Revista Española de Cirugía Ortopédica y Traumatología 69 (2025) T587–T596

Revista Española de Cirugía Ortopédica y Traumatología

www.elsevier.es/rot

ORIGINAL

[Translated article] Utility of postoperative drainage in total hip arthroplasty. A systematic review

C. Moreno-Benet[a], P. Castells-Ayuso[b], I. Miranda[a,c,*], F.J. Miranda[d]

[a] *Facultad de Ciencias de la Salud, Universidad Católica de Valencia, Valencia, Spain*
[b] *Hospital Vithas Valencia 9 de Octubre, Valencia, Spain*
[c] *Servicio de Cirugía Ortopédica y Traumatología, Hospital Arnau de Vilanova, Valencia, Spain*
[d] *Departamento de Fisiología, Universidad de Valencia, Valencia, Spain*

Received 8 July 2024; accepted 23 February 2025
Available online 9 July 2025

KEYWORDS
Drainage;
Total hip arthroplasty;
Transfusion

Abstract
Aim and hypothesis: To investigate the advantages associated with the use of drainage in primary total hip arthroplasty (THA) versus not using drainage and to determine if drainage can be systematically discontinued. The starting hypothesis was that eliminating the use of drainage systematically in THA does not significantly increase the risk of postoperative complications.
Materials and methods: A systematic review was carried out following the PRISMA guidelines in the PubMed and Cochrane Library databases. The search was conducted on February 15, 2024, by entering the terms (''suction drainage'') AND (''total hip arthroplasty''). The Joanna Briggs Institute quality assessment tool was used to assess the quality of the included studies.
Results: Sixteen clinical trials comparing the use of drainage with no drainage in THA were included. No differences were observed in terms of infection rate or haematoma. Some authors find that the use of drainage increases the percentage of patients requiring transfusion and the length of hospitalisation. Of 16 studies, 13 recommend not to use drainage routinely in THA.
Conclusions: The use of drainage in THA has no advantage over no drainage. The results of the clinical trials reviewed suggest that drainage should not be used routinely in THA.

PALABRAS CLAVE
Drenaje;
Artroplastia total de cadera;
Transfusión

Utilidad del drenaje postoperatorio en la artroplastia total de cadera. Una revisión sistemática

Resumen
Objetivo e hipótesis: Conocer las ventajas asociadas al uso de drenaje en la artroplastia total de cadera (ATC) primaria frente a su no utilización y determinar si se puede dejar de utilizar el

DOI of original article: https://doi.org/10.1016/j.recot.2025.02.019
* Corresponding author.
E-mail address: nachomigo@hotmail.com (I. Miranda).

https://doi.org/10.1016/j.recot.2025.07.011

drenaje de forma sistemática. La hipótesis de partida fue que la eliminación del uso de drenaje de forma sistemática en la ATC no aumenta significativamente el riesgo de complicaciones postoperatorias.
Materiales y métodos: Se realizó una revisión sistemática siguiendo la guía PRISMA en las bases de datos PubMed y Cochrane Library. Se realizó la búsqueda el 15 de febrero de 2024, introduciendo los términos («suction drainage») AND («total hip arthroplasty»). Se utilizó la herramienta de evaluación de calidad del Instituto Joanna Briggs para evaluar la calidad de los estudios incluidos.
Resultados: Se han incluido 16 ensayos clínicos que comparan la utilización de drenaje con su no utilización en la ATC. No se observan diferencias en cuanto a tasa de infección ni hematoma. Algunos autores encuentran que con el uso de drenaje aumenta el porcentaje de pacientes que precisaron transfusión y el tiempo de hospitalización. De 16 estudios, 13 recomiendan dejar de usar el drenaje en la ATC de forma rutinaria.
Conclusiones: El uso de drenaje en la ATC no presenta ventajas frente a su no utilización. Los resultados obtenidos en los ensayos clínicos revisados sugieren que el drenaje no debería utilizarse de forma rutinaria en la ATC.

Introduction

Total hip arthroplasty (THA) is a procedure that is currently widely performed for a variety of hip ailments. The use of closed suction drainage is routinely used to decrease the complications arising from this surgery, given that it removes the fluid that remains within the surgical wound (keeping haematomas from forming) and has been associated with lower rates of infection, pain, hospital stay, among others, although it has also been linked to an increased risk of infection as a result of having a port of entry; greater blood loss, and other problems with the wound.[1–3]

Recent studies that have probed the use of drainage in other joints (ankle, shoulder, knee) have also concluded that its use is not routinely indicated;[4–6] indeed, some works do not recommend it for revision hip arthroplasty either.[7,8]

The following questions are posed: What are the advantages of using drainage versus not using it in THA and Should drainage be used routinely in all THA? The starting hypothesis was that it is possible that eliminating the routine use of drainage in THA does not significantly elevate the risk of postoperative complications, and could, in fact, contribute to shortening the duration of hospital stay and lowering the costs associated with the use of drainage.

The aim of this work was to ascertain the advantages associated with the use of drainage in THA relative to not using drainage, as well as to establish whether drainage can be discontinued as a routine practice in THA.

Material and methods

A systematic review was undertaken in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses -PRISMA-[9] guidelines. The bibliographic search was carried out in the PubMed and Cochrane Library databases on 15 February 2024, by entering the terms ('suction drainage') AND ('total hip arthroplasty'). A total of 237 articles resulted from this database search (fig. 1). The references of the selected articles were also cross-referenced (fig. 1). All abstracts and full texts were reviewed by two researchers; in the event of disagreement regarding the selection of the works, it was discussed, and, in case of doubt, they were assessed by another senior researcher in order to make a final decision

Inclusion criteria: 1) studies involving the use of drainage in postoperative primary THA; 2) studies that compare the use of drainage with non-use of drainage in postoperative THA, and 3) full text available in English or Spanish.

Exclusion criteria: 1) bibliographic review, systematic review, and meta-analysis; 2) animal or cadaveric studies; 3) case reports or case series without a control group; 4) letters to the editor or editorial comments; 5) description of the study technique or protocol without clinical results; 6) oral communication at a conference/ poster at a conference; 7) article not available in English or Spanish, and 8) duplicate articles or results.

After having chosen the articles that were selected for full-text review, their methodological quality was determined and appraised on the basis of the Joanna Briggs Institute (JBI) checklist for randomised clinical trials[10] (Table 1) (original in Annex I).

Results

This systematic review included 16 articles (fig. 1).[11-26] All of them are randomised clinical trials that compare the use of drainage to non-use in primary THA; all are rated as level 1 evidence (Table 2). The tranexamic acid and antibiotic protocols used, pre- and postoperative haemoglobin (Hb) levels, and transfusion requirements (Table 3), complications (Table 4) and in all cases, the conclusions of the studies included are presented (Table 5).

Table 1 Joanna Briggs Institute Critical Checklist for Randomized Controlled Trials.

	Bartosz et al.[11]	Fagotti et al.[12]	Białecki et al.[13]	Suarez et al.[14]	Koyano et al.[15]	Kleinert et al.[16]	Cheung et al.[17]	Strahovnik et al.[18]	Dora et al.[19]	Matsuda et al.[20]	Walmsley et al.[21]	González della Valle et al.[22]	Niskanen et al.[23]	Crevoisier et al.[24]	Ovadia et al.[25]	Murphy and Scott[26]
Was true randomization used for assignment of participants to treatment groups?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Was allocation to treatment groups concealed?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	D	Y	Y	N
Were treatment groups similar at the baseline?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Were participants blind to treatment assignment?	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Were those delivering the treatment blind to treatment assignment?	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Were outcome assessors blind to treatment assignment?	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N	D	N
Were treatment groups treated identically other than the intervention of interest?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Table 1 (*Continued*)

	Bartosz et al.[11]	Fagotti et al.[12]	Białecki et al.[13]	Suarez et al.[14]	Koyano et al.[15]	Kleinert et al.[16]	Cheung et al.[17]	Strahovnik et al.[18]	Dora et al.[19]	Matsuda et al.[20]	Walmsley et al.[21]	González della Valle et al.[22]	Niskanen et al.[23]	Crevoisier et al.[24]	Ovadia et al.[25]	Murphy and Scott[26]
Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Were participants analysed in the groups to which they were randomized?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Were outcomes measured in the same way for treatment groups?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Were outcomes measured in a reliable way?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Was appropriate statistical analysis used?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
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	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	D	Y	Y	N
Total score (%)	10 (77)	10 (77)	10 (77)	11 (85)	10 (77)	10 (77)	10 (77)	10 (77)	11 (85)	10 (77)	10 (77)	10 (77)	8 (62)	10 (77)	10 (77)	8 (62)

D: doubtful; RCT: randomised clinical trial; N: no; Y: yes.

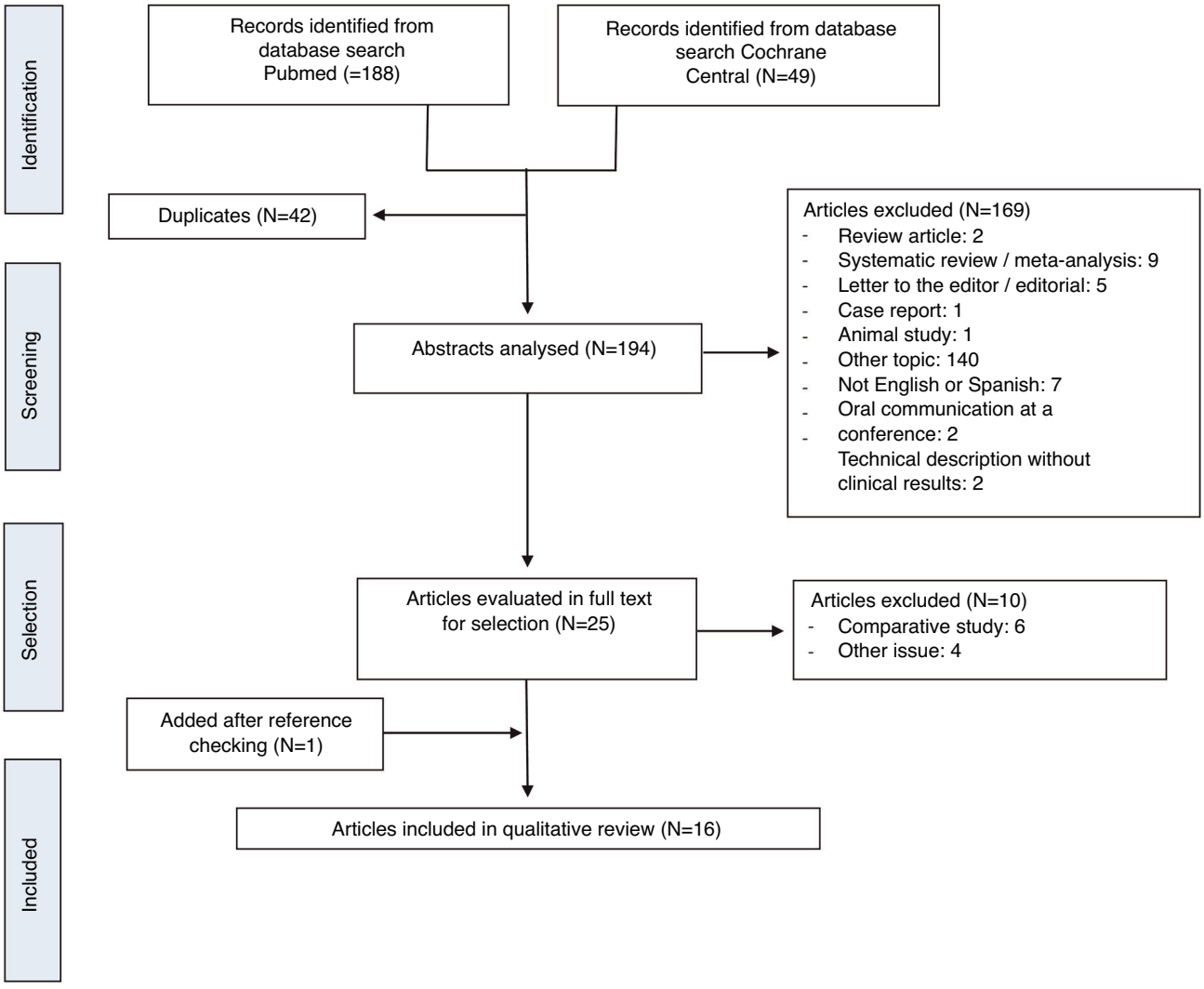

Figure 1 Flow diagram depicting the bibliographic search undertaken.

Discussion

All of the clinical works included in this systematic review are clinical trials that carry an evidence level of 1.

In the studies analysed, a variety of surgical approaches were used: anterior,[15,16] lateral,[12,18,19,24] anterolateral,[15,21] posterolateral,[11,13,15,22,25] and posterior;[17,20] the posterolateral approach was the most frequently used. Both cemented prostheses and uncemented prostheses or hybrids have been used in the works. In some studies, several types of prostheses have been used simultaneously.[13,17,18,22,24,25] This variability of approaches and types of implants notwithstanding, it does not appear that any of them benefit especially from or are particularly disadvantaged by the use of drainage.

Intravenous tranexamic acid has proven to significantly decrease the incidence of anaemia, transfusions, as well as to shorten hospital stay following THA,[27–29] and is being used more and more in standard protocols. In keeping with this trend, tranexamic acid was used as an antifibrinolytic in three of the four most recently published studies included in this series.[11,13,14] Tranexamic acid use has no bearing on the outcomes with respect to the use of drainage, and all three works recommend discontinuing the use of drainage as a matter of course.[11,13,14]

Most of the works analysed used different pharmacological measures for antithrombotic prophylaxis, with the exception of one[26] that did not use any measure whatsoever,[26] and another one[20] that used only compression tights and inflatable boots.[20] The remaining studies predominantly used LMWH;[11,13,15,16,18,19,22–24] others administered heparin,[25] and still others, aspirin[14] in different doses; however, one study used a combination of prophylactic options, heparin and aspirin,[21] while still another called for aspirin together with compression tights.[17] Following these various protocols was not associated with any impact on the outcomes of the use of drainage.

Drainage was left in place for 24 or 48 h in the studies analysed, and 24 h drainage versus 48 h drainage was only compared by Strahovnik et al.[18] in as many groups, finding no significant differences. Removing drainage at 24 or 48 h makes no difference to the majority conclusion to the effect that it is not required on a routine basis.

Table 2 Studies included in the systematic review.

Authors	Year	N	Comparison	Approach	Prosthesis	Drainage time
Bartosz et al.[11]	2021	100	D/no D	PL	Uncemented	-
Fagotti et al.[12]	2018	93	D/no D	L	Uncemented	24 h
Białecki et al.[13]	2017	90	D/no D	PL	Cemented/uncemented	48 h
Suarez et al.[14]	2016	120	D/no D	-	-	-
Koyano et al.[15]	2015	54	BL, D/no D	AL/PL/A	Uncemented	48 h
Kleinert et al.[16]	2012	120	D/no D/AT	A	Uncemented	48 h
Cheung et al.[17]	2010	153	D/no D/AT	P	Cemented/uncemented/ hybrid	24 h
Strahovnik et al.[18]	2010	139	No D/ D 24 h/D 48 h	L	Cemented/uncemented	24/48 h
Dora et al.[19]	2007	100	D/no D	L	Hybrid	48 h
Matsuda et al.[20]	2007	40	D/no D	P	Uncemented	48 h
Walmsley et al.[21]	2005	577	D/no D	AL	-	24 h
González della Valle et al.[22]	2004	104	D/no D	102 PL, 2 TransTr	Cemented/hybrid	24 h
Niskanen et al.[23]	2000	58	D/no D	-	Cemented	24 h
Crevoisier et al.[24]	1998	66	D/no D	L	Hybrid/uncemented	48 h
Ovadia et al.[25]	1997	30	D/no D	PL	Hybrid/cemented	48 h
Murphy and Scott[26]	1993	40	D/no D	-	Cemented	24 h

A: Anterior; AL: Anterolateral; AT: Autotransfusion; BL: Bilateral arthroplasty performed in a single surgical procedure, one with drainage and the other without drainage; D: Drainage; L: lateral; P: Posterior; PL: Posterolateral; TransTr: transtrochanteric.

Haematomas are difficult to prevent as a complication post-THA. They can exert extra pressure on the surrounding tissues and decrease perfusion, thereby fostering bacterial growth.[23] Consequently, while drainage has been proposed as a solution to the accumulation of blood and to promote wound healing,[1] studies have concluded that drainage does not reduce the volume of haematomas after THA.[24,26,30] Subjects with haematomas have been found in both treatment groups, and there is no statistically significant difference between the groups with and without drainage (table 4).

THA is a procedure that involves considerable bleeding, with statistically significant differences between pre- and postoperative Hb values, according to most works. The use of drainage has been associated with greater blood loss[11,12] and significantly lower postoperative Hb and hematocrit levels.[1] Some of the literature reviewed reports no significant differences in postoperative Hb or hematocrit levels, total blood loss, or transfusion[12,16,19,20,24] (table 3). Nevertheless, other studies have documented a substantially greater need for transfusion in the group in which drainage was used.[17,21] These two studies are the ones with the largest sample of all those included in this review, which suggests that, given that the actual transfusion rate in THA is relatively low, in studies involving a small study sample, albeit there is a trend toward more transfusions being administered in those cases in which drainage has been placed,[12,22,25] it is not enough to detect statistically significant differences because it is a relatively rare event. However, in studies involving larger samples, those groups in whom drainage is used are found to have a higher rate of transfusions.[17,21]

Postoperative infection is another possible complication of THA and drainage use.[1,31] Drainage has been linked to the development of infection, as it allows the soft tissues to communicate with the exterior, thereby enabling retrograde migration of micro-organisms.[32,33] Despite the fact that drainage has been correlated with the presence of infection, in these clinical trials, the sample size is not large enough to detect differences in this complication at such a low incidence. In almost all studies a prophylactic antibiotic regimen was administered, with cefuroxime the drug most frequently used.

A hospital stay is a necessary part of the recovery process, which has been found to be prolonged when drainage is used. In three of the studies examined, significant differences with respect to the number of days spent in hospital following surgery were observed among, with a longer mean length of stay in the group in which drainage was used.[16,17,22]

Of the 16 studies included in this systematic review, 13 conclude that drainage should not be routinely used in Primary THA (Table 5), whereas on work concludes that it does not improve anaemia,[20] and only two advocate its use as a matter of course.[15,18]

The present work has its limitations, inasmuch as a variety of surgical approaches, and cemented and uncemented prostheses were used; furthermore, different protocols for thromboprophylaxis and antibiotic therapy were applied, and, in the more recent studies, the use of tranexamic acid was introduced. All of these variables, while they have not been linked to changes in the outcomes from the use of drainage in, could be a potential risk for bias. The

Table 3 Tranexamic acid, anticoagulant, haemoglobin, and transfusion.

Authors	Tranexamic acid	Protocol anticoagulant	Hb pre/Day 1 post (g/dL)		Transfusion n (%)	
			D	No D	D	No D
Bartosz et al.[11]	2 doses (15 mg/kg), 10 min before	LMWH sc before and 35 days post-surgery	-	-	5 (10)	5 (10)
Fagotti et al.[12]	-	Enoxaparin (40 mg) sc 12 h after and for 4 wk	-	-	10 (24)	7 (13)
Białecki et al.[13]	One dose (15 mg/kg) 10 min before	LMWH sc adjusted for weight, 1st dose 12 h before	-/11.4	-/11.4	-	-
Suarez et al.[14]	2 doses (1 g), 1st postoperative and 2nd 24 h	ASA (325 mg) po twice per day	13.7/10.8	13.8/10.9	1 (2)	0
Koyano et al.[15]	-	Enoxaparin (4,000 U/day) sc or edoxaban (30 mg/ day) po	-	-	-	-
Kleinert et al.[16]	-	Enoxaparin (40 mg) sc day from before and 1 dose daily for 6 wk	14/10,2	13.6/9.9	4 (10)	4 (10)
Cheung et al.[17]	-	ASA (150 mg) po daily for 6 wk and a PPI. Compression tights and inflatable boots	13.7/10.5	14.0/10.4	19 (37)	6 (13)*
Strahovnik et al.[18]	-	LMWH sc 12 h before and 12 h after surgery. Continue one dose per day for 35 days	-	-	-	-
Dora et al.[19]	-	LMWH sc before and after surgery as per product recommendations	-	-	-	-
Matsuda et al.[20]	-	Compression tights and inflatable boots. No medication was used	13.4/11.1	13.6/11.0	-	-
Walmsley et al.[21]	-	UFH (15 U/kg) sc and ASA (500 mg) *po* for 3 wk. High-risk cases, enoxaparin (40 mg) sc and ASA (500 mg)	13.4/10.3	13.6/10.5	93 (33)	78 (26)*
González della Valle et al.[22]	-	LMWH (5,000 U) sc until discharge and compression tights	-	-	21 (40)	18 (36)
Niskanen et al.[23]	-	LMWH (5,000 U) sc until discharge and compression tights for 3 days	-	-	-	-
Crevoisier et al.[24]	-	LMWH (0.3-0-4 ml/24 h) sc until discharge	-	-	-	-
Ovadia et al.[25]	-	Heparin (5,000 U) sc twice per day until discharge and compression tights	13.5/9.9	13.5/10.2	9 (50)	2 (17)
Murphy and Scott[26]	-	-	-	-	-	-

ASA: Acetylsalicylic acid (aspirin); D: Drainage; Hb: Haemoglobin; LMWH: Low molecular weight heparin; UFH: Unfractionated heparin; PPI: Proton pump inhibitor; sc: Subcutaneous; po: *per os*.
* $p < 0.05$.

selection of the works selected might be too modest to pick up on statistically significant differences in uncommon complication rates, such as infection or the need for transfusion.

Conclusions

Using drainage in THA does not yield any advantages *versus* not using it.

Table 4 Complications.

Authors	Infection profunda, n (%)		Haematoma, n (%)		Days of hospitalisation	
	D	No D	D	No D	D	No D
Bartosz et al.[11]	0	2 (4)	8 (16)	7 (14)	7	7
Fagotti et al.[12]	0	1 (2)	0	3 (6)	-	-
Białecki et al.[13]	2 (4)	0	3 (6)	6 (15)	7	7
Suarez et al.[14]	-	-	0	0	1.6	1.5
Koyano et al.[15]	0	3 (6)	-	-	-	-
Kleinert et al.[16]	0	0	0	0	6.6	5.4*
Cheung et al.[17]	0	0	-	-	7	6*
Strahovnik et al.[18]	0	0	-	-	7	7
Dora et al.[19]	0	0	-	-	-	-
Matsuda et al.[20]	2 (10)	0	-	-	-	-
Walmsley et al.[21]	2 (0.7)	2 (0.7)	0	1 (0.3)	10	10
González della Valle et al.[22]	0	0	2 (4)	0	5.1	4.7*
Niskanen et al.[23]	-	-	-	-	-	-
Crevoisier et al.[24]	0	0	3 (9)	2 (6)	18	17
Ovadia et al.[25]	0	0	-	-	10.1	8.3
Murphy and Scott[26]	1 (5)	0	-	-	-	-

D: Drainage.
* $p < 0.05$.

Table 5 Conclusions.

Works	Conclusions
Bartosz et al.[11]	Does not recommend the use of drainage in patients who undergo thromboprophylaxis
Fagotti et al.[12]	Recommends stopping the use of drainage, inasmuch as it has revealed no changes with respect to complication rates
Białecki et al.[13]	Recommends stopping the use of drainage, except for selected cases, given that it has failed to demonstrate any statistically significant changes
Suarez et al.[14]	Does not recommend that drainage be used routinely, due to the fact that they find no benefits to its use in patients in whom they used drainage
Koyano et al.[15]	Closed suction drainage improves aspects that have to do with inflammation of the surgical site; as a result, they recommend its use to decrease recovery time
Kleinert et al.[16]	Recommends discontinuing the use of drainage in hip surgeries performed with the anterior approach and uncemented prostheses.
Cheung et al.[17]	Demonstrates that there is no clear benefit associated with the use of suction drainage other than for autologous transfusions.
Strahovnik et al.[18]	Asserts that the use of drainage is independent of associated complications and that it is safe, as well as improving the patient's well-being in the postoperative period.
Dora et al.[19]	Does not advocate the routine use of drainage because it has been found that those in whom drainage was not used had faster wound care and recovered more quickly, in addition to having a shorter hospital stay.
Matsuda et al.[20]	Evinces that not using drainage does not lower the incidence of postoperative anaemia.
Walmsley et al.[21]	Claims that there is evidence that there is no benefit to the use of drainage as regards complications in total hip arthroplasty.
González della Valle et al.[22]	Recommends discontinuing the routine use of drainage because there are no significant differences between the two groups; furthermore, its use increases costs and can expose the patient to adverse effects.
Niskanen et al.[23]	Recommends abandoning the routine use of drainage, inasmuch as all the clinical parameters studied revealed comparable outcomes in those cases in which drainage was used and those in which it was not.
Crevoisier et al.[24]	Indicates that drainage is not required when the surgery is uncomplicated, given that the use of drainage has not proven to yield significant differences among patients as regards haematomas, transfusion, rehabilitation, or length of hospitalisation.

Table 5 (*Continued*)

Works	Conclusions
Ovadia et al.[25]	Claims that routine drainage use is no longer necessary.
Murphy and Scott[26]	Asserts that drainage is associated with increased blood loss, does not reduce haematoma, and is unlikely to improve infection rates.

The outcomes attained in the clinical trials reviewed point toward drainage not being recommended for routine use in THA.

Level of evidence

Level of evidence I.

Registration

The protocol for this systematic review has not been registered.

Ethical considerations

This study has not involved the use of humans or animals. No patient data has been extracted; a systematic review of the bibliography has been carried out and, therefore, does not require the approval of the ethics committee or informed consent to be given by the patients.

Funding

No funding has been received to conduct this work.

Conflict of interests

The authors have no conflict of interests to declare.

Appendix A. Supplementary data

Supplementary data associated with this article can be found in the online version available at https://doi.org/10.1016/j.recot.2025.07.011.

References

1. Chen ZY, Gao Y, Chen W, Li X, Zhang YZ. Is wound drainage necessary in hip arthroplasty? A meta-analysis of randomized controlled trials. Eur J Orthop Surg Traumatol. 2014;24:939–46, http://dx.doi.org/10.1007/s00590-013-1284-0.
2. Migliorini F, Maffulli N, Betsch M, Eschweiler J, Tingart M, Baroncini A. Closed suction drainages in Lower Limb Joint Arthroplasty: A level I evidence based meta-analysis. Surgeon. 2022;20:e51–60, http://dx.doi.org/10.1016/j.surge.2021.02.014.
3. Zhou XD, Li J, Xiong Y, Jiang LF, Li WJ, Wu LD. Do we really need closed-suction drainage in total hip arthroplasty? A meta-analysis. Int Orthop. 2013;37:2109–18, http://dx.doi.org/10.1007/s00264-013-2053-8.
4. Garcia-Maya B, Morais S, Diez-Sebastian J, Antuña S, Barco R. Drain use can be avoided in reverse shoulder arthroplasty. Injury. 2023;54 Suppl 7:111041, http://dx.doi.org/10.1016/j.injury.2023.111041.
5. Mazzotti A, Artioli E, Giannini I, Zielli SO, Arceri A, Langone L, et al. Drain versus no drain after total ankle arthroplasty: Are there any differences in complications rate? Arch Orthop Trauma Surg. 2024;144:1071–6, http://dx.doi.org/10.1007/s00402-023-05165-6.
6. Albasha A, Salman LA, Elramadi A, Abudalou A, Mustafa A, Hejleh HAA, et al. Outcomes of drain versus no drain in total knee arthroplasty: A retrospective cohort study. Int Orthop. 2023;47:2985–9, http://dx.doi.org/10.1007/s00264-023-05946-z.
7. Umer HM, Iqbal HJ, Shah N, Vora H, Mahmood A, Board T. Is it safe to perform revision hip arthroplasty without suction drains? Cureus. 2023;15:e39682, http://dx.doi.org/10.7759/cureus.39682.
8. Okuzu Y, Goto K, Kuroda Y, Kawai T, Matsuda S. Closed suction drainage may not be beneficial in revision total hip arthroplasty: A propensity score-matched cohort study. Indian J Orthop. 2023;57:1041–8, http://dx.doi.org/10.1007/s43465-023-00901-x.
9. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. J Clin Epidemiol. 2021;134:178–89, http://dx.doi.org/10.1016/j.jclinepi.2021.03.001.
10. Tufanaru C, Munn Z, Aromataris E, Campbell J, Hopp L. Systematic reviews of effectiveness. In: Aromataris E, Porritt K, Pilla B, Jordan Z, editors. JBI manual for evidence synthesis. Adelaide: JBI; 2020.
11. Bartosz P, Marczyński W, Para M, Kogut M, Białecki J. Comparative study of suction drainage placement in cementless hip replacement among patients undergoing extended thromboprophylaxis: A prospective randomized study. BMC Musculoskelet Disord. 2021;22:6886888, http://dx.doi.org/10.1186/s12891-021-04583-0.
12. Fagotti L, Ejnisman L, Miyahara HS, Gurgel HMC, Croci AT, Vicente JRN. Use of closed suction drainage after primary total hip arthroplasty: A prospective randomized controlled trial. Rev Bras Ortop. 2018;53:236–43, http://dx.doi.org/10.1016/j.rboe.2018.01.001.
13. Białecki J, Bartosz P, Marczyński W, Zając J. Usefulness of ultrasonography in the diagnosis of hematoma after primary hip arthroplasty. J Ultrason. 2017;17:149–53, http://dx.doi.org/10.15557/JoU.2017.0022.
14. Suarez JC, McNamara CA, Barksdale LC, Calvo C, Szubski CR, Patel PD. Closed suction drainage has no benefits in anterior hip arthroplasty: A prospective, randomized trial. J Arthroplasty. 2016;31:1954–8, http://dx.doi.org/10.1016/j.arth.2016.02.048.
15. Koyano G, Jinno T, Koga D, Hoshino C, Muneta T, Okawa A. Is closed suction drainage effective in early recovery of hip joint function? Comparative evaluation in one-stage bilateral total hip arthroplasty. J Arthroplasty. 2015;30:74–8, http://dx.doi.org/10.1016/j.arth.2014.08.007.

16. Kleinert K, Werner C, Mamisch-Saupe N, Kalberer F, Dora C. Closed suction drainage with or without re-transfusion of filtered shed blood does not offer advantages in primary non-cemented total hip replacement using a direct anterior approach. Arch Orthop Trauma Surg. 2012;132:131–6, http://dx.doi.org/10.1007/s00402-011-1387-1.
17. Cheung G, Carmont MR, Bing AJF, Kuiper JH, Alcock RJ, Graham NM. No drain, autologous transfusion drain or suction drain? A randomised prospective study in total hip replacement surgery of 168 patients. Acta Orthop Belg. 2010;76 :619–27.
18. Strahovnik A, Fokter SK, Kotnik M. Comparison of drainage techniques on prolonged serous drainage after total hip arthroplasty. J Arthroplasty. 2010;25:244–8, http://dx.doi.org/10.1016/j.arth.2008.08.014.
19. Dora C, von Campe A, Mengiardi B, Koch P, Vienne P. Simplified wound care and earlier wound recovery without closed suction drainage in elective total hip arthroplasty. A prospective randomized trial in 100 operations. Arch Orthop Trauma Surg. 2007;127:919–23, http://dx.doi.org/10.1007/s00402-006-0260-0.
20. Matsuda K, Nakamura S, Wakimoto N, Kobayashi M, Matsushita T. Drainage does not increase anemia after cementless total hip arthroplasty. Clin Orthop Relat Res. 2007;458:101–5, http://dx.doi.org/10.1097/BLO.0b013e31802ea45f.
21. Walmsley PJ, Kelly MB, Hill RM, Brenkel I. A prospective, randomised, controlled trial of the use of drains in total hip arthroplasty. J Bone Joint Surg Br. 2005;87:1397–401, http://dx.doi.org/10.1302/0301-620X.87B10.16221.
22. González della Valle A, Slullitel G, Vestri R, Comba F, Buttaro M, Piccaluga F. No need for routine closed suction drainage in elective arthroplasty of the hip: A prospective randomized trial in 104 operations. Acta Orthop Scand. 2004;75:30–3, http://dx.doi.org/10.1080/00016470410001708050.
23. Niskanen RO, Korkala OL, Haapala J, Kuokkanen HO, Kaukonen JP, Salo SA. Drainage is of no use in primary uncomplicated cemented hip and knee arthroplasty for osteoarthritis: A prospective randomized study. J Arthroplasty. 2000;15:567–9, http://dx.doi.org/10.1054/arth.2000.6616.
24. Crevoisier XM, Reber P, Noesberger B. Is suction drainage necessary after total joint arthroplasty? A prospective study. Arch Orthop Trauma Surg. 1998;117:121–4, http://dx.doi.org/10.1007/s004020050210.
25. Ovadia D, Luger E, Bickels J, Menachem A, Dekel S. Efficacy of closed wound drainage after total joint arthroplasty. A prospective randomized study. J Arthroplasty. 1997;12:317–21, http://dx.doi.org/10.1016/S0883-5403(97)90029-2.
26. Murphy JP, Scott JE. The effectiveness of suction drainage in total hip arthroplasty. J R Soc Med. 1993;86:388–9, http://dx.doi.org/10.1177/014107689308600706.
27. Miranda I, Collado-Sánchez A, Peregrín-Nevado I, Díaz-Martínez JV, Sánchez-Alepuz E, Miranda FJ. Utilización del ácido tranexámico tópico en la artroplastia total primaria de cadera. Eficacia y seguridad. Nuestra experiencia. Rev Esp Cir Ortop Traumatol. 2020;64:114–9, http://dx.doi.org/10.1016/j.recot.2019.09.011.
28. Franchini M, Mengoli C, Marietta M, Marano G, Vaglio S, Pupella S, et al. Safety of intravenous tranexamic acid in patients undergoing major orthopaedic surgery: A meta-analysis of randomised controlled trials. Blood Transfus. 2018;16:36–43, http://dx.doi.org/10.2450/2017.0219-17.
29. Cao G, Huang Z, Xie J, Huang Q, Xu B, Zhang SY, et al. The effect of oral versus intravenous tranexamic acid in reducing blood loss after primary total hip arthroplasty: A randomized clinical trial. Thromb Res. 2018;164:48–53, http://dx.doi.org/10.1016/j.thromres.2018.02.007.
30. Widman J, Jacobsson H, Larsson SA, Isacson J. No effect of drains on the postoperative hematoma volume in hip replacement surgery: A randomized study using scintigraphy. Acta Orthop Scand. 2002;73:625–9, http://dx.doi.org/10.1080/000164702321039570.
31. Mosquera CW, Rueda G, Cabezas CA, Tovar JL, Rodríguez HA. Complicaciones postoperatorias tempranas en reemplazo primario de cadera por artrosis entre 2012-2016. Repert Med Cir. 2017;26:152–7, http://dx.doi.org/10.1016/j.reper.2017.07.002.
32. Takada R, Jinno T, Koga D, Hirao M, Muneta T, Okawa A. Is drain tip culture prognostic of surgical site infection? Results of 1380 drain tip cultures in total hip arthroplasty. J Arthroplasty. 2015;30:1407–9, http://dx.doi.org/10.1016/j.arth.2015.02.038.
33. Overgaard S, Thomsen NO, Kulinski B, Mossing NB. Closed suction drainage after hip arthroplasty. Prospective study of bacterial contamination in 81 cases. Acta Orthop Scand. 1993;64:417–20, http://dx.doi.org/10.3109/17453679308993657.