

## Review

# The efficacy and safety of modified Robert Jones bandage in total knee arthroplasty: A meta-analysis of randomized-controlled trials



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## ABSTRACT

**Background:** The efficacy of modified Robert Jones bandage in primary total knee arthroplasty (TKA) is controversial. On the basis of randomized controlled trials (RCTs), this systematic review and meta-analysis was conducted to evaluate the modified Robert Jones bandage in TKA.

**Methods:** The electronic databases of EMBASE, PubMed, Web of Science and Cochrane Library were searched from the inception to November 2018 for all relevant English studies. The outcome measurements consisted of total blood loss, hemoglobin decline, transfusion rates, pain score, range of motion, length of hospitalization, knee circumference difference, and adverse effects. Data were analyzed using STATA 14.0 software (The Cochrane Collaboration, Oxford, United Kingdom). Quality assessment was conducted according to the Cochrane Handbook for systematic review of interventions.

**Results:** A total of 5 randomized controlled trials (RCTs) were included in the systematic review and meta-analysis. The present meta-analysis indicated that there were no significant differences in terms of total blood loss, hemoglobin decline, transfusion rates, pain score, range of motion, length of hospitalization, knee circumference difference, or adverse effects.

**Conclusions:** Although published articles have shown improved outcome of blood loss, pain, and knee swelling after application of a modified Robert Jones bandage, our study suggest the use of modified Robert Jones bandage may not be necessary after primary TKA.

## 1. Introduction

Total knee arthroplasty (TKA) is a popular surgical procedure for reducing pain in patients with end-stage osteoarthritis and rheumatoid arthritis [1,2]. With the aging population, there has been a marked increase in the number of joint arthroplasty in recent years. However, TKA was associated with major bleeding ranging from 460 to 920 ml [3–5]. Postoperative anemia may cause many adverse events, including increased mortality and morbidity and prolonged hospitalization due to transfusion-related needs. Several effective strategies have been used for the perioperative blood management, including hemostatic agent administration, hypothermic anesthesia, tourniquet and minimally invasive procedures [6,7]. However, blood loss in TKA still remains a huge challenge, with an incidence of 32% patients who required an average of two units of blood transfusion.

Recently, modified Robert Jones bandage from toes to mid-thigh is widely used in patients with TKA which was considered to reduce intra-articular blood loss and soft tissue edema by increasing intra-

tissular pressure, thereby helping lower limb venous reflux. It is a type of soft splint bandage comprises some layers of soft material wrapped around knee joint [8]. Previous studies have reported that modified Robert Jones bandage was effective and safety in for reducing post-operative bleeding and pain following TKA. However, some authors reported the opposite view that it was not associated with reducing blood loss and that it could potentially increase complications including peroneal paralysis, pressure ulcers, bruise, and blisters, which may limit its use [9].

Controversy still exists regarding the clinical effects of modified Robert Jones bandage in TKA. To our knowledge, no meta-analyses have directly compared clinical outcomes of modified Robert Jones bandage and it is not clear that the potential advantages outweigh its disadvantages. Therefore, we performed a meta-analysis from randomized-controlled trials (RCTs) to assess the effect of using modified Robert Jones bandage on knee swelling, blood loss, pain and complications after TKA.

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**Table 1**  
Characteristics of the included studies.

Study	Year	Design	Diagnosis	Age		Gender (Male %)		No. of patients		Intervention	Mean follow up
				MRJB	Control	MRJB	Control	MRJB	Control		
Gibbons et al.	2001	RCT	Knee OA and RA	71	72	46%	53%	50	50	Intervention: MRJB (48 h) Control: Cold therapy (1 h)	NS
Smith et al.	2002	RCT	Knee OA	72	72	52%	48%	40	44	Intervention: MRJB (24 h) Control: Cold therapy (24 h)	6 months
Pinsornsak et al.	2013	RCT	Knee OA	69	70	17%	17%	30	30	Intervention: MRJB (24 h) Control: Conventional dressing	3 weeks
Pomrattanamane et al.	2018	RCT	Knee OA	69	71	20%	5%	35	35	Intervention: MRJB (24 h) Control: Non-compressive dressing	4 weeks
Yu et al.	2018	RCT	Knee OA	69	69	23%	23%	44	44	Intervention: MRJB (24 h) Control: The conventional dressing	3 weeks

RCT: randomized controlled trial, MRJB: modified Robert Jones bandage, NS: not stated.

**Table 2**  
Risk of bias summary.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Gibbons 2001	+	?	?	-	+	+	+
Pinsornsak 2013	+	+	+	+	+	+	+
Pomrattanamane 2018	+	+	?	?	+	+	+
Smith 2002	+	?	?	?	+	+	+
Yu 2018	+	+	+	+	+	+	+

**2. Methods**

The work has been reported in line with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) and AMSTAR (Assessing the methodological quality of systematic reviews) Guidelines [10]. Ethical approval is unnecessary because it is a review of previously published articles and does not involve any treatment of individual patient data.

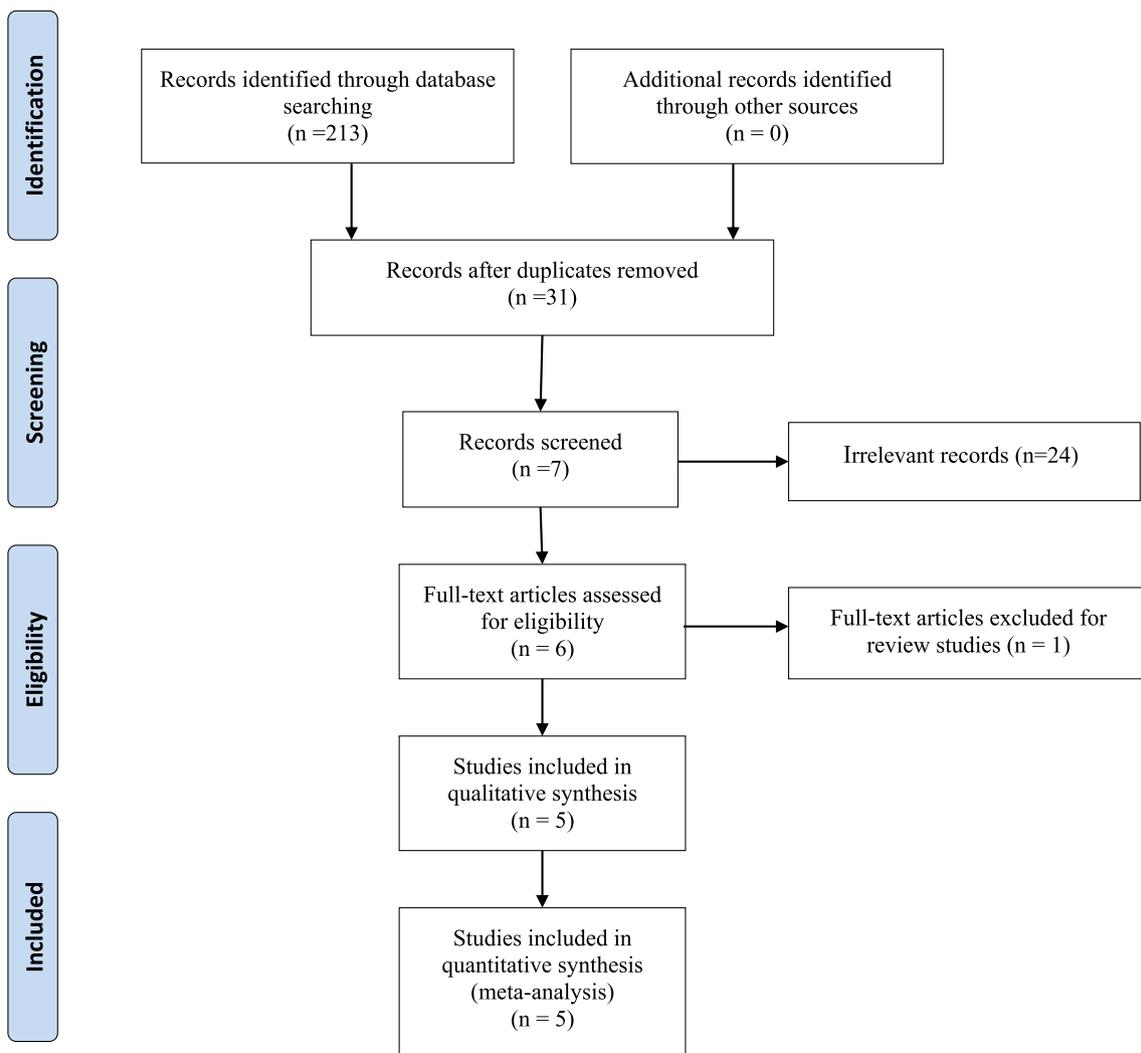
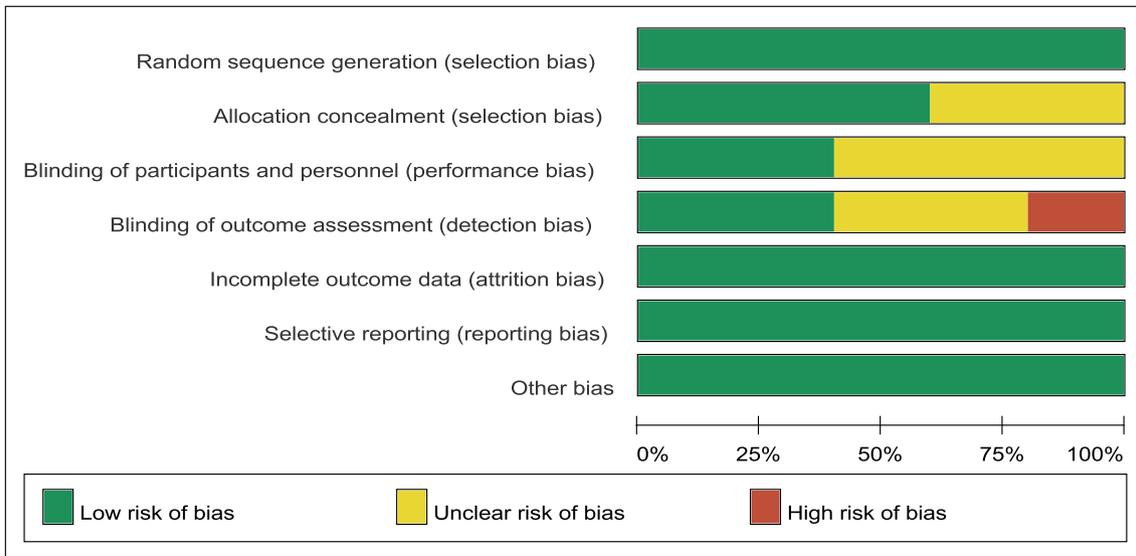
*2.1. Search strategy*

The electronic databases of EMBASE, PubMed, Web of Science, CNKI, and Cochrane Library were searched from the inception to November 2018 for all relevant English studies. The detailed search strategy was as follows: (total knee arthroplasty or total knee replacement) and (modified Robert Jones bandage) and (random or blind). Furthermore, the reference lists from published original articles and relevant reviews were also assessed to identify more relevant studies.

*2.2. Inclusion criteria and exclusion criteria*

Randomized controlled trials were included if they met the PICOS criteria as follows: Population: patients diagnosed with osteoarthritis and prepared for total knee arthroplasty; Intervention: modified Robert Jones bandage; Comparator: placebo or conventional wound dressing for TKA; Outcomes: total blood loss, drainage volume, transfusion requirements, pain score, range of motion and complications. Study design: RCTs or prospective clinical controlled studies. Exclusion criteria included the following points: (1) non-RCTs such as case reports,

**Table 3**  
Risk of bias graph.



**Fig. 1.** Flow chart of study selection.

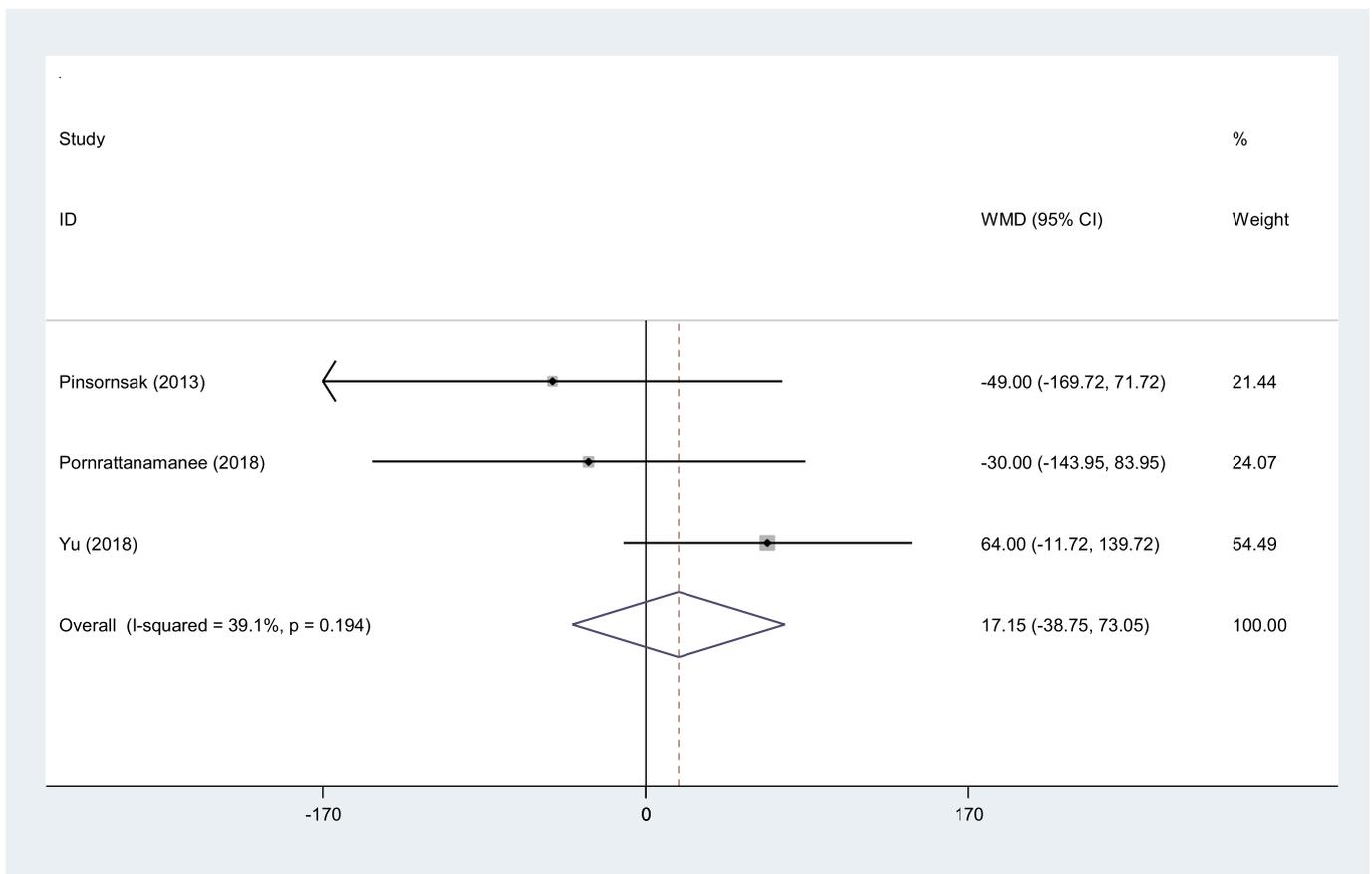


Fig. 2. Forest plot diagram of total blood loss.

animal trials, letters, retrospective studies, and reviews; (2) conference abstracts and duplicate reports; (3) studies with no data analysis and/or power analysis.

2.3. Data extraction

Two reviewers independently extracted data, and the third reviewer checked the consistency between them. A standard form was used; the extracted items included the following: (1) the general study information, for example, the authors, publishing date, country, study design, case number, age, gender, intervention method and follow-up term. If necessary, correspondence author was consulted for the missing data and additional information.

2.4. Assessment of methodological quality

Two reviewers independently assessed the methodological quality of the included studies which were performed by the Cochrane Collaboration for Systematic Reviews, including assessment of random sequence generation, allocation sequence concealment, blinding of participants and personnel, blinding of outcomes assessment,

incomplete outcome data, selective reporting, and other bias. The overall methodological quality of each included study was characterized as “Yes” (low risk of bias), “No” (high risk of bias), or “Unclear” (unclear risk of bias). Differences will be resolved by consensus after discussion and, if necessary, a third reviewer will be consulted.

2.5. Data analysis

Data were analyzed using STATA 14.0 software (The Cochrane Collaboration, Oxford, United Kingdom). Continuous variable was analyzed using the weighted mean differences (WMD), whereas dichotomous data were analyzed using the risk difference (RD) measure. Both were reported with 95% confidence intervals (CIs), and a P value of 0.05 was used as the level of statistical significance. Heterogeneity was tested using Chi square test and quantified by calculating I<sup>2</sup> statistic, for which P < 0.1 and I<sup>2</sup> > 50% was considered to be statistically significant. Random-effects or fixed-effects models were used depending on the heterogeneity of the studies included. Publication bias was not assessed due to the small number of included studies.

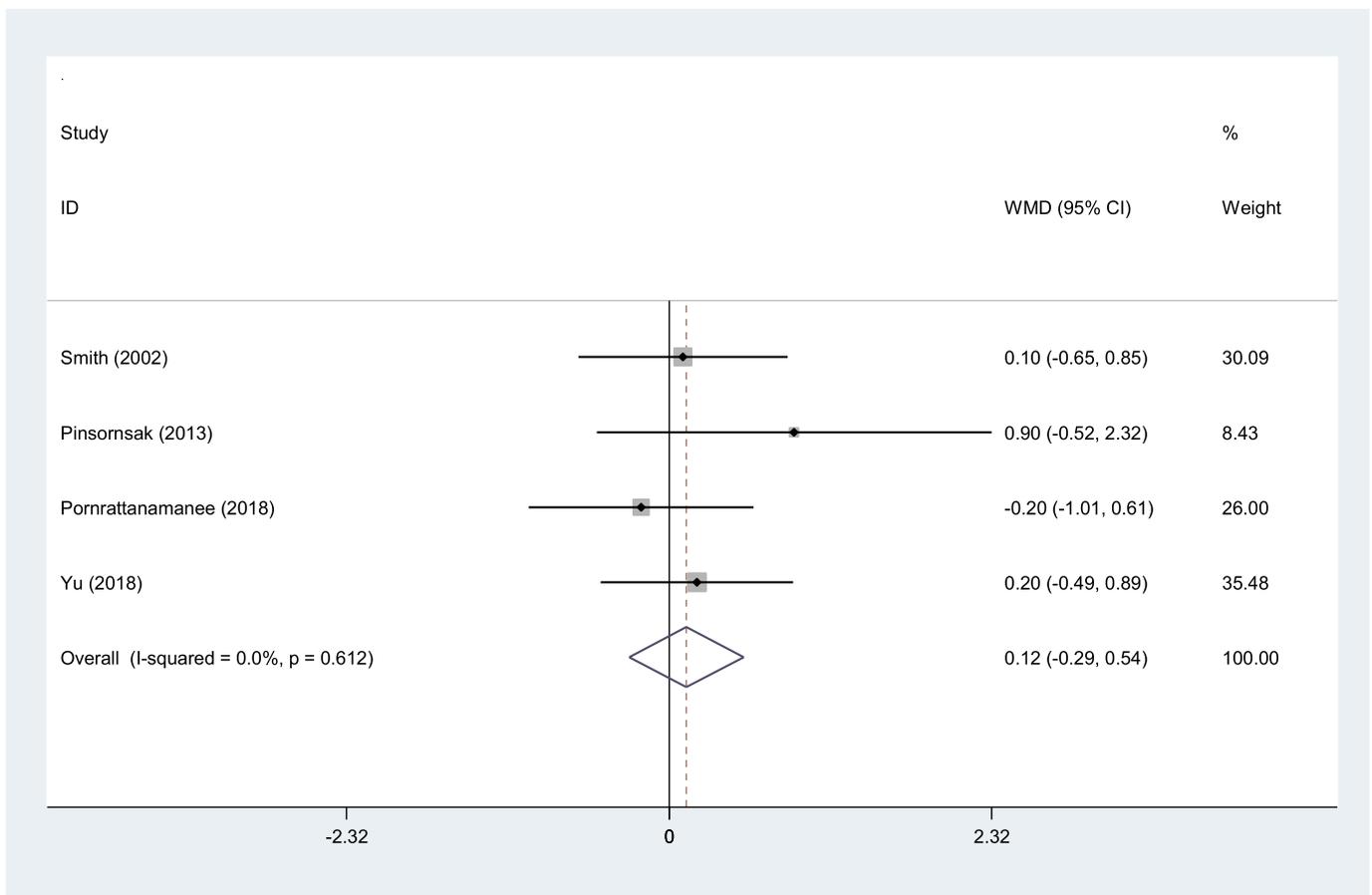


Fig. 3. Forest plot diagram of hemoglobin decline.

### 3. Results

#### 3.1. Search results

Initially, a total of 213 studies were searched via the databases and other source.

Endnote X8 (version 18.0.0.10063) was used to remove 182 duplicate studies. After reading the full text of the 31 remaining studies in detail, studies were excluded based on the titles and abstracts of these papers. Finally, 5 RCTs [11–15] with 402 patients (modified Robert Jones bandage = 199, control = 203) were included in our meta-analysis. General characteristic of the included studies can be seen in Table 1. No Chinese article was enrolled.

#### 3.2. Risk of bias

Cochrane Collaboration's tool was adopted to assess the risk of bias. As shown in Table 2, all RCTs reported that participants were randomized with a computerized random number generator. Three RCTs showed that opaque, sealed envelope was used to make sure allocate concealment. Two studies performed double blinding and confirmed the blinding of outcome assessor. All RCTs showed complete outcome data.

Other assessment of bias was low risk. Each risk of the bias item was expressed in terms of the percentage across all the included studies, which indicated the proportion of risk levels for each item bias (Table 3) (see Fig. 1).

#### 3.3. Outcome measurements

##### 3.3.1. Total blood loss

Three articles provided the relevant data of total blood loss. The summarized estimate of effect size did not show a statistically significant difference between the compared groups (WMD = 17.15, 95% CI = -38.75 to 73.05, P = 0.55, Fig. 2). At the same time, no significant statistical heterogeneity was present ( $\chi^2 = 3.28$ , df = 2,  $I^2 = 39.1\%$ , P = 0.19).

##### 3.3.2. Hemoglobin decline

Data extracted from four studies substantiated that no statistically significant difference was found between the two groups (WMD = 0.13, 95% CI = -0.29 to 0.54, P = 0.55, Fig. 3), with an absence of statistical heterogeneity ( $\chi^2 = 1.81$ , df = 3,  $I^2 = 0\%$ , P = 0.61).

##### 3.3.3. Transfusion rates

A total of four RCTs provided the data on transfusion rates. The

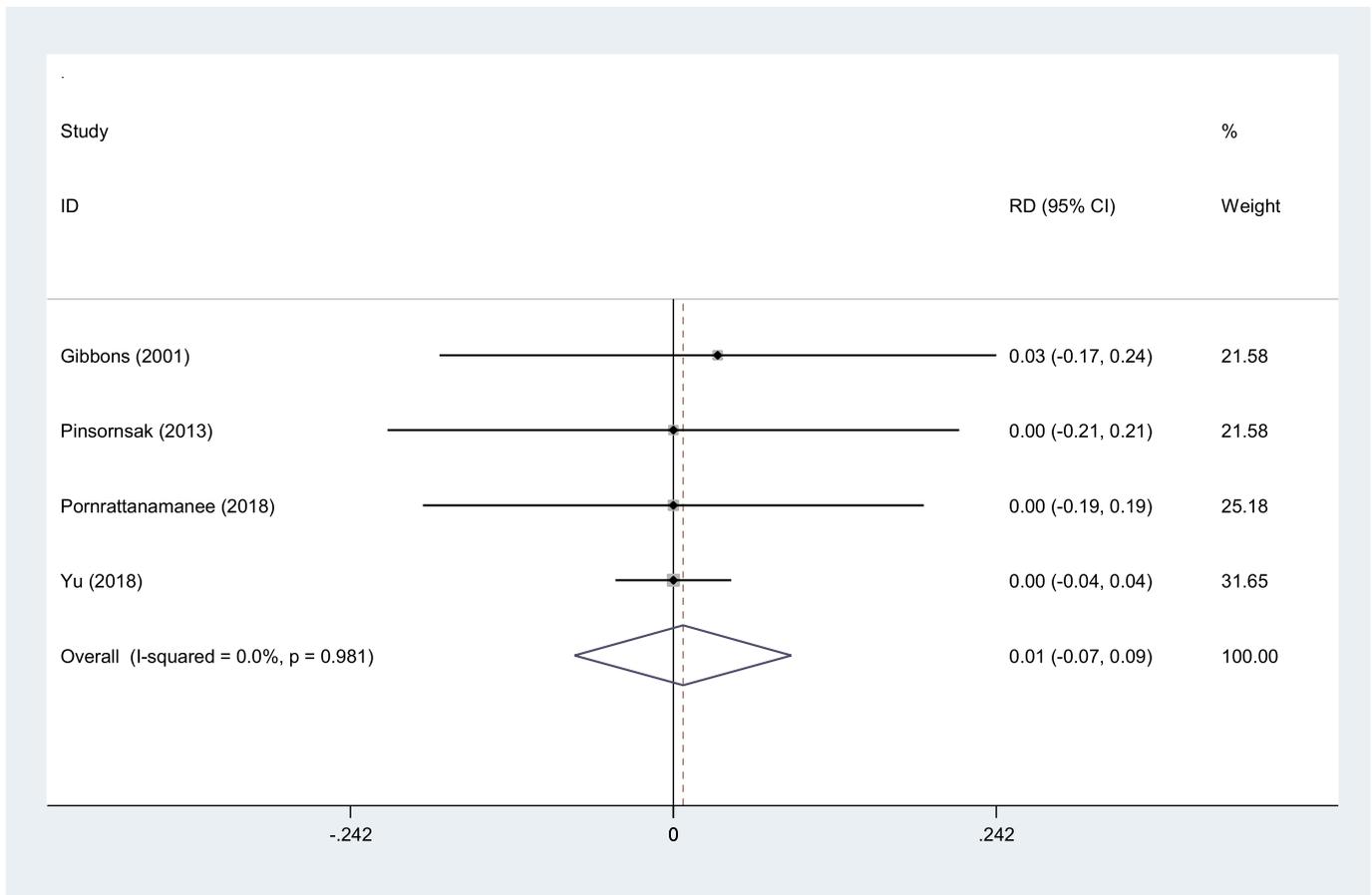


Fig. 4. Forest plot diagram of transfusion rates.

pooled data indicated that no significant difference was observed between the two groups (RD = 0.01, 95% CI -0.07, 0.10; P = 0.86, Fig. 4) with low heterogeneity ( $\chi^2 = 0.18$ , df = 3,  $I^2 = 0\%$ , P = 0.98).

3.3.4. Pain score

Four studies provided data regarding postoperative pain score. The pooled estimate of information showed that there was no significantly difference between group in pain score after TKA (WMD = 0.12, 95% CI = -0.16 to 0.40, P = 0.41, Fig. 5), and statistical heterogeneity was not present ( $\chi^2 = 3.77$ , df = 3,  $I^2 = 20.5\%$ , P = 0.29).

3.3.5. Range of motion (ROM)

Four RCTs provided data on ROM. There was no significant heterogeneity ( $\chi^2 = 0.45$ , df = 3,  $I^2 = 0\%$ , P = 0.92); therefore, a fixed-effect model was used. The overall pooled results indicated that there was no significant difference between the compared groups in ROM (WMD = 1.18, 95% CI: 1.17 to 3.54, P = 0.33; Fig. 6).

3.3.6. Length of hospitalization

Four RCTs showed length of hospitalization. A fixed effect model was used ( $\chi^2 = 1.27$ , df = 3,  $I^2 = 0\%$ , P = 0.74). The pooled results revealed that there was no significant difference in length of hospitalization (WMD = 0.10, 95% CI: 0.33 to 0.53, P = 0.65; Fig. 7).

3.3.7. Knee circumference difference

Data regarding the knee circumference difference at thigh and calf was reported in two studies. The pooled data suggested that there was no significant difference between groups (WMD = -0.01, 95% CI: 0.32 to 0.14, P = 0.46; Fig. 8), with an absence of statistical heterogeneity ( $\chi^2 = 1.49$ , df = 3,  $I^2 = 0\%$ , P = 0.41).

3.3.8. Adverse effects

A total of four RCTs reported wound-related complications. No significant difference was found between the two groups (RD = -0.004, 95% CI: 0.01 to 0.05, P = 0.89; Fig. 9).

4. Discussion

To the best of our knowledge, this is the first meta-analysis that assesses the clinical outcomes of modified Robert Jones bandage for postoperative recovery in TKA. The most important findings of the present meta-analysis showed that compared with the conventional dressing, the modified Robert Jones bandage did not show improved outcomes in total blood loss, transfusion rates, range of motion or pain relief.

With the aging population, the incidence of joint osteoarthritis has significantly increased. Joint arthroplasty is an effective method to treat

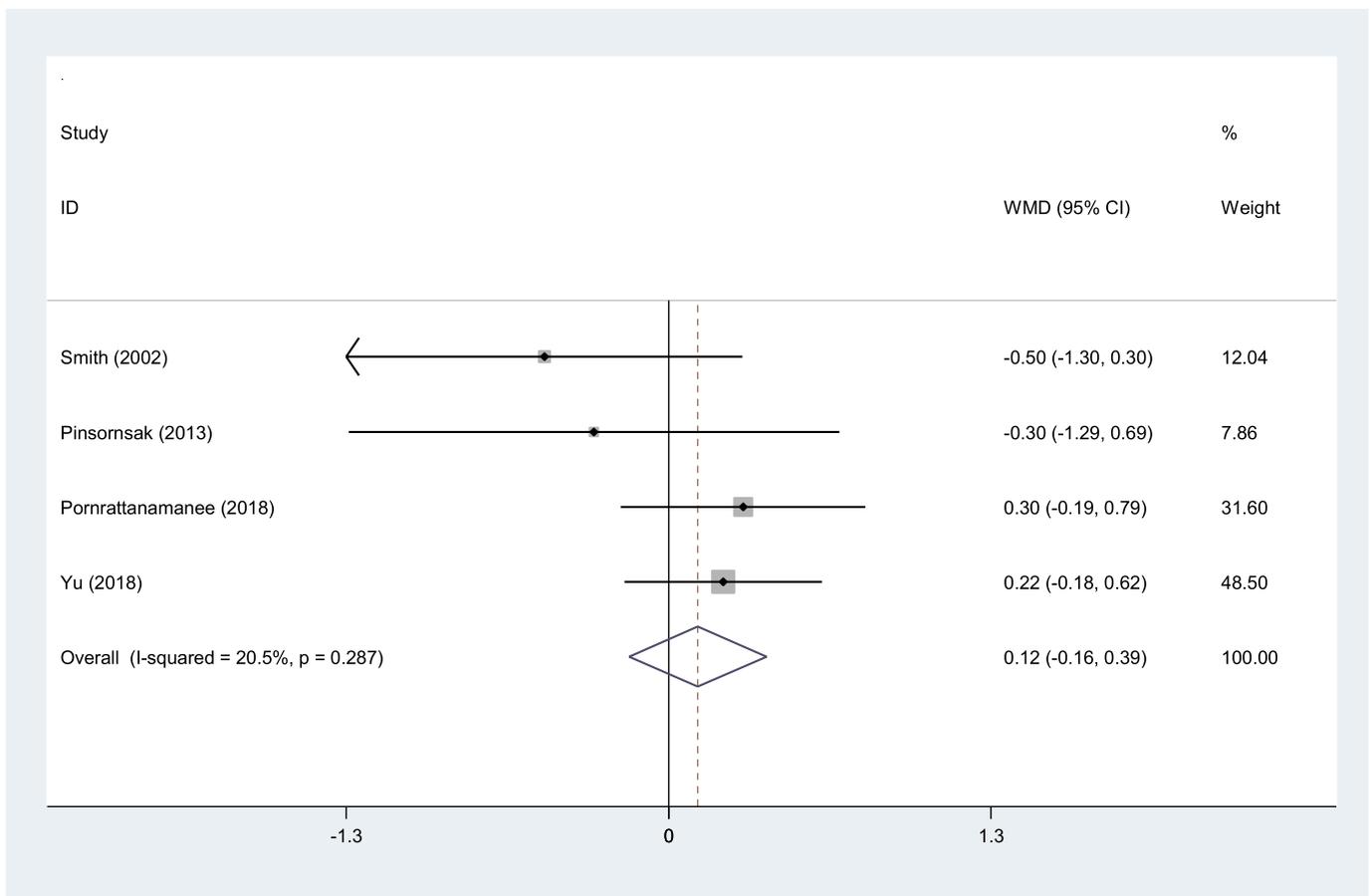


Fig. 5. Forest plot diagram of pain score.

the end-stage degenerative osteoarthritis. Blood conservation after arthroplasties have received considerable attention in recent years. Although intravenous antifibrinolytic agents have been widely used and showed superior results after TKA, thrombotic complications and anaphylactic reaction were still major concerns [16,17]. Compressive dressings are popular and modified Robert Jones bandage was first introduced in 1986 by Brodell et al. [18]. It was bulky compression dressing, which has been widely used for more than 60 years. It was recommended for the protection of soft tissue and knee reconstruction surgery. The mechanism for blood control is to increase intramuscular and intraarticular pressures. In the available studies, there were various clinical outcomes in the comparison of modified Robert Jones bandage and conventional dressing with mixed results. Yu et al. [15] demonstrated that modified Robert Jones bandage has a similar effect compared with the conventional wound dressing. Pinsornsak et al. [13] performed a RCT including 60 participants also reported that there was no significant difference in blood loss in patients with modified Robert Jones bandage compared with conventional dressing. However, Gibbons et al. [11] reported that modified Robert Jones bandage was associated with a larger blood loss in the surgical drains. In our study, 4 RCTs with 402 patients were included and we found that the use of

modified Robert Jones bandage did not result in a significantly reduction of total blood after TKA. Blood transfusion rates associated with TKA have been historically reported at 12–45% [19,20]. Thus, allogenic blood transfusion becomes necessary to relieve anemia. However, potential adverse effects may occur, for instance, infection, allergic reactions and nonhemolytic febrile reaction [21,22]. All included RCTs reported a similar transfusion rates between two groups, the present meta-analysis indicated that modified Robert Jones bandage was not associated with a reduction of transfusion rates.

Another important finding was that no significant difference was identified regarding the range of motion or knee circumference difference, which was in accordance with a RCT performed by Yu et al. [15]. On the contrary, Charalambides et al. [23] showed that patients treated with compression bandaging recovered a greater range of flexion on discharge. Several factors may influence the results. Firstly, subbandage pressure was not measured in patients treated with modified Robert Jones bandage. Secondly, the drainage and intraoperative tourniquet was not routinely applied in all included RCTs. Due to the limited number of the studies, we did not perform a subgroup analysis, so further trials were necessary.

Pain can be challenging after major orthopedic surgery. It was

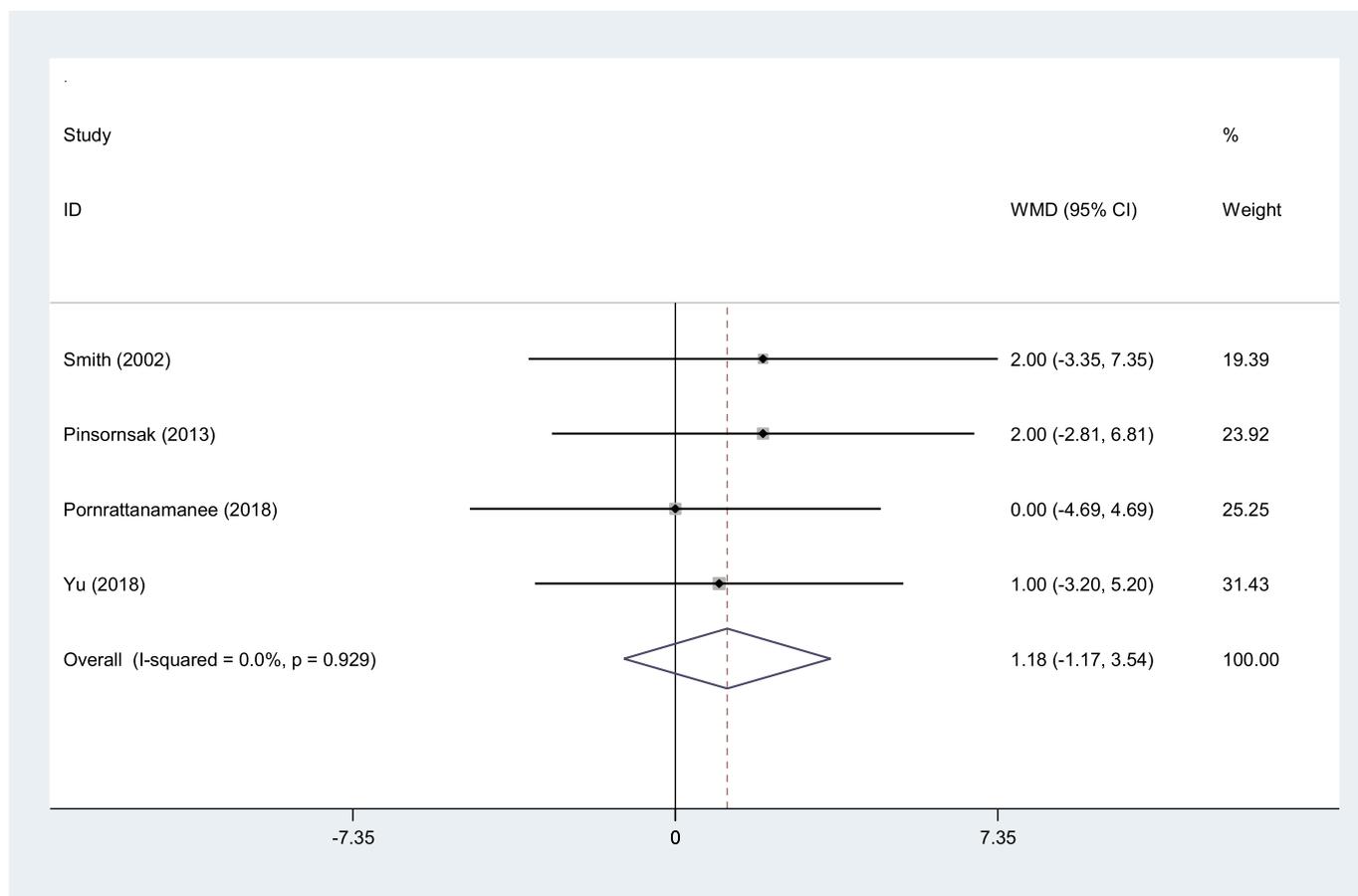


Fig. 6. Forest plot diagram of range of motion.

reported that more than 30% of patients suffered postoperative pain ranging from moderate to severe after knee replacement [24,25]. Inadequate pain management during TKA was associated with postoperative complications, such as cardiovascular disease, deep venous thrombosis, pulmonary infection and urinary retention. In addition, persistent pain would influence rehabilitation, which is crucial for regaining muscle strength and joint function. Opioid is commonly used for relieving pain after surgical procedures [26]. However, it may be associated with several adverse effects including vomiting, pruritus, drug tolerance, and respiratory depression [26,27]. Brodell et al. [18] reported compression bandaging can produce and maintain external compression to the soft tissues over the limb for at least 24 h. The pressure ranged from 40 to 50 mm Hg at the first application and decreased to 10 mm Hg within 48 h. Therefore, Robert Jones bandage can achieve the effect of decreasing pain and swell after surgical procedures. Although published articles have reported compression bandaging results in an improved pain relief, Hughes et al. [28] showed that there was no differences in the pain score during the 21 days' follow up. Postoperative pain was measured using a visual analogue scale. The present meta-analysis found a similar level of pain between modified

Robert Jones bandage groups and control groups. In animal trials, modified Robert Jones bandage was reported to reduce swelling after injury. However, inadequate application may obliterate blood flow to soft tissue. Our study did not find any difference between groups in terms of swelling.

Some complications may be associated with the application of modified Robert Jones bandage, such as peroneal nerve palsy, pressure ulcers, subcutaneous hematoma, and blister, which have been reported by various studies. All RCTs reported the compression-related complications between groups. For the safety evaluation, no significant difference was identified. All of them were mild and resolved using conservative treatments.

Several limitations of the meta-analysis should be noted: (1) only five RCTs with 402 participants were included, and the sample size was small; (2) level of inflammation factors during operation were not measured; (3) subbandage pressure was not detected although we tried to standardize the bandaging; (4) publication bias is unavoidable because the identified language was restricted to English; (4) combining clinical outcomes from different follow-up time points will introduce heterogeneities and potential biases.

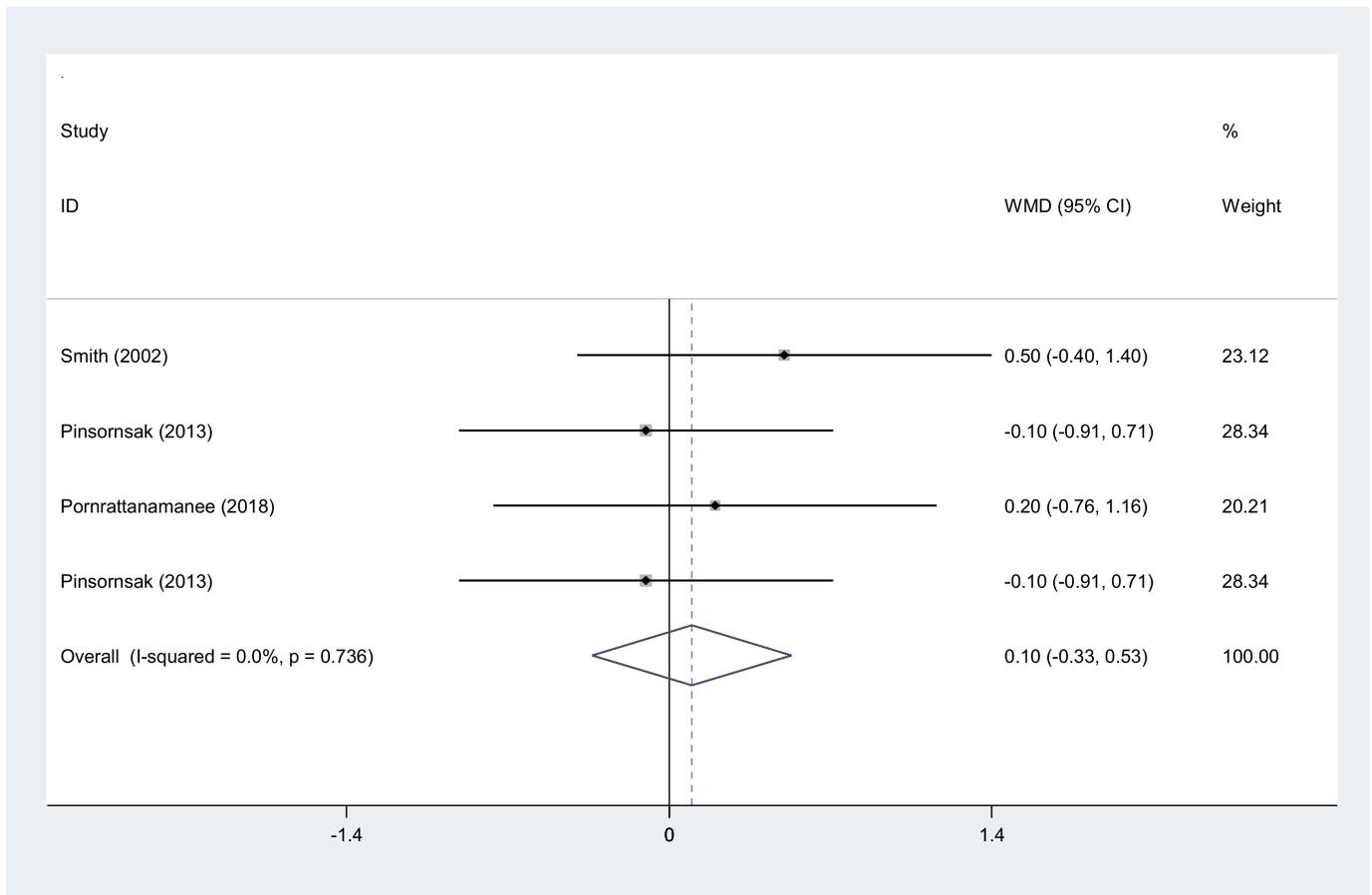


Fig. 7. Forest plot diagram of length of hospitalization.

**5. Conclusion**

Although published articles have shown improved outcome of blood loss, pain, and knee swelling after application of a modified Robert Jones bandage, our study suggest the use of modified Robert Jones bandage may not be necessary after primary TKA.

**Provenance and peer review**

Not commissioned, externally peer-reviewed.

**Ethical approval**

Ethical approval was not application.

**Sources of funding**

None.

**Author contribution**

Xiaobing Feng: writing.  
 Guoquan: Zhao: data collections and data analysis.  
 Quan Yan: study design.

**Conflicts of interest**

We declared that there is no conflicts of interest.

**Trial registry number**

This is a review article.

**Guarantor**

Quan Yan.

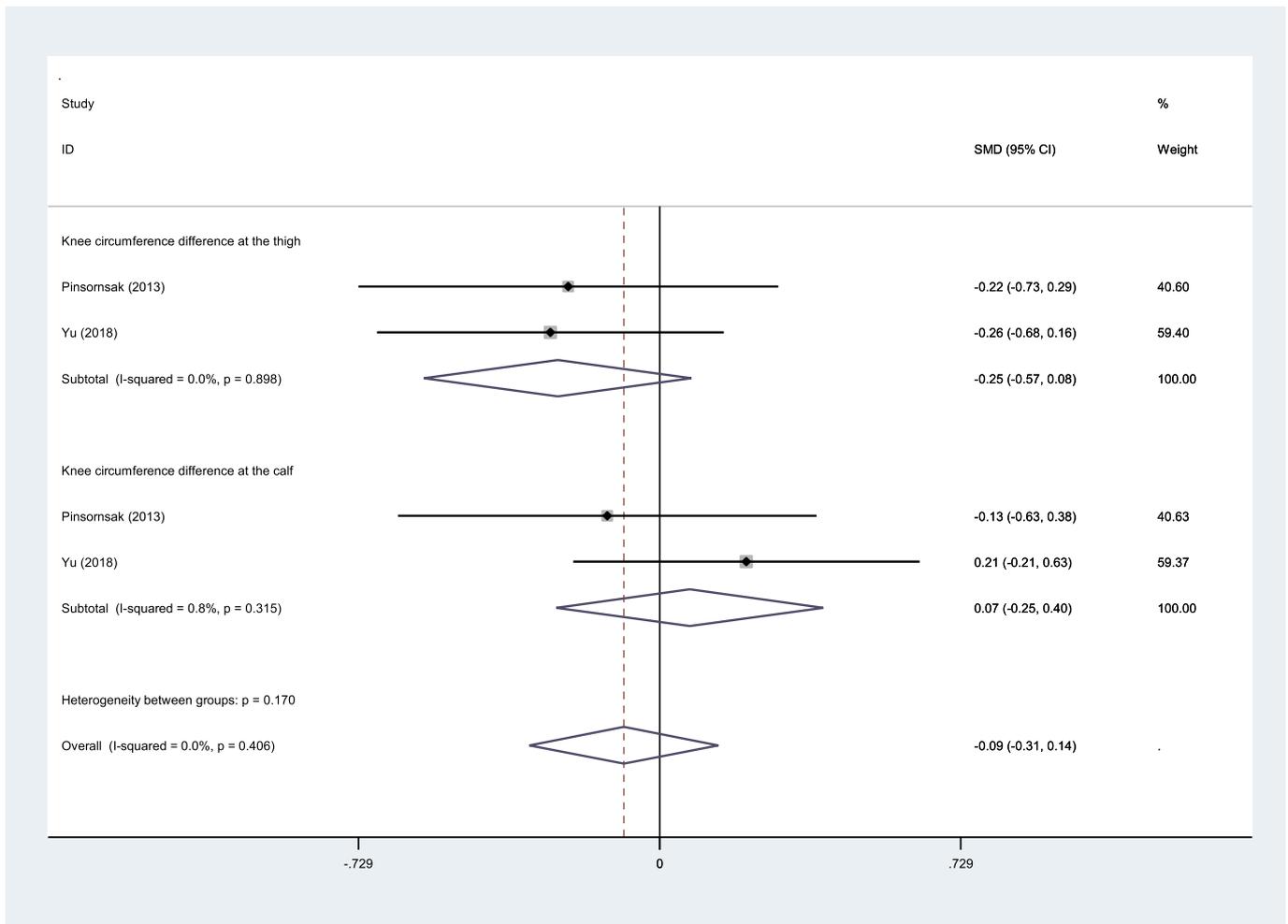


Fig. 8. Forest plot diagram of knee circumference difference.

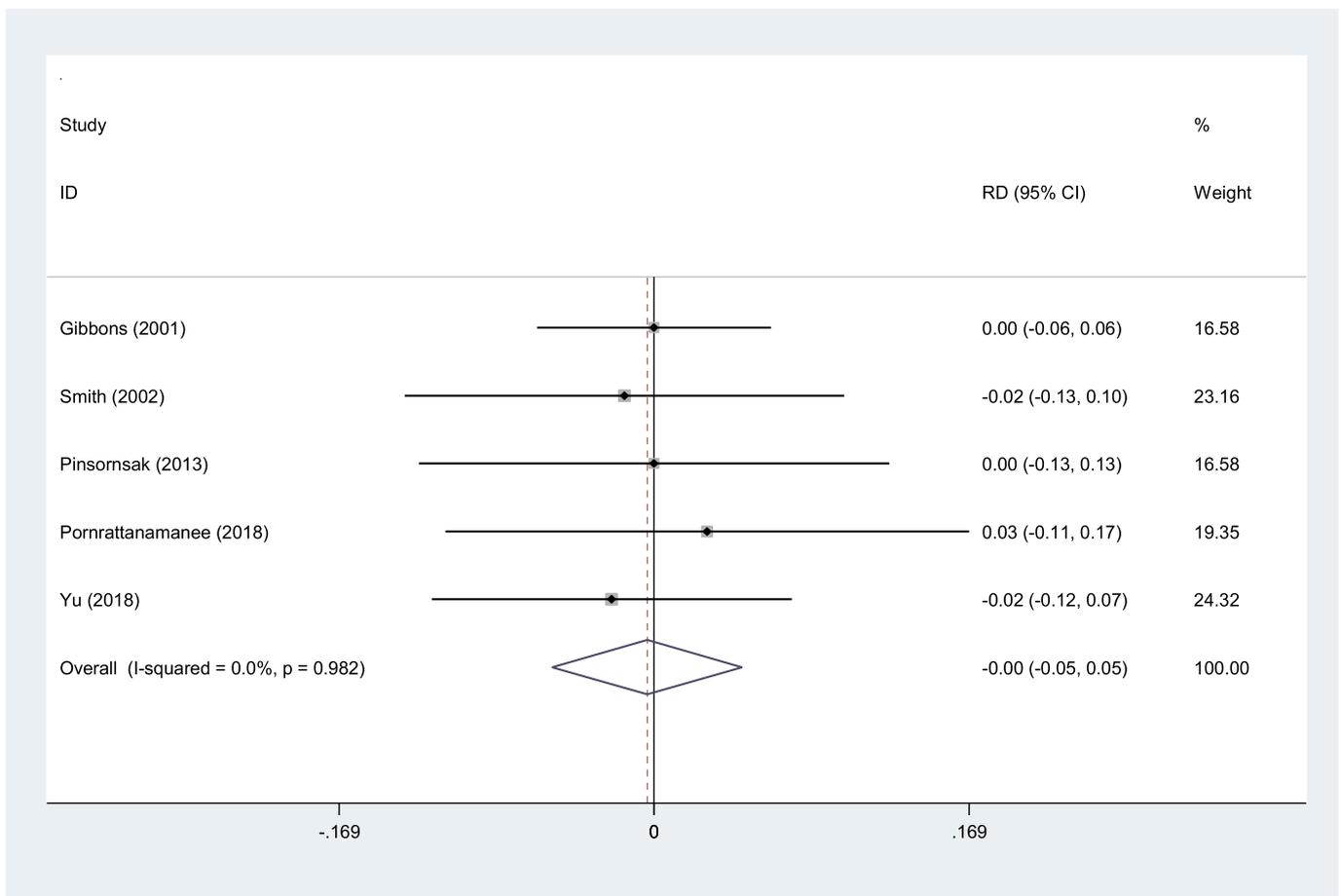


Fig. 9. Forest plot diagram of adverse events.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijssu.2019.01.015>.

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