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INTERVENTIONAL AFFECTING HEMOSTASIS TIME AFTER ARTERIOVENOUS FISTULA NEEDLE REMOVAL IN HEMODIALYSIS PATIENTS: A META-ANALYSIS

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ABSTRACT
Hemostasis following arteriovenous fistula (AVF) needle removal is a key determinant of vascular access outcomes in hemodialysis patients. This meta-analysis aimed to evaluate the effect of hemostatic dressings and needle bevel position on hemostasis time following arteriovenous fistula (AVF) needle removal in hemodialysis patients. This meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A comprehensive search of eight electronic databases identified randomized controlled trials and quasi-experimental studies published between January 2016 and June 2025. Eligible studies evaluated the effects of hemostatic dressings and needle bevel position on hemostasis time following AVF needle removal in adult hemodialysis patients. Study quality was assessed using the Joanna Briggs Institute critical appraisal tools. Due to substantial heterogeneity, random-effects meta-analyses were performed, and standardized mean differences (SMDs) with 95% confidence intervals (CIs) were calculated. Seven studies met the inclusion criteria. Three studies evaluating hemostatic dressings demonstrated a significant reduction in hemostasis time at arterial sites (SMD = −1.23, 95% CI −2.36 to −0.11; p=0.032) and venous sites (SMD = −1.35, 95% CI −2.16 to −0.54; p=0.001). Four studies assessing needle bevel position showed that the bevel-down position significantly reduced hemostasis time compared with the bevel-up position (SMD = −1.30, 95% CI −2.45 to −0.14; p=0.028). All pooled analyses exhibited high heterogeneity.

Keywords: arteriovenous fistula; hemodialysis; hemostasis; needle bevel position; vascular access

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INTRODUCTION

Hemodialysis is the most common renal replacement therapy for patients with end-stage renal disease (ESRD), accounting for approximately 69% of all kidney replacement therapies and 89% of all dialysis treatments (Bello et al., 2022; Rout & Aslam, 2025). For hemodialysis to work, there needs to be a reliable way to connect the patient's blood flow to the extracorporeal dialysis circuit (Murdeshwar et al., 2025). An arteriovenous fistula (AVF) is recommended as the first-choice vascular access for patients undergoing long-term Hemodialysis (Lok et al., 2020; Shawahna et al., 2025).

Patients with end-stage renal disease (ESRD) undergo repeated needle cannulation and decannulation of the arteriovenous fistula (AVF) during each hemodialysis session (Pinto et al., 2022; Terashima et al., 2025). Proper needle removal techniques are important to protect the fistula wall from injury and to support effective hemostasis (Álvaro Cristóbal et al., 2021). Hemostasis is defined as a process that stops bleeding and regulates vascular integrity (B. Guo et al., 2021; Koupenova et al., 2017; LaPelusa & Dave, 2025). Clinical practice guidelines advise applying pressure at the puncture site for a minimum of 10 minutes or until bleeding stops, using constant pressure (Lok et al., 2020; Meléndez-Lugo et al., 2020). The time required to achieve hemostasis in

hemodialysis patients can be influenced by multiple factors, including patient comorbidities, the condition of the skin at the puncture site, platelet count, use of anticoagulant or antiplatelet medications, and the blood flow rate through the vascular access (Terashima et al., 2025). Prolonged bleeding after AVF needle removal can cause significant discomfort for patients and increases the nursing workload and monitoring time until hemostasis is achieved (Bizari et al., 2019).

The standard intervention to achieve hemostasis is manual compression of the puncture site with gauze and finger pressure (Álvaro Cristóbal et al., 2021). However, other factors related to cannulation can affect hemostasis too. The cannulation technique (e.g., buttonhole vs. rope-ladder vs. area puncture) and the needle orientation during insertion (bevel up vs. bevel down) have been reported to influence bleeding time (Milosevic et al., 2024). Some guidelines say it's acceptable to use extra pressure devices like clamps or tourniquets, while others say it's not a good idea (Álvaro Cristóbal et al., 2021). Additionally, sustained pressure on an AVF puncture site may result in clot formation and possible damage to the vascular access (Bizari et al., 2019).

In light of these factors, there is an increasing interest in discovering enhanced methods to attain hemostasis effectively following AVF needle removal. This study aims to identify the effect of hemostatic dressing and bevel needle position on hemostasis time after AVF decannulation in hemodialysis patients.

METHOD

This article is a meta-analysis with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to identify the articles (Page et al., 2021). The PICO framework was used to formulate the research question. The population of interest was adult hemodialysis patients (age ≥ 18) with ESRD who use an AVF for vascular access. The interventions of interest were strategies to achieve hemostasis after AVF needle removal, particularly the use of advanced hemostatic dressings and modified cannulation techniques. The comparison conditions encompassed traditional management utilising standard gauze and manual compression, as well as conventional needle orientation. The outcomes measured included the time required to achieve hemostasis and any associated safety issues.

We performed literature searches in the following databases: PubMed, Scopus, ScienceDirect, ProQuest, EBSCOhost, Wiley Online Library, Springer Nature Link, and SAGE Journals. They were published between January 2026 until June 2025. We searched for original research articles that evaluated strategies to achieve hemostasis after AVF needle removal in post-hemodialysis patients. The final search was conducted in September 2025. The search was conducted using a combination of keywords and Boolean operators, as follows: (“hemostasis” OR “bleeding control” OR “coagulation”) AND “arteriovenous fistula” AND (“needle removal” OR “needle withdrawal”) AND (“after hemodialysis” OR “post-hemodialysis”) NOT “surgery”. After conducting the searches, duplicate records were removed, and results were limited by applying filters according to the inclusion criteria (publication in the past 10 years, research article type, English language, and availability of full text). Then, we followed a two-stage screening process (title/abstract screening followed by full-text screening) to identify the studies for inclusion.

The studies that met the inclusion criteria for this review included (1) adult patients aged ≥18 years with ESRD who were undergoing hemodialysis using AVF vascular access; (2) studies discussing strategies to assist in achieving hemostasis after AVF needle removal; (3) articles published in English; (4) articles published within the last 10 years (2016-2025); and (5) studies utilizing RCT or quasi-experimental designs. Studies were excluded if (1) the patient population had ESRD and used non-AVF access during hemodialysis; (2) they included only non-adult patients; (3) they were unrelated to the post-hemodialysis procedure; or (4) they omitted a comparison intervention.

Studies were manually and independently screened by two authors (Y.P and A.U) based on titles and abstract, without the use automation tools. The full articles were subsequently reviewed to confirm inclusion. Data was collected using a standardised data extraction form. A matrix table was created to systematically extract data from the selected study, focusing on summarising the characteristics of the studies, including author name, year, study location, intervention technique to achieve hemostasis, measurement outcomes, total of population sample, study design, follow-up, and results.

Study risk of bias assessment

Two authors (Y.P and A.U) independently assessed the risk of bias in the studies using Joanna Briggs Institute's (JBI) checklist for quasi-experimental studies and randomized controlled trial studies. The JBI Checklist for Quasi-Experimental Studies consists of 9 items which evaluate five domains of bias: (1) related temporal precedence, (2) selection and allocation, (3) confounding factors, (4) administration of intervention, and (5) participant retention.(Barker et al., 2024) The JBI Checklist for Randomized Controlled Trials consists of 13 items which evaluate four domains of bias: (1) related to selection and allocation, (2) administration of intervention, (3) assessment, detection, and measurement of the outcome, and (4) participant retention (Barker et al., 2023). Each item contains a question with four possible answers: yes, no, unclear, or not applicable. Studies with more than 75% “yes” answers were categorised as having high methodological quality, those between 50-75% as moderate quality, and below 50% as low quality.

Synthesis methods

The synthesis method used is narrative synthesis. Narrative synthesis is a method that uses a text-based or word-based approach to systematically review and combine results. The data synthesis process consisted of the following: (1) extracted data were tabulated to summarise key study characteristics, (2) studies were grouped according to intervention categories, (3) the methodological quality of each study was integrated into the synthesis using the JBI Critical Appraisal Checklist score, and (4) results were synthesized thematically and interpreted in relation to clinical relevance, nursing implications, and alignment with existing vascular access care guidelines.

The studies selected for the systematic review were presented in a summary table with the following main attributes: the author’s name, year of publication, country, intervention, outcome, sample size, study design, follow-up, and result. We performed a meta-analysis only when studies were sufficiently homogeneous in term of participants, intervention, outcome, measurement, and method of aggregation (e.g., mean and standard deviation). Mean differences (MDs) or standardised mean differences (SMDs) with 95% confidence intervals (CIs) were computed for continuous data. A weighted fixed-effect model was used if there was no significant heterogeneity; otherwise, a random-effect model was used. Statistical heterogeneity was analysed by I^2 statistics. Heterogeneity was categorised as follows: low, I^2 = 0-25%; medium, I^2 = 25-50%; high, I^2 = 50-75%; strong, I^2 = 75-100%. An I^2 of less than 50% was considered acceptable heterogeneity. Publication bias was tested using Egger’s regression test. A p-value < 0.05 was considered significant. Meta-analysis was performed with the generic inverse variance method using Cochrane Collaboration Review Manager software (RevMan 5.4) for Windows. This study has been registered with PROSPERO under ID number CRD420261292097 since January 24, 2026.

RESULT

The article selection process is illustrated in the PRISMA flow diagram (Fig. 1). After removing duplicates and applying limiters, the systematic search yielded 1,303 articles with full-text availability. These records were screened by title and abstract, from which 1,284 were excluded. Nineteen articles remained for further evaluation. The full texts of these 19 articles were assessed for eligibility, resulting in the exclusion of 10 articles because they were either irrelevant to post-

hemodialysis needle removal hemostasis or had an inappropriate study design (for example, some were systematic literature reviews or scoping reviews). These removals left 9 studies that initially met all inclusion criteria. Upon closer examination, 2 of these 9 studies were excluded for meta-analysis because they focused on achieving hemostasis after percutaneous AVF procedures rather than routine post-dialysis needle removal. Finally, there were seven articles that met the inclusion criteria for meta-analysis.

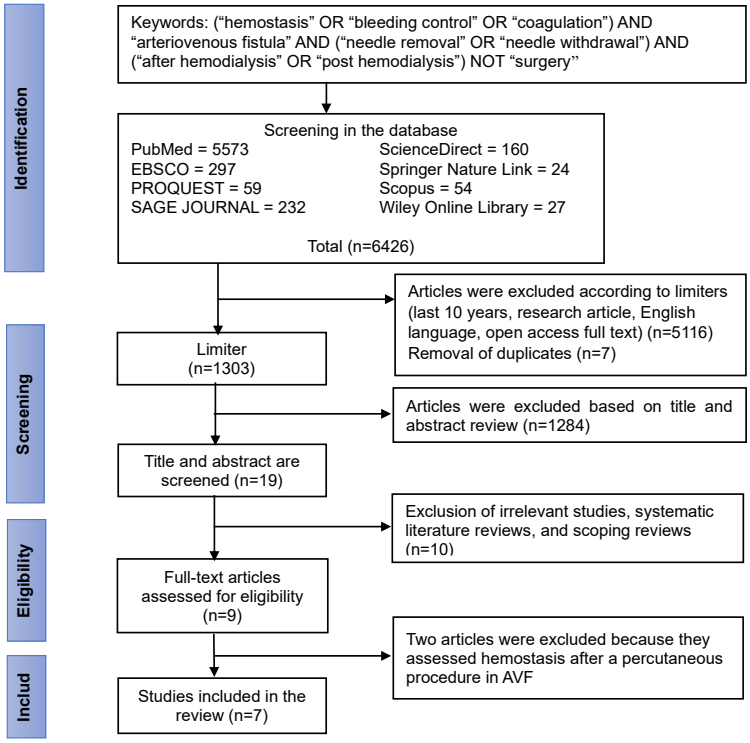

Figure 1. PRISMA flowchart

Six quasi-experimental studies and one randomized controlled trial involving adult patients aged ≥18 years with ESRD and AVF vascular access were included. (Bizari et al., 2019; Kliuk-Ben-Bassat et al., 2021; Loizeau et al., 2023; Mahmoud et al., 2025; Misgav et al., 2017; Ozen et al., 2022; Yilmaz et al., 2022) Five studies collected data primarily from Asia,(Bizari et al., 2019; Kliuk-Ben-Bassat et al., 2021; Misgav et al., 2017; Ozen et al., 2022; Yilmaz et al., 2022) and one study each from Africa and Europe.(Loizeau et al., 2023; Mahmoud et al., 2025) Three studies compared the use of hemostatic dressings with conventional gauze to achieve minimal hemostasis time after AVF needle removal at both arterial and venous puncture sites.(Bizari et al., 2019; Kliuk-Ben-Bassat et al., 2021; Misgav et al., 2017) Four studies compared needle insertion techniques and orientations that affect hemostasis time after AVF needle removal.(Loizeau et al., 2023; Mahmoud et al., 2025; Ozen et al., 2022; Yilmaz et al., 2022) Three studies indicated that hemostatic dressings significantly accelerated hemostasis time ($p<0.001$),(Bizari et al., 2019; Kliuk-Ben-Bassat et al., 2021; Misgav et al., 2017) three other studies indicated that bevel-down needle orientation accelerated hemostasis time ($p<0.05$),(Mahmoud et al., 2025; Ozen et al., 2022; Yilmaz et al., 2022) and one study showed no significant difference in hemostasis time for both needle orientation technique ($p=0.72$).(Loizeau et al., 2023) Two studies excluded from meta-analysis were presented in the narrative synthesis.(Lai et al., 2020; O'Reilly et al., 2016) The summary of characteristics of the included studies is shown in Table 1.

Risk of bias in studies

The methodological quality assessment of these seven studies was conducted using the JBI checklist for quasi-experimental and randomized controlled trials (Table 2). The methodological appraisal revealed that all studies in this review were of high quality (>75%) according to JBI

criteria, with common limitations including a lack of randomisation and short follow-up periods. Despite these weaknesses, the consistency of outcome measures and alignment across studies support the validity of the synthesized evidence.

Hemostatic intervention techniques

Across the evaluated literature, the interventions for achieving hemostasis after AVF needle removal can be categorised into two main types, namely application of hemostatic dressings and adjustments in needle bevel position during cannulation. The three studies investigating hemostatic dressing interventions included a chitosan-based pad, a commercial polymer sponge dressing (HemoFoam®), and a chemically treated cellulose gauze (WoundClot® (Bizari et al., 2019; Kliuk-Ben-Bassat et al., 2021; Misgav et al., 2017). The four studies focusing on needle bevel orientation compared it to traditional bevel-up cannulation (Loizeau et al., 2023; Mahmoud et al., 2025; Ozen et al., 2022; Yilmaz et al., 2022). Two studies that were not included in the meta-analysis used a simple tourniquet and pneumatic compression device for bleeding control or acquiring hemostasis of arterio-venous hemodialysis fistula access after percutaneous procedure (Lai et al., 2020; O'Reilly et al., 2016). A retrospective study of simple tourniquet technique showed that bleeding was successfully controlled in all patients in the study (n=1966) (Lai et al., 2020). Another retrospective study on the use of pneumatic compression devices showed that hemostasis was achieved in 26 of 27 access sites following 15-29 minutes of compression (O'Reilly et al., 2016).

Three articles reported on the effects of hemostatic dressing on hemostasis time post-AVF needle removal in hemodialysis patients (Bizari et al., 2019; Kliuk-Ben-Bassat et al., 2021; Misgav et al., 2017). The three articles measured hemostasis time in arterial and venous site. There was high heterogeneity among arterial hemostasis time in these studies (I^2 = 90.8%); therefore, a random-effect model was used for the analysis. The analysis indicated a significant difference in hemostasis time between the experimental and control groups (SMD = -1.23 min)

Table 1.
Summary of characteristics of the included studies

No	Authors, years	Intervention techniques	Measuring outcome	Total population samples	Study design	Follow-up	Key results
1	Misgav et al., 2017 (Israel)	Chitosan pad vs. Gauze pad	Hemostasis or bleeding time after AVF needle removal (minute)	Hemodialysis patient with AVF (n=15) The study involved five HD sessions using a chitosan pad, followed by five sessions using a gauze pad, until reaching a total of 144 applications for each type	Quasi-experimental	Five hemodialysis sessions	Mean time to hemostasis was significantly shorter with the chitosan pad compared to the gauze pad application for both access points (arterial 3.00±1.87 min vs. 18.76±9.20 min and venous 2.83±1.77 min vs. 13.28±6.75 min, p<0.001).
2	Bizari et al., 2019 (Iran)	HemoFoam® vs. Conventional Gauze Dressing	Hemostasis or bleeding time after AVF needle removal (minute)	Hemodialysis patient with AVF (n=60) 1st session with HemoFoam® 2nd session with gauze dressing	Quasi-experimental	Immediately after the procedure	The mean time of hemostasis in the conventional gauze dressing group was longer than the HemoFoam® group (venous 10.54±6.65 min vs. 2.86±1.87 min and arterial 12.74±9.24 min vs. 3.15±1.97 min,

No	Authors, years	Intervention techniques	Measuring outcome	Total population samples	Study design	Follow-up	Key results
							p<0.001).
3	Kliuk-Ben-Bassat et al., 2021 (Israel)	WoundClot® hemostatic gauze vs. cotton gauze	Hemostasis or bleeding time after AVF needle removal (minute)	Hemodialysis patient with AVF (n=49) Intervention group with WoundClot® (n=24) and control group with cotton gauze (n=25)	Quasi-experimental	12 months	WoundClot® use shortened significantly the time needed for hemostasis (mean venous bleeding time decreased 3.99±4.6 min and mean arterial bleeding time decreased 6.38±4.8 min with mean bleeding time at baseline higher in the WC group (p<0.001)).
4	Yilmaz et al., 2022 (Turkey)	Needle bevel position (up vs. down)	Hemostasis or bleeding time after AVF needle removal (minute	Hemodialysis patient with AVF (n=55) 1st HD session used bevel-up and LMWH anticoagulant 2nd HD session used bevel-down and LMWH anticoagulant 3rd HD session used bevel-up and UFH anticoagulant 4th HD session used bevel-down and UFH anticoagulant	Quasi-experimental (experiment observation)	Immediately after the procedure	Bleeding stop times in bevel-down puncture were significantly shorter compared to bevel-up puncture: 3±1 min vs. 6±1 min in patients with LMWH anticoagulant and 3±0 min vs. 5±1 min with UFH anticoagulant (p<0.05).
5	Ozen et al., 2022 (Turkey)	Needle bevel position (up vs. down)	Puncture pain with VAS and hemostasis or bleeding time after AVF needle removal (minute)	Hemodialysis patient with AVF (n=35) 1st six HD sessions with bevel-up 2nd six HD sessions with bevel-down	Quasi-experimental	Occurring during each hemodialysis session	The VAS value was higher in the bevel-up group in all sessions. The bleeding time was lower in the bevel-down group in all sessions, with a mean postremoval bleeding time of 5.89±1.43 min when the needle bevel pointed upward and 4.76±0.98 min when the needle pointed downward (p<0.001).
6	Loizeau et al., 2023 (France)	Needle bevel orientation (up vs. down)	Minimum compression time required or hemostasis time (minute)	Hemodialysis patient with AVF (n=42) Bevel-up group (n=22) bevel-down group (n=20) crossover in the next phase HD session	RCT	Across two intervention periods	There is no significant difference in compression time required for hemostasis between needle insertion bevel up and bevel down (p=0.72), with the mean hemostasis time in the bevel-down period being 10.82±5.11 min,

No	Authors, years	Intervention techniques	Measuring outcome	Total population samples	Study design	Follow-up	Key results
							while in the bevel-up period it was 11.86±4.67 min.
7	Mahmoud et al., 2025 (Egypth)	Needle bevel orientation (up vs. down)	Puncture pain with VAS and hemostasis or bleeding time after AVF needle removal (minute)	Hemodialysis patient with AVF (n=50) Bevel-up group (n=25) Bevel-down group (n=25)	Quasi-experimental	Six HD sessions	There was no statistically significant difference between the two groups regarding level of pain (p=0.169); however, bleeding time was lower in patients who had their arterial needle inserted in a bevel-down orientation (p<0.05). The hemostasis mean for the bevel-up position was 3.08±0.86 min, while the bevel-down position was 2.20±0.76 min.

Table 2.
Article quality assessment using the JBI Checklist

No	Randomized Control Trial	A6	Quasi-Experimental	A1	A2	A3	A4	A5	A7
1	Was true randomization used for assignment of participants to treatment groups?	Y	Is it clear in the study what is the "cause" and what is the "effect" (i.e. there is no confusion about which variable comes first)?	Y	Y	Y	Y	Y	Y
2	Was allocation to treatment groups concealed?	Y	Was there a control group?	Y	Y	N	NA	Y	N
3	Were treatment groups similar at the baseline?	Y	Were participants included in any comparisons similar?	Y	Y	NA	Y	Y	Y
4	Were participants blind to treatment assignment?	Y	Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	Y	Y	Y	Y	Y	Y
5	Were those delivering the treatment blind to treatment assignment?	Y	Were there multiple measurements of the outcome, both pre and post the intervention/ exposure?	Y	Y	Y	Y	Y	Y
6	Were treatment groups treated identically other than the intervention of interest?	Y	Were the outcomes of participants included in any comparisons measured in the same way?	Y	Y	Y	Y	Y	Y
7	Were outcome assessors blind to treatment assignment?	Y	Were outcomes measured in a reliable way?	Y	Y	Y	Y	Y	Y
8	Were outcomes measured in the same way for treatment groups?	Y	Was follow-up complete and if not, were differences between groups in terms of their follow-up adequately described and analyzed?	Y	Y	Y	Y	Y	Y
9	Were outcomes measured in a reliable way?	Y	Was appropriate statistical analysis used?	Y	Y	Y	Y	Y	Y
10	Was follow up complete and if not, were differences between groups in terms of their follow up	Y							

No	Randomized Control Trial	A6	Quasi-Experimental	A1	A2	A3	A4	A5	A7
	adequately described and analysed?								
11	Were participants analysed in the groups to which they were randomized?	Y							
12	Was appropriate statistical analysis used?	Y							
13	Was the trial design appropriate and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	Y							
Percentage (%)		100		100	100	77.8	88.9	88.9	88.9

*A: Article; Y: Yes; N: No; NA: Not Applicable

95% CI [-2.36, -0.11], $p = 0.032$), as shown in Figure 2. Egger's regression test showed no evidence of publication bias ($p = 0.89$), but the number of studies was only 3, so Egger's regression test may not be statistically valid. Heterogeneity among venous hemostasis time in these studies was also high ($I^2 = 82.1\%$); therefore, a random-effect model was used for the analysis. The analysis indicated a significant difference in hemostasis time between the experimental and control groups (SMD = -1.35 min, 95% CI [-2.16, -0.54], $p = 0.001$), as shown in Figure 3. Egger's regression test showed no evidence of publication bias ($p = 0.95$), but the number of studies was only 3, so Egger's regression test may not be statistically valid.

The confidence interval does not cross zero at both the arterial and venous sites, indicating that the difference is real. A subgroup analysis also suggested that hemostatic dressings significantly reduce hemostasis time in the Iranian study, while there was no significant hemostatic dressing effect on Hemostasis time in the Israel studies. A negative trend in all studies, meaning that hemostatic dressing interventions tended to result in shorter hemostasis time in both arterial and venous site.

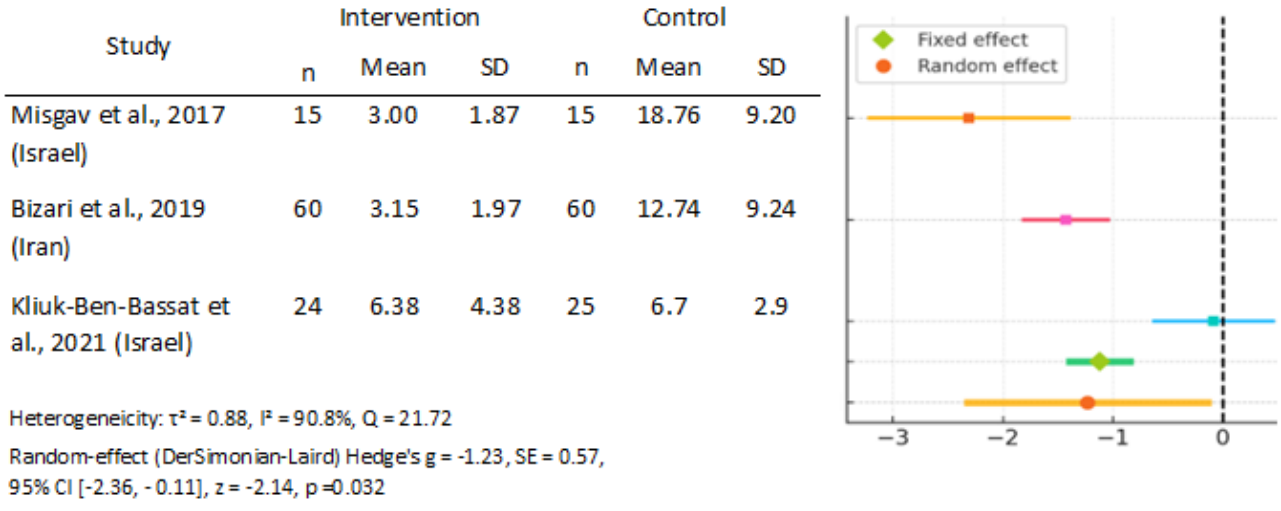

Figure 2. Effect of hemostatic dressing on arterial hemostasis time

Study	Intervension			Control		
	n	Mean	SD	n	Mean	SD
Misgav et al., 2017 (Israel)	15	2,83	1,77	15	13,28	6,75
Bizari et al., 2019 (Iran)	60	2,86	1,87	60	10,54	6,65
Kliuk-Ben-Bassat et al., 2021 (Israel)	24	3,99	4,6	25	6,10	2,90

Heterogeneicity: $\tau^2 = 0.41$, $I^2 = 82.1\%$, $Q = 11.18$

Random-effect (DerSimonian-Laird) Hedge's g = -1.35, SE = 0.41, 95% CI [-2.16, - 0.54], z = -3.26, p < 0.001

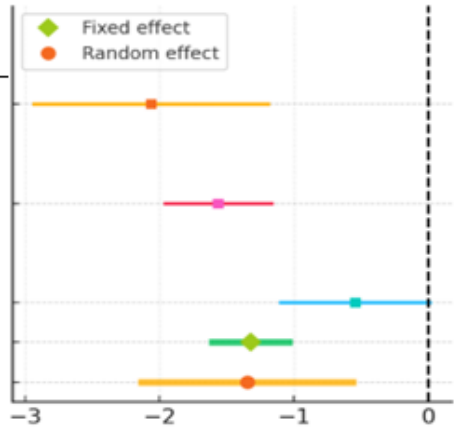

Figure 3. Effect of hemostatic dressing on venous hemostasis time

Study	Bevel-down			Bevel-up		
	n	Mean	SD	n	Mean	SD
Yilmaz et al., 2022 (Turkey)	55	3.00	1.00	55	6.00	1.00
Ozen et al., 2022 (Turkey)	35	4.76	0.98	35	5.89	1.43
Loizeau et al., 2023 (France)	20	10.82	5.11	22	11.86	4.67
Mahmoud et al., 2025 (Egypt)	25	2.20	0.76	25	3.08	0.86

Heterogeneicity: $\tau^2 = 1.31$, $I^2 = 94.2\%$, $Q = 52.08$

Random-effect (DerSimonian-Laird) Hedge's g = -1.30, SE = 0.59, 95% CI [-2.45, - 0.14], z = -2.20, p < 0.029

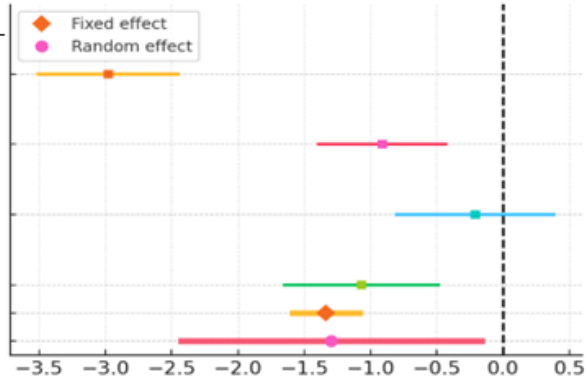

Figure 4. Effect of neddle bevel position on AVF hemostasis time

Four articles reported on the effect of needle bevel position during cannulation on hemostasis time post-AVF needle decannulation procedure (Loizeau et al., 2023; Mahmoud et al., 2025; Ozen et al., 2022; Yilmaz et al., 2022). The heterogeneity among studies was high (I^2 = 94.2%); therefore, a random-effect model was used for the analysis. The result indicated that there was a significant difference in hemostasis time between the bevel-down and bevel-up groups (SMD = -1.30 min, 95% CI [-2.45, -0.14], p = 0.029), as shown in Figure 4. The p-value < 0.05 indicates that there is a statistically significant difference between the needle bevel-down and bevel-up positions. The SMD = -1.3 indicates a large effect, with the average hemostasis time in the bevel-down group being approximately 1 standard deviation lower than in the bevel-up group. The confidence interval does not cross zero, reinforcing the conclusion that this difference is real. Egger's regression test showed no evidence of publication bias (p = 0.76), but the number of studies was only 4, so Egger's regression test may not be statistically valid.

Intervention risks and patient comfort

In addition to hemostasis times, the included studies reported on any adverse events or other outcomes related to the interventions. Misgav et al. noted that no episodes of prolonged bleeding occurred when using the chitosan pad, though minor skin irritation or lesions were not specifically assessed (Misgav et al., 2017). Two patients experienced recurrent bleeding at home after

WoundClot® was applied and removed, and one patient had a skin lesion at the site (Kliuk-Ben-Bassat et al., 2021). In the control group using standard gauze, 2 patients (3.3%) had re-bleeding episodes, and 1 patient (1.6%) developed a haematoma (Bizari et al., 2019; Kliuk-Ben-Bassat et al., 2021). Meanwhile, among patients treated with HemoFoam®, no haematomas or recurrent bleeding were reported, whereas the gauze group had a few instances as noted (Bizari et al., 2019).

Needle bevel position was examined not only for bleeding time but also for its effect on cannulation pain. Pain scores using a Visual Analogue Scale (VAS) were significantly lower when the needle was inserted with the bevel down; the mean VAS pain score was 1.16 with bevel-down vs. 1.66 with bevel-up ($p<0.001$) (Ozen et al., 2022; Yilmaz et al., 2022). But two other studies reported no significant difference in pain between bevel-up and bevel-down groups ($p>0.05$) (Loizeau et al., 2023; Mahmoud et al., 2025).

The use of a simple tourniquet technique for bleeding control after percutaneous Hemodialysis fistula and graft procedures has been several complications, such us haematoma (2.9%), thrombosis (0.6%), and rebleeding (0,4%) (Lai et al., 2020). No complications were reported with the use of the pneumatic compression device after the percutaneous procedure (O'Reilly et al., 2016).

DISCUSSION

ESRD patients undergoing hemodialysis with AVF vascular access will experience a hemostasis process at the end of each hemodialysis session after the arterial and venous needles are removed. The results of the analysed studies indicate that the intervention techniques used to achieve hemostasis in hemodialysis patients have a significant impact on the time required to stop bleeding, patient comfort, and the potential for long-term complications in the AVF. A meta-analysis of three quasi-experimental studies indicated that the use of hemostatic dressings significantly reduced the hemostasis time after AVF needle removal at both arterial and venous sites. A meta-analysis of another three quasi-experimental studies and one RCT study also indicated that the bevel-down needle orientation during cannulation significantly reduced the time to hemostasis after AVF needle removal.

Compression with hemostatic agents can reduce the time to achieve hemostasis (De Melo Neto et al., 2026). The chitosan pad and HemoFoam® dressing are based on the polysaccharide chitosan, derived from crustacean shells, known for its pro-coagulant properties. Chitosan works by aggregating red blood cells, increasing platelets, activating hemostasis-related pathways, and enhancing clot formation (B. Guo et al., 2021; Y. Guo et al., 2026). In practice, when using a chitosan pad on a dialysis puncture, place the pad directly over the puncture site immediately after needle removal and apply gentle pressure for about 2 minutes. If hemostasis is achieved within this timeframe, the pad is then secured with adhesive and left in place (it can be removed after roughly 8 hours). If the bleeding doesn't stop after 2 minutes, the pad is replaced with a new chitosan pad, and pressure is applied for another 4 minutes. This stepped approach capitalizes on chitosan's efficacy; in most cases, bleeding stopped within the first few minutes of application (Misgav et al., 2017).

HemoFoam® is a flexible sponge dressing that is also biocompatible and designed to be non-irritating. According to Bizari et al. (2019), HemoFoam® can absorb up to 8 times its weight in blood within about 2 minutes. To use it, the sponge is placed over the puncture site, and manual two-finger pressure is applied. After two minutes, one checks for bleeding by observing through the semi-porous sponge; if bleeding persists, compression is continued in additional two-minute intervals until bleeding stops. HemoFoam® was reported to achieve hemostasis more reliably and quickly than gauze and, importantly, provided consistent pressure distribution at the site. The study noted no allergic reactions or local tissue irritation with HemoFoam®, underlining its safety profile (Bizari et al., 2019).

WoundClot® is a newer hemostatic gauze composed of chemically modified cellulose. Upon contact with blood, WoundClot® transforms into a sticky, transparent hydrogel that adheres to the wound site. This action closes the wound and starts the process of blood clotting in the area. In the clinical use described by Kliuk-Ben-Bassat et al. (2021), WoundClot® is placed on the AVF puncture site immediately after needle withdrawal, and manual pressure with two fingers is applied to halt bleeding initially. The hydrogel-forming gauze stays in place as a protective seal after the bleeding has stopped. The study's long-term use of WoundClot® over 12 months was associated with not only faster hemostasis but also a slight improvement in dialysis efficacy and no increase in access complications (Kliuk-Ben-Bassat et al., 2021).

Four studies in this meta-analysis examined the effect of needle bevel position (down vs. up) on post-dialysis hemostasis time (Loizeau et al., 2023; Mahmoud et al., 2025; Ozen et al., 2022; Yilmaz et al., 2022). Collectively, their findings lean toward bevel-down position being advantageous for hemostasis in most cases. A plausible explanation for this benefit is related to the nature of the puncture wound created. When the bevel is orientated downwards during cannulation, the sharp edge likely causes a smaller, more slit-like wound in the vessel wall, because the bevel may slice through the intima more cleanly and the opening is partially occluded by the needle's own shaft during withdrawal. This smaller defect can seal more rapidly with a clot once pressure is applied. In contrast, the bevel-up position might create a slightly larger or more gaping wound in the vessel, as the needle's sharp edge faces upward and potentially lifts the intimal flap as it exits, thereby widening the hole (Ozen et al., 2022; Yilmaz et al., 2022). In simpler terms, bevel-down cannulation is like skin "cutting downward", which allows the top part of the vessel puncture to close quicker, whereas bevel-up cannulation is like "cutting upward" and leaving a flap that bleeds longer.

Ozen et al. also argued that bevel-down positioning could reduce trauma and pain because the needle's angle relative to the vessel wall might cause less stretching of the tissue on insertion (Ozen et al., 2022). Our synthesis finds that two studies did record lower pain with bevel-down, aligning with that hypothesis, though others did not see a pain difference. Bevel-down cannulation may necessitate staff training, as numerous dialysis nurses are familiar with bevel-up insertion and may initially perceive bevel-down insertion as counterintuitive (Loizeau et al., 2023). Nonetheless, these studies suggest that it is a simple, zero-cost technique change that could benefit hemostasis and comfort in many patients.

One consistent point across all included studies is that manual compression remains a fundamental component of post-needle removal care, regardless of any adjunct dressing or technique used (Ghouti-Terki et al., 2022). In every study, after removing the needle, some form of pressure was applied to the site-either by a nurse's or patient's fingers. The Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines (2019 update) also recommend direct two-finger pressure as the standard for achieving hemostasis in AVF (Lok et al., 2020). However, manual digital pressure has limitations. The pressure can change over time, starting out strong and then easing off on its own. If bleeding starts again, the pressure may be reapplied firmly (Álvaro Cristóbal et al., 2021). This variability can prolong the time to stable clot formation (Bizari et al., 2019). The use of mechanical pressure aids (such as clamps or tourniquets specifically designed for AVF) remains controversial (Álvaro Cristóbal et al., 2021). Tourniquets work by squeezing large blood vessels (Galante, 2017). Some dialysis units use compression clamps or band devices to free staff hands, but concerns exist regarding excessive pressure leading to tissue damage or thrombosis if not used carefully. Cristóbal et al., in his study on the comparison of direct two-finger pressure to an adjustable device during the AVF hemostasis process, showed that the use of the adjustable device applied lower and more consistent pressure (Álvaro Cristóbal et al., 2021).

This meta-analysis has several limitations. The number of studies for each outcome was relatively small, resulting in limited statistical power and pooled results that were highly influenced by individual studies. High heterogeneity between studies in all analyses, reflecting variations in methods, populations, and clinical procedures, thereby reducing the certainty of effect estimates. The assessment of publication bias was suboptimal because the number of studies was below the minimum threshold for Egger's test. Further research needs to be conducted with larger samples and stronger designs, including standardised procedural protocols, to reduce heterogeneity. Multicentre studies with more comprehensive methodological reporting are also needed to ensure that effect estimates are stable and generalisable.

CONCLUSION

In summary, this meta-analysis shows that the hemostatic dressing evaluated consistently shortens hemostasis time at both arterial and venous sites. The needle bevel-down position cannulation technique has a significant effect on reducing hemostasis time compared to the needle bevel-up position. These findings provide promising preliminary evidence and confirm the potential of the intervention to improve hemostasis efficiency.

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