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HIP ARTHROPLASTY

Comparison between autologous blood transfusion drainage and no drainage/closed-suction drainage in primary total hip arthroplasty: a meta-analysis

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Abstract
Purpose Primary aim of this meta-analysis of randomized controlled trials (RCTs) was to compare blood loss, transfusion rate and postoperative hemoglobin levels at 24–48 h after primary total hip arthroplasty (THA) between autologous blood transfusion (ABT) drainage and no drainage/closed-suction drainage and to obtain a powerful conclusion which way of drainage had the best clinical efficacy. Secondary aim was to compare the postoperative complication rates during the first year to indentify which way of drainage was safest.
Methods We searched the PubMed, Embase and Cochrane Central Register of Controlled Trials and identified 12 RCTs (including a total of 1,574 patients) for the meta-analysis. Methodological quality was assessed by the Physiotherapy Evidence Database scale. Two researchers extracted relevant data including study characteristics, blood loss, transfusion rate, hemoglobin levels, hospital stay and complications. After data extraction, we compared results using fixed-effects or random-effects models depending on the heterogeneity of the included studies.
Results Autologous blood transfusion drainage had less total blood loss and lower superficial infection rate than no drainage/closed-suction drainage. While there were no statistical differences in postoperative pain, hematoma, hemoglobin levels, hospital stay and other complications between ABT drainage and no drainage/closed-suction drainage.
Conclusions Autologous blood transfusion drainage and no drainage/closed-suction drainage have similar clinical efficacy and safety in primary THA with regard to clinical outcomes and complication rates.

Keywords Drainage · Closed-suction drainage · ABT drainage · Total hip arthroplasty

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Introduction

Total hip arthroplasty (THA) is a standardized highly successful procedure. Autologous blood transfusion (ABT) drainage has become a new intra-operative and postoperative filtered salvaged blood re-transfusion system for primary THA. However, it is still a hot issue to use no drainage, closed-suction drainage or ABT drainage in primary THA. Drains are often used with the purpose of preventing hematoma accumulation, decreasing the risk of infection and delaying wound healing [1]. Horstmann et al. [2] proclaimed the use of a new intra-operative ABT filter system combined with a postoperative ABT unit resulted in higher postoperative hemoglobin (Hb) levels and less total blood loss compared with a high-vacuum drain following THA. Some studies have shown the effectiveness of closed-suction drainage in THA, but no studies demonstrate any benefits in postoperative pain, wound healing and incidence of infection [3, 4]. Furthermore, using drains might increase needs for homologous blood transfusions or reduce them by postoperative re-transfusion of drained blood [5–7].

Up to now, no studies have found sufficient evidence to recommend no drainage, closed-suction drainage or ABT drainage in primary THA. The review involving closed-suction drainage versus no drainage by Zhou et al. [8]

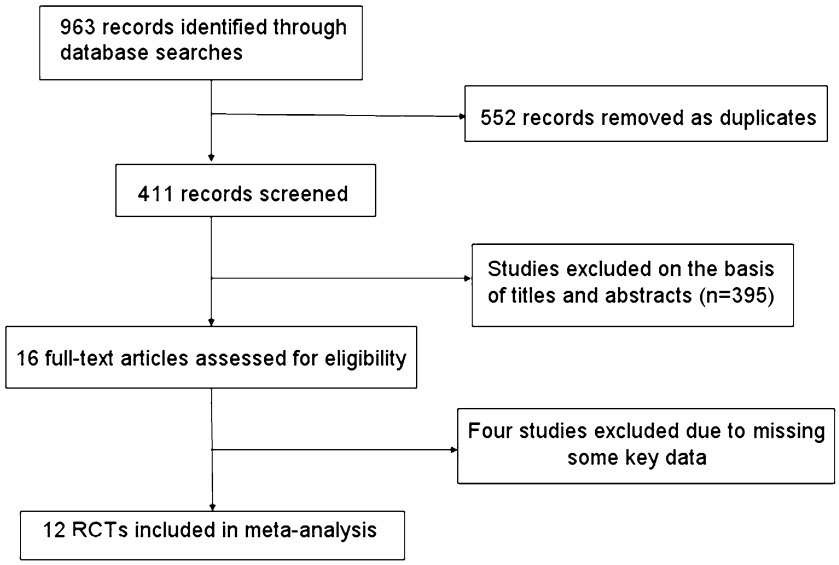

Fig. 1 Flow diagram of study selection

remained the only meta-analysis that has been ever made in this field, but they did not differentiate closed-suction drainage or ABT drainage. Therefore, it is necessary to have a latest, up-to-date meta-analysis to investigate this issue to obtain a powerful conclusion which way of drainage is best. The primary objective of this meta-analysis was to determine which way of drainage had the best clinical efficacy with regard to blood loss, transfusion rate and Hb levels at 24–48 h after primary THA. The secondary aim was to find out which way of drainage was safest regarding to the complication rates during the first year.

Materials and methods

Literature search

Electronic databases (Medline, EMBASE and Cochrane Central Register of Controlled Trials) were searched without limit by two independent reviewers, which were published up to January 2013. The search terms were "drainage" or "drain", "total hip arthroplasty" or "total hip replacement" and "randomized controlled trial". We also searched the reference lists of related reviews and original articles identified for any relevant trials including clinical trials and randomized controlled trials (RCTs) involving adult humans.

Eligibility criteria

Studies were identified by two researchers according to the following criteria: (1) the comparison was between ABT drainage and no drainage/closed-suction drainage, (2) some key data were described, such as blood loss, transfusion rate, preoperative/postoperative Hb levels, hematoma, swelling, postoperative pain, hospital stay and complications, (3) a RCT was designed, (4) full text were published in English.

Quality assessment

Two investigators independently assessed methodological quality of each included RCT using the physiotherapy evidence database (PEDro) scale [9]. The 11 items were based on the Delphi list [10]. Each item was scored "yes" or "no" with a maximum score of 10 because criterion one was not scored. A trial with a score of six or more was considered high quality. Conflicts were resolved by discussion with other investigators.

Data extraction

Both researchers extracted relevant data including sample size, study design, patient age, gender, length of follow-up, preoperative/postoperative Hb levels, transfusion, hematoma, swelling, postoperative pain, hospital stay and complications.

Statistical analysis

Meta-analysis was conducted with Cochrane Collaboration Review Manager 5.0. If the standard deviation was not reported, it was imputed with use of the technique described by Ma et al. [11]. For continuous data, weighted mean difference (WMD) and 95 % confidence interval (CI) were used in this study. The statistical method was inverse variance. For dichotomous outcomes, an odds ratio (OR) and 95 %CI were calculated as the summary statistics. The statistical heterogeneity was tested with the Chi^2 test and I^2

Table 1 Study characteristics

Authors	Country	Sample size				Mean age (Y)			Sex (M/F)			Antibiotics	Thrombo-prophylaxis	Surgical approach	Follow up (months)
		Pts	A	B	C	A	B	C	A	B	C				
Cheung et al. [17]	UK	153	48	52	53	69	70.5	65	23/30	24/30	22/39	Cefuroxime	Aspirin	Posterior	12
Dora et al. [18]	Switzerland	100	50	50	0	66 ± 10	61 ± 13	NR	23/27	22/28	NR	Cephalosporin	LMWH	Transgluteal	12
Gonzalez et al. [19]	USA	102	51	53	0	61	65	NR	28/22	26/26	NR	NR	Aspirin or Clexane	Posterolateral	3
Horstmann et al. [20]	The Netherlands	100	50	0	50	69.0 ± 9.2	NR	68.6 ± 9.1	14/36	NR	13/37	Cefazolin	Fondaparinux	Posterolateral anterolateral	3
Kleinert et al. [21]	Switzerland	120	40	40	40	66 ± 10	64 ± 11	66 ± 10	17/13	21/19	21/19	Cefuroxime	LMWH	Anterior	3
Matsuda et al. [22]	Japan	40	20	20	0	62.4 ± 10	59.6 ± 8.1	NR	4/16	5/15	NR	NR	Mechanical	Posterior	3
Niskanen et al. [4]	Finland	58	31	27	0	69	72	NR	12/19	10/17	NR	NR	LMWH	NR	2
Ovadia et al. [3]	Israel	30	12	18	0	69.1 ± 2.6	69 ± 2.3	NR	5/7	10/8	NR	NR	Heparin	Posterolateral	6
Smith et al. [5]	UK	158	0	82	76	NR	75.5	73.5	NA	40/42	36/40	Cefuroxime	Aspirin LMWH	Lateral posterior	2
Strahovnik et al. [23]	Slovenia	139	42	0	97	69	NR	65	13/29	NA	33/64	Cefazolin	LMWH	Lateral	3
Walmsley et al. [24]	UK	552	295	282	0	68	68	NR	109/186	104/178	NR	Cefuroxime	LMWH	Anterolateral	36
Widman et al. [25]	Sweden	22	12	10	0	69	73	NR	4/8	5/5	NR	Cloxacillin	Dalteparin	Hardinge	NR

Y year, *M* male, *F* female, *A* no drainage, *B* closed-suction drainage, *C* autologous blood transfusion drainage, *NR* not reported, *LMWH* low molecular weight heparin

Table 2 PEDro critical appraisal score

Authors	Physiotherapy evidence database scale											Total
	1	2	3	4	5	6	7	8	9	10	11	
Cheung et al. [17]	+	+	+	+	−	−	−	+	+	+	+	7
Dora et al. [18]	+	+	+	+	−	−	−	+	−	+	+	6
Gonzalez et al. [19]	+	+	+	+	−	−	−	+	−	+	+	6
Horstmann et al. [20]	+	+	+	+	−	−	+	+	+	+	+	8
Kleinert et al. [21]	+	+	+	+	−	−	−	+	+	+	+	7
Matsuda et al. [22]	+	+	+	+	−	−	−	+	−	+	+	6
Niskanen et al. [4]	−	+	−	+	−	−	−	+	−	+	+	5
Ovadia et al. [3]	−	+	+	+	−	−	−	+	−	+	+	6
Smith et al. [5]	+	+	+	+	−	−	−	+	−	+	+	6
Strahovnik et al. [23]	+	+	+	+	−	−	−	+	−	+	+	6
Walmsley et al. [24]	−	+	+	+	−	−	−	+	−	+	+	6
Widman et al. [25]	+	+	+	+	−	−	−	+	−	+	+	6

Physiotherapy evidence database scale: *1* eligibility criteria, *2* random allocation, *3* concealed allocation, *4* baseline comparability, *5* participant blinding, *6* therapist blinding, *7* assessor blinding, *8* >85 % follow-up, *9* intention-to-treat analysis, *10* between-groups statistical comparison for at least one key outcome, *11* point estimates and variability measures for at least one key outcome

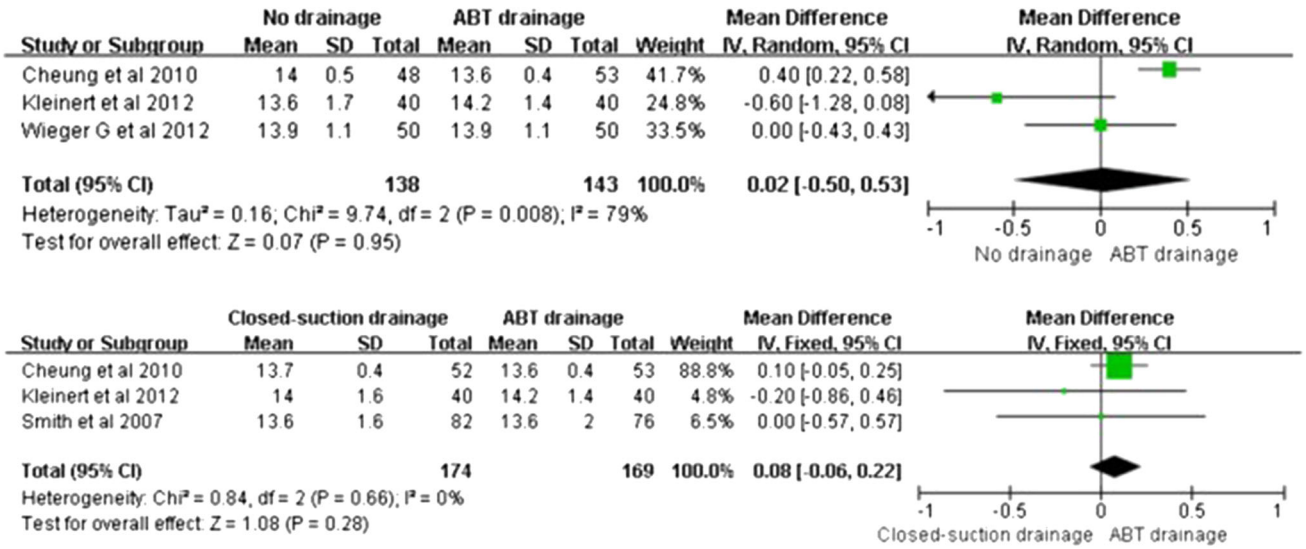

Fig. 2 Forest plot of comparison for preoperative Hb levels (g/dl) between ABT drainage and no drainage/closed-suction drainage

test. I^2 <25 % was considered low statistical heterogeneity; I^2<50 %, moderate statistical heterogeneity; I^2 <75 %, high statistical heterogeneity [12]. The source of high heterogeneity was calculated by random effects after clinical heterogeneity of the included studies was excluded.

Results

Literature search initially yielded 963 relevant trials. There were 411 articles after removing duplicates. We excluded 395 of these articles on the basis of titles and abstracts, leaving 16 potentially relevant studies. Nevertheless, four studies were excluded since some key data, such as blood loss, transfusion rate, Hb levels, and complications, were not reported [13–16]. Finally, 12 RCTs published in English met the predetermined inclusion criteria [3–5, 17–25] (Fig. 1).

The demographic characteristics of 12 studies were presented in Table 1. The dataset included 1,574 patients involving 651 no drainage, 634 closed-suction drainage and 316 ABT drainage. Follow-up period ranged from 2 to 36 months.

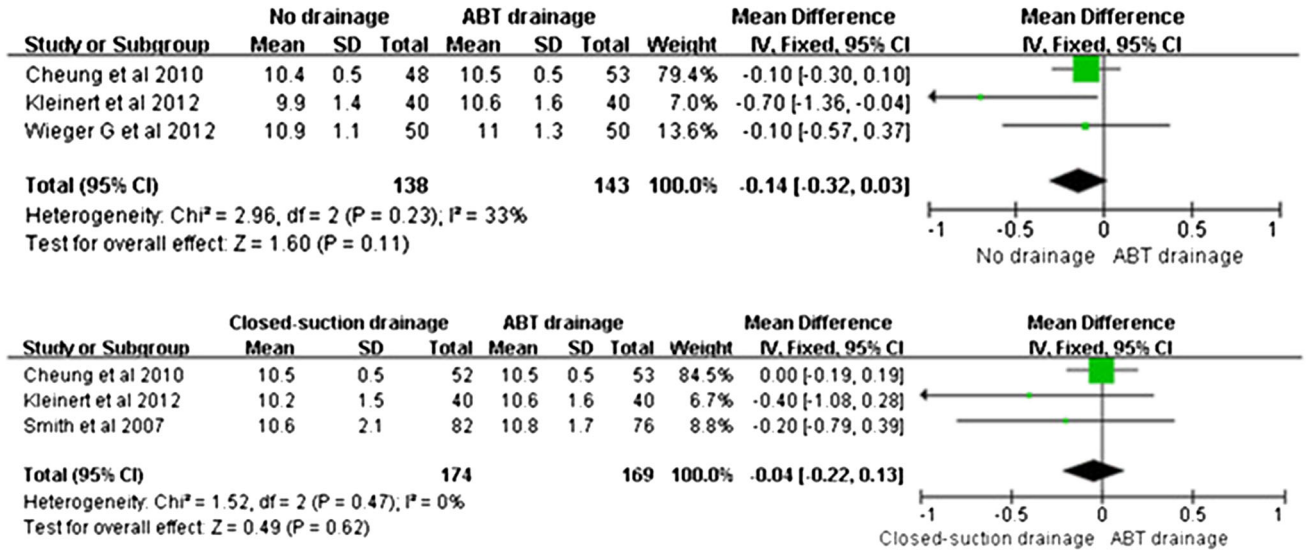

Fig. 3 Forest plot of comparison for postoperative Hb levels (g/dl) between ABT drainage and no drainage/closed-suction drainage

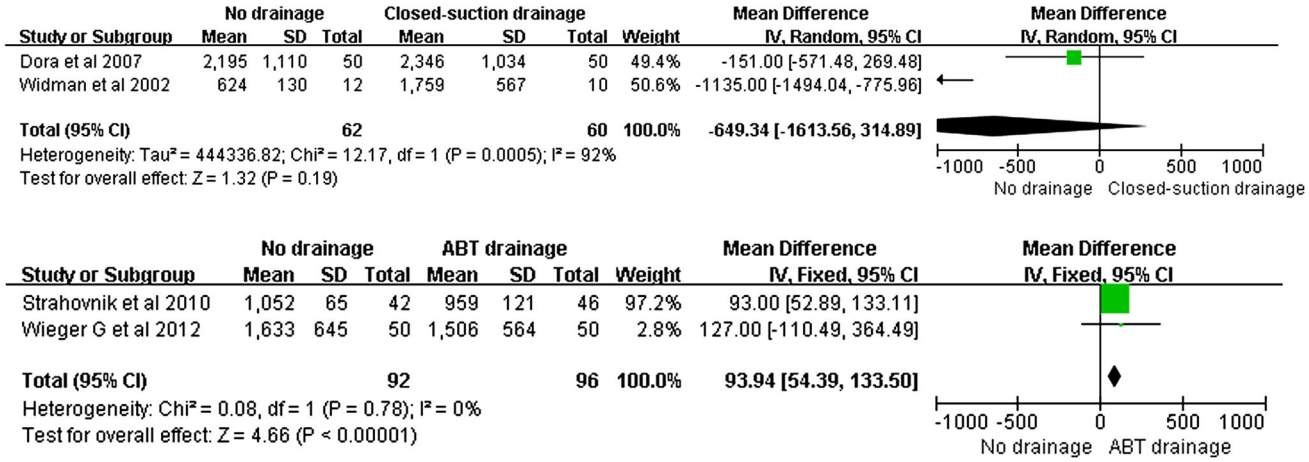

Fig. 4 Forest plot of comparison for total blood loss (ml) between between ABT drainage and no drainage/closed-suction drainage

The methodological quality of each included RCT was assessed in accordance with the PEDro scale (Table 2). The results showed that 11 RCTs were high and one trial was low methodological quality. All of the studies used the randomized method. 11 studies used the concealed allocation. One study used blinding method.

The forest plot for preoperative Hb levels indicated no statistical difference between ABT drainage and no drainage/closed-suction drainage (Fig. 2). Similarly, there were also no statistical difference for postoperative Hb levels between ABT drainage and no drainage/closed-suction drainage (Fig. 3).

For total blood loss, there was statistical difference between no drainage and ABT drainage (WMD = 94; 95 % CI, 54–134; $p < 0.001$), while no statistical difference existed between no drainage and closed-suction drainage (WMD = −649; 95 % CI, −1,613–315; $p = 0.19$), (Fig. 4). As for transfusion rate, the forest plot showed no statistical differences between the groups (Fig. 5).

As regard to postoperative swelling, the forest plot showed statistical difference between no drainage and ABT drainage (WMD = 1.77; 95 % CI, 1.56–1.98; $p < 0.001$), while there was no statistical difference between ABT drainage and closed-suction drainage (Fig. 6). For postoperative hematoma, postoperative pain and hospital stay, there was no statistical difference between the groups (Figs. 7, 8, 9).

As for postoperative complications, such as infection, deep vein thrombosis, pulmonary embolism, wound

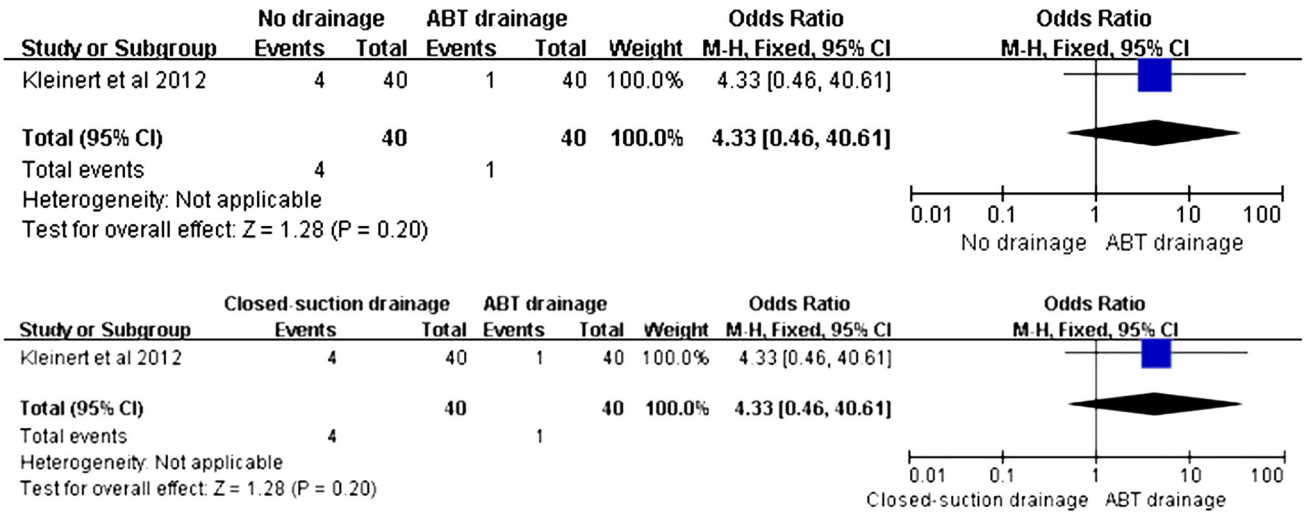

Fig. 5 Forest plot of comparison for transfusion rate (%) between ABT drainage and no drainage/closed-suction drainage

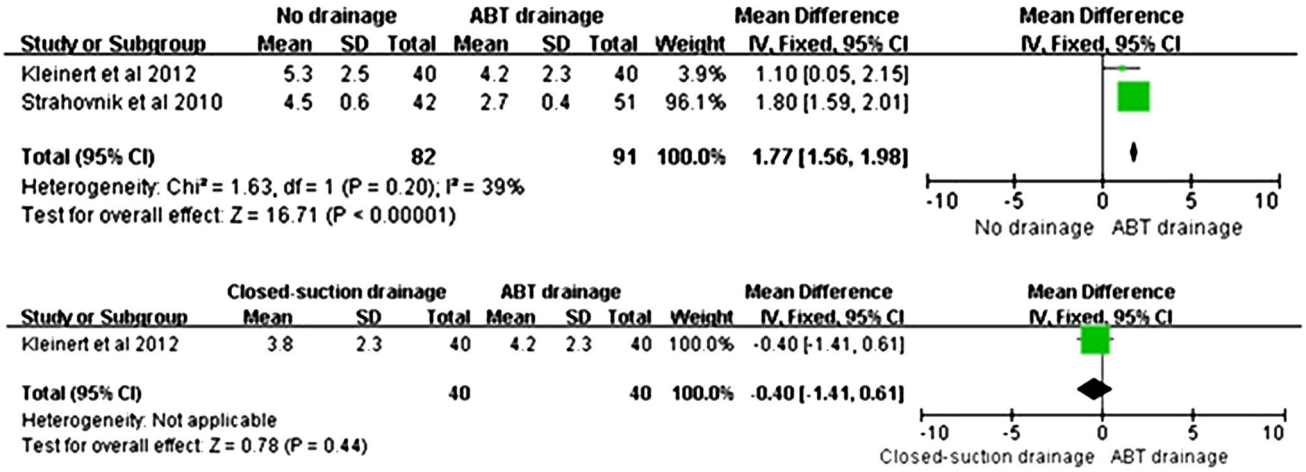

Fig. 6 Forest plot of comparison for swelling (cm) between ABT drainage and no drainage/closed-suction drainage

healing, persistent drainage, trochanteric fracture, surgical revision and death, which were presented in Table 3 and showed no statistical differences except superficial infection between the groups.

Discussion

Drainage was widely used in many orthopaedic surgical procedures with the theory of effectively decreasing hematoma formation, accelerating wound healing and reducing infection rate. Nevertheless, some studies claimed that no drainage would have more benefits in THA [4, 19, 23, 24, 26]. As a result, this meta-analysis was conducted to evaluate the objective clinical effect and complication rates of no drainage, closed-suction drainage and ABT drainage in primary THA. The most significant finding of the present study was that both ABT drainage and no drainage/closed-suction drainage have similar clinical efficacy and safety for THA with regard to preoperative/postoperative Hb levels, blood loss, transfusion rate, swelling, hospital stay and complication rates.

As we knew, postoperative Hb level was an important indicator to evaluate which way of drainage had the best clinical efficacy for THA. The latest RCT by Horstmann et al. [27] showed that ABT drainage resulted in a smaller maximum decrease in Hb levels than no drainage (102 ABT drainage versus 102 no drainage). However, according to the results of the current study, there were no statistical differences in postoperative Hb levels between ABT drainage and no drainage/closed-suction drainage (143 ABT drainage versus 138 no drainage; 169 ABT drainage versus 174 closed-suction drainage). Certainly, the postoperative Hb levels mostly depended on

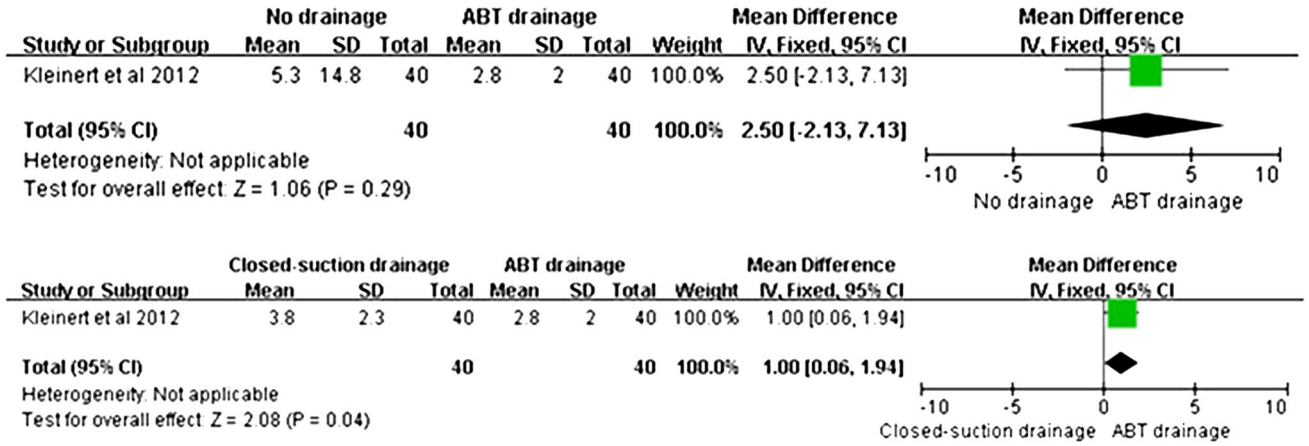

Fig. 7 Forest plot of comparison for hematoma (cm^3) between ABT drainage and no drainage/closed-suction drainage

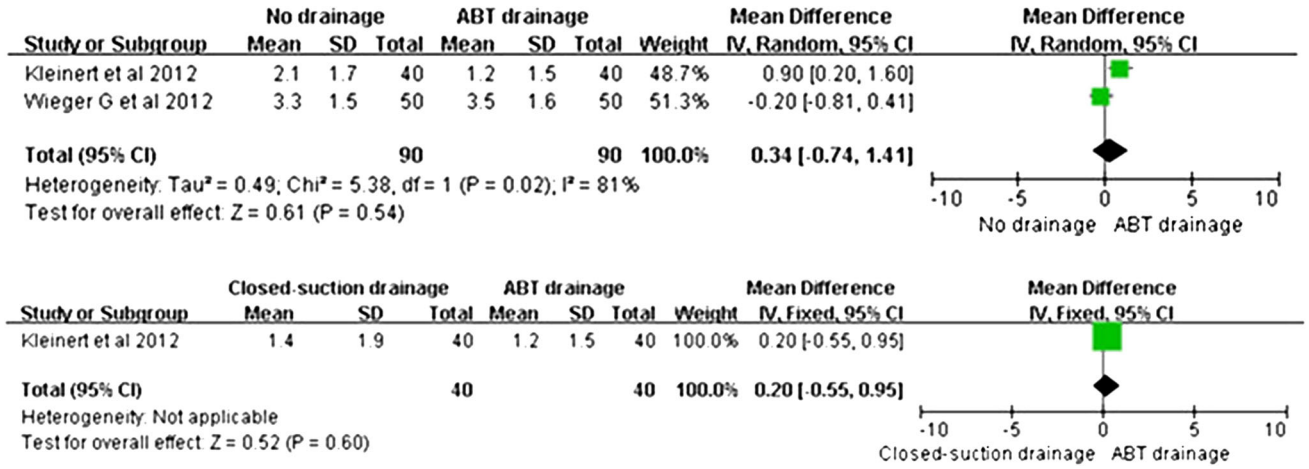

Fig. 8 Forest plot of comparison for postoperative pain (VAS score 1–10) between ABT drainage and no drainage/closed-suction drainage

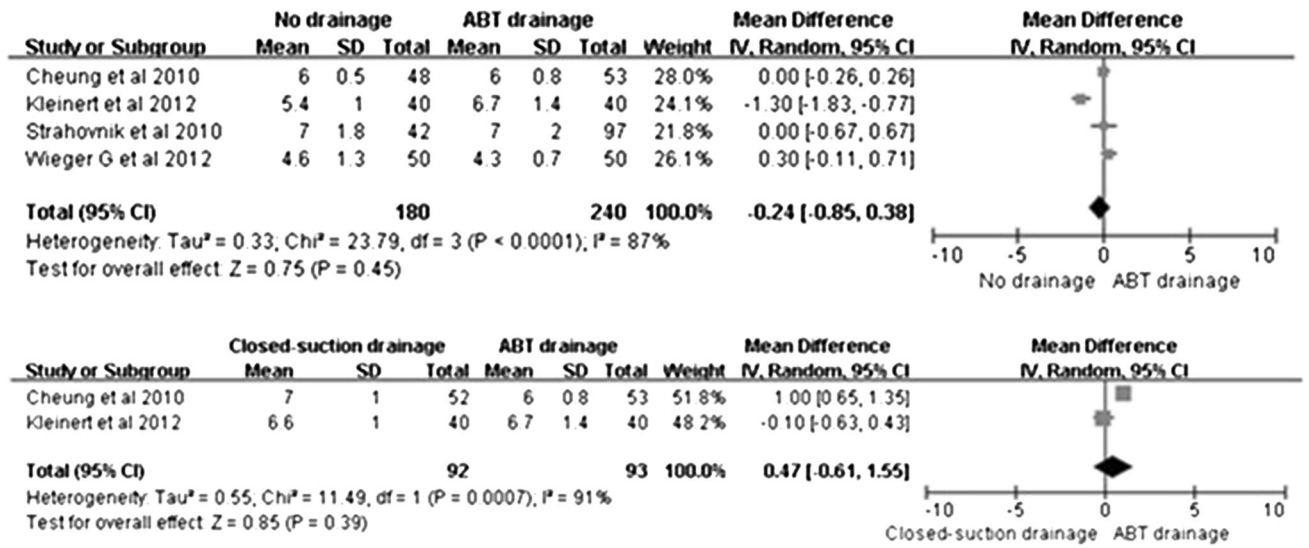

Fig. 9 Forest plot of comparison for hospital stay (day) between ABT drainage and no drainage/closed-suction drainage

Table 3 Postoperative complications

	No. of studies	A (%)	B (%)	C (%)
Superficial infection	9	24 (4.2)**	25 (4.1)*	2 (0.8)
Deep infections	6	5 (1.1)	3 (0.7)	2 (1.4)
Surgical revision	4	3 (0.7)	1 (0.2)	1 (1.1)
Persistent drainage	4	5 (3.5)	5 (5.1)	0
DVT	4	3 (0.7)	5 (1.3)	0
Pulmonary embolism	3	1 (0.3)	3 (0.9)	0
Trochanteric fracture	2	0	3 (3.3)	1 (2.5)
Death	2	0	5 (1.5)	0
Wound healing	1	0	1 (2.5)	1 (2.5)

THA total hip arthroplasty, *A* no drainage, *B* closed-suction drainage, *C* autologous blood transfusion drainage, *DVT* deep vein thrombosis

* $p < 0.05$, ** $p < 0.01$

preoperative Hb levels, total blood loss and transfusion. According to the results of the current study, we knew that there was no statistical difference on preoperative Hb levels between ABT drainage and no drainage/closed-suction drainage, and ABT drainage just had less total blood loss of 94 ml than no drainage/closed-suction drainage. Besides, ABT drainage did not correlate significantly with the amount of allogenic transfusion in TKA and THA [28]. Thus, on Hb level change, the efficacy was similar between ABT drainage and no drainage/closed-suction drainage in primary THA.

As for postoperative pain, hematoma and hospital stay, there were also no statistical differences between ABT drainage and no drainage/closed-suction drainage according to the results of the current study. Consequently, ABT drainage was not superior in clinical efficacy compared with no drainage/closed-suction drainage in THA.

ABT drainage had lower superficial infection rate, persistent drainage rate, deep vein thrombosis rate, pulmonary embolism rate and higher deep infection rate, surgical revision rate than no drainage/closed-suction drainage in THA, but there were no statistical differences except superficial infection. Therefore, ABT drainage had the similar safety compared with no drainage/closed-suction drainage.

Some possible limitations to this meta-analysis should be pointed out. First, this meta-analysis limited the included articles published in English. There might be selection bias in language. Second, the number of some key data was too small to have much power as expected, such as transfusion rate. Third, the follow-up period of included studies ranged from 2 to 36 months, so long-term complication rates are still unclear.

In conclusion, this meta-analysis demonstrates that ABT drainage and no drainage/closed-suction have similar clinical efficacy and safety with regard to postoperative pain, hematoma, swelling, Hb levels, hospital stay and complications.

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Conflict of interest Each author certifies that he or she, or a member of their immediate family, has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

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