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Research article

Risk factors for venous thromboembolism following knee arthroscopy: A systematic review and meta-analysis of observational studies

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ABSTRACT

Objectives: To evaluate the risk factors for increased risk of venous thrombosis after arthroscopic knee surgery.

Methods: PubMed, EMBASE and Cochrane Library were searched from their inception to April 4, 2023. Observational studies investigated venous thrombosis following arthroscopic knee surgery were included. The Newcastle Ottawa Scale (NOS) was used to evaluate the methodological quality of included studies. The odd ratios (ORs) and 95% confidence intervals (CIs) pertaining to each risk factor were synthesized through a random effects model by STATA 14 software.

Results: The protocol this meta-analysis has been registered on PROSPERO (CRD42023410283). A total of 22 observational studies were included in the systematic review, all of which were of moderate or high methodological quality. The results of the meta-analysis revealed that several factors were significantly associated with an elevated risk of venous thrombosis following arthroscopic knee surgery. These factors included age (mean age ≥30 years) [OR = 1.08, 95%CI (1.04, 1.13), P = 0.001], overweight or obesity [OR = 1.31, 95%CI (1.13, 1.52), P < 0.001], oral contraceptive use [OR = 1.90, 95%CI (1.52, 2.37), P < 0.001], and smoking history [OR = 1.35, 95%CI (1.06, 1.71), P = 0.014]. Furthermore, the subgroup analysis indicated that patients with an average age over 50 years [OR = 3.18, 95%CI (1.17, 8.66), P = 0.001] and those who underwent surgery with a tourniquet for ≥90 min [OR = 4.79, 95%CI (1.55, 14.81), P = 0.007] were at a significantly increased risk of venous thrombosis after knee arthroscopy.

Conclusion: Age, obesity, oral contraceptives, smoking history, and prolonged tourniquet use may increase the risk of venous thrombosis after arthroscopic knee surgery. The incidence of venous thrombosis after knee arthroscopy is on a downward trend, but due to its severity, increasing awareness of risk factors and implementing effective prophylaxis are important tasks for clinicians to prevent the risk of venous thrombosis after knee arthroscopy.

1. Introduction

Knee arthroscopy is a prevalent orthopedic procedure frequently utilized for repairing anterior cruciate ligament (ACL) and meniscal tears, as well as aiding in the diagnosis of persistent knee pain in physically fit individuals [1,2]. Globally, there are an estimated 3–5 million knee arthroscopies performed annually, with over 700,000 procedures conducted in the United States alone [3].

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Compared to other orthopedic procedures, knee arthroscopy is recognized as low risk, with a complication rate of less than 1% when scientific prevention strategies are adopted. However, in the absence of a scientific prevention and treatment, the risk of venous thromboembolism may be as high as 9.9% [4,5]. The most frequently encountered complications include local hematoma, septic arthritis, and thromboembolic events [6]. Nonetheless, the absence of apparent risks following knee arthroscopic surgery does not preclude the possibility of venous thromboembolism, which, if occurring, poses a critical threat to patients' well-being, resulting in heightened rates of unplanned medical visits and soaring medical expenditures [7]. The incidence of deep vein thrombosis following knee arthroscopic surgery has been reported to be 9.9% overall [6]. However, the most concerning type of venous thromboembolism is pulmonary embolism, given its potentially fatal case fatality rate that could reach as high as 3.9% [8,9]. Therefore, it is of important clinical value to actively identify the risk factors of venous embolism after arthroscopic knee surgery and take appropriate prevention and intervention timely and effectively.

The American College of Chest Physicians recommends that for patients without a previous history of venous thromboembolism, knee arthroscopy can be performed without thromboprophylaxis in the United States [10]. In contrast, the European guidelines advocate for prophylaxis with medications for knee arthroscopy, even for patients without a high risk of venous thromboembolism [11]. The 2020 Canadian guidelines recommend using low-molecular-weight heparin or direct oral anticoagulants for the prevention of venous thrombosis during high-risk knee arthroscopy, such as major knee reconstruction, previous venous thromboembolism, cancer, or other venous thromboembolism risk factors [12]. It can be seen that different clinical practice guidelines have been based on different risk factors for the development of venous thromboprophylaxis strategies after knee arthroscopy, but the kinds and numbers of these risk factors still differ greatly. To our knowledge, the potential risk factors for venous thromboembolism after knee arthroscopy have never been systematically integrated. Identifying these risk factors that predispose individuals to venous thromboembolism after knee arthroscopy is critical to screening for venous thromboembolism risk as well as optimizing knee arthroscopy procedures to minimize the risk of venous thromboembolism for these patients. Therefore, the hypothesis of this meta-analysis was to clarify what are the risk factors for venous thromboembolism after knee arthroscopy? To provide more information for clinical practitioners to formulate scientific prevention strategies for venous thromboembolism after knee arthroscopy.

2. Methods

This meta-analysis is reported in accordance with the updated guidelines and exemplars for reporting systematic reviews (PRISMA 2020 statement) [13] and the protocol has been registered on PROSPERO (CRD42023410283).

2.1. Data sources

We conducted a comprehensive literature search of PubMed, EMBASE and Cochrane Library from inception to April 4, 2023, without any restrictions. Subject terms (Emtree in Embase, Mesh in PubMed) and their corresponding keywords were employed, including arthroscopy, arthroscopic surgery, knee joint, patellar dislocation, anterior cruciate ligament, posterior cruciate ligament, venous thrombosis, deep vein thrombosis, deep venous thrombosis, pulmonary embolism, risk and their variants. In addition, the reference lists of the retrieved studies and previous systematic reviews were examined for potential inclusion of relevant studies. The complete search strategy for these databases is available in Supplementary Tables 1–3.

2.2. Eligibility criteria

Inclusion criteria comprised the following: (1) Population (P): venous thrombosis. These studies encompassed various types of venous thrombosis, such as pulmonary thrombosis and thrombosis with or without symptoms. (2) Exposure (E): following arthroscopic knee surgery, regardless of the type of knee injury or lesion, and regardless of age or gender were included. (3) Control (C): no experience of knee arthrocentesis or healthy individuals. (4) Outcomes (O): the study should investigate at least one risk factor associated with venous thrombosis. (5) Study (S): observational studies with a prospective, retrospective, or cross-sectional design were included.

Exclusion criteria were as follows: (1) Literature not in English. (2) Repetitive literature, abstracts, meeting minutes, review articles, and case-report studies were excluded. (3) Studies whose data could not be extracted were also excluded.

2.3. Study selection

The retrieved initial records were imported into the NoteExpress reference management software, and duplicate entries were eradicated. Subsequently, the titles and abstracts were reviewed independently by two reviewers (Y Z and GD ZH) to exclude irrelevant records. After the initial screening, the remaining records were categorized as either included, excluded or uncertain based on predefined criteria. If any query arose regarding uncertain records, their full texts were examined to ensure eligibility for inclusion. In case of any disagreements, consensus was reached through group discussions.

2.4. Data extraction

A data extraction form was developed using Microsoft Corporation's Excel software, wherein eligible studies were assessed by two reviewers (Y Z and GD ZH) who independently extracted relevant data. This data included the first author, publication date, study

design, source of population, study period, sample size, type of thrombus, thrombus events, and potential risk factors. The extracted data underwent a rigorous cross-checking procedure, and any discrepancies were resolved by means of discussion.

2.5. Study quality

The quality of cohort and case-control studies was assessed using the Newcastle-Ottawa Scale (NOS) [14], which assigns stars ranging from 0 to 9 points. Selection of participants and measurement of exposure were awarded 4 stars, comparability was awarded 2 stars, and assessment of outcomes and adequacy of follow-up were awarded 3 stars. The more stars a study garnered, the higher its quality. Scores of 0–3, 4–6, and 7–9 were regarded as indicating low, moderate, and high quality, respectively. Similarly, we employed the American Agency for Health Care Quality and Research's (AHRQ) [15] cross-sectional study quality evaluation items to assess the quality of a cross-sectional study. We awarded a score of '1' if the answer was 'Yes', and '0' if the answer was 'Unclear' or 'No'. The following criteria were used to interpret the scores: low quality (0–3), moderate quality (4–7), and high quality (8–11).

2.6. Data synthesis

The odds ratios (ORs) pertaining to each risk factor were synthesized through a random effects model as opposed to a fixed effects model, given that the studies included within this meta-analysis represented samples from varying cases, reasons for surgery, and study designs [16,17]. ORs and 95% confidence intervals (CIs) were presented as pooled statistics. Sensitivity analyses were conducted to ensure the reliability of the overall results and to investigate possible sources of heterogeneity. Additionally, funnel plots and Egger's regression tests were employed to identify potential publication bias. The I^2 statistic was utilized to assess statistical heterogeneity. Two-tailed statistical tests were performed with a statistical significance threshold set at $p < 0.05$. All data analysis was carried out using Stata software (version 14).

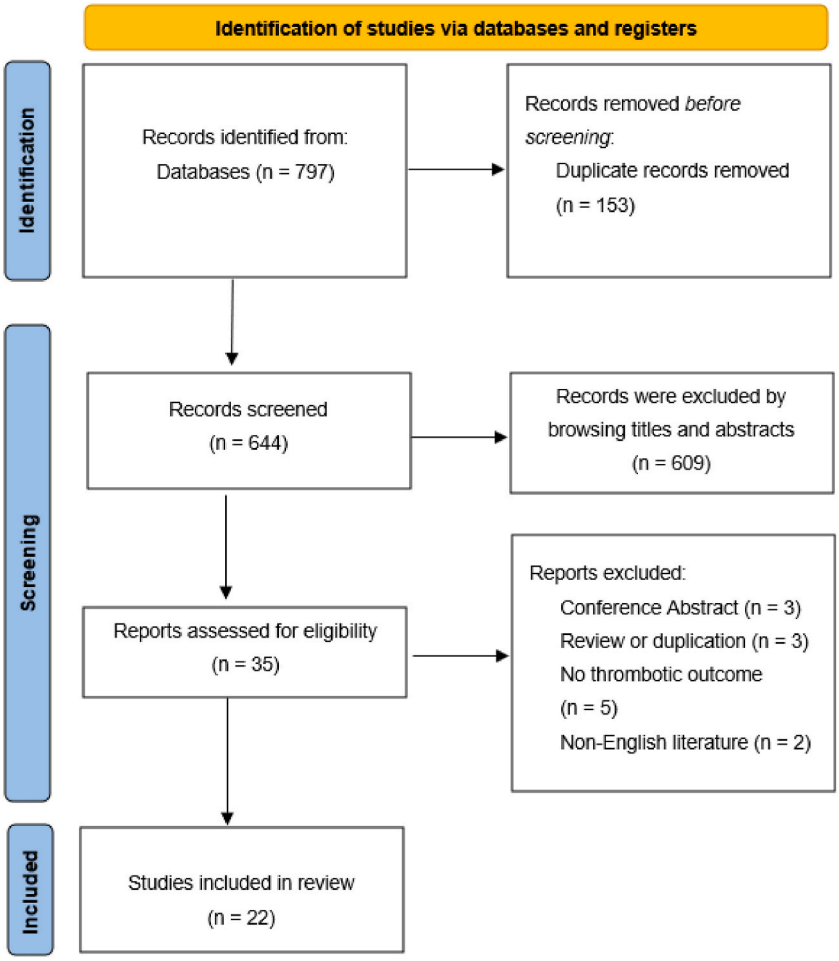

Fig. 1. PRISMA flow diagram.

Table 1
The basic characteristics of included observational studies.

Author	Year	Study type	Population source	Study period	Sample size	Type of thrombus	Potential risk factors	Quality of studies
Chang et al.	2023	Case-control study	China	2019–2021	110	Deep venous thrombosis (DVT)	Age, overweight or obesity, coagulation parameters, surgical approach	6
Kanaya et al.	2022	Case-control study	Japan	2012–2017	112	Deep vein thrombosis (DVT)	Age, sex , overweight or obesity, operative time, tourniquet time, simultaneous treatment, weight bearing	6
Holler et al.	2022	Cross-sectional study	America	2010–2020	718,289	Symptomatic venous thromboembolism (VTE)	Perioperative thromboprophylaxis, moderate-to-higher risk surgical approach, oral contraceptive pills use, renal disease, congestive heart failure, overweight or obesity, alcohol use disorder, age	8
Pang et al.	2022	Case-control study	China	2018–2019	320	Postoperative venous thromboembolism (VTE)	Age, overweight or obesity, sex (male), smoking, concomitant surgery, caprine score, tourniquet time	7
Ying et al.	2021	Case-control study	China	2014–2020	172	Deep venous thrombosis (DVT)	Age, gender, overweight or obesity, post-surgery D-dimer, tourniquet time (more than 60 min), smoking, hypertension, diabetes mellitus	6
Traven et al.	2021	Case-control study	America	2010–2015	64,165	Venous thromboembolism (VTE), Deep vein thromboses (DVT), Pulmonary embolism (PE)	Overweight or obesity, smoking, oral contraceptive pills use	7
Oshiba et al.	2020	Cohort study	Japan	2012–2015	256	Deep venous thrombosis (DVT)	Age, overweight or obesity, tourniquet time (more than 60 min), Duration of Operation (more than 90 min)	6
Dai et al.	2019	Case-control study	China	2014–2019	431	Deep venous thrombosis (DVT)	Triglycerides; total cholesterol; high-density lipoprotein cholesterol; low-density lipoprotein cholesterol; apolipoprotein A1; apolipoprotein B	7
Nicolay et al.	2019	Cohort study	America	2006–2016	141,335	Deep vein thromboses (DVT), Pulmonary embolism (PE)	Age, Female sex, Underweight, Overweight, Obesity, Principal arthroscopic procedure-Hip, Principal arthroscopic procedure-Knee	7
Chen et al.	2017	Case-control study	China	2007–2015	128	Deep venous thrombosis (DVT)	Age, durations of tourniquet application, VAS scores, D-dimer levels, Cholesterol	7
Gaskill et al.	2015	Cohort study	America	2005–2011	16,558	Deep vein thromboses (DVT), Pulmonary embolism (PE)	Age, Sex, Nicotine history, BMI category, Race, Initial/ secondary anterior cruciate ligament procedure, Medication	7
Krych et al.	2015	Cohort study	America	1988–2008	12,595	Venous Thromboembolism (VTE)	History of malignancy , History of VTE , more than 2 risk factors, chronic use of anticoagulants, Use of OCP or HRT, History of vascular disease	6
Dong et al.	2015	Cohort study	China	2009–2011	282	Deep venous thrombosis (DVT)	Tourniquet application time, type of surgical procedure	8
Hetsroni et al.	2011	Cohort study	America	1997–2006	323	Pulmonary embolism (PE)	Age, gender, type of surgery, operating time	6
Moreno et al.	2009	Cohort study	Colombia	2001–2004	93	Deep venous thrombosis (DVT)	Age, Gender, Tourniquet duration, Hormonal therapy	8

(*continued on next page*)

Table 1 (*continued*)

Author	Year	Study type	Population source	Study period	Sample size	Type of thrombus	Potential risk factors	Quality of studies
Delis et al.	2001	Cohort study	England	NA	102	Deep vein thrombosis (DVT)	Age, Past DVT, Chronic Venous Insufficiency, Obesity, Tourniquet time, Hormonal replacement therapy or Oral contraception	8
Jaureguito et al.	1999	Cohort study	America	1995.01–1995.04	239	Deep vein thrombosis (DVT); Superficial venous thrombosis (SVT)	Age, tourniquet time, surgical time	7
Li et al.	2017	Cohort study	China	2012–2014	864	Deep vein thrombosis (DVT)	Increasing age, complex surgical procedures	7
Adrichem et al.	2015	Case-control study	Netherlands	1999–2004	10,566	Vein thromboses (VT)	Oral contraception, obesity, FV Leiden, Prothrombin G20210A mutation, non-O blood type	7
Schmitz et al.	2019	Cohort study	Sweden	2006–2013	26,014	Venous thromboembolism (VTE), Deep vein thromboses (DVT), Pulmonary embolism (PE)	Age, gender, thromboprophylaxis, perioperative data	8
Mauck et al.	2013	Cohort study	America	1988–2005	4833	Venous Thromboembolism (VTE)	Age, BMI, hospitalization either prior to or after knee arthroscopy	7
Forlenza et al.	2022	Cohort study	America	2007–2017	11,910	Venous thromboembolism (VTE): Deep vein thromboses (DVT), Pulmonary embolism (PE)	Age, Hospital inpatient, PCL reconstruction, Meniscal transplant, Osteochondral allograft, COPD, Tobacco use	7

3. Results

3.1. Study selection

A total of 797 records were identified. After screening for duplication, 153 records were excluded. Subsequently, 644 records were eliminated based on a review of their titles and abstracts for irrelevance to the research topic. The remaining 35 studies underwent a rigorous assessment process, resulting in 22 observational studies [18–39] being selected for inclusion in the present meta-analysis. The study selection process is presented in Fig. 1.

3.2. Study characteristics

Twenty-two observational studies were included and published between 1999 and 2023, including 13 cohort studies, 8 case-control studies, and 1 cross-sectional study. Patients in these studies came from 7 countries, of which 9 were from the United States, 7 were from China and 2 were from Japan. A total of 998,978 patients were observed. The main types of thrombosis were deep venous thrombosis (DVT). The top 5 potential risk factors were age, body mass index (BMI), duration of tourniquet use, oral contraceptives, smoking history, and operative time. The characteristics of the included studies are presented in Table 1.

3.3. Quality assessment

The 13 cohort studies exhibited a high level of quality, with an average score of 7.07, a minimum score of 6, and a maximum score of 8. The case-control studies display medium quality with all scores ranging between 6 and 7 stars. Furthermore, one cross-sectional study was assessed to be of medium quality with a score of 8 (Table 1). Details of risk of bias are available in and Supplementary Tables 4–5.

4. Synthesis of the results

4.1. Age

A total of 15 studies examined age and the risk of venous thrombosis after arthroscopic knee surgery, and pooled analysis showed that age (mean $\geq$ 30 years) was associated with the risk of venous thrombosis after arthroscopic knee surgery [OR = 1.08, 95%CI (1.04,

1.13), $I^2 = 82.6\%$, P = 0.001; Fig. 2]. As $I^2 \geq 50$, sensitivity analysis was performed and the results of meta-analysis were found to be robust. In addition, a subgroup analysis was performed to compare the magnitude of age-specific associations with the risk of venous thrombosis after arthroscopic knee surgery [mean age≥50 years: OR = 3.18, 95%CI (1.17, 8.66); mean age≥30 years: OR = 1.11, 95% CI (1.04, 1.18), Fig. 3], which suggests that the higher the mean age, the higher the risk of venous embolism after arthroscopy.

4.2. Overweight or obesity

A total of 12 studies examined overweight or obesity and the risk of venous thrombosis after arthroscopic knee surgery, and pooled analysis showed that overweight or obesity was associated with the risk of venous thrombosis after arthroscopic knee surgery [OR = 1.31, 95%CI (1.13, 1.52), $I^2 = 86.3\%$, P < 0.001; Fig. 4]. Sensitivity analysis was performed and the results of meta-analysis were found to be robust. And a subgroup analysis was performed to compare the magnitude of the association of overweight or obesity alone with the risk of venous thrombosis after arthroscopic knee surgery [overweight: OR = 1.19, 95%CI (1.00, 1.43); obesity: OR = 1.38, 95%CI (1.04, 1.84), Fig. 5], which suggests that overweight was associated with an increased risk of venous thrombosis, but not statistically significant; obesity was statistically significant with an increased risk of venous thrombosis after arthroscopy.

4.3. Oral contraceptives

Five studies examined the relationship between oral contraceptives and the risk of venous thrombosis during arthroscopic knee surgery. A pooled analysis showed that oral contraceptives were an independent risk factor for venous thrombosis after arthroscopic knee surgery [OR = 1.90, 95%CI (1.52, 2.37), $I^2 = 44.9\%$, P < 0.001; Fig. 6].

4.4. Tourniquet time

A total of 7 studies have investigated the association between tourniquet use duration and the incidence of thrombosis following arthroscopic knee surgery. Upon analyzing tourniquet use durations of ≥30min, ≥60min, and ≥90min, it has been observed that tourniquet use of ≥90min represents a significant risk factor for thrombosis after knee arthroscopic surgery [OR = 4.79, 95%CI (1.55, 14.82), $I^2 = 13.5\%$, P = 0.007; Fig. 7].

4.5. Smoking history

Five studies examined the relationship between smoking history and the risk of venous thrombosis during arthroscopic knee surgery. A pooled analysis showed that smoking history was an independent risk factor for venous thrombosis after arthroscopic knee surgery [OR = 1.35, 95%CI (1.06, 1.71), $I^2 = 0\%$, P = 0.014; Fig. 8].

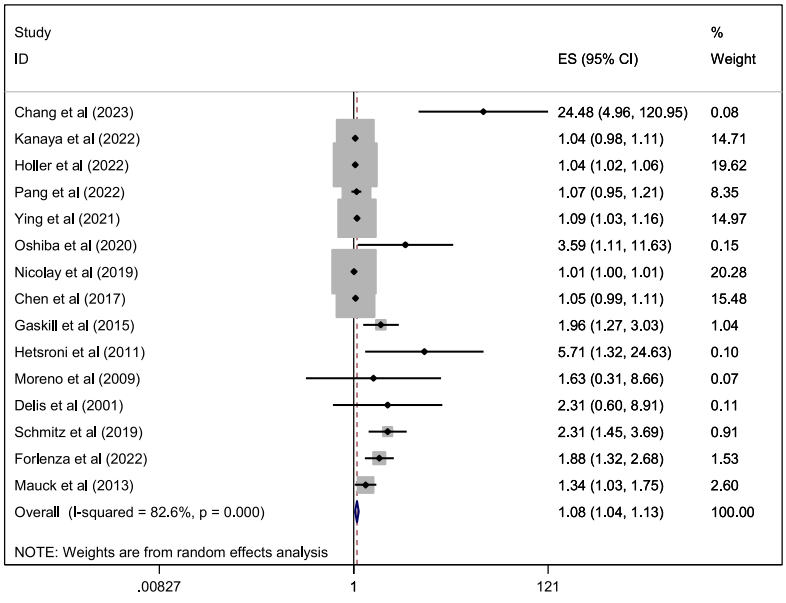

Fig. 2. Forest plot detailing the association of age.

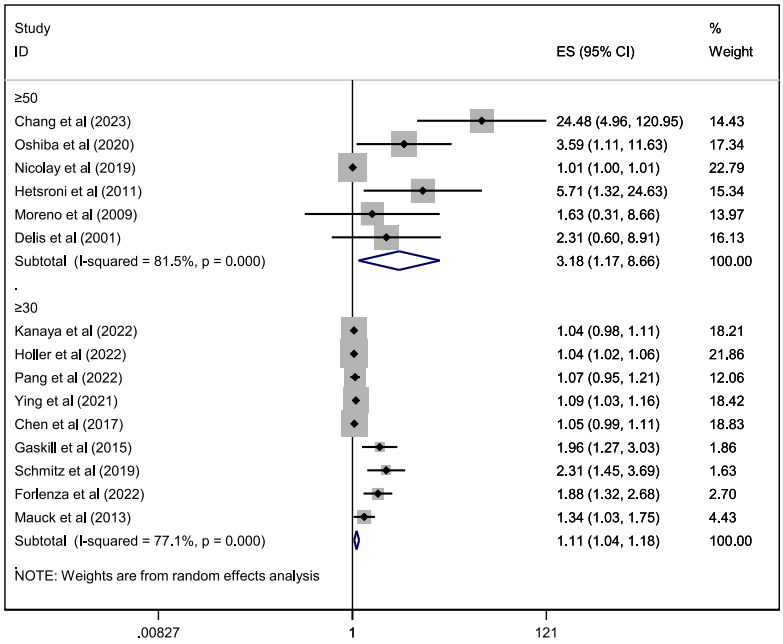

Fig. 3. Forest plot detailing the association of different age.

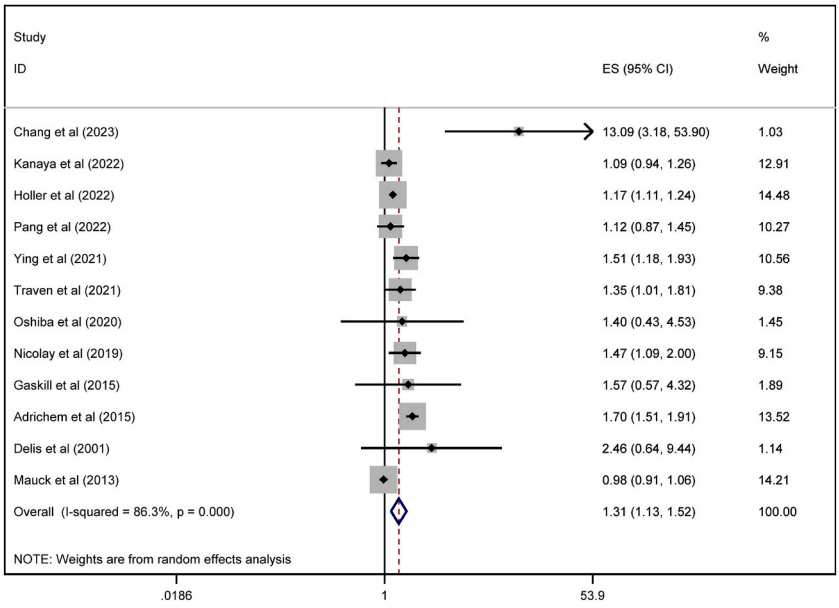

Fig. 4. Forest plot detailing the association of BMI.

4.6. *Operative time*

Four studies examined the relationship between operative time (≥90min) and the risk of venous thrombosis during arthroscopic knee surgery. The time of endoscopic knee surgery (≥90 min) is not related to the risk of venous thrombosis after surgery [OR = 1.09, 95%CI (0.62, 1.92), I^2 = 78.3%, P = 0.003; Fig. 9].

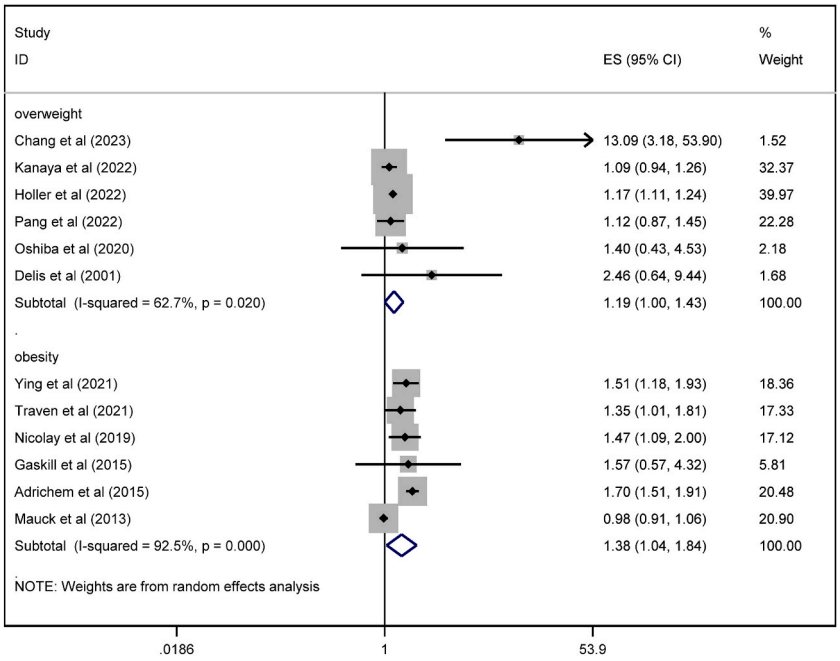

Fig. 5. Forest plot detailing the association of overweight or obesity alone.

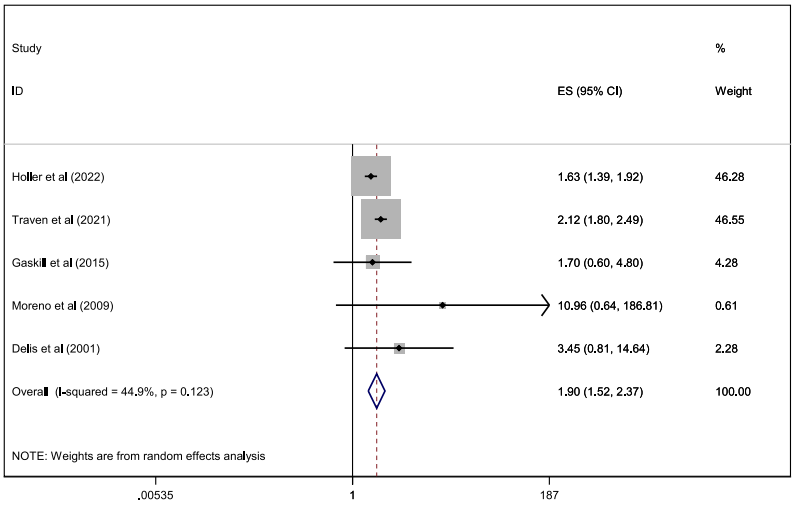

Fig. 6. Forest plot detailing the association of oral contraceptives.

4.7. Postoperative high D-dimer

Two studies examined the relationship between postoperative high D-dimer and the risk of venous thrombosis during arthroscopic knee surgery. Postoperative high D-dimer is not related to the risk of venous thrombosis after arthroscopic knee surgery [OR = 2.25, 95%CI (0.52, 9.77), $I^2 = 89.5\%$, P = 0.280, Fig. 10].

4.8. Publication bias

We conducted a publication bias test on risk factors with a total number of studies ≥10, and found that the funnel plot of age risk factors was asymmetric (Supplementary Fig. 1). The Egger's test (P < 0.001) indicated potential publication bias in the included study.

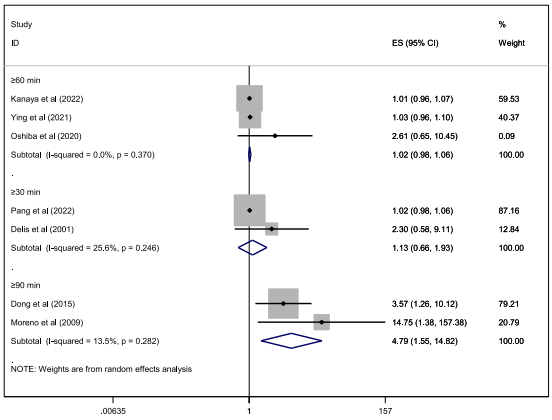

Fig. 7. Forest plot detailing the association of tourniquet time.

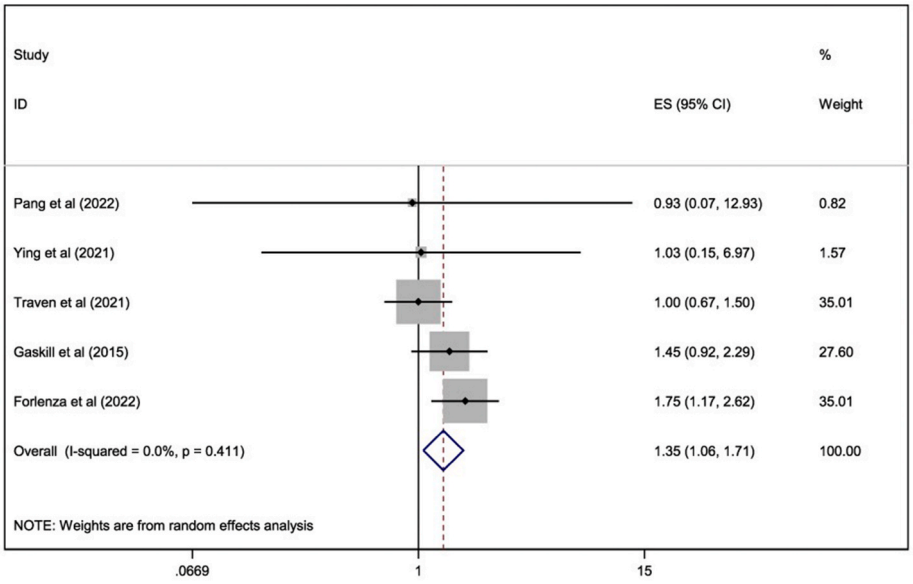

Fig. 8. Forest plot detailing the association of smoking history.

Based on the trim-and-fill method, 7 studies were imputed (Supplementary Fig. 2), and the correction for potential publication bias did not change the correlation between age and the risk of venous thrombosis after knee arthroscopy.

Visual inspection showed that the funnel plot of risk factors for overweight or obesity appeared to be asymmetric. But in statistical tests, including Egger's test ($P = 0.151$), showed that no publication bias. The funnel plot is shown in Fig. 11.

5. Discussion

5.1. Main findings

This meta-analysis of 22 observational study included 998,978 patients undergoing knee endoscopic surgery, indicating that certain epidemiological and clinical risk factors are associated with a high risk of venous embolism during knee endoscopic surgery. In particular, older age (≥30 years), obesity, oral contraceptives, smoking, and tourniquet (≥90 min) were significantly associated with an increased risk of venous thrombosis after arthroscopic knee surgery. In addition, subgroup analysis showed that patients aged 50 years or older who underwent knee endoscopic surgery had a higher risk of venous embolism than those aged 30 years. The risk of venous embolism significantly increases in obese patients undergoing knee endoscopic surgery. In addition, there is no statistically significant correlation between overweight, surgical time, plasma D-dimer, and the risk of venous embolism in patients undergoing knee endoscopic surgery.

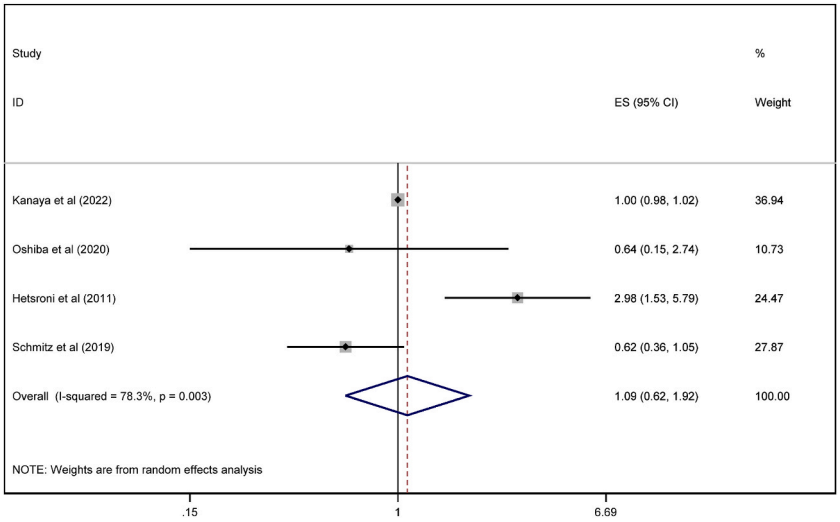

Fig. 9. Forest plot detailing the association of operative time.

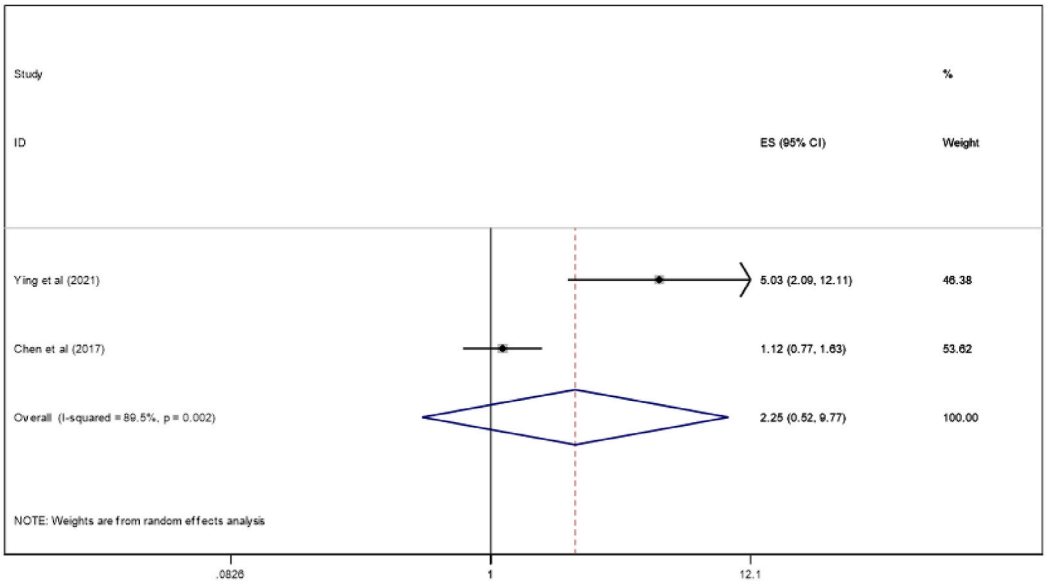

Fig. 10. Forest plot detailing the association of postoperative high D-dimer.

5.2. Interpretation of findings

The risk factor of age is an unavoidable topic that can lead to complications or affect treatment outcomes of any disease. Research has shown that age is a factor influencing the risk of infection [17] and the direction of re-admission [40] after knee arthroscopy. This meta-analysis found that patients aged ≥30 years old who underwent knee arthroscopy may have an increased risk of venous embolism, while the risk is more pronounced in patients aged ≥50 years old. A previous meta-analysis identified age older than 60 years as a statistically significant risk factor for venous thromboembolism (OR: 1.84, 95% CI: 1.03–3.29; P = 0.04) [41], and our results are consistent with this, while combining the results of our meta-analysis, a window migration is needed for age to be a risk factor and ≥30 years can be used as a watershed in adult.

There is conflicting and controversial evidence about whether obesity, smoking history, oral contraceptives, and longer use of tourniquet will increase the risk of venous thromboembolism after arthroscopic knee surgery. A meta-analysis of included cohort studies published by Davis et al., 2021 [41], noted that a history of malignancy (OR: 2.61, 95% CI: 0.97–7.00), a history of prior venous thromboembolism (OR: 4.14, 95% CI: 0.90–19.14) tended to be significant, but other factors such as obesity, smoking, duration of tourniquet use, and oral contraceptive use were not found to be statistically significant risk factors for venous thromboembolism after knee arthroscopy. In contrast to its findings, the results of our meta-analysis showed that obesity, smoking history, oral contraceptive

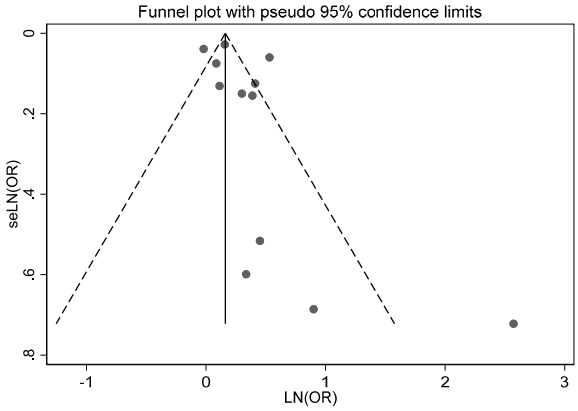

Fig. 11. Funnel plot of overweight or obesity.

use, and excessive tourniquet use were all statistically significant risk factors. The reason for this, may be that we included more recent studies reporting these several risk factors, or it may be that we included other types of observational studies, including cohort studies, case-control and cross-sectional studies, that the results were more comprehensive. In addition, our meta-analysis results enrich the evidence-based evidence that oral contraceptives and obesity risk factors increase the risk of venous complications after knee arthroscopy, which may be poorly recognized among orthopedic surgeons in the past [42,43].

The present study also performed a meta-analysis of perioperative D-dimer and operative time, which showed that postoperative high D-dimer [or = 2.25, 95% CI (0.52, 9.77)] and knee endoscopic operative time [or = 1.09, 95% CI (0.62, 1.92)] were not associated with the risk of venous thrombosis after arthroscopic needle surgery, although there was a trend, which was not statistically significant. The reasons considered were the small number of included literatures and the large heterogeneity of different studies resulted.

5.3. Policy recommendations and limitations

This study systematically collected observational study on the risk of thromboembolism after knee arthroscopy for meta-analysis, and identified older age, obesity, smoking history, oral contraceptives, and long-term use of tourniquet as independent risk factors for high risk of thromboembolism after knee arthroscopy. The identification of these risk factors has important practical value for early identification of the risk of thrombosis and the adoption of scientific prevention strategies in clinical practice. Especially in the past, clinical practice guidelines have focused more on intervention after the occurrence of thrombosis, but the discovery of these risk factors can better reduce the risk of venous thrombosis from the source, providing warning strategies for doctors, nursing staff, and patients to prevent and treat venous embolism in a timely and early manner. However, this meta-analysis inevitably has some limitations. First, because the risk factors of venous embolism after arthroscopic knee surgery reported in each observational study are different, and the control group is different, such risk factors as gender, operation time, and tumor history cannot be reasonably meta-pooled, and we expect to update our meta-analysis results when more homogeneity appears. Second, considering the different types of surgery, different causes, and different surgical methods that include different types of observational study and knee arthroscopy, there is inevitably clinical heterogeneity and methodological heterogeneity in the meta-analysis of different risk factors. Therefore, we use random effect models to conduct meta-analysis and interpret our findings more carefully. In addition, we found that individual lifestyle and individual characteristics of patients with older age, obesity, oral contraceptives, and smoking history are independent risk factors for thromboembolism after knee arthroscopy, and cannot cover all aspects and links of clinical practice. In addition, as with mechanistic studies of other diseases, more research is needed to validate this scientific evidence and thus revolutionize the clinical management of the risk of thrombosis after knee arthroscopy [44]. Furthermore, drawing on new perspectives such as tumor screening methods and strategies is the best strategy we can hope for if we consider the goal of reducing the risk of venous thrombosis [45]. Finally, most of the study populations included in this meta-analysis were from North America, Europe, and subgroups, but further research is needed to explore the level of risk and risk factors for thrombosis after knee arthroscopy for groups or ethnicities outside of these.

6. Conclusions

Our meta-analysis revealed that advancing age, obesity, oral contraceptive use, smoking history, and prolonged tourniquet usage may elevate the risk of venous thrombosis following knee arthroscopic surgery. Despite the decreasing trend in venous thrombosis risk after knee endoscopic surgery, it still possesses significant potential consequences. Enhancing awareness of its risk factors and implementing efficacious preventive strategies remain crucial for reducing the incidence of venous thrombosis subsequent to knee arthroscopic surgery.

Ethical approval

Ethics approval was not required for this study. This study is a review, and data were freely available in the literature.

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Data availability statement

All data generated or analyzed during this study are included in this published article and its supplementary information files.

CRediT authorship contribution statement

Yue Zou: Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization. **Guodong Zhang:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Data curation. **Xiujiang Sun:** Writing – review & editing, Writing – original draft, Project administration, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e25939.

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