *et al* Vascular access for hemodialysis. *Kidney Int* 1999; 55: 2078–2090
29. Fan PY, Schwab SJ. Vascular access: concepts for the 1990s. *J Am Soc Nephrol* 1992; 3: 1–11
30. Tsai WC, Chen HY, Lin CL *et al* Excessive access cannulation site bleeding predicts long-term all-cause mortality in chronic hemodialysis patients. *Ther Apher Dial* 2015; 19: 486–490
31. HAS. Les pansements - Indications et utilisations recommandées. Haute Autorité de Santé (CEPP - HAS); 2011.
32. Matsubara M, Banshodani M, Takahashi A *et al* Vascular access management after percutaneous transluminal angioplasty using a calcium alginate sheet: a randomized controlled trial. *Nephrol Dial Transplant* 2019; 34: 1592–1596
33. Lin CL, Chen HY, Huang SC *et al* Increased blood loss from access cannulation site during hemodialysis is associated with anemia and arteriovenous graft use. *Ther Apher Dial* 2014; 18: 51–56
34. Remuzzi G, Pusineri F. Coagulation defects in uremia. *Kidney Int Suppl* 1988; 24: S13–17
35. Lassalle M, Couchoud C. REIN rapport. Reseau epidemiologique information nephrologie & Agence de la biomedecine; 2010