

ANNEXES TO CHAPTER 3

Clinical Question VIII. What is the needling technique of choice for the different types of arteriovenous fistula: the three classical ones and self-cannulation?

Clinical Practice Guidelines (CPG)

Five CPG have been identified that evaluate the cannulation technique of choice for the different types of vascular access (UK 2011¹, DOQI 2006², ERBP 2007³, JAPAN 2005⁴, SPANISH 2004⁵); of these only three¹⁻³ provide recommendations. The UK 2011 CPG¹ are the most recent and the only ones that grade recommendations with the GRADE system.

Vascular access (VA) cannulation can be performed according to one of the following methods: specific puncture area, puncture-site rotation or buttonhole technique⁵.

1. **Specific puncture zone or area technique.** Consists of cannulating in a small area of the vein (2-3 cm). Although this technique facilitates cannulation when the area is more dilated, giving sufficient flow and being less painful for the patient, we find that repeated punctures destroy the elastic properties of the vessel wall and the skin, favouring the formation of aneurysms, the appearance of post-aneurysm stenotic areas and longer bleeding time.
2. **Buttonhole technique (BH).** Consists of cannulating at the same place and at the same angle and depth in each haemodialysis session, with the scab formed from the previous cannulation being removed and the needle inserted into the same tunnelled track. Because a track develops under the skin, this facilitates cannulation and minimises complications.
3. **Site-rotation or rope-ladder technique (RL).** Consists of using the whole available area, by rotating the puncture sites. Requires a well-established venous line, and causes more pain and a higher rate of unsuccessful and repeated punctures.

UK CPG¹ (Fluck R, Kumwenda 2011)

An observational study conducted by Van Loon in 2010 compared the buttonhole (BH) and rope-ladder (RL) techniques. Compared to the RL arm, subjects in the BH arm had greater success with cannulations, a significant reduction in the risk of haematoma and formation of aneurysms and less intervention with angioplasty. There was however, an increased risk of infection associated with the BH technique. The BH technique is recommended for cannulating fistulae, but aseptic measures necessary for the prevention of infection must be taken into account.

Recommendations: (GRADE system: 1: strong, 2: weak, B: moderate level of evidence)

1. We suggest the *Buttonhole* technique as preferred cannulation method (2B).

DOQI CPG, 2006.² These CPG base their clinical recommendations on a number of observational studies and group consensus.

Recommendations: (A: high impact; B: moderate impact)

Arteriovenous grafts (AVG) should not generally be cannulated for at least 2 weeks after

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<p>placement and not until swelling has diminished so that palpation may be performed. Puncture-site rotation is necessary to prevent the formation of pseudoaneurysms. (B)</p>	
<p>EBPG CPG³ (Tordoir 2007).</p> <p>Although there is little scientific data available on the manipulation of the VA and the outcomes of specific cannulation techniques, the rope ladder technique is recommended for arteriovenous grafts (AVG), to prevent the graft from disintegrating and the formation of pseudoaneurysms. In AVF, particularly those with a short segment of vein available for cannulation, the BH method is preferred.</p> <p>Recommendations: These CPG do not grade the recommendations; they only clarify the grades of evidence on which they based the recommendations.</p> <ol style="list-style-type: none"> 1. The rope-ladder technique should be used for cannulation of arteriovenous grafts. (Level of evidence III) 	
<p>Japanese CPG⁴ (Seiji Ohira 2005)</p> <p>These guidelines recommend that cannulation of an AVF or AVG be performed on as large an area as possible. The BH method can be applied to patients who find cannulation extremely painful. Patients on home HD programmes can also use this method.</p>	
<p>Spanish 2004 CPG⁵</p> <p>Vascular access (VA) cannulation can be performed according to one of the following methods: specific puncture area, puncture-site rotation or buttonhole technique. The specific-zone and BH techniques are completely contraindicated in patients with prosthetic AVG, as they damage the prosthetic material and increase the risk of pseudoaneurysms.</p>	
<p>MacRae 2012.⁶ Randomised study conducted in Canada, in adult patients in HD centres with a mature AVF (with constant flow rate in the previous 4 months and no surgical and/or radiological interventions). Included 140 patients on HD randomly assigned to buttonhole technique (BH, n=70) or rope-ladder technique (RL, n=70). Of the 140 subjects randomised, 131 completed the study: 66 subjects in the RL arm and 65 in the BH arm. All patients were included in the analysis of the results. The primary endpoint of this study was the pain perceived by the patient 8 weeks after cannulation, as measured by visual analogue scale (VAS) with scores of 0-10 (0 = no pain; 10 = worst pain imaginable). As secondary endpoints, the following complications were recorded: presence of bruising, the time to homeostasis post-puncture and infections. Also recorded were age, gender, diabetes history, cardiovascular disease, and information about the AVF (type and place, date created, recent-access flow rate). After the 8-week study period, patients were followed up for one year to assess the patency of the AVF and infectious complications.</p> <p>Struthers 2010.⁷ Randomised study conducted in the UK on 56 adult patients on HD with an AVF. Patients were randomised, 28 in the buttonhole technique (BH) group and 28 in the control group which used the rope-ladder technique (RL). All patients were included in the analysis of the results. There were no significant differences between groups in age, presence of diabetes and mean age of the AVF. The following variables were evaluated before randomisation and at 6 months after the introduction of the BH technique: pain scores using a visual analogue scale (VAS, 0-10), the use of local anaesthetics (LA), time needed to stop bleeding post-dialysis, the</p>	

maximum diameter of the fistula, and other complications such as thrombosis, infection and infiltrations (subcutaneous haematomas). Patients indicated their preferred technique at six months and a questionnaire on nursing staff satisfaction with the two techniques was completed at the end of the trial. The follow-up lasted for six months.

Chow 2011.⁸ Multicentre randomised study conducted in Australia, which included 70 adult patients with end-stage kidney disease receiving HD with an access flow rate ≥ 500 ml/min, an AVF or prosthesis in saphenous vein with sufficient area for the use of the BH cannulation technique. The study included patients on treatment in HD units, at home or in tertiary health service facilities. Demographic clinical characteristics of patients and their VA were recorded at a first visit. Patients were randomised in equal proportions to an intervention group (buttonhole technique - BH) or a control group which used the rope-ladder cannulation technique (RL). The follow-up lasted for six months. Of the 70 patients 69 were randomised: 34 to the BH group and 35 to the control group. In the BH group, 70% (n=24) had a 6-month follow-up and 29 patients completed the study. In the control group 30 completed the follow-up. There were no significant differences between the two patient groups in demographic and clinical characteristics. The following variables were evaluated: quality of life, pain of the cannulation measured by visual analogue scale (VAS, 0-10), use of local anaesthetic (lidocaine), fistula observations, and complications.

O'Brien 2012.⁹ Retrospective cohort study in 127 adult patients receiving haemodialysis (HD) through an AVF between May 2004 and May 2011 in Ireland. Patients received the HD at a hospital or in HD programmes at home. In 53 patients, the rope-ladder technique (RL) was used to access the AVF and in 74, the buttonhole technique (BH) was used. All patients received information about the two techniques and health-care providers received instruction and training. Blood cultures were performed for all patients with pyrexia and suspicion of infection due to the presence of exudate at the puncture site. Data were collected from patients on age, gender, diabetes mellitus, time on haemodialysis and number of days since the AVF was created. The study's primary endpoint was detecting AVF-associated infection. Infection was considered when both blood cultures and puncture area cultures were positive for the same microorganism.

Van Loon 2010.¹⁰ Prospective observational study which included 145 adult patients on HD with AVF between January 2007 and November 2007 in three different centres in the Netherlands. Cannulation of the AVF was performed using BH in 75 patients and RL in 70 patients. The AVF included were mature and located in the upper arm, with an access flow rate of ≥ 500 and diameter ≥ 6 mm. Patient characteristics, comorbidities, medication and AVF characteristics (type, location, date of creation and duration) were all recorded. The following variables were evaluated; cannulation technique, inspection of the haematoma, redness and auscultation of aneurysm, use of local anaesthesia, needle type, number of cannulations and ease of performing the cannulation per the years of experience of the nurses. During each dialysis session, puncture pain was assessed by a 10-point verbal rating scale (VRS) (1 = no pain, 10 = extreme pain). Fear of puncture was documented once a week, using the 10-point VRS (1 = no fear, extreme fear = 10). Duration of follow-up was 9 months. The study objective was to assess the presence of complications in both cannulation techniques.

Verhallen 2007.¹¹ Prospective study performed from July 2004 to January 2006 in 33 adult patients receiving home haemodialysis with a native arteriovenous fistula, either in the wrist or the elbow, and able to perform self-cannulation of the fistula. The buttonhole technique was used with these patients and it was compared to the reference data obtained with the rope-ladder technique the patients had used before (control group). The following parameters were recorded at the start and at 1.5, 3, 6, 12 and 18 months after inclusion: ease of cannulation, need for repeated insertion, pain, compression time after removal of the cannula, exudate of blood with the cannula, re-bleeding from the puncture site after compression, signs of infection, formation of aneurysms and thrombosis. Follow-up was 18 months.

<p>Ward 2010.¹² Study conducted at an outpatient dialysis centre in the UK in which the buttonhole technique (BH) was used in 53 adult patients (29 men, mean age 68.5 ± 1.9 years) who attended for dialysis three times a week. Twelve (23%) of the patients had started with this technique and 41 (77%) had previously used the rope ladder method. None of the patients used local anaesthetic creams, injections or aerosols or other topical preparations prior to cannulation of the AVF. The AVF recirculation rate, presence of bleeding, aneurysm or infections and the need for fistulography were all assessed. Using a 4-point visual assessment scale (1 = BH worse, 2 = BH the same, 3 = BH better, 4 = BH much better), the patients' experiences with the change in puncture technique were compared in terms of pain on needle insertion, bleeding time and the appearance of the fistula. Patients were followed up for a mean of 14 months (range 9.5-22.5).</p>	
<p>MacRae 2012.⁶ The median pain score at 8 weeks was similar (RL = 1.2 [0.4-2.4] vs BH = 1.5 [0.5 to 3.4], p=0.57). In the BH group, more patients had excess pain (20/70, 28.6%), defined as a mean score >3 at 8 weeks compared to the RL group (11/70, 15.7%, p=0.07; odds ratio [OR] = 2.15; 95% confidence interval [CI] = 0.87-5.44).</p> <p>The rate of haematoma formation was higher in the RL group (436 per 1000 dialysis sessions) than in the BH group (295 per 1000 sessions, p=0.03).</p> <p>The haemostasis time post-dialysis was similar for both groups at 23.6 and 28.3 per 1000 dialysis sessions in RL and BH respectively (p=0.40).</p> <p>The localised infection rate was 22.4 per 1000 dialysis sessions in the RL group compared to 50 per 1000 dialysis sessions in the BH group (p=0.003). During the 8-week study period, there was one episode of Staphylococcus aureus (SA) bacteraemia at 6 weeks in the BH group; there were no such events in the RL group (p=1.00). After the end of the study (but within the 12-month follow-up), two other patients in the BH group developed SA bacteraemia and nine patients developed needling site abscesses; there were no such events in the RL group (p=0.003).</p>	<p>Moderate quality</p>
<p>Struthers 2010.⁷ Nine of the 22 patients in the BH group reduced or stopped use of LA for needling compared to one of the 25 patients in the traditional or RL group (p <0.01). Although the pain scores did not go down, the BH group had a previous mean pain score of 3 to 10 and a score of 2.5 after six months and the traditional group had a mean score of 1 to 2 points (no p data provided).</p> <p>The diameter of the AVF in the BH group remained unchanged, while in the control group, it enlarged by 30% ± 7% (p<0.01), equivalent to an absolute increase of 5 mm.</p> <p>There were no differences between groups in the post-dialysis bleeding times: BH group 342 ± 36 seconds before the trial and 300 ± 26 seconds after six months; RL group 402 ± 33 seconds before and 400 ± 31 seconds after six months. There were 11 reported episodes of bleeding at the puncture site during dialysis in the BH group, compared to 17 in the control group. There were 19 infiltrations (subcutaneous haematomas) reported in the control group and 27 recorded in the BH group. Each group had one fistula thrombosis, and the BH group had one infection in the fistula (no data are presented on statistical significance).</p> <p>The BH cannulation method was strongly preferred by patients and nursing staff (21 of the 22 patients and 15 of the 23 nurses).</p>	<p>Moderate quality</p>

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<p>Chow 2011.⁸ There were no differences between groups in pain scores measured by VAS at the start of the study (BH: average 0.81, 95% CI 0.41-1.20; RL 0.81, 95% CI 0.48-1.15) and end of follow-up (BH: average 0.56, 95% CI 0.13-0.99; RL 0.71, 95% CI 0.34-1.09). However, pain during the dialysis session at the cannulation site was reported as a complication in the BH group (p=0.012).</p> <p>There were no differences between groups in the mean scores for the quality of life subscales at the beginning or end of follow-up, except in the area of social functioning, where the RL group had a higher score (p=0.045).</p> <p>At the final follow-up appointment lidocaine use was significantly lower in the BH group (44.4%) than in the RL group (76.7%) (p=0.013). However, data were not available for 12 (17%) patients.</p> <p>A total of 47 complications were reported in 28 participants: 33 complications in 17 patients in the BH group; and 14 complications in 11 patients in the control group. Four patients in the BH group and one in the RL group developed infection at the puncture site (p=0.11). Haematomas at the puncture site during the dialysis session were more frequently recorded in the BH group (p=0.027).</p>	<p>Moderate quality</p>
<p>With respect to the results seen in observational studies, O'Brien 2012⁹ showed nine episodes of AVF infection in the BH group, equivalent to 0.073 cases per 1000 AVF days. There were no AVF infections in the RL group (p=0.023). Five of the patients received HD in a hospital and four at home. The prevalent pathogen was methicillin-sensitive <i>Staphylococcus aureus</i> (MSSA), isolated in samples from eight patients. The other patient developed a <i>Staphylococcus epidermidis</i> infection. Four of the eight patients with SAMS infections developed infective endocarditis. This corresponds to a rate of 0.02 events with infective endocarditis per 1000 AVF days.</p>	<p>Low quality</p>
<p>Van Loon 2010.¹⁰ In the BH group there were more unsuccessful cannulations (defined as the need to insert more than one needle per arterial or venous connection) (p<0.0001) and less haematoma formation (p<0.0001). Aneurysm formation was significantly more common (p<0.0001) in patients using the rope-ladder technique (67%) than in the patients who used the BH technique (1%).</p> <p>Although for both groups the pain was mild on average, the BH patients experienced more pain (p<0.001) and fear (p<0.002) than RL patients. However, the need to apply local anaesthetic was more common in patients using RL than in those who used the BH technique (p<0.001).</p> <p>Patients in the BH group required significantly fewer endovascular interventions (angioplasty), only 10 out of 75 patients (p<0.001), compared to the RL group, with 41 out of 70 patients requiring intervention (p<0.001).</p> <p>In the BH group, there was more treatment with antibiotics due to infection related to the access (p<0.001). Treatment with intravenous antibiotics was necessary in four patients in the BH group because of infection related to the access.</p>	<p>Low quality</p>
<p>Verhallen 2007.¹¹ Compared to RL, there was greater ease of cannulation with the BH technique; the VAS score went down from 2.9 ± 2.4 to 1.3 ± 0.2 (p=0.002).</p>	<p>Low quality</p>

<p>The need for repeat puncture (bad sticks) decreased significantly with the BH method from 0.8 ± 1.4 to 0.3 ± 0.6 incidents per two weeks ($p=0.03$). There were no significant differences between groups in terms of pain (VAS score in BH 1.6 ± 2.0 and in RL 2.3 ± 2.2, $p=0.12$). There was no increase in the compression time or bleeding: 8.7 ± 3.6 to 7.6 ± 4.0 ($p=0.004$). In the BH group three patients developed skin infections (no data on statistical significance are provided).</p>	
<p>Ward 2010.¹² In the 41 patients who had previously had the rope-ladder technique to their AVF, switching to the buttonhole technique produced a reduction in the fistula recirculation flow rate from $9.3\% \pm 0.4\%$ to $8.3\% \pm 0.3\%$ ($p=0.016$).</p> <p>Before switching to the buttonhole technique, 24% of these patients had required at least one angioplasty to treat venous stenosis, and since the switch, angioplasty has only been required in 3 patients ($p=0.008$).</p> <p>Since starting to use the buttonhole technique, no patients had developed localised infection at the site of the fistula or systemic bacteraemia with <i>Staphylococcus aureus</i> or commensal skin bacteria. Similarly, no patients had suffered from a major bleeding from the fistula or aneurysmal dilation (no data on statistical significance are provided).</p> <p>Patients who had previously had the rope-ladder technique completed a 4-point visual assessment scale (1 = BH worse, 2 = BH the same, 3 = BH better, 4 = BH much better) designed to compare the patients' experiences after the change in puncture technique: 93% of patients reported a shorter bleeding time after withdrawal of the needle, 81% less pain on needle insertion, and 80% better appearance of the fistula compared to the rope-ladder technique (no data on statistical significance are provided).</p>	<p>Low quality</p>
<p>Summary of the evidence from RCT</p> <p>All the results of the different variables evaluated by the randomised clinical trials (RCT) are summarised below, followed by the conclusions of each individual study.</p> <p>In two RCT (MacRae 2012; Struthers 2010)^{6,7} and one open-label controlled study (Chow 2011),⁸ the buttonhole (BH) and rope-ladder (RL) techniques were compared in patients on HD with AVF.</p> <p>In all three studies (MacRae 2012; Struthers 2010; Chow 2011),⁶⁻⁸ there were no differences between the BH and RL groups in the pain scores measured by VAS (0-10). However, the open-label study (Chow 2011)⁸ found more patients with pain at the puncture site in the BH group during the dialysis session (very few events).</p> <p>The three studies (MacRae 2012; Struthers 2010; Chow 2011)⁶⁻⁸ evaluated the number of infections, and agree on a higher risk in the BH group. It must be taken into account that only the MacRae⁶ RCT presents significant data. The data presented by the open-label study (Chow 2011)⁸ are not significant and the Struthers 2010 RCT⁷ provides no data on statistical significance and the authors themselves point out that conclusions cannot be drawn about this variable.</p> <p>Two studies (Struthers 2010; Chow 2011)^{7,8} assessed the use of local anaesthetic and agree that it is used less in the BH group.</p> <p>There were no differences between the two groups evaluated by two RCT in bleeding time and haemostasis (MacRae 2012; Struthers 2010)^{6,7}.</p>	

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<p>One RCT and the open-label study (MacRae 2012; Chow 2011)^{6,8} present data on haematoma formation with both methods; the MacRae RCT⁶ found a smaller number of haematomas in the BH group. Controversially, the Chow study⁸ shows a higher number of haematomas in this group, with the authors attributing the increase to a lack of experience on the part of the nursing staff.</p>	
<p>MacRae 2012.⁶ This study is the first randomised trial in patients on conventional HD comparing BH to RL. There were no differences between the BH and RL groups in the perception of pain. The BH group developed fewer haematomas but had a higher risk of localised infections and bacteraemia. Routine use of the BH technique was associated with a higher risk of infection.</p>	<p>Moderate quality</p>
<p>Struthers 2010.⁷ Both nurses and patients preferred the BH cannulation technique for AVF as it reduced the need for local anaesthetic, discomfort during needling, and enlargement of the AVF. It also had a low level of complications. The authors suggest the use of BH for patients with significant aneurysm formation, those with discomfort or pain at the needling site, and those with an AVF with a limited area for needle insertion.</p>	<p>Moderate quality</p>
<p>Chow 2011.⁸ Patients in whom buttonhole needling was used had more infections, haematomas and pain at the puncture site during dialysis than the control group (rope-ladder needling). The high incidence of comorbidity in the buttonhole group combined with the fact that nursing staff were at learning stages with the technique may have contributed to the study results.</p>	<p>Moderate quality</p>
<p>Summary of the evidence from OS</p> <p>All the results of the different variables evaluated by the observational studies (OS) are summarised below, followed by the conclusions of each individual study.</p> <p>Four OS (O'Brien 2012; Van Loon 2010; Verhallen 2007; Ward 2010)⁹⁻¹² compared the buttonhole (BH) and rope-ladder (RL) techniques in patients on HD with AVF.</p> <p>The Van Loon and Ward studies^{10,12} report a decrease in pain in the BH group compared to the RL group, although only the Van Loon study provides data on statistical significance (Van Loon 2010).¹⁰ The same studies present significant data showing fewer interventions to treat stenosis of the fistula in the BH group.</p> <p>According to the results presented by Van Loon¹⁰ the BH group has fewer haematomas and aneurysms and uses less local anaesthetic than the RL group, with these data being statistically significant.</p> <p>The Verhallen study¹¹ found no differences between groups in bleeding time, in contrast to Ward¹², who reported shorter bleeding time in the BH group, although without providing data on statistical significance.</p> <p>All 4 studies (O'Brien 2012; Van Loon 2010; Verhallen 2007; Ward 2010)⁹⁻¹² agree that the BH group has a higher risk of infections than the RL group. Only two of the studies show significant data (O'Brien 2012; Van Loon 2010)^{9,10}. The other two studies (Verhallen 2007; Ward 2010)^{11,12} do not provide data on statistical significance.</p>	

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<p>All studies agree that the BH technique is advisable as self-cannulation technique for patients as there are fewer complications, and recommend meticulous asepsis and hygiene to prevent infections of the VA. Three of the OS included patients with plans for home HD, but only Verhallen¹¹ clarifies that a proportion of their patients may opt for self-cannulation, although without providing any comparative data.</p>	
<p>O'Brien 2012.⁹ This study reveals a significantly higher rate of infections in the AVF accessed using the BH technique, highlighting the life-threatening complication of infective endocarditis in this group. The authors suggest the need for continuous and renewed education of patients and healthcare providers on this cannulation technique in order to reduce complications.</p>	Low quality
<p>Van Loon 2010.¹⁰ The rate of complications associated with cannulation of the AVF was significantly lower with the BH technique than with the RL method. However, the significant number of infections in the BH group is stressed, highlighting the importance of strict aseptic technique during the procedure. It was suggested that the method can improve self-cannulation by patients.</p>	Low quality
<p>Verhallen 2007.¹¹ Compared to the rope-ladder technique, the buttonhole method has the advantage of being an easier self-cannulation procedure with fewer “bad sticks” and is of particular benefit to patients with limited sites for good access or difficult-to-cannulate fistulas. This method can make a considerable contribution towards facilitating self-cannulation by patients, helping provide better quality of life.</p>	Low quality
<p>Ward 2010.¹² Patient satisfaction improved due to the lower pain scores, shorter bleeding times after withdrawal of the needle and better appearance of the fistula. AVF recirculation flow rates and the number of angioplasties were also reduced.</p>	Low quality
<p>Patients' values and preferences <i>No relevant studies related to this aspect have been identified.</i></p>	
<p>Use of resources and costs <i>No relevant studies related to this aspect have been identified.</i></p>	
<p>Recommendations [Proposal]</p>	
Weak	<p>Use of the buttonhole technique is suggested in patients with an arteriovenous fistula with a limited area for needle insertion or with significant aneurysm formation and/or discomfort or pain at the needling site.</p> <p>Asepsis and hygiene must be meticulous in order to prevent infection.</p>
Weak	<p>Use of the buttonhole technique is suggested as self-cannulation method, with this being a good option for home haemodialysis, in view of the low complication level (in terms of extravasation, haematomas, aneurysms) compared to other techniques.</p>

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Weak	The rope-ladder technique is suggested for prosthetic arteriovenous grafts. The specific-zone and BH techniques are contraindicated as they damage the prosthetic material and increase the risk of pseudoaneurysms.
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GRADE Tables

Date: 2013-10-30

Question: Should the buttonhole technique or the rope-ladder technique be used for adult patients with CRD on HD with VA?

Bibliography: • 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. 2012 Oct;7(10):1632-8. doi: 10.2215/CJN.02730312. Epub 2012 Jul 19. PubMed PMID: 22822010; PubMed Central PMCID: PMC3463206.

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Buttonhole technique (n=70)	Rope-ladder technique (n=70)	Relative (95% CI)	Absolute		
haematomas (mean follow-up of 12 months)												
1	randomised trials	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	295/1000 (29.5%) ¹	436/1000 (43.6%) ¹	p 0.03 (0 to 0)	423 fewer per 1000 (from 436 fewer to 436 fewer)	⊕⊕⊕⊕ HIGH	CRITICAL
infection (12-month follow-up)												
1	randomised trials	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	50/1000 (5%) ²	22/1000 (2.2%) ²	p 0.003 (0 to 0)	22 fewer per 1000 (from 22 fewer to 22 fewer)	⊕⊕⊕⊕ HIGH	CRITICAL
haemostasis (12-month follow-up)												
1	randomised trials	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	28/1000 (2.8%) ³	24/1000 (2.4%) ³	p 0.40 (0 to 0)	14 fewer per 1000 (from 24 fewer to 24 fewer)	⊕⊕⊕⊕ HIGH	CRITICAL
pain (assessed with: VAS score (0-10)⁴)												

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1	randomised trials	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	1,5 (0,5 a 3,4) ⁴	1,2 (0,4-2,4) ⁴	p 0.57 (0 to 0)		⊠⊠⊠⊠ HIGH	CRITICAL
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¹ haematomas per 1,000 dialyses

² infections per 1,000 dialyses ³ type of haemostasis per 1,000 dialyses

⁴ VAS scores

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Bibliography: 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. 2011 Jun;37(2):85-93. doi: 10.1111/j.1755-6686.2011.00211.x. PubMed PMID: 21561544.

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Buttonhole technique	Rope-ladder technique	Relative (95% CI)	Absolute		
xylocaine use (6-month follow-up)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	15/34 (44.1%)	27/35 (77.1%)	p 0.013 (0 to 0)	761 fewer per 1000 (from 771 fewer to 771 fewer)	⊠⊠⊠⊠ LOW	CRITICAL
pain at the puncture site (6-month follow-up; assessed with: as complication)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	5/34 (14.7%)	0/35 (0%)	p 0.012 (0 to 0)		⊠⊠⊠⊠ LOW	CRITICAL
infection at the puncture site (6-month follow-up)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	4/34 (11.8%)	1/35 (2.9%)	p 0.11 (0 to 0)	25 fewer per 1000 (from 29 fewer to 29 fewer)	⊠⊠⊠⊠ LOW	CRITICAL
haematomas (6-month follow-up)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	Serious ²	none	4/34 (11.8%)	0/35 (0%)	p 0.027 (0 to 0)		⊠⊠⊠⊠ LOW	CRITICAL

¹ patients lost to follow-up, no blinding of open-label study

² few patients, few events

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Bibliography: Struthers J, Allan A, Peel RK, Lambie SH. Buttonhole needling of arteriovenous fistulae: a randomized controlled trial. ASAIO J. 2010 Jul-Aug;56(4):319-22. doi: 10.1097/MAT.0b013e3181dae1db. PubMed PMID: 20418768

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Buttonhole technique	Rope-ladder technique	Relative (95% CI)	Absolute		
Use of local anaesthesia (6-month follow-up)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	9/22 (40.9%)	1/25 (4%)	p < 0.01 (0 to 0) ³	40 fewer per 1000 (from 40 fewer to 40 fewer)	LOW	CRITICAL
haemorrhages (6-month follow-up)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	11/28 (39.3%)	17/28 (60.7%)		607 fewer per 1000 (from 607 fewer to 607 fewer)	LOW	CRITICAL
Subcutaneous infiltrations/haematomas (6-month follow-up)												
1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	19/28 (67.9%)	27/28 (96.4%)		964 fewer per 1000 (from 964 fewer to 964 fewer)	LOW	CRITICAL
increase in AVF diameter (6-month follow-up)												

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1	randomised trials	serious ¹	no serious inconsistency	no serious indirectness	serious ²	none	1%+/- 22% (mean +/- SEM), ³	30%+/- 22% (mean +/- SEM), ³	p 0.01 (0 to 0)	283 fewer per 1000 (from 286 fewer to 286 fewer)	LOW	CRITICAL
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¹ no blinding, high loss in BH group, no intent-to-treat

² few patients, few events

³ percent increase in AVF diameter

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Bibliography: O'Brien, F; Arterio-venous fistula buttonhole cannulation technique: a retrospective analysis of infectious complications. Clin Kidney J (2012) 5(6): 526-529

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Buttonhole technique	Rope-ladder technique	Relative (95% CI)	Absolute		
AVF-associated infection (assessed with: blood cultures and AVF puncture site)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	9/74 (12.2%)	0/53 (0%)	p 0.023 (0 to 0)		LOW	CRITICAL

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Bibliography: 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. 2010 Jan;25(1):225-30. doi: 10.1093/ndt/gfp420. Epub 2009 Aug 29. PubMed PMID: 19717827.

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Buttonhole technique	Rope-ladder technique	Relative (95% CI)	Absolute		
Haematomas (mean follow-up of 9 months)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	2/75 (2.7%)	14/70 (20%)	p 0.0001 (0 to 0)	200 fewer per 1000 (from 200 fewer to 200 fewer)	LOW	CRITICAL
Aneurisms												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	1/75 (1.3%)	47/70 (67.1%)	p 0.001 (0 to 0)	671 fewer per 1000 (from 671 fewer to 671 fewer)	LOW	CRITICAL
Miscannulations												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	8/75 (10.7%)	4/70 (5.7%)	p 0.001 (0 to 0)	57 fewer per 1000 (from 57 fewer to 57 fewer)	LOW	CRITICAL
Angioplasty performed												

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1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	2/75 (2.7%)	35/70 (50%)	p 0.001 (0 to 0)	500 fewer per 1000 (from 500 fewer to 500 fewer)	⊕⊕⊕⊕ LOW	CRITICAL
Need for local anaesthesia (pain)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	6/75 (8%)	21/70 (30%)	p 0.001 (0 to 0)	300 fewer per 1000 (from 300 fewer to 300 fewer)	⊕⊕⊕⊕ LOW	CRITICAL
Antibiotic treatment due to infections												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	4/75 (5.3%)	0/70 (0%)	p 0.001 (0 to 0)	-	⊕⊕⊕⊕ LOW	CRITICAL

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Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Buttonhole technique N=41	Rope-ladder technique N=41	Relative (95% CI)	Absolute		
AVF recirculation rate (mean follow-up of 14 months)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	8.3 +/- 0.3%	9.3 +/- 0.4 %	P 0.0016 (0 to 0)	73 fewer per 1000 (from 73 fewer to 73 fewer)	LOW	CRITICAL
Fistulography (mean follow-up of 14 months)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	1/41 (2.4%)	10/41 (24.4%)	p 0.008 (0 to 0)	242 fewer per 1000 (from 244 fewer to 244 fewer)	LOW	CRITICAL

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Bibliography: Verhallen AM, Kooistra MP, van Jaarsveld BC. Cannulating in haemodialysis: rope-ladder or buttonhole technique? Nephrol Dial Transplant. 2007 Sep;22(9):2601-4. Epub 2007 Jun 8. PubMed PMID: 17557776.

Quality assessment							No of patients		Effect		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Buttonhole technique N=33	Rope-ladder technique N=33	Relative (95% CI)	Absolute		
puncture ease (18-month follow-up; assessed with: VAS score)¹												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	1.3+/-2 -1	2.9+/-2.4 -	p 0.02 (0 to 0)		LOW	CRITICAL
Bad stick (follow-up 18 months; assessed with: Absolute incidence during the 2 weeks preceding the interview)												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	0.3+/-0.6	0.8+/-1.4	p 0.03 (0 to 0)		LOW	CRITICAL
Decreased pain (18-month follow-up; assessed with: VAS score)¹												
1	observational studies	no serious risk of bias	no serious inconsistency	no serious indirectness	no serious imprecision	none	1.6+/-2.0	2.3+/-2.2	p 0.12 (0 to 0)		LOW	CRITICAL

¹ Patient's score on the Visual Analogue Scale, from 0 ('no problem at all') to 10 ('too hard to cope with').