Journal of Orthopaedic Surgery

Article

Journal of Orthopaedic Surgery
27(1) 1–8

DOI: 10.1177/2309499019828550
journals.sagepub.com/home/osj

SAGE

Should the patella be everted during primary total knee arthroplasty? A systematic review of overlapping meta-analyses

Alberto Grassi[1,2], Riccardo Compagnoni[3,4], Paolo Ferrua[3,4], Stefano Pasqualotto[4], Carlo Zaolino[5], Stefano Zaffagnini[1,2] and Pietro Randelli[3,4,6]

Abstract

Patellar eversion during total knee arthroplasty (TKA) is a debated issue. The aim of this study is to perform a review of overlapping meta-analyses analyzing clinical outcomes of patellar eversion compared to noneversion. A search was performed in PubMed\MEDLINE, Scopus, and Cochrane Library. Inclusion criteria were meta-analysis of randomized controlled trials (RCTs) or quasi-RCTs;l comparison between TKAs with or without patellar eversion; and at least one outcome, such as reoperation rate, pain, and functional scores. Meta-analyses were evaluated with the A Measurement Tool to Assess Systematic Review (AMSTAR) score, addressing the most relevant one with the Jadad algorithm. Three meta-analyses were identified and included in this review. No significant differences were found regarding complications, quadriceps strength, functional, and radiological outcomes. The meta-analysis by Zan et al. was selected as the best available one. Patellar eversion group showed a shorter tourniquet time but a longer skin incision. In conclusion, eversion and noneversion techniques did not demonstrate any significant or clinically relevant difference.

Level of Evidence: Level II, systematic review of meta-analyses

Keywords

arthroplasty, eversion, knee, meta-analysis, patella, prosthesis, TKA

Date received: 27 March 2018; accepted: 13 January 2019

Introduction

In the last decade, total knee arthroplasty (TKA) technique underwent several modifications to improve tissue sparing throughout the surgical procedure.[1] These changes include more anatomical implant designs, less invasive instrumentations, and variations of the traditional surgical approach in order to increase clinical outcomes and

[1] II° clinica ortopedica e traumatologica, IRCCS Istituto Ortopedico Rizzoli, Bologna, Italy
[2] Laboratorio di Biomeccanica ed Innovazione Tecnologica, Istituto Ortopedico Rizzoli, Bologna, Italy
[3] Laboratorio di biomeccanica applicata, dipartimento di scienze biomediche per la salute, Università degli studi di Milano, Milano, Italy
[4] I° Clinica Ortopedica, ASST Centro Specialistico Ortopedico Traumatologico Gaetano Pini-CTO, Milan, Italy
[5] U.O. Ortopedia e Traumatologia VII, IRCCS Istituto Ortopedico Galeazzi, Milan, Italy
[6] Dipartimento per le Scienze Biomediche per la Salute, Università Degli Studi di Milano, Milan, Italy

Corresponding author:
Riccardo Compagnoni, Laboratory of Applied Biomechanics, Department of Biomedical Sciences for Health, Università degli Studi di Milano, I Clinica Ortopedica, ASST Centro Specialistico Ortopedico Traumatologico Gaetano Pini-CTO, Milan, Italy.
Email: riccardo.compagnoni@gmail.com

patient's satisfaction.[2] During conventional TKA, patella is routinely everted to maximize knee exposure. Recent studies reported that patellar eversion could be responsible for quadriceps muscle impairment and for damaging and scaring patellar tendon with detrimental effects on early rehabilitation phase and complications such as postoperative patella infera.[3–6] To reduce these side effects and to promote restoration of knee function, proponents of minimal invasive TKA suggest to retract or subluxate the patella on the lateral gutter rather than evert it.

Several randomized controlled trials (RCTs) have been conducted with the aim of comparing the relative effect of patellar eversion with patellar noneversion during TKA, and the results have been included in numerous meta-analyses with the aim of summarizing the outcomes of this approach and delineating the clear guidelines based on the available evidences.[7–15] However, a 2016 review by Jia et al. concluded that "patellar eversion and patellar non-eversion could achieve similar results,"[9] whereas Yang et al. analyzed the same RCTs concluded that "patellar non-eversion offers a shorter hospital stay and a lower incidence of postoperative complications."[8] Despite this scenario could appear paradoxical, it could represent an important source of confusion when clinicians aim to implement evidence-based approach in daily clinical practice.

To solve the issue related to discordant findings from various meta-analyses on similar topics and RCTs, a reviews of overlapping meta-analyses with a systematic approach and quality evaluation could be performed, as recently applied to different orthopedic issues such as patellar resurfacing versus patellar retention,[16] early versus delayed motion after rotator cuff repair,[17] minimally invasive versus open surgery for acute Achilles tendon rupture,[18] internal versus external fixation for the treatment of distal radial fractures.[19]

To the best of our knowledge, there is no systematic review of overlapping meta-analyses investigating the relative effects between patellar eversion or non-eversion during TKA. The objective of the present study was to perform a systematic review of overlapping meta-analyses regarding patellar resurfacing versus nonresurfacing during TKA, to answer the following questions: (1) Is patellar noneversion superior to eversion regarding clinical outcomes such as anterior knee pain or universally recognized knee scores (IKS; KSS)? (2) Is complication rate superior in patellar eversion? and (3) Which is the most relevant and valid meta-analysis on patellar eversion versus noneversion according to the Jadad algorithm?[20]

Materials and methods

Search strategy and criteria

A literature search was performed by two independent investigators in February 2018 from the databases of PubMed\MEDLINE, Web of Science, Scopus, and Cochrane Library. Gray literature was evaluated screening the website *clinicaltrials.gov*. The keywords used were "patella*," combined with "TKA" OR "total knee replacement" OR "total knee prosthesis" OR "total knee arthroplasty" AND "meta-analysis." No language restrictions were applied. The references of the included studies were also checked to find possible meta-analyses on this topic. The titles and abstracts were first reviewed, and the full texts were acquired if the information was not sufficient to determine inclusion or exclusion of the result. Disagreements were settled by discussion, and a third author was consulted when necessary.

The inclusion criteria of the present systematic review were meta-analysis of RCTs or quasi-RCTs; comparison between the outcomes of TKA with eversion or non-eversion; and at least one outcome, such as reoperations, complications, anterior knee pain, functional scores. Narrative reviews, systematic reviews without meta-analysis, meetings abstract, correspondences were excluded.

A piloted form was designed for data extraction prior to study start and two investigators independently extracted the following information from each meta-analysis, according to Grassi et al.[16]: first author, journal, year of publication, databases for search and date of search, primary study design, and the number of RCTs included. Details of methodology such as level of evidence, software used, use of execution of subgroup analysis, sensitivity analysis, meta-regression or evaluation of publication bias were collected as well. The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) guidelines were applied during data extraction.[21] This is a common, sensible, and transparent approach to grade quality (or certainty) of evidence and strength of recommendations in the scientific literature. Finally, the results from each meta-analysis were extracted, and the heterogeneity of outcomes was assessed.

Quality evaluation

The quality of the included meta-analyses was evaluated by the Oxford Levels of Evidence.[22]

A level I meta-analysis was defined by including level I RCTs; a level II meta-analysis was defined by including at least one quasi-randomized study (with inadequate randomization) or low-quality RCTs (e.g. <80% follow-up rate). Additionally, A Measurement Tool to Assess Systematic Reviews (AMSTAR) was applied.[23] The AMSTAR has been widely used to evaluate the quality of systematic reviews.[19,24,25] This is an 11-item score, ranging from a minimum of 0 to a maximum of 11 points, indicating the highest quality. The quality of the meta-analyses was independently evaluated by two authors. Potential disagreements between authors were settled by discussion, and the senior author was consulted if necessary.

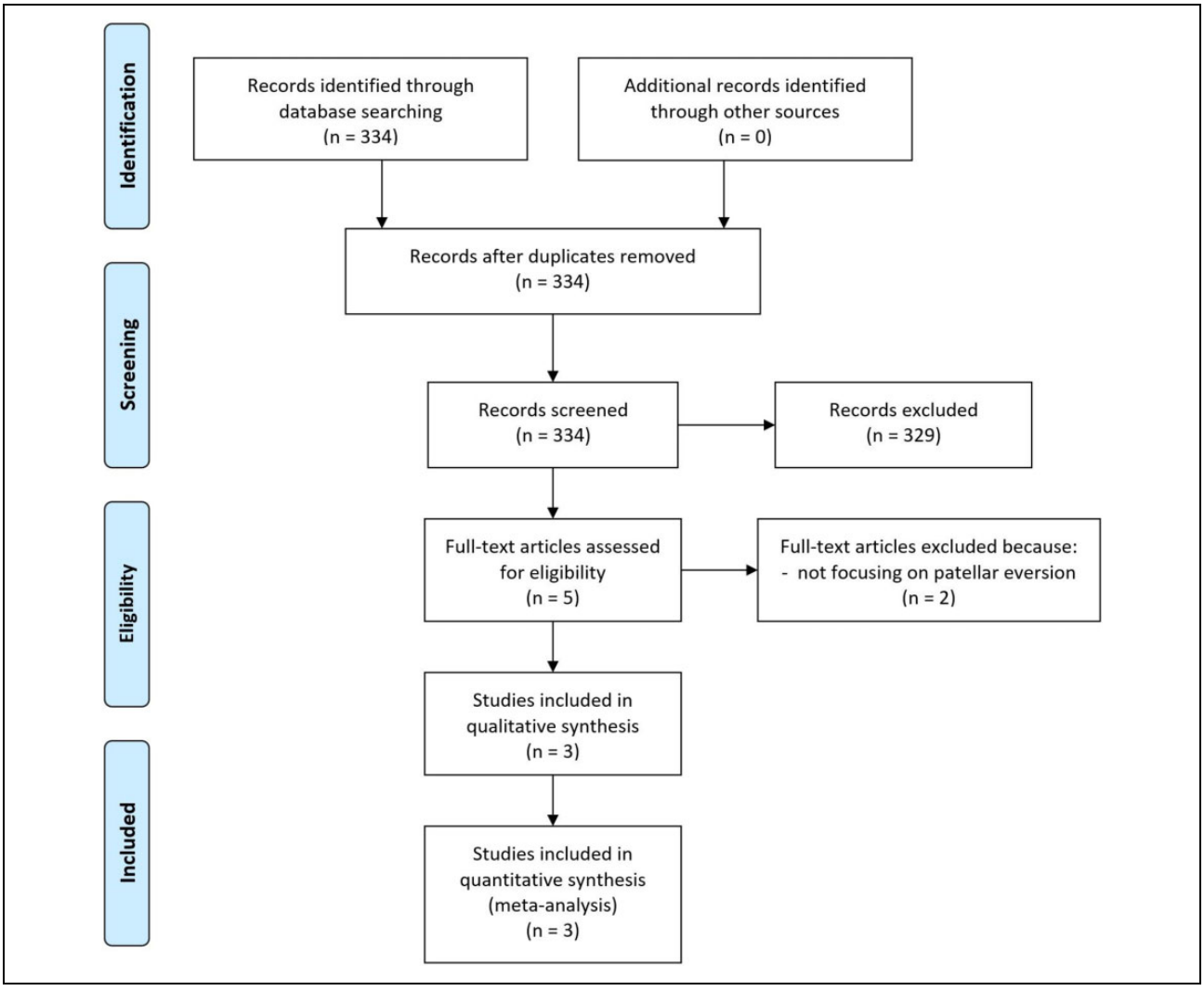

Figure 1. PRISMA flow-chart for the selection of the included studies.

Application of Jadad decision algorithm

The Jadad algorithm was applied to evaluate outcomes and quality parameters of the meta-analyses that only included RCTs.[20] The Jadad decision algorithm was designed based on following questions: (1) Do the meta-analyses ask the same question? (2) Do the meta-analyses include the same studies? (3) Do the meta-analyses containing the same trials have the same methodological quality? and (4) Do the discordant meta-analyses including different trials use the same selection criteria? This method has been already employed to offer treatment recommendations among meta-analyses with discordant conclusions.[19,24,25] The algorithm was independently applied by three authors, who reached a consensus regarding which meta-analysis offered the best available evidence.

The meta-analysis of the highest quality was selected based on the following factors: publication status and methodology of the primary studies, language restrictions and the analysis of data on individual patients. Concerning the publication characteristics, the included meta-analyses were published over an extended period of time; thus, more recent meta-analyses were preferred to less recent ones.

Results

The initial search yielded a total of 334 results. After initial screening, 329 studies were excluded for not meeting the inclusion criteria. Two further papers were excluded because meta-analyses were evaluating the patellar management in TKA but without specific focus on patellar eversion. Finally, three meta-analyses were included in the final systematic review (Figure 1).[7–9] The included meta-analyses were published between 2014 and 2015 on the same journal and included a similar number of RCTs, ranging from 5 to 6. (Table 1). In total, the six available original studies published between 2007 and 2014 were included in only one meta-analysis[7]; the RCT by Dalury et al.[10] was in fact included in only one of the three meta-analyses (Table 2). All meta-analyses searched the PubMed

Table 1. Methodological information of the included meta-analyses.

Author	Journal name	Date of last literature search	Date of publication	Number of included trials	Number of included RCTs
Jia et al.[9]	*Knee Surgery, Sports Traumatology, Arthroscopy*	June 2014	October 2, 2014	5	5
Zan et al.[7]	*Knee Surgery, Sports Traumatology, Arthroscopy*	NA	January 4, 2015	6	6
Yang et al.[8]	*Knee Surgery, Sports Traumatology, Arthroscopy*	August 23, 2014	February 13, 2015	5	5

RCT: randomized controlled trial.

Table 2. Primary studies included in the included meta-analyses.

	Jia et al.[9]	Zan et al.[7]	Yang et al.[8]
Walter et al.[11]	+	+	+
Dalury et al. [10]		+	
Arnout et al. [15]	+	+	+
Umrani et al. [12]	+	+	+
Reid et al. [13]	+	+	+
Jenkins et al. [14]	+	+	+

database, Embase, and the Cochrane. One meta-analysis applied restriction based on publication status[9] and one based on language (Table 3).[8] The software used for data analysis in included meta-analyses was RevMan (Open source software, Cochrane collaboration). The results of each meta-analysis are depicted in Figure 2.

Quality appraisal

All the three meta-analyses included only RCTs and were therefore determined as level of evidence I. Quality appraisal was performed with the Consolidated Standards Of Reporting Trials (CONSORT) in two meta-analyses,[7,8] whereas one applied the Cochrane Risk of Bias Tool.[9] Only one meta-analysis reported to follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, while none of the three performed a sensitivity analysis, a publication bias evaluation or reported the evidences according to the GRADE principles (Table 4). The result of AMSTAR score ranged from 6 to 7, with none of the meta-analyses presenting a priori design (Table 5). Some entity of heterogeneity for at least one of the investigated outcomes was reported in two of the three meta-analyses. Only one study performed a subgroup analysis, based on the medial parapatellar or subvastus approach. The outcomes with the lowest heterogeneity were tourniquet time, length of skin incision patella infera and pain. The outcomes with higher heterogeneity were complications and length of stay (Table 6). Finally, the study by Zan et al. [7] was selected as the meta-analysis offering the best current evidence (Figure 3)

Results of meta-analysis outcomes

Subjective outcomes. Only Zan et al. [7] evaluated this aspect, reporting no significant differences of the 3-month Knee Society Score (KSS) between the two approaches. A similar result was reported by Jia et al.[9] evaluating pain measured with the VAS scale.

Objective outcomes. Both the two meta-analyses that evaluated tourniquet time reported a significantly shorter time when patella was everted. However, when evaluating skin incision length, only one meta-analysis reported a shorter incision when noneversion approach was used.

Considering the length of stay, one meta-analysis reported no differences, while another showed a shorter stay when patella was not everted.

Complications. Two of the three meta-analyses reported no significant differences in complications between the two approaches, while only Yang et al. reported a lower incidence in the noneverted group. Patella infera and patellar tendon avulsion were evaluated in only one meta-analysis, reporting no significant differences between the two groups.

Radiographic outcomes. Only the Insall-Salvati ratio was reported as radiographic outcome, by a single meta-analysis, which reported no significant differences between the two approaches.

Results of Jadad decision algorithm

The meta-analysis by Zan et al. [7] was selected independently by all the evaluating authors as the study of the highest quality according to the Jadad algorithm.

This study resulted to be the most complete because (a) it includes a greater number of studies; (b) used a better search strategy using a larger number of databases; and (c) did not use language restrictions or publication status of the articles.

This meta-analysis revealed that patella eversion group showed a shorter tourniquet time (mean difference $= -5.50$ min; 95% confidence interval $= -9.13$ to -1.87; $p = 0.003$); the length of stay has not shown any statistically significant difference (mean difference $= 0.66$ day; 95% confidence interval $= -0.11$ to 1.41; $p =$ n.s.); the

Table 3. Search strategies and details of inclusion\exclusion criteria.

Authors	Restriction of publication language	Restriction of publication status	PubMed	MEDLINE	Embase	Cochrane Library	CINAHL	Others
Jia et al.[9]	No	No	+		+	+		
Zan et al.[7]	No	Yes	+	+	+	+		+
Yang et al.[8]	Yes	No	+	+	+	+		

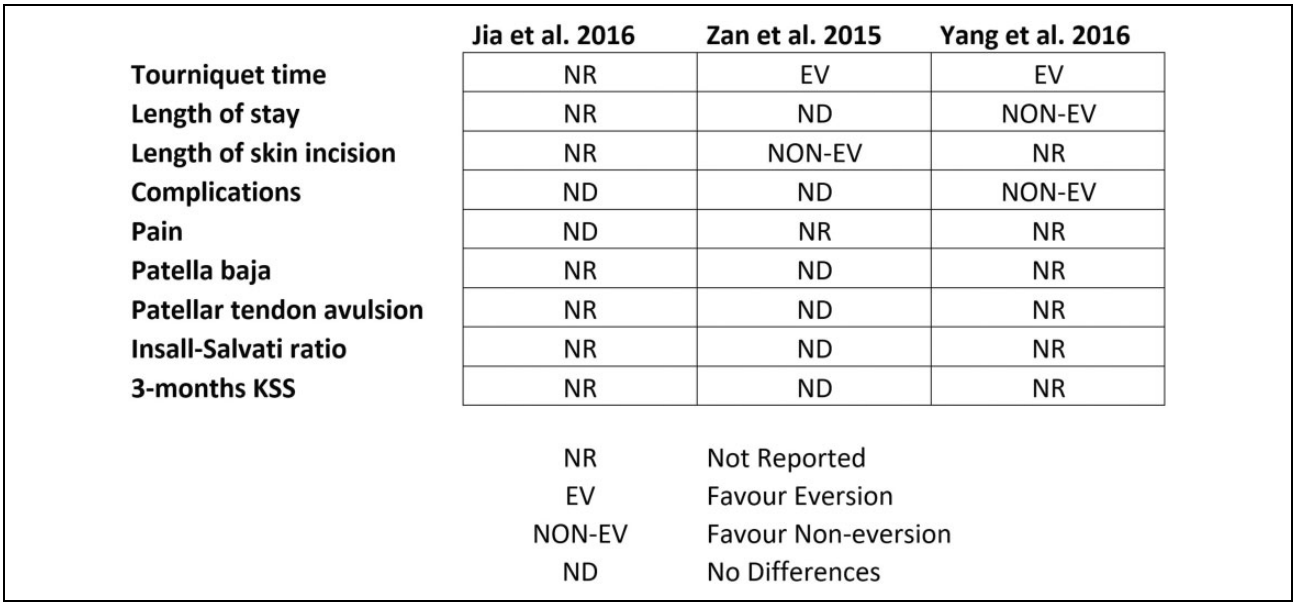

Figure 2. Summary table for the outcomes of the included meta-analyses.

Table 4. Characteristics of the included meta-analyses.

Author	Design of included studies	Level of evidence	Software	Assessment of study quality	GRADE use	Sensitivity analysis	Subgroup analysis	Meta-regression	Publication bias	PRISMA
Jia et al.[9]	RCTs	Level I	RevMan	Cochrane Tool	No	No	No	No	No	No
Zan et al.[7]	RCTs	Level I	RevMan	CONSORT	No	No	No	No	No	No
Yang et al.[8]	RCTs	Level I	RevMan	CONSORT	No	No	Yes (Approach)	No	No	Yes

RCT: randomized controlled trial.

length of the skin incision has proved to be longer in the patella eversion group (mean difference = 0.99 min; 95% confidence interval = 0.68–1.29; $p < 0.00001$). No differences were found in the incidence of postoperative complications (odds ratio = 1.29; 95% confidence interval = 0.32–5.22; p = n.s.), and patella baja and patellar tendon avulsion showed no prevalence differences in the two groups (respectively odds ratio = 0.54; 95% confidence interval = 0.11–2.58; p = n.s. and odds ratio = 1.12; 95% confidence interval = 0.28–4.56; p = n.s.). No differences were found in quadriceps strength at 6 months from surgery; only the study of Jenkin's et al. showed a statistically significant difference in quadriceps strength from 6 weeks to 3 months after surgery, with a strength improvement in the eversion group ($p = 0.04$).[14]

Difference in Insall-Salvati ratio was found nonstatistically significant (mean difference = −0.06 min; 95% confidence interval = −0.16 to 0.05; p = n.s.).

Regarding clinical evaluation score, KSS collected at 3 months after surgery showed no significant difference between the groups (mean difference = −3.03 points; 95% confidence interval = −13.55 to 7.50; p = n.s.); no significant differences were found comparing Short-Form 36 PCS and MCS at 1 year after surgery in a different study; VAS score was reported in different forms and times, and no analysis could be performed.

Table 5. AMSTAR score evaluating the quality of the included meta-analyses.

	Jia et al.[9]	Zan et al.[7]	Yang et al.[8]
Was an a priori design provided?	0	0	0
Was there duplicate study selection and data extraction?	1	1	1
Was a comprehensive literature search performed?	1	1	1
Was the status of publication (i.e. grey literature) used as an inclusion criterion?	0	0	0
Was a list of studies (included and excluded) provided?	0	1	0
Were the characteristics of the included studies provided?	1	1	1
Was the scientific quality of the included studies assessed and documented?	1	1	1
Was the scientific quality of the included studies used appropriately in formulating conclusions?	1	1	1
Were the methods used to combine the findings of studies appropriate?	1	1	1
Was the likelihood of publication bias assessed?	0	0	0
Was the conflict of interest stated	0	0	0
Total	**6**	**7**	**6**

AMSTAR: A Measurement Tool to Assess Systematic Reviews.

Table 6. Evaluation of the heterogeneity for the various outcomes in the included meta-analyses.

	Jia et al.[9]	Zan et al.[7]	Yang et al.[8]
Tourniquet time		0%	2%
Length of stay		83%	57%
Length of skin incision		0%	
Complications	0%	61%	35%
Pain	0%		
Patella baja		0%	
Patellar tendon avulsion		28%	
Insall-Salvati ratio		NA	
Three-months KSS		NA	

KSS: Knee Society Score.

Discussion

The most important finding of the present study is the nonsuperiority of patella noneversion compared to eversion in TKA. A systematic review of overlapping meta-analysis was performed

to find a consensus in the existing literature about this topic. Subjective results, patient's satisfaction and the 3-month postoperative KSS showed not much significant differences between the two approaches. When evaluating postoperative pain using Visual Analog Scale, there were no differences between eversion and noneversion. Pain after TKA typically recognizes a multifactorial etiology related not only to surgery but also to a number of preoperative and postoperative aspects.[26–29] Patient satisfaction and pain control are complex outcomes and seem to be difficult to find a direct correlation with a single surgical step as patellar eversion. Tourniquet time was found significantly shorter in the eversion group. This is possibly related to extended approach and consequently enhanced visualization of the knee during the procedure, permitting an easier and consequently faster procedure. This result is consistent with the observed skin incision length, which is significantly shorter in the noneversion technique. One possible further explanation could be that noneversion is typically associated with minimally invasive surgery, which includes dedicated instruments, less invasive surgical approaches both on the skin and of the extensor apparel. Considering length of stay and comprehensive complication rate, there were no definite consensus between meta-analyses with one favoring noneversion and the other two, including the highest rated one, reporting no significant differences. It is in fact interesting to note the opposite conclusions between the meta-analysis by Jia et al.[9] and the one by Yang et al.,[8] despite including the same 5 RCTs. This paradoxical situation should be related to the definition of the "complication" outcome, because a different amount of events in the different studies alters the effect sizes, thus influencing the final results of the meta-analysis. In fact, in the study designs of the considered meta-analyses, a precise and univocal definition of "complication" is not provided. This possibly explains, as an example, why the complications in the patellar-eversion group of the RCT by Jenkins et al.[14] ranged from 23 to 27 according to the data presented in the different meta-analyses. Moreover, in the latter RCT of 120 patients, a disproportionate number of patients developing pulmonary emboli in the eversion group were found. Despite the authors did not attributed the higher rate of pulmonary emboli to the eversion per se and rather considered it only an association, this event increased both the complication rate and length of stay. Therefore, the mere extraction of outcome from this study could be responsible for at least misinterpret meta-analysis results.

Another issue to consider when interpreting the complication outcome of the available meta-analysis is the use of fixed- or random-effect model for statistical analysis. Despite reporting a relevant amount of statistical heterogeneity for both the overall rate of complication ($I^2 = 35\%$) and the medial parapatellar subgroup complications ($I^2 = 47\%$), Yang et al.[8] utilized a fixed-effect method, which is known to be less conservative and reserved to cases of null or limited heterogeneity. Due to the confidence intervals almost approaching the null value (odd ratio = 1), it could be possible that utilizing the more conservative random-effect model, a nonsignificant and less clinically relevant odd ratio could be found for this outcome.

Another of the hypothesis of superiority of the noneversion technique is that minimizing stresses on patellar

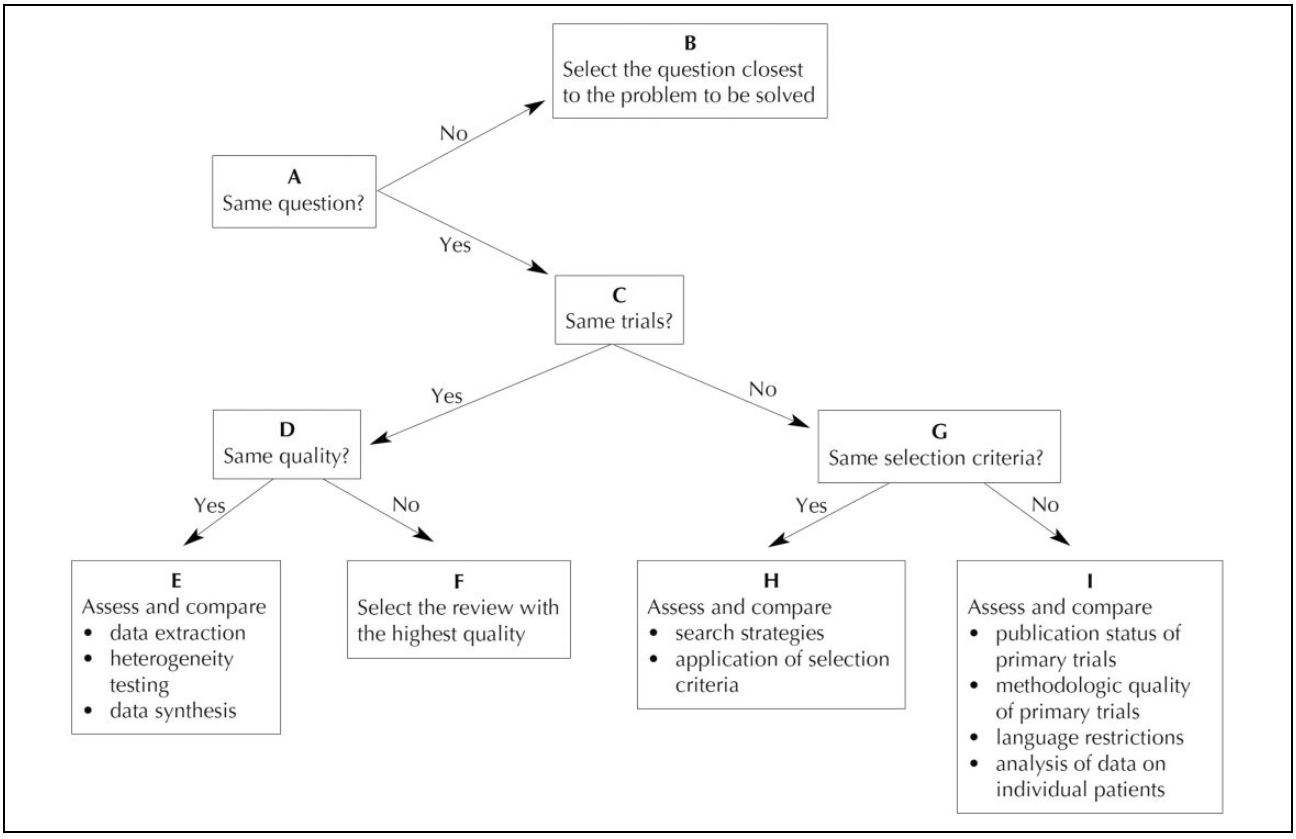

Figure 3. Jadad algorithm for the selection of the best quality of evidences.

tendon during surgery could lower the risk of postoperative patella infera caused by fibrotic reaction of the tendon to the increased traction and minimize the risk of patellar tendon avulsion from tibial tuberosity. However, this statement could not be confirmed as there were nonsignificant differences between noneversion and eversion regarding patella infera (assessed with Insall-Salvati ratio) and patellar tendon avulsion relative incidence.

The main limitation of this review of overlapping meta-analysis relies on its design. It represents a systematic and critical evaluation of studies that summarize the evidence from RCTs using statistical artifacts. Therefore, no novel data are provided by this study. Moreover, the limited number of meta-analysis on this topic could question the purpose of this study. However, a similar study design has been used to assess only four original meta-analyses evaluating patellar dislocation and Achilles tendon rupture.[18,30] Furthermore, the considerably different conclusions provided by the meta-analyses on patellar management in TKA were, in our opinion, worthy of a systematic and quality assessment. Another structural limitation is that the design of this kind of studies permits to present the information provided by selected meta-analyses, allowing only a descriptive presentation and an arbitrary selection of the most reliable findings. The database choice, the inclusion of unpublished studies or the application of language restriction were not consistent among the various meta-analyses and the high statistical heterogeneity of the outcomes contributed to the inconsistency of the results.

Conclusions

Based on the evidence from different meta-analyses, patellar eversion compared to noneversion did not demonstrate significant differences that could influence postoperative outcomes or intraoperative procedure safety. The final decision still relies on surgeon habits, personal preferences and experience.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Riccardo Compagnoni https://orcid.org/0000-0001-8259-8488

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