Orthopaedic Surgery

REVIEW ARTICLE

Comparisons of the Efficacy and Safety of Total Knee Arthroplasty by Different Surgical Approaches: A Systematic Review and Network Meta-analysis

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Abstract

The purpose of this network meta-analysis was to investigate the efficacy and safety of total knee arthroplasty (TKA) considering seven different surgical approaches. Four databases (PubMed, Cochrane Library, EMBASE, Web of Science) were searched for clinical randomized controlled trials (RCTs) involving TKA with different surgical approaches. STATA 14.0 was used to construct network maps and publication bias graphs and conduct inconsistency tests, network meta-analyses, and surface under the cumulative ranking (SUCRA) calculations. A total of 51 RCTs involving 4061 patients and 4179 knees from 18 countries were included. Among the seven surgical approaches, the midvastus approach (MV) was the top choice to reduce tourniquet use time, the subvastus approach (SV) had the shortest operation time, the mini-midvastus approach (Mini-SV) was associated with the least amount of time to achieve straight leg raise (SLR) after surgery, the mini-medial parapatellar approach (Mini-MP) reduced postoperative pain effects, and the medial parapatellar approach (MP) was the best approach to improve range of motion (ROM). Excluding the quadriceps-sparing approach (QS), which was not compared, the use of the mini-midvastus (Mini-MV) may shorten the hospital stay. There were no significant differences in blood loss, postoperative complications, American Knee Society Score (AKSS) objective, or AKSS functional between the seven surgical approaches ($P > 0.05$).

Key words: Network meta-analysis; Randomized controlled trials; Surgical approaches; Total knee arthroplasty

Introduction

Total knee arthroplasty (TKA) utilizes an artificial prosthesis to replace a severely injured knee that has lost its normal function, eliminate pain, restore knee stability, and improve quality of life[1]. TKA is mainly used for non-suppurative arthritis (such as rheumatoid arthritis and osteoarthritis), traumatic arthritis, and so on, which can cause severe knee pain, instability, and serious daily life disorders in those for whom conservative treatment has been ineffective or treatment failure cases[2]. As the population ages, the prevalence of knee osteoarthritis is increasing[3,4]. A large number of clinical applications indicate that TKA is the best treatment for advanced osteoarthritis[2,5]. Relevant studies have shown that approximately 90% of patients experience excellent or good TKA results, and the 10-year survival of the

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prosthesis may reach 96%, significantly improving the quality of life of patients[6,7].

There are abundant studies on different surgical approaches for TKA in clinical practice, and there is still no unified conclusion on which surgical approach is recommended. The medial parapatellar approach (MP) is the classic approach for TKA. It is safe and easy to conduct and is widely used in the clinic[8]. Because the MP requires an incision in the quadriceps femoris, serious damage to the knee extensor tissue may occur, resulting in postoperative complications, such as patellar dislocation, subexation, and knee extensor weakness, delaying early postoperative rehabilitation training in patients[8,9]. The subvastus approach (SV) and quadriceps-sparing approach (QS) are regarded as necessary to preserve the anatomy in the highly technical approaches. Compared with the traditional MP, the SV and QS completely retain the extensor tissue of the knee joint and cause minimal damage to the blood vessels around the knee joint[5]. However, studies have shown that the application of the QS may prolong tourniquet time and operation time[10]. The midvastus approach (MV) minimizes damage to the peripheral blood vessels and muscles in the knee and exposes a good surgical field of view[11]. Because of the relatively large incision, the traditional surgical approach is characterized by extensive trauma to the surrounding tissues of the knee joint. In recent decades, the concept of minimally invasive surgery has spread rapidly in the field and has been widely applied to the surgical approach of TKA. This minimally invasive approach to total knee surgery is a technical improvement and supplement to traditional knee replacement. It has the advantages of a small skin incision, minor trauma, and an aesthetically appealing appearance. However, the efficacy and safety of minimally invasive total knee arthroplasty (MIS-TKA) are still the focus of current research. To date, there is still some debate and even doubt about MIS-TKA.[5,12,13] Some researchers believe that the long-term effects of TKA through minimally invasive incisions are still unknown and that poor exposure to the surgical field may lead to problems such as implant fixation, poor alignment, and even an increased risk of postoperative infection[12,13]. Clinical studies suggest that MIS-TKA, such as the mini-midvastus approach (Mini-MV) and the mini-medial parapatellar approach (Mini-MP), shows no significant differences in terms of blood loss, incision length, operation time, or hospital stay compared with traditional surgical approaches[14–19]. Of course, there are also views that in the early postoperative period, the Mini-MV has significantly better results than the MP in range of motion (ROM), straight leg raise (SLR), and blood loss.

Although the traditional surgical approach is associated with certain trauma, its safety and operability have been guaranteed after years of clinical practice. However, as a newly developed surgical method, MIS-TKA may still have certain risks. The use of traditional or minimally invasive surgical approaches still requires more authoritative, evidence-based results. We compared the clinical efficacy and safety of commonly used TKA approaches directly and indirectly by conducting a network meta-analysis to provide current data for decision-making and clinical applications of TKA.

Methods

This meta-analysis of RCTs was performed in accordance with the PRISMA statements. And this study was registered on PROSPERO website https://www.crd.york.ac.uk/PROSPERO/ (registration number CRD42020162704).

Inclusion Criteria

The inclusion criteria are as follows: (i) only clinical randomized controlled trials (RCTs) were included; (ii) patients with knee osteoarthritis who underwent TKA for the first time, regardless of race, age, sex, height, or weight were included. Moreover, there was no significant difference in patients' preoperative basic conditions (age, sex, basic diseases, etc.), and the type of prosthesis was not limited; (iii) TKA by different surgical approaches was included; (iv) if the study was a three-arm or four-arm test, all the data of each arm were recorded; (v) the original data in the literature included at least one or more of the following indicators and was accurately described in detail: tourniquet duration, operation duration, blood loss, American Knee Society Score objective (AKSS objective, ×/100 points), American Knee Society Score functional (AKSS functional, ×/100 points), ROM, visual analogue scale (VAS) score, days to SLR, length of stay, and complications. The statistical data for continuous variables were presented as the mean ± standard deviation; and (vi) only studies published in English were included.

Exclusion Criteria

The exclusion criteria were as follows: (i) patients with revision surgery, knee infection, or severe deformity were excluded; (ii) reviews, case reports, retrospective studies, and cohort studies were excluded; (iii) studies with duplicate publications or data were excluded; and (iv) studies in which the data were obviously wrong, incomplete, or unclear were excluded.

Literature Retrieval Strategy

The PubMed, Cochrane Library, EMBASE, and Web of Science databases were searched, and RCTs involving TKA by all surgical approaches were included. The retrieval time was from the establishment of each database to October 2019. And the search terms were as follows: ("randomized controlled trial" OR "controlled clinical trial" OR "clinical trials as topic" OR randomized OR randomized OR randomly OR placebo OR trial) AND ("total knee arthroplasty" OR "total knee replacement" OR TKA OR "Knee Replacement Arthroplasties" OR "Knee Replacement Arthroplasty" OR "Knee Arthroplasty") AND (Surgical Approaches OR "conventional TKR approach" OR "anterior knee approaches" OR standard approaches OR "MIS TKR" OR "minimally invasive surgery" OR MIS OR "Minimally invasive knee surgery" OR "minimally invasive approaches" OR "Lateral parapatellar approach" OR subvastus OR SV OR "southern approach" OR "subvastus approach" OR "mini-subvastus approaches" OR midvastus OR MV OR midvastus approach OR mini-midvastus approach OR Mini-midvastus OR "quadriceps sparing" OR quadriceps-sparing OR "Medial paraptellar approach" OR "minimally invasive medial approaches" OR "mini-medial parapatellar approach" OR "mini-medial parapatellar" OR "minimally invasive medial parapatellar approach"). Each database retrieval strategy can be found in supplement 1 in Appendix S1.

Literature Screening and Data Extraction

Two orthopaedic surgeons (GH Liang and WY Yang) conducted the literature retrieval, and the preliminary and secondary screening of the literature was conducted strictly in accordance with the pre-established inclusion and exclusion criteria. The two researchers (GH Liang and WY Yang) extracted the data independently, and a third researcher (JK Pan) carried out the comparison. In cases of errors or differences, the third researcher (JK Pan) and corresponding author (J Liu) assisted in the judgment.

The main data extracted in this study included the title, first author, publication year, sample size, intervention measures, age, relevant items for literature quality evaluation, and relevant outcome indicators of clinical efficacy. For the outcome indicators with more than two time points of statistical data, referring to relevant statistical theories[20] and Cochrane Handbook recommendation, we extracted the time point data of the last follow-up as the statistical data source.

Bias Risk Assessment of Included Studies

The Cochrane risk of bias tool was used for quality evaluation[21]. The tool includes evaluation in seven areas: random sequence generation, allocation blinding, blinding of participants, blinding of outcome measures, incomplete outcome data, selective reporting, and other biases. The risk of bias in each area was judged to be low, high, or unclear[22].

Statistical Analysis

The statistical methods in this network meta-analysis were all based on the frequency framework, and a random effects model was used to conduct statistics on the network meta-analysis results. The evaluation indexes in this study included binomial variables and continuous variables. The relative risk (RR) was used to evaluate the effects of binary variables, weighted mean differences (WMDs) were used to evaluate the effects of continuous variables, and 95% confidence intervals (*CIs*) of the RRs and WMDs were calculated. Review Manager 5.3.5 software (Cochrane Collaboration, Oxford, UK) was used for literature quality evaluation. STATA 14.0 software (STATA Corporation, Lakeway, Texas, USA) was used to construct network maps and publication bias test graphs and to conduct inconsistency tests, network meta-analyses, and surface under the cumulative ranking (SUCRA) calculations[23]. To assess the absolute differences between direct and indirect evidence, we calculated inconsistency factors and 95% *CIs* for each closed loop in the network[24]. This calculation method detected loop inconsistencies with the ifplot command in STATA. If the lower limit of the 95% *CI* was 0 or $P > 0.05$, the direct comparative evidence was considered very consistent with the indirect comparative evidence. The estimated variance used to examine heterogeneity (t^2) to assess statistical heterogeneity was calculated. t^2 values of approximately 0.04, 0.16, and 0.36 indicated low, moderate, and high heterogeneity, respectively[25,26]. In this study, the SUCRA method was used to calculate the cumulative ranking probability of each treatment scheme. The higher the value of SUCRA, the better the effect of the intervention[23,27].

Results

Literature Screening Process and Results

A total of 1678 relevant studies were obtained in the initial search of the PubMed ($n = 190$), EMBASE ($n = 477$), Cochrane Library ($n = 531$), and Web of Science ($n = 460$) databases, as well as from manual retrieval ($n = 20$). After excluding duplicate literature and applying the inclusion criteria and exclusion criteria, 51 RCTs[15,28-77] were finally included in this study, of which 42[15,29-37,39-47,49-59,62-63,65-67,70-76] were clearly approved by ethics committees, while the approval of nine was not reported. Two three-arm tests were included in the analysis, while the remainder were all two-arm tests. A total of 4061 patients, 4179 knees, and seven surgical approaches, including MP, MV, SV, QS, Mini-MP, Mini-MV, Mini-SV, were included. The literature screening process and results are shown in Figure 1, and the basic information of the included literature is shown in supplement 2 in Appendix S1.

Quality Evaluation of the Included Literature

ptIn terms of randomization, a total of 29 studies were considered low risk; two studies did not perform random allocation, and 20 studies did not specify the method of random allocation. In terms of allocation blinding, a total of 27 studies correctly implemented allocation blinding, three studies failed to achieve allocation blinding, and 21 studies did not report blinding. Because it is difficult to blind the surgical approach adopted by the surgeon, the implementation bias was considered high risk. In terms of measurement bias of outcome indicators, 32 studies were low risk, while 19 studies did not report the risk. Incomplete data, selective reporting, and other risks were generally low. In general, among the 357 minor risk assessments of the 51 studies included in this study, the percentages of low risk, unclear risk, and high risk were 67.51%, 16.80%, and 15.69%, respectively. The bias risk assessment results of the included studies are shown in Figure 2.

Network Map

The network map is shown in Figure 2 and supplement 3 in Appendix S1. The line between the two points represents evidence for a direct comparison between two surgical approaches, while the absence of a line indicates that there was no direct comparison and that results were obtained by indirect comparison. The thickness of the line indicates the number of studies using both surgical approaches. The dot size indicates the total number of cases enrolled in the surgical approach (Figure 3).

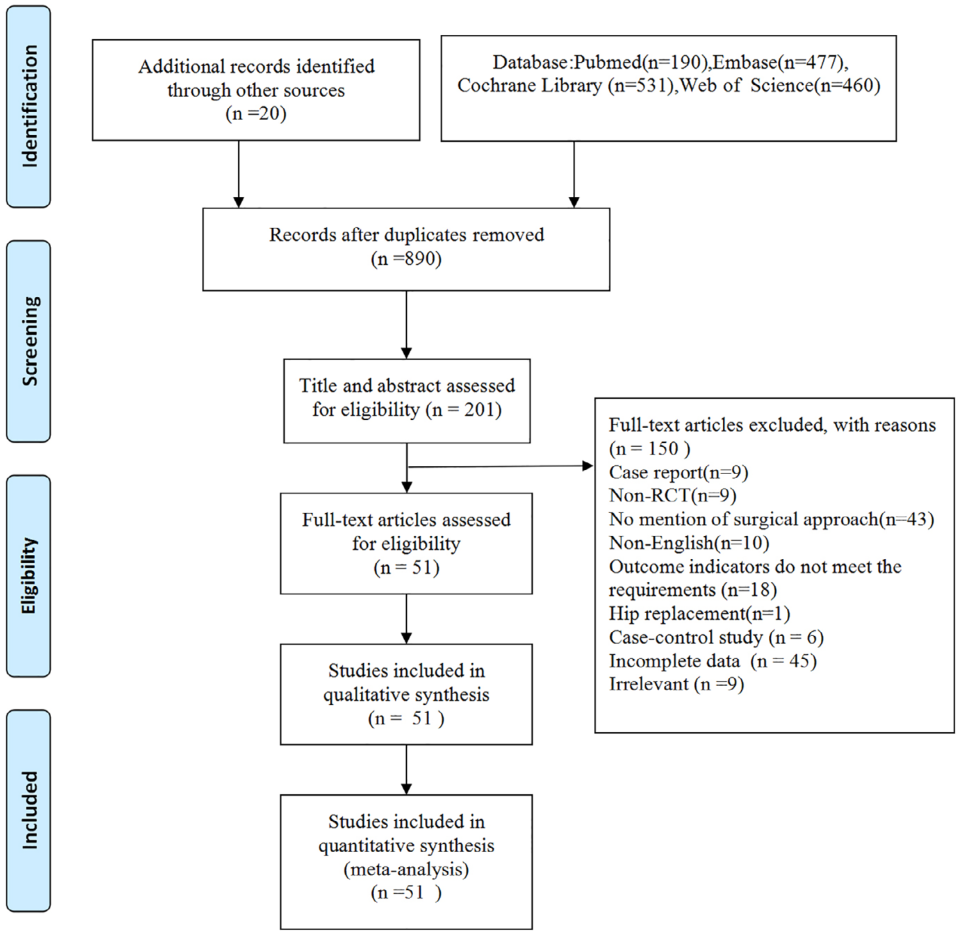

Fig. 1 Flow diagram of databases searched according to PRISMA guidelines

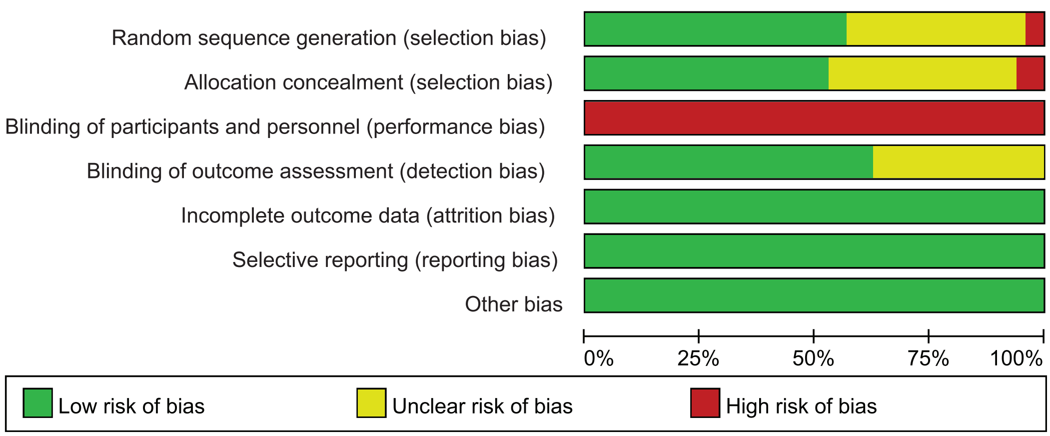

Fig. 2 Risk of bias graph of all included RCTs

Network Meta-analysis

Tourniquet Duration

We extracted data on the duration of tourniquet use during TKA from 18 studies. The results of the network meta-analysis showed that the tourniquet time of the Mini-MV, MP, Mini-MP, and MV were all shorter than that of the QS, with statistically significant differences ($P < 0.05$). The results of pairwise meta-analysis are shown in Figure 4. The duration of the Mini-SV was longer than that of the Mini-MP (WMD = 1.53, 95% *CI* 0.07–2.99), and the difference was statistically significant ($P < 0.05$) (Supplement Table 1 in

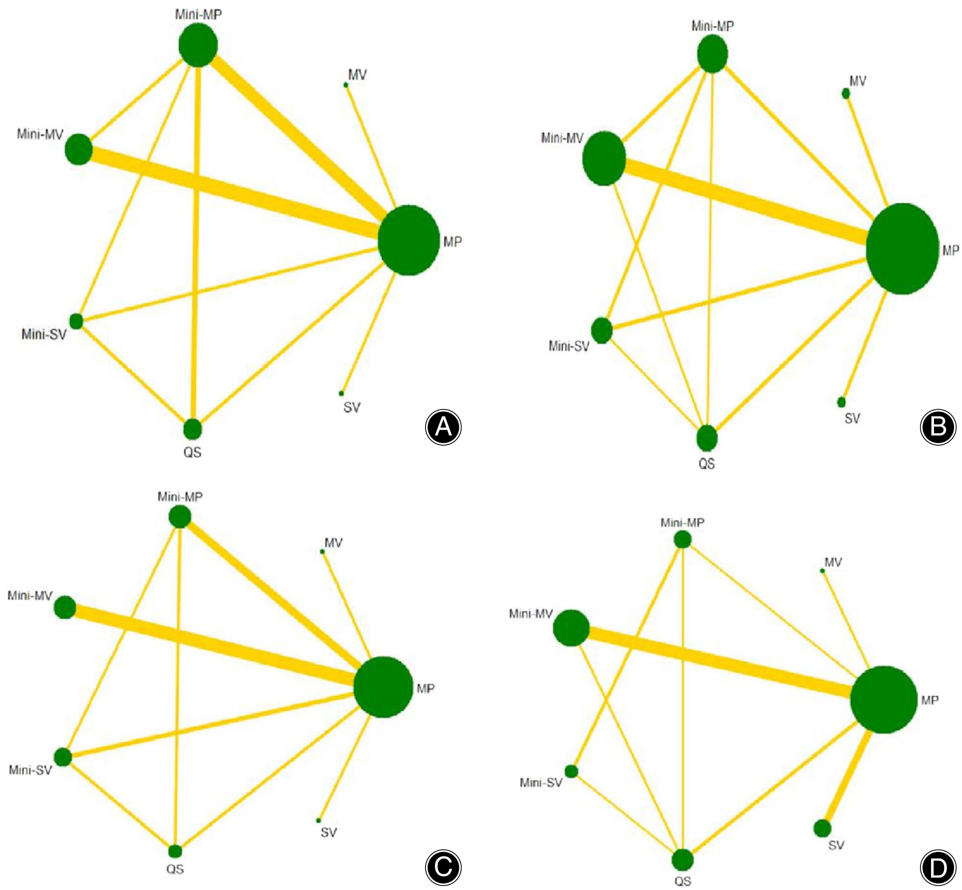

Fig. 3 Network diagrams depicting direct evidence used in network meta-analysis. (A) Network diagram of tourniquet duration shows 10 direct comparisons. (B) Network diagram of operation duration shows 11 direct comparisons. (C) Network diagram of the blood loss shows nine direct comparisons. (D) Network diagram of the complications shows nine direct comparisons. Lines between two nodes mean there is direct evidence between two interventions; line thickness corresponds to the number of studies and the size of the nodes represents the total sample size of the treatments

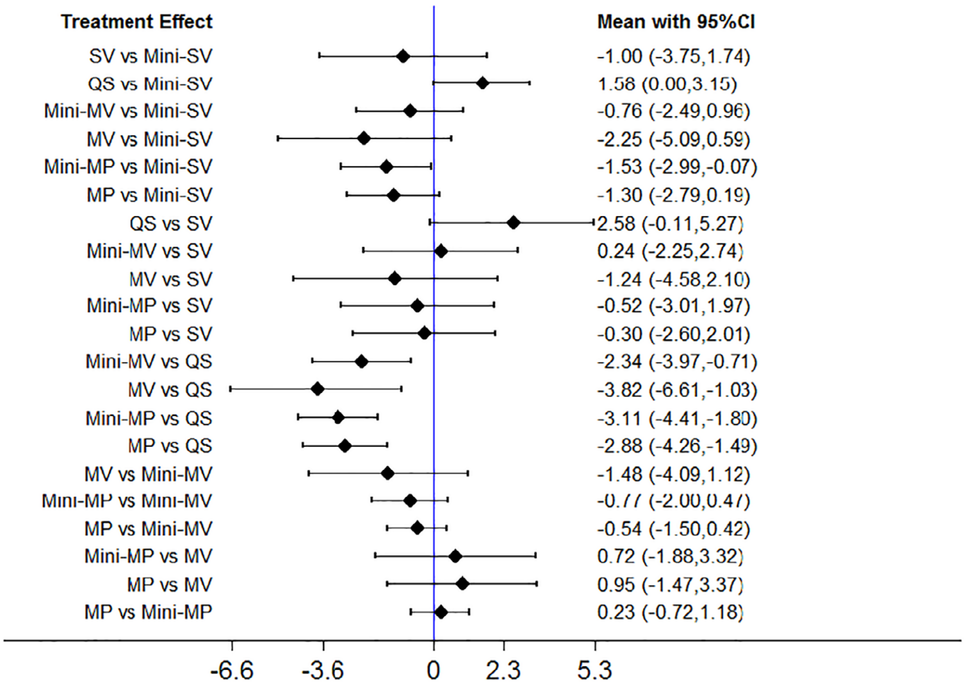

Fig. 4 The forest plots of pairwise meta-analysis of the tourniquet duration

TABLE 1 The results of SUCRA

Outcome indicators	Surgical approach						
	Mini-SV	SV	QS	Mini-MV	MV	Mini-MP	MP
Tourniquet duration	25.2%	55.3%	1.2%	42.9%	84.2%	75.2%	66.0%
Operation duration	77.7%	85.1%	56.5%	38.5%	12.5%	5.9%	73.7%
Blood loss	62.4%	43.9%	29.8%	52.3%	54.3%	77.6%	29.7%
Length of stay	24.5%	27.4%	—	86.0%	50.6%	85.8%	25.7%
American Knee Society Scores Functional	70.9%	35.7%	55.5%	44.7%	32.7%	78.7%	31.9%
American Knee Society Scores Objective	22.9%	42.6%	69.1%	51.3%	81.9%	46.0%	36.3%
Visual analog scale	60.8%	30.9%	60.9%	43.7%	41.9%	89.5%	22.3%
Range of motion	16.8%	68.8%	44.7%	49.7%	74.5%	13.3%	82.4%
Straight leg raise	99.2%	51.9%	80.5%	45.0%	17.3%	47.2%	8.8%
Complications	68.4%	23.6%	75.9%	59.1%	35.5%	66.7%	20.8%

Appendix S1). The MV (84.2%) had the maximum SUCRA value, and the QS had the minimum (1.2%) (Table 1). The SUCRA diagram corresponding to all the outcome indicators is shown in supplement 4 in Appendix S1. The above data analysis indicates that the MV may be the most effective approach to reduce tourniquet use time during TKA.

Operation Duration

We extracted data on the duration of TKA from 22 studies. The operation times of the MV, Mini-MP, MP, SV, and Mini-MV were shorter than that of the QS, and the difference was statistically significant ($P < 0.05$). The results of pairwise meta-analysis are shown in Figure 5. The operation times of the MV, Mini-MP, MP, and SV were shorter than that of the Mini-SV, and the difference was statistically significant ($P < 0.05$). The time of the MP was shorter than that of the Mini-MV (WMD = −0.81, 95% *CI* −1.42 to −0.20), and the difference was statistically significant ($P < 0.05$) (Supplement Table 1 in Appendix S1). The SV (85.1%) has the maximum SUCRA value, and the Mini-MP had the minimum value (5.9%) (Table 1). The above data analysis indicates that the SV may be the shortest approach for TKA.

Blood Loss

We extracted data on TKA-associated blood loss from 16 studies. The results of the network meta-analysis showed that there were no significant differences in blood loss between the different surgical approaches ($P > 0.05$) (Supplement Table 1 in Appendix S1). The results of pairwise meta-analysis are shown in Figure 6. The Mini-MP (77.6%) had the maximum SUCRA value, and the MP had the minimum value (29.7%) (Table 1).

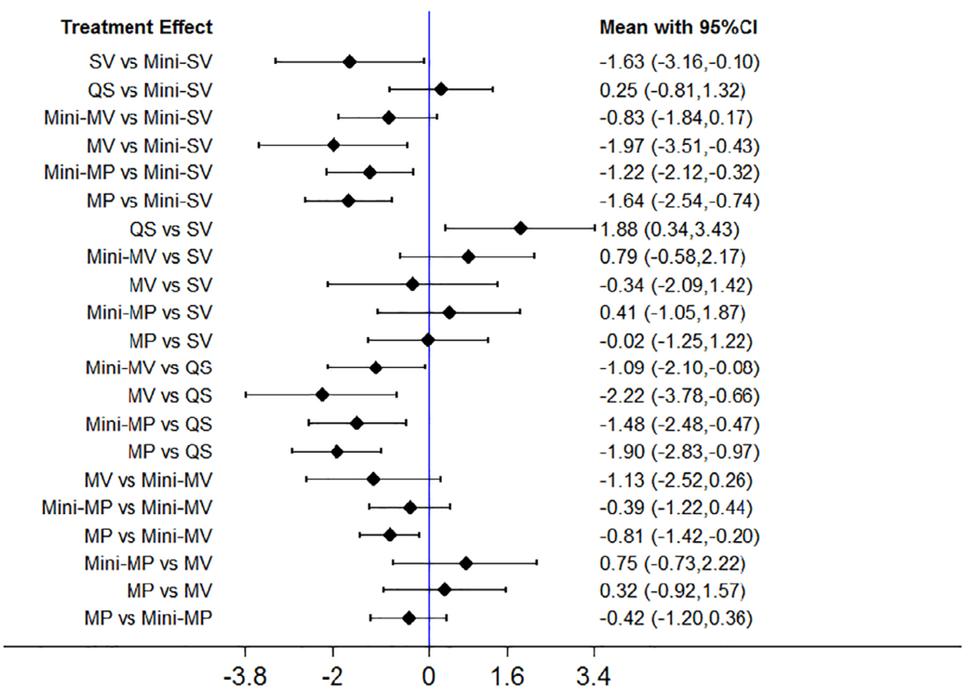

Fig. 5 The forest plots of pairwise meta-analysis of the operation duration

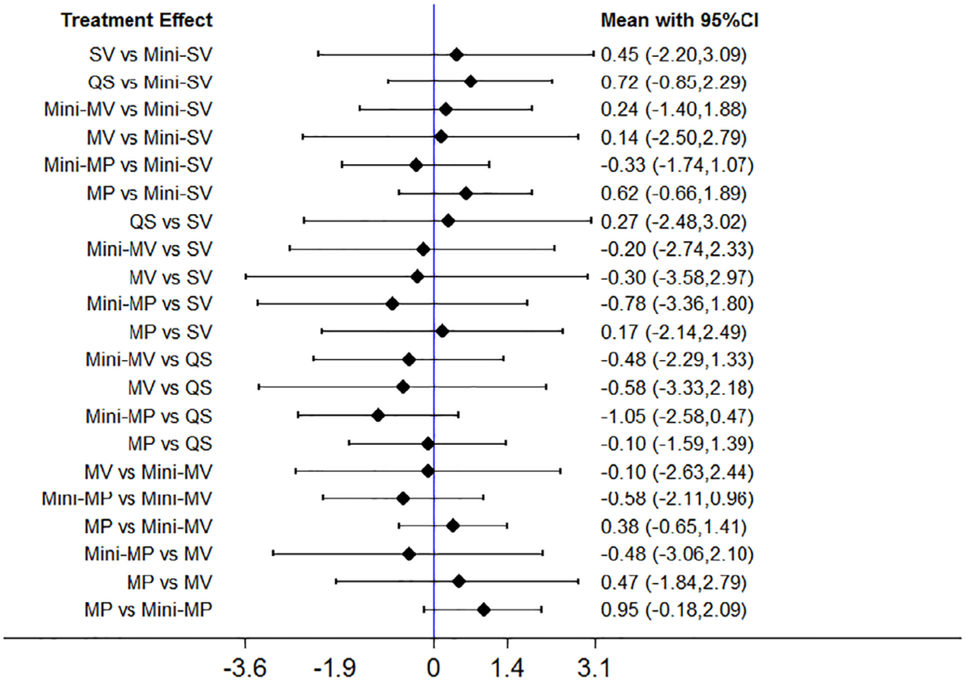

Fig. 6 The forest plots of pairwise meta-analysis of the blood loss

AKSS Functional
We extracted AKSS functional data from 18 studies at the last follow-up after TKA. The results of the network meta-analysis showed that there were no significant differences in the AKSS functional at the last follow-up after each surgical approach ($P > 0.05$) (Supplement Table 1 in Appendix S1). The results of pairwise meta-analysis are shown in Figure 7. The Mini-MP (78.7%) had the maximum SUCRA value, and the MP had the minimum value (31.9%) (Table 1).

AKSS Objective
We extracted the AKSS objective at the last follow-up after TKA from 19 studies. The results of the network meta-analysis showed that there were no significant differences in

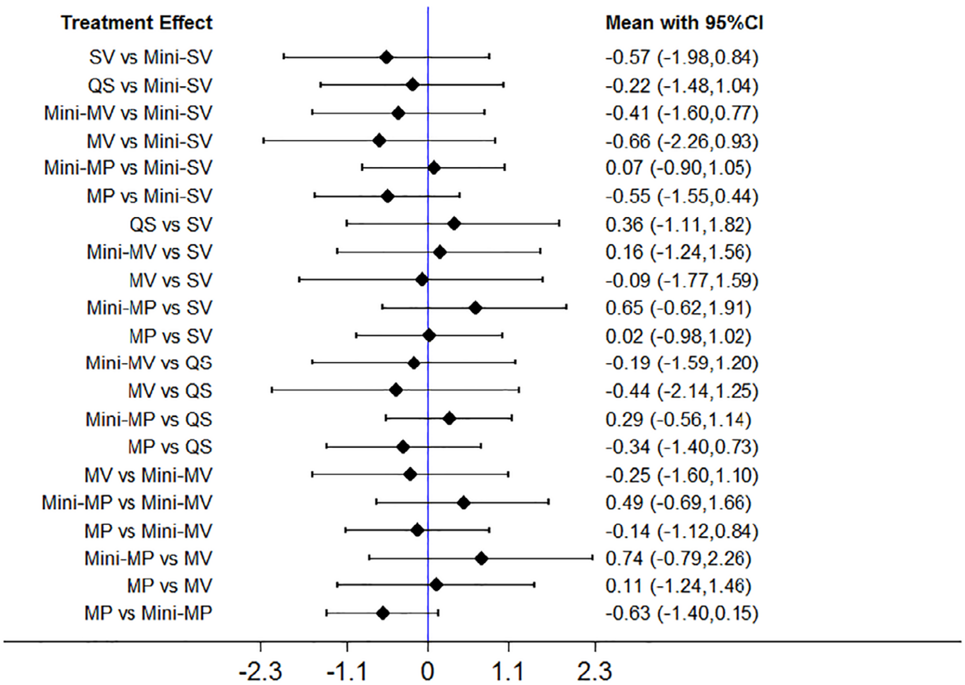

Fig. 7 The forest plots of pairwise meta-analysis of the AKSS functional

the AKSS objective at the last follow-up after each surgical approach ($P > 0.05$) (Supplement Table 1 in Appendix S1). The results of pairwise meta-analysis are shown in Figure 8. The MV (81.9%) had the maximum SUCRA value, and the Mini-SV had the minimum value (22.9%) (Table 1).

VAS Score

The VAS score at the last follow-up after total knee replacement was extracted from 16 studies. The VAS scores of patients who underwent MP was higher than that of patients who underwent the Mini-MP (WMD = 0.87, 95% *CI* 0.13–1.61), and the Mini-MP was more effective in alleviating postoperative pain than the MP ($P > 0.05$) (Supplement Table 1 in Appendix S1). The results of pairwise meta-analysis are shown in Figure 9. The Mini-MP (89.5%) had the maximum SUCRA value, and the MP had the minimum value (22.3%) (Table 1). The above data analysis shows that the Mini-MP is the most effective approach to reduce postoperative pain.

Days to SLR

We extracted data from 11 studies on the number of days required for SLR after TKA. Considering the Mini-SV group as the control group, the MP, MV, Mini-MV, Mini-MP, and SV groups all required more days for SLR than the Mini-SV group, and the difference was statistically significant ($P < 0.05$). Considering the QS group as the control group, the number of days required for SLR in the MP and MV groups was more than that in the QS group, with a statistically significant difference ($P < 0.05$). The number of days required for SLR after the MP was higher than that after the SV (WMD = 1.05, 95% *CI* 0.24–1.85) (Supplement Table 1 in Appendix S1). The results of pairwise meta-analysis are shown in Figure 10. The Mini-SV (99.2%) had the maximum SUCRA value, and the MP had the minimum value (8.8%) (Table 1). The above data analysis indicates that the Mini-SV may be the approach with the least number of days required for SLR after surgery.

ROM

We extracted ROM data at the last follow-up after TKA from 24 studies. Considering the MP group as the control group, the ROMs in the Mini-SV and Mini-MP groups were greater than that in the MP group at the last postoperative follow-up, with a statistically significant difference ($P < 0.05$) (Supplement Table 1 in Appendix S1). The results of pairwise meta-analysis are shown in Figure 11. MP (82.4%) had the maximum SUCRA value, and the Mini-MP had the minimum value (13.3%) (Table 1). The above data analysis shows that the MP has the best effect on improving the ROM after TKA.

Length of Stay

We extracted data on the length of hospital stay after TKA from 14 studies. The results of the network meta-analysis showed that considering MP as the control group, the hospital stays in the Mini-SV and Mini-MP groups were shorter than that in the MP group, with a statistically significant difference ($P < 0.05$) (Supplement Table 1 in Appendix S1). The Mini-MV (86.0%) had the maximum SUCRA value, and the Mini-SV had the minimum value (24.5%) (Table 1). The results of pairwise meta-analysis are shown in Figure 12. The above data analysis shows that the Mini-MV is the best approach to shorten the hospitalization time of patients with TKA.

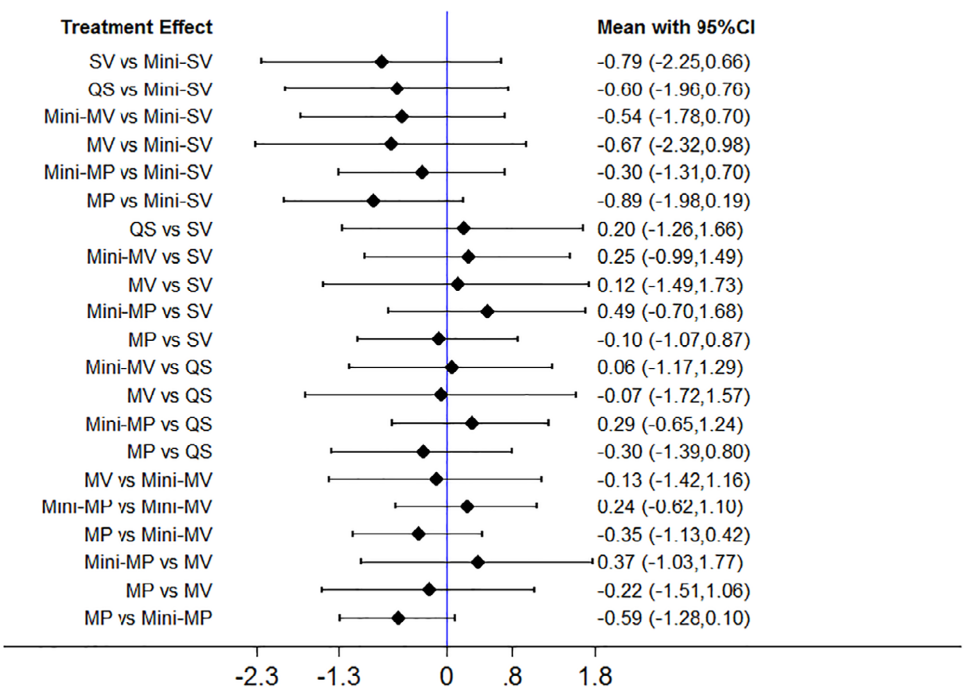

Fig. 8 The forest plots of pairwise meta-analysis of the AKSS objective

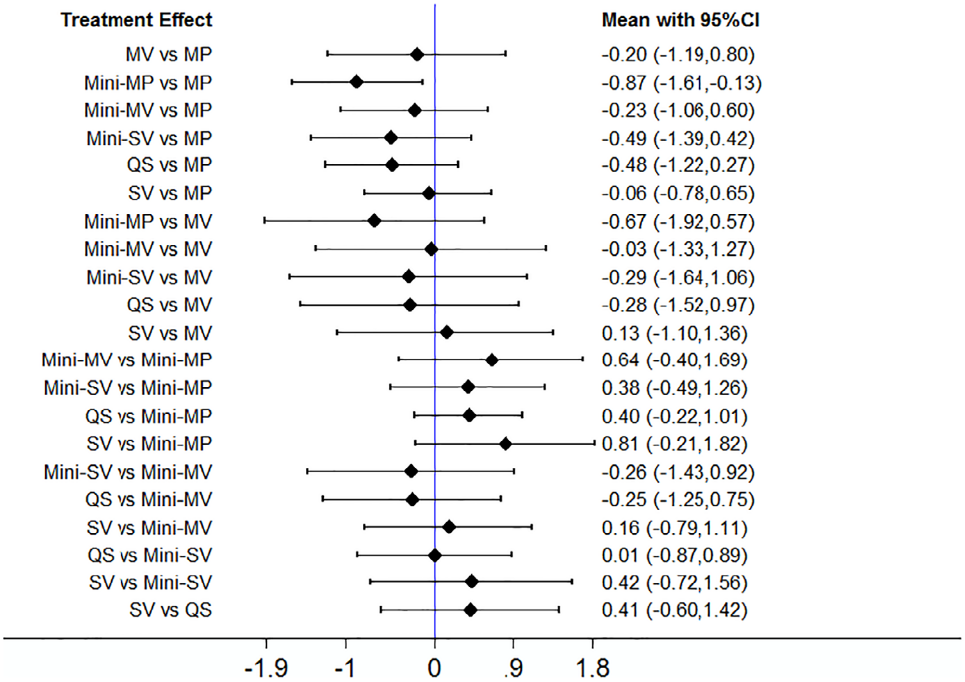

Fig. 9 The forest plots of pairwise meta-analysis of the VAS

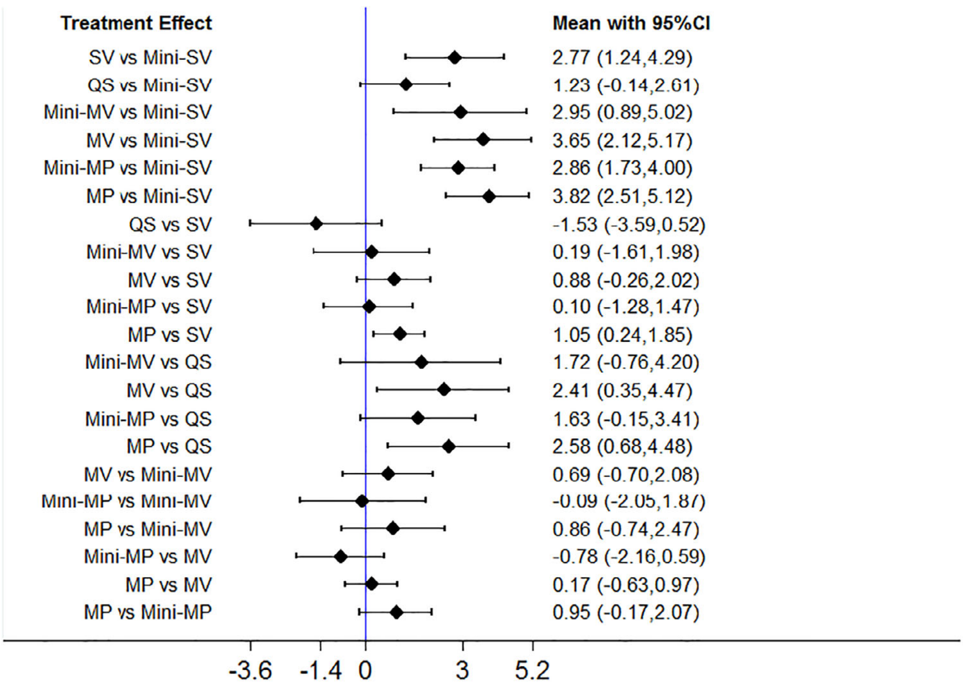

Fig. 10 The forest plots of pairwise meta-analysis of the SLR

Complications

We extracted data on TKA-associated complications from 18 studies. The results of the network meta-analysis showed that there were no significant differences in the incidence rates of postoperative complications among the different surgical approaches ($P > 0.05$) (Supplement Table 1 in Appendix S1). The QS (75.9%) had the maximum SUCRA value, and the SV had the minimum value (23.6%) (Table 1).

Quality of the Evidence Domains

We tested for inconsistencies in the closed loop formed by interventions involving all outcome measures. The inconsistency factor (IF) between each characteristic cycle factor

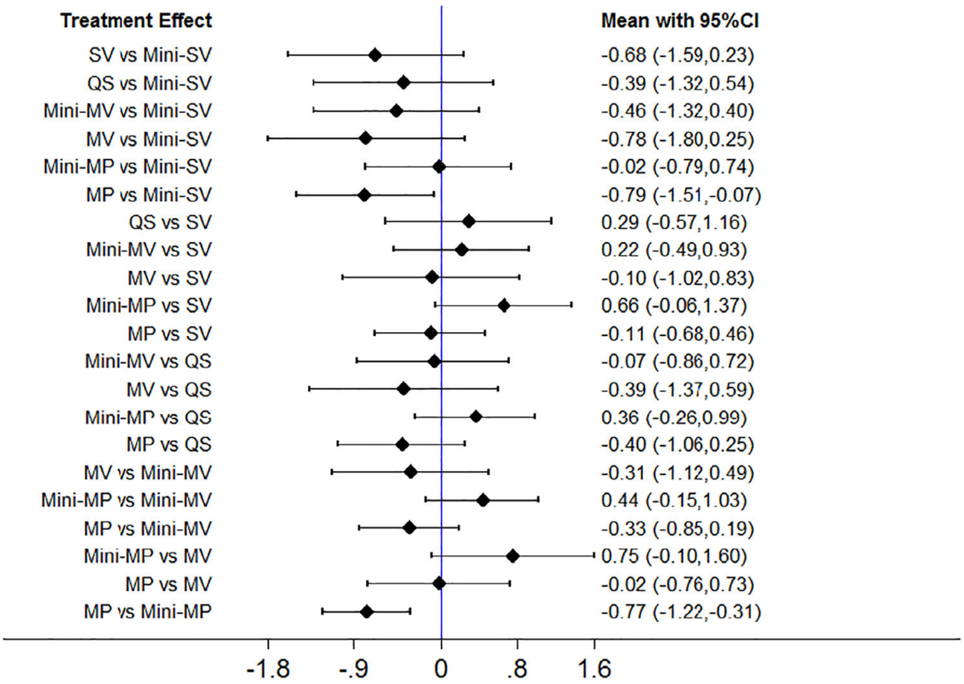

Fig. 11 The forest plots of pairwise meta-analysis of the ROM

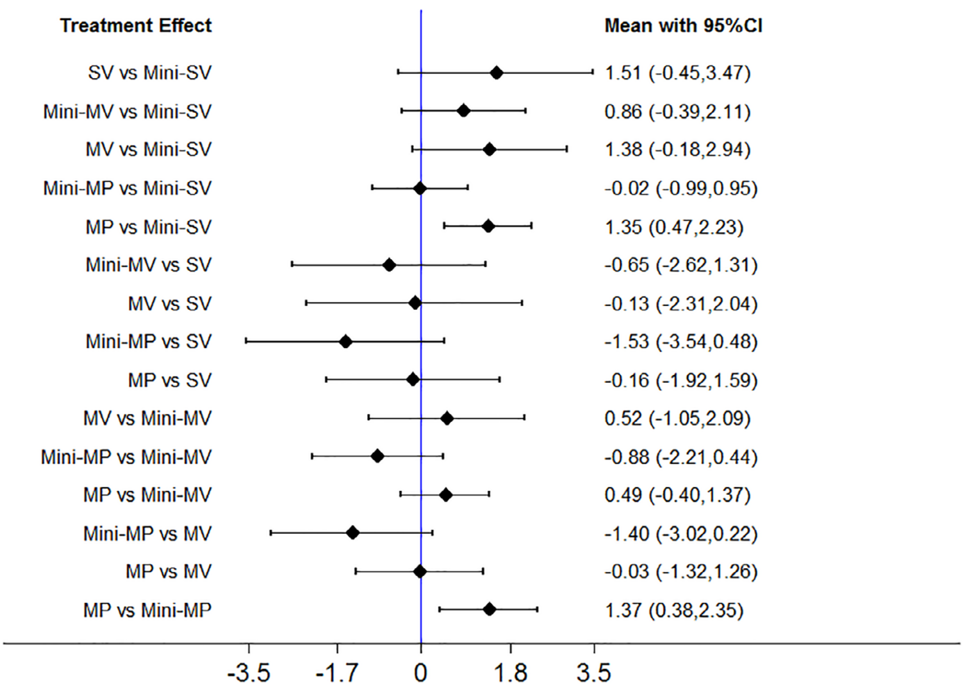

Fig. 12 The forest plots of pairwise meta-analysis of the length of stay

detection, *P* values of the test of inconsistency, and loop heterogeneity parameters (t^2) are presented in supplement 6 in Appendix S1. Our results showed that the t^2 values of all outcome indicators were <0.04, indicating that the comparative data of all the outcome indicators had low heterogeneity. The 95% *CI*s and *P* values of the inconsistency between the direct and indirect evaluation results indicated that in addition to blood loss, length of hospital stay, and ROM, the closed-loop consistency of the other outcome indicators was improved. Direct and indirect comparisons had little effects on the results of the whole network meta-analysis, and the statistical results of the network meta-analysis were highly reliable (the statistical results are shown in supplement 5 in Appendix S1). We constructed a funnel chart to compare

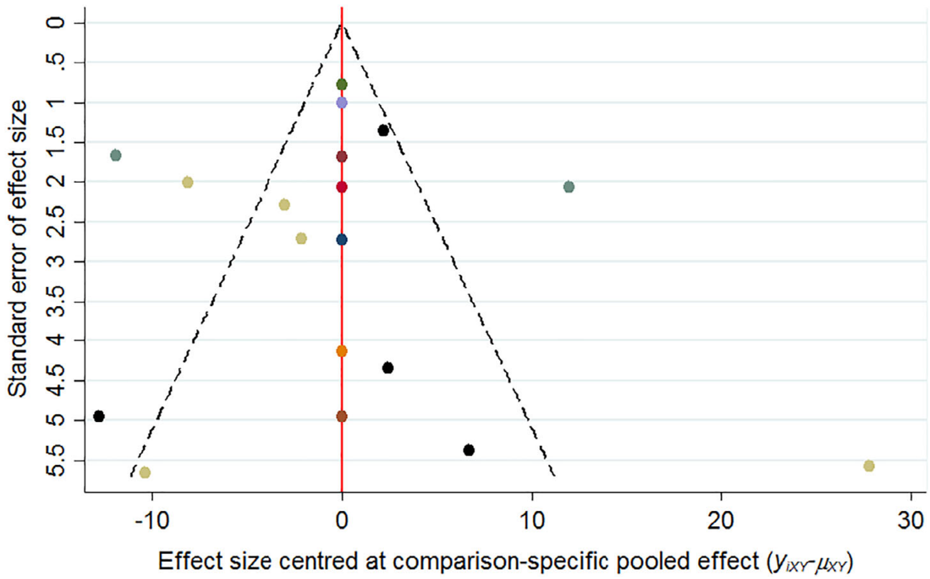

Fig. 13 Comparison-adjusted funnel plot of tourniquet duration

and adjust all outcome indicators (Figure 13 and supplement 6 in Appendix S1). The results suggest that tourniquet duration, blood loss, length of hospital stay, VAS score, ROM, and the corresponding funnel points on the funnel plot are roughly symmetrical based on the zero line, and the angle between the adjusted auxiliary line and the zero line is relatively small, so it is likely that there is no serious publication bias. However, the points on the funnel chart corresponding to the operation time, SLR, AKSS objective, and AKSS functional are asymmetric based on the zero line, and the angle between the adjusted auxiliary line and the zero line is slightly increased; therefore, there may be some publication bias. The results should be interpreted with caution.

Discussion

This study is the first systematic review and network meta-analysis of the intraoperative and postoperative clinical efficacy and safety of seven surgical approaches for TKA. This study compared the outcomes of seven surgical approaches (categorized as traditional incisions or minimally invasive incisions) for TKA and made up for the limitation of a lack of RCTs for certain surgical approaches in previous traditional meta-analyses. Each surgical approach (regardless of traditional approach or minimally invasive approach) has advantages and disadvantages. We should choose the appropriate surgical approach from the perspective of the patient and clinical practice while considering the economic burdens of the different surgical approaches. The main findings of this network meta-analysis are as follows.

Discussion of Approaches on Operation-Related Indexes

Influence on Tourniquet Duration

The tourniquet time in the QS was longer than that in the Mini-MV (WMD = 2.34, 95% *CI* 0.71–3.97), MP (WMD = 2.88, 95% *CI* 1.49–4.26), Mini-MP (WMD = 3.11, 95% *CI* 1.80–4.41), and MV (WMD = 3.82, 95% *CI* 1.03–6.61). The Mini-SV took longer than the Mini-MP (WMD = 1.53, 95% *CI* 0.07–2.99), and the differences were statistically significant. According to the SUCRA statistics, the MV may be the best approach to reduce tourniquet use time. An RCT[64] showed that compared with the MP, the use time of the tourniquet in the MV was significantly reduced ($P = 0.029 < 0.05$), consistent with the SUCRA results calculated in the current study.

Influence on Operation Time

The MV (WMD = −2.22, 95% *CI* −3.78 to −0.66), Mini- MP (WMD = −1.48, 95% *CI* −2.48 to −0.47), MP (WMD = −1.90, 95% *CI* −2.83 to −0.97), SV (WMD = −1.88, 95% *CI* −3.43 to −0.34), and Mini-MV (WMD = −1.09, 95% *CI* −2.10 to −0.08) all had shorter operation times than the QS. The MV (WMD = −1.97, 95% *CI* −3.51 to −0.43), Mini-MP (WMD = −1.22, 95% *CI* −2.12 to −0.32), MP (WMD = −1.64, 95% *CI* −2.54 to −0.74), and SV (WMD = −1.63, 95% *CI* −3.16 to −0.10) all required shorter operation times than the Mini-SV. The MP (WMD = −0.81, 95% *CI* −1.42 to −0.20) was shorter than the Mini-MV, and the above differences were statistically significant. According to the SUCRA statistics, the SV may be the least time-consuming option for TKA. From the above results, we know that, as a whole, the operation time of traditional surgical approaches is relatively shorter than that of minimally invasive approaches. Because minimally invasive surgery requires only a small incision, the exposed surgical field is less than that of a traditional incision, increasing technical difficulty for the surgeon; thus, the operation time may be increased[12]. Our statistical results indicate that the SV with a conventional incision may be the approach that requires the least surgical time. The results of a prospective clinical study[77] showed that the SV required less surgical time, consistent with our findings.

Effect on Blood Loss
The statistical results showed that there were no significant differences in TKA-associated blood loss between the seven different surgical approaches. Our results showed that there were no significant differences in intraoperative blood loss between the seven surgical approaches included in the study; this result is in contrast with the traditional belief that blood loss in the large-incision approach is generally greater than that in the minimally invasive approach. Because the minimally invasive approach requires precise surgical techniques and has a poor visual field, it may prolong the operation time and increase blood loss[78]. Many clinical studies[15,18,79] have reported no significant differences in blood loss between minimally invasive and conventional surgical approaches, between the Mini-MV and Mini-MP, and between the MV and SV.

Discussion of Approaches on Postoperative Clinical Efficacy

Days to SLR
The MP (WMD = 3.82, 95% *CI* 2.51–5.12), MV (WMD = 3.65, 95% *CI* 2.12–5.17), Mini-MV (WMD = 2.95, 95% *CI* 0.89–5.02), Mini-MP (WMD = 2.86, 95% *CI* 1.73–4.00), and SV (WMD = 2.77, 95% *CI* 1.24–4.29) groups required more days to achieve postoperative straight leg elevation than the Mini-SV group. The MP (WMD = 2.58, 95% *CI* 0.68–4.48) and MV (WMD = 2.41, 95% *CI* 0.35–4.47) groups required more days for straight leg elevation than the QS group. The MP (WMD = 1.05, 95% *CI* 0.85) group required more days for straight leg elevation than the SV group, and the above differences were statistically significant. According to the SUCRA statistics, the Mini-SV may require the shortest amount of time to straight leg elevation after TKA. One of the advantages of minimally invasive surgical approaches is that the incision is small, which can make patients feel that the operation is simple and promote positive attitudes[80]. A meta-analysis[81] showed that straight leg elevation took less time after the Mini-SV, consistent with our findings.

Length of Stay
The Mini-SV (WMD = −1.35, 95% *CI* −2.23 to −0.47) and Mini-MP (WMD = −1.37, 95% *CI* −2.35 to −0.38) groups had shorter hospital stays than the MP group. According to the SUCRA statistics, the Mini-MV may be the best option to reduce length of stay. A clinical study[36] showed that the hospital stay in the Mini-MV group was significantly shorter than that in the MP group, consistent with our findings.

The VAS score in the MP (WMD = 0.87, 95% *CI* 0.13–1.61) group was higher than that in the Mini-MP group, and the difference was statistically significant. According to the SUCRA statistics, the Mini-MP may be the best option for relieving pain after TKA. A clinical study[45] with a 5-year follow-up showed that the Mini-MP reduced the postoperative VAS score more than the MP, which may be related to the smaller incision.

ROM
Considering the MP group as the control group, the Mini-SV (WMD 0.79, 95% *CI* 0.07–1.51) and Mini-MP (WMD = 0.77, 95% *CI* 0.31–1.22) groups had greater knee ROM than the MP group. According to the statistical results of SUCRA, the MP may be the best option to improve postoperative knee ROM. The MP can provide a good surgical field of vision and a relatively large operating space, while a minimally invasive surgical approach is associated with poor exposure of the surgical field[48]; thus, it is more ideal for prosthesis implantation. We hypothesized that this would be beneficial for the recovery of knee motion at a later stage. The results showed[32] that the ROM after the MP was greater than that after the SV, and the general trend was consistent with our results.

AKSS Objective and AKSS Functional
The results of this network meta-analysis showed that there were no significant differences between the AKSS objective and AKSS functional at the last follow-up after TKA by seven surgical approaches. The AKSS objective and AKSS functional reflected the overall effect after TKA, indicating that regardless of which approach was used for TKA, the effect on the recovery of knee function at a later stage was the same, which was consistent with two published meta-analyses[18,79].

Safety
The impact of the approach on clinical safety was evaluated. The results of the network meta-analysis showed that there were no significant differences in the incidence of complications (such as thrombus and prosthesis looseness) among the seven surgical approaches after TKA. According to the SUCRA statistics, the QS may be the safest approach for TKA, with the least complications. Since there were no statistically significant differences in the incidence of complications after TKA by the seven surgical approaches, the results of the SUCRA rankings should be interpreted with caution.

Limitations
This network meta-analysis has several limitations. First, individual-approach RCT-related research has decreased reliability because the network meta-analysis as a whole has a certain influence. Second, according to the inclusion and exclusion criteria of this study, QS-related RCTs were not included in the length of hospitalization evaluation, and the length of hospitalization associated with the QS was not compared with the six other approaches. If new clinical results emerge, we will update the relevant outcome indicators as necessary. Third, the basic diseases of the included cases and the characteristics of each population were not considered in this study. Moreover, there were certain differences in the pain thresholds of the patients, which may lead to certain bias in the evaluation of individual outcome indicators (such as VAS scores and ROM). Fourth, the last follow-up time of the outcome indicators in some studies was not consistent, which may have had a certain influence

on the relevant outcome indicators. Fifth, there was a lack of economic burdens, incision lengths, and other comparative evaluations. Among the literature included in this study, there were few studies that considered economic burden and incision length comparisons, so they were difficult to evaluate, and a network meta-analysis was not carried out, which is also content to be added to subsequent studies.

Conclusions

This network meta-analysis showed that among the seven surgical approaches, the MV was the best choice to reduce the tourniquet use time, the SV required the shortest operation time, the Mini-SV was associated with the least amount of time to achieve straight leg elevation after surgery, the Mini-MP reduced postoperative pain effects, and the MP was the best approach to improve ROM. Excluding the QS, which was not compared, the use of the Mini-MV may shorten the hospital stay. There were no significant differences in blood loss, the AKSS objective, or AKSS functional between the seven surgical approaches. There was no significant difference in the incidence of postoperative complications between the seven surgical approaches.

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None.

Conflict of Interest

The authors declare that they have no competing interests.

Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Supporting Information

Additional Supporting Information may be found in the online version of this article on the publisher's web-site:

Appendix S1: Web appendix: Supplementary materials

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