META-ANALYSIS

Effect of Body Temperature Protection on Intraoperative Bleeding in Elderly Patients Undergoing Arthroplasty: A Meta-Analysis

Wei Zhao, MD; Yang Hu, MD; Xing Wang, BD

ABSTRACT

Background • Artificial joint replacement has become one of the most effective means for the clinical treatment of senile degenerative end-stage bone and joint diseases. All complications were directly or indirectly related to bleeding, and low body temperature can lead to bleeding, which have been a conceren in rthroplasty for elderly patients.

Methods • The computer retrieves eight databases, including Cochrane Library, PubMed, EMbase, Web of Science, CNKI, China Biomedical Literature Database (CBM), VIP and WanFang, to obtain controlled trials at home and abroad on the effects of body temperature protection on intraoperative bleeding in elderly patients undergoing arthroplasty. The search term is "temperature", "bleeding," and "arthroplasty". The search time was from the establishment of the library until February 2022. The literature screening results were obtained by reading the full text, and the process was completed independently by 2 researchers.After a rigorous literature quality evaluation, data analysis was performed using RevMan 5.3 software.

Results • 9 studies were ultimately included in this meta-analysis. 8 studies reported the blood loss of the test group and the control group. Meta-analysis showed that the blood loss of the test group was significantly lower (SMD: -45.09; 95% Cl: -67.76, -22.43; $P < .01$) than the control group. 44 studies showed that the Number of blood transfusions of the experimental group was significantly lower than the control group (OR:0.60; 95% Cl: 0.39,0.92; $P = .01$). 3 studies showed that the intraoperative temperature of the experimental group was significantly higher than the control group (SMD:0.60; 95% Cl: 0.20,0.99; $P = .003$). 4 studies showed that the postoperative temperature of the test group was significantly higher than the control group (SMD: 0.83; 95% Cl: 0.47,1.19; $P < .01$). 4 studies showed that the shiver incidence of the experimental group was significantly lower than the control group (OR:0.29; 95% Cl: 0.19,0.46; $P < .01$).

Conclusion • The results of this study suggest that active body temperature protection may be effective on intraoperative bleeding in elderly patients undergoing arthroplasty, as evidenced by blood loss, number of blood transfusions, intraoperative temperature, postoperative temperature, shiver incidence, length of hospital stay. (*Altern Ther Health Med.* [E-pub ahead of print.])

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INTRODUCTION

The global elderly population is increasing rapidly. According to data, the global elderly population will reach 1 billion in 2019. It is expected that by 2030, the Number will increase to 1.4 billion, and by 2050, the Number will increase to 2.1 billion, among which the population aging situation in developing countries is relatively serious.[1-2] The aging population is one of the main reasons for the increasing incidence rate of various bone and joint diseases.[3] Since the elderly do not engage in or rarely engage in running, jumping, weight-bearing and other intense or heavy physical activities for a long time, joint function will gradually develop in the direction of atrophy and regression. The occurrence of bone and joint diseases will not only bring pain to patients but also limit their limb activities and many other problems, which will have a serious impact on the daily life of patients.[4-5] With the development of medical technology, artificial joint replacement has become one of the most effective means for the clinical treatment of senile degenerative end-stage bone and joint diseases.

Artificial joint replacement (AJR) is a bone and joint operation that uses artificial joints made of artificial materials to replace damaged joints according to the shape, structure and function of human joints, which can effectively relieve pain and improve joint function. With the continuous development of joint replacement technology, the success rate of surgery has gradually increased, and more and more patients choose to perform joint replacement.[6-7] According to statistics, total hip arthroplasty (THA) is expected to increase by 71% to 635 thousand in the United States by 2030, and total knee arthroplasty (TKA) is expected to increase by 85% to 1.26 million.[8] As of 2019, the Number of total joint arthroplasties performed in China has exceeded 950 thousand cases, 6 and has been of great clinical success and is considered to be one of the most successful orthopedic operations of the 20th century. Also known as the "Surgery of the century," more than 90% of patients currently have a prosthesis that is more than 20 years old.[9] The health outcome after total joint replacement depends not only on the successful operation but also on the good functional exercise after the operation. However, the elderly patients were affected by such factors as poor physical function, poor prognosis, more preoperative complications, poor nutritional status, high risk of postoperative complications, and slow postoperative rehabilitation; therefore, the subjects of this study are elderly patients with joint replacement.

Hypothermia during surgery is a common clinical accident, and the current literature reports an incidence of approximately 11.2%-43.9% in joint replacement.[10-12] The decrease of the patient's body temperature during the operation is the result of the combined action of many factors. Among them, long-term exposure to low temperature environment is the primary factor causing intraoperative hypothermia. After the patient enters the operating room, his body temperature begins to be affected by the low temperature environment. In addition, when general anesthesia is performed, the patient's consciousness is lost, the function of hypothalamic thermoregulatory center is also lost, and the patient's muscles are relaxed and heat production is reduced. Intraoperative hypothermia can lead to a series of complications, such as fever, increased risk of heart disease, increased incidence of surgical site infection, prolonged use of anesthetics, and prolonged hospital stay; among them, hypothermia has a significant impact on the patient's intraoperative wound bleeding, leading to increased blood transfusion during the operation, which leads to the patient's postoperative recovery time prolonged and so on.[13]

Artificial joint replacement can reconstruct the function of joints and improve the life quality of patients. Arthroplasties treat diseases including ankylosing spondylitis, knee osteoarthritis, hip arthritis, femoral neck fracture, hip dysplasia osteoarthritis, Rheumatoid Arthritis, and aseptic necrosis of the femoral head. Diseases requiring joint replacement, especially fractures, have a high perioperative blood loss of approximately 1118-1651 ml,[14] so a large proportion of patients require blood transfusion.[15-16] Since most patients undergoing total joint replacement are elderly. The elderly are more likely to have underlying diseases than the young, massive blood loss undoubtedly increases the deterioration of underlying diseases. There are also some risks associated with blood transfusions, such as transfusion reaction, immunosuppression, transmission of infectious disease, kidney failure and so on.[17] At present, there are some methods to reduce perioperative allogeneic blood transfusion, including controlled hypotension, autologous blood transfusion, hypotension anesthesia, the use of anti-fibrinolytic drugs, etc. Many clinical research ideas that perioperative blood loss of patients, not only intraoperative bleeding, postoperative drainage, such as these several dominant blood loss. Many scholars put forward the concept of recessive blood loss, pointing out that recessive blood loss accounts for 60.60% of total blood loss.[18] The possible causes of recessive blood loss are mainly hemolytic mechanism, tissue space exudation[19-20] and so on. The mechanism of occult blood loss is still unclear, and how to control the amount of blood loss is an urgent problem to be managed in hip arthroplasty. Thus, we conducted a meta-analysis to examine the effect of body temperature protection on intraoperative bleeding in elderly patients undergoing arthroplasty.

MATERIALS AND METHODS

Selection of Studies.

The inclusion criteria. The randomized controlled trials (RCTs) on the effects of body temperature protection on intraoperative bleeding in elderly patients undergoing arthroplasty. No language restrictions were applied in this search.

The exclusion criteria. The animal trials were excluded.

Selection of Participants

Elderly patients undergoing arthroplasty.

Types of Interventions

The intervention group received active body temperature protection in the treatment of elderly patients undergoing arthroplasty, and the control group received routine body temperature protection in the treatment of elderly patients undergoing arthroplasty.

Types of Outcome Measures.

Outcome indicators for elderly patients undergoing arthroplasty: According to research, the assessment tools for the effects of body temperature protection on intraoperative bleeding in elderly patients undergoing arthroplasty are: (1) Blood loss; (2) Number of blood transfusions; (3) Intraoperative temperature; (4) Postoperative temperature; (5) Shiver incidence; (6) Length of hospital stay. The literature included in this study evaluated outcome measures using at least one of the above scales.

Search Strategy

The computer retrieves the databases: Cochrane Library, PubMed, EMbase, Web of Science, CNKI, China Biomedical Literature Database (CBM), VIP and WanFang. The search

term is "temperature", "bleeding," and "arthroplasty". The search time was from the establishment of the library until February 2022. The specific steps of the literature search are: (1) search for relevant documents in the Chinese and English databases, read the title, abstract, and Keywords to further identify the search terms for this study; (2) The English database search used "MeSH Terms" to identify the subject terms, searched using a combination of subject words and keywords.

Data Extraction and Quality Assessment.

The abstract was initially screened, and after the initial screening, the literature screening results were obtained by reading the full text, and the process was completed independently by 2 researchers. Exchange screening results, discuss dissenting literature or consult a third researcher until the results are agreed. The information extracted from the data includes basic information of the literature, type of study, study object, sample size, intervention content, outcome measures, etc. Cochrane bias risk assessment tool was used to quality assessment.

Statistical Analysis.

This meta-analysis was conducted by using Review Manager (RevMan). Effects are combined: The outcome measures in this study were all measured data, and the tools used to evaluate are different. There are differences between scores; therefore, the standardized mean difference is used (standardized mean difference, SMD) and 95%Letters to the zone (confidence interval, CI) As an indicator of effect. Standard Deviation is most commonly used in probability statistics as the degree of statistical distribution (stati). (2) Heterogeneity test: Chi-square tests are used to determine whether there is heterogeneity between studies, if $P > .1$, $I^2 < 50\%$,The included studies were said to be more homogeneous, Proceed with a fixed-effects model Meta analysis; if $P<0.1$, $I^2 \geq 50\%$, Heterogeneity was indicated in the included studies. Analyze heterogeneous sources, If there is no clinical heterogeneity, A random-effects model is used Meta analyses. Furthermore, possible differences of qualitative factors were subgroup analyzed. $P < .05$ was considered as significant difference.

RESULTS

Search Results

Based on the search strategy, 652 references were identified. After excluding duplicate studies, 50 studies were scanned based on abstract and title. Then, 12 articles were evaluated in full text. After full-text evaluation, 3 records were excluded for the following reasons: data mismatch (n=2) and missing data (n=1). Ultimately, 9 studies[21-29] were included in this meta-analysis (Table 1). The PRISMA statement flow chart shows this process (Figure 1).

Blood loss

8 studies reported the blood loss of the test group and the control group. Meta-analysis showed that the blood loss of the test group was significantly lower (SMD: -45.09; 95% CI: -67.76, -22.43; $P < .01$, Figure 2) than the control group. Sensitivity analyses are performed to assess the robustness of the results by testing the impact of individual studies on the

Table 1. The basic characteristics of the included studies.

Study	Sample Size(T/C)	Man/ Woman	Age (years)(Mean±SD) (T/C)	T	C	Main Outcomes
Xu,2019	83/78	70/91	70.4±4.7/69.3±4.9	Active	Routine	①⑤
Yi,2018	30/32	46/16	57.9±11.8/58.5±11.5	Active	Routine	①②⑥
Winkler,2000	75/75	65/85	65±11/64±11	Active	Routine	①②③④
Sun,2016	44/44	41/47	53.8±3.3/54.0±3.5	Active	Routine	①⑤
Pan,2017	40/40	44/36	68.12/66.2	Active	Routine	①③④⑤
Gu,2013	75/75	54/96	73.3±4.7/72.6±4.4	Active	Routine	①②⑥
Si,2017	20/20	23/17	64.1±7. 5/66.3+6.8	Active	Routine	①③④
Liang,2016	28/35	29/34	57.54±13.84/53.94±14.63	Active	Routine	②④⑤⑥
Zhang,2019	50/50	71/29	70.44±7.58/70.44±7.58	Active	Routine	①

Abbreviations: T: trial group; C: control group. Active: Active body temperature protection; Routin: Routin body temperature protection. ① Blood loss; ② Number of blood transfusions; ③ Intraoperative temperature; ④ Postoperative temperature; ⑤ Shiver incidence; ⑥ Length of hospital stay.

Figure 1. Flow Chart.

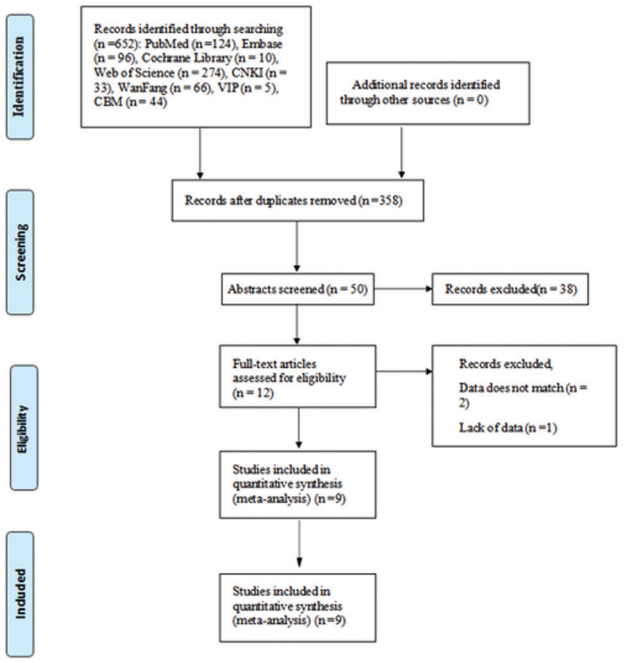


Figure 2. Forest illustration of the Blood loss.

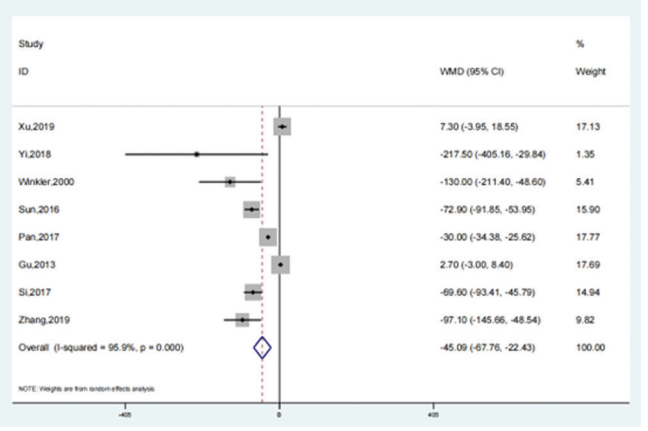


Figure 3. Sensitivity analysis of the Blood loss.

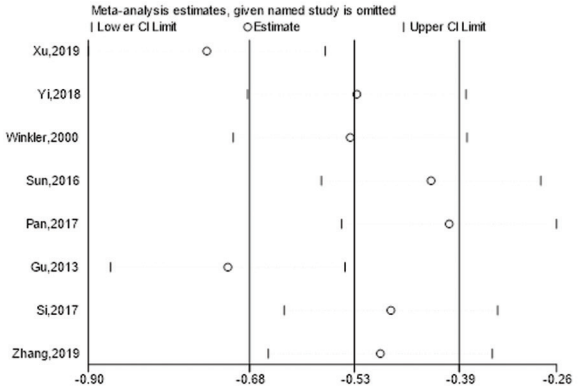


Figure 4. Forest illustration of the Number of blood transfusions.

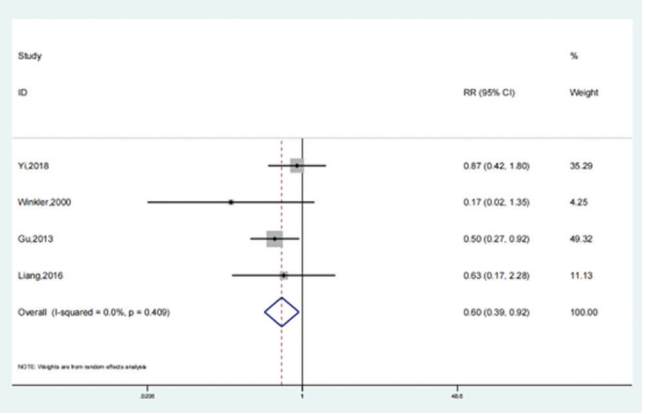


Figure 5. Sensitivity analysis of the Number of blood transfusions.

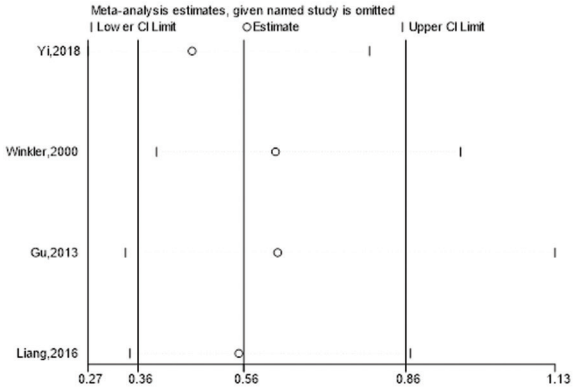
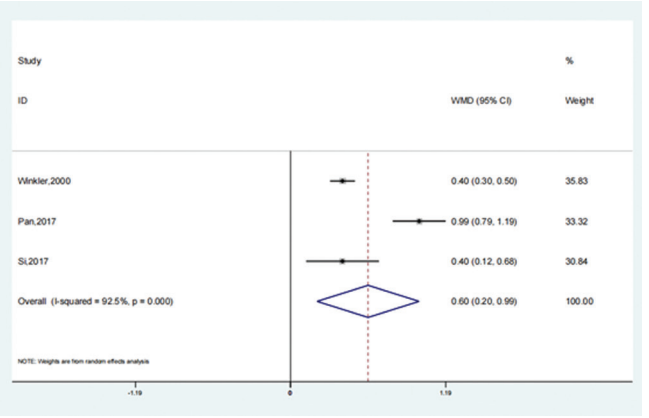


Figure 6. Forest illustration of the Intraoperative temperature.

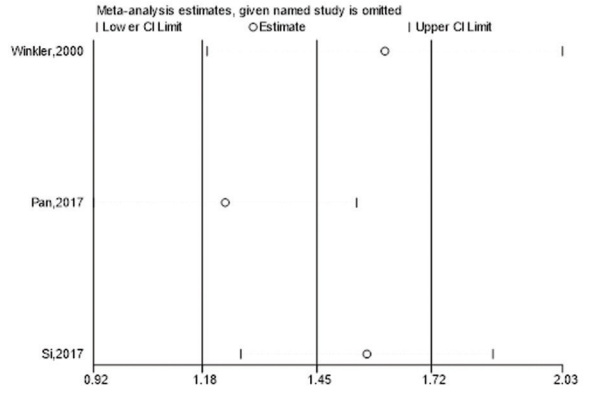


overall findings. The results of all these trials showed high heterogeneity, and a sensitivity analysis was conducted (Figure 3). Compared with the control group, active body temperature protection in the treatment of elderly patients undergoing arthroplasty decreases the level of blood loss. Begg's test, Egger's test, and Macaskill's test are three common meta-analyses were used to quantitatively evaluate their "publication bias. Begg's test calculation is more complex, after the standardizd judgment of the effect size y* and the variance v , the existence of publication bias is evaluated.The Begg's Test is 0.536, and the Egger's test is 0.313, so this research results are relatively stable, and there is no obvious publication bias.

Number of blood transfusions.

4 studies reported the Number of blood transfusions of the test group and the control group. Meta-analysis showed that the Number of blood transfusions of the experimental group was significantly lower than the control group (OR:0.60; 95% Cl: 0.39,0.92; *P* = .019, Figure 4). Compared with the control group, active body temperature protection in the treatment of elderly patients undergoing arthroplasty decreases the Number of blood transfusions. The results of all these trials showed low heterogeneity, and a sensitivity analysis was conducted (Figure 5).

Figure 7. Sensitivity analysis of the Intraoperative temperature.



Intraoperative temperature.

3 studies reported the intraoperative temperature of the test group and the control group. Meta-analysis showed that the intraoperative temperature of the experimental group was significantly higher than the control group (SMD:0.60; 95% Cl: 0.20,0.99; *P* = .003, Figure 6). Compared with the control group, active body temperature protection in the treatment of elderly patients undergoing arthroplasty increases the level of intraoperative temperature. The results of all these trials showed high heterogeneity, and a sensitivity analysis was conducted (Figure 7).

Figure 8. Forest illustration of the Postoperative temperature.

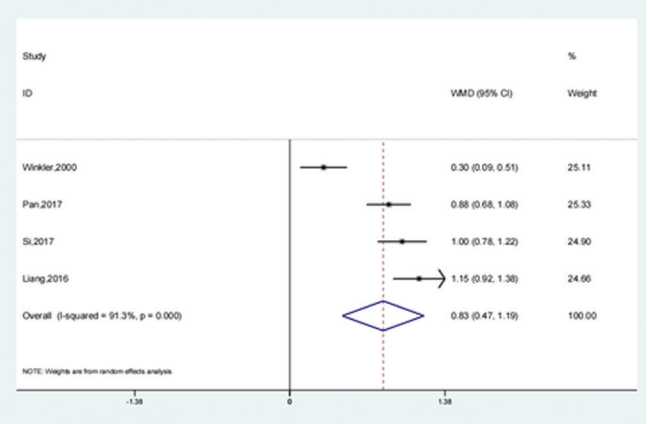


Figure 9. Sensitivity analysis of the Postoperative temperature.

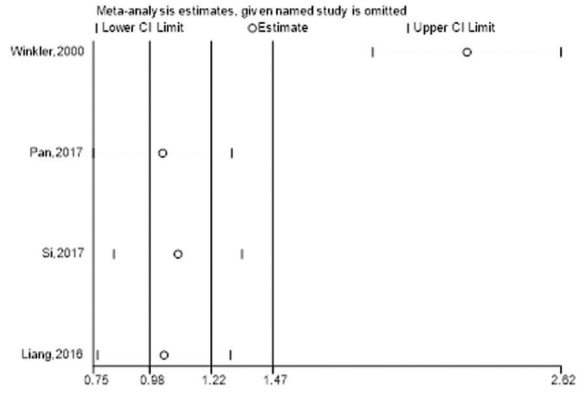


Figure 10. Forest illustration of the Shiver incidence.

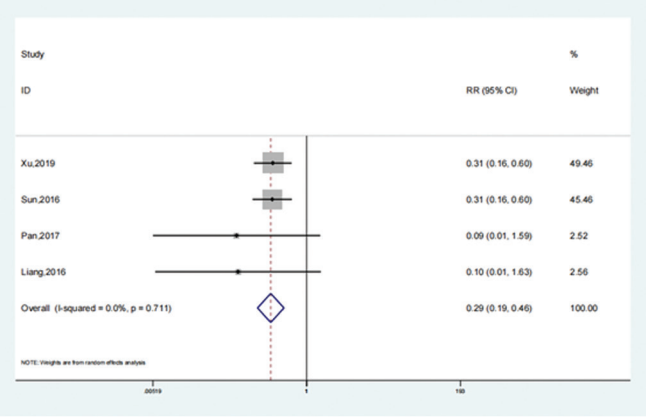
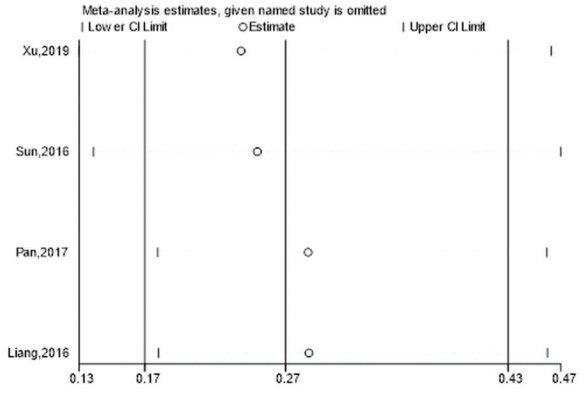


Figure 11. Sensitivity analysis of the Shiver incidence.



Postoperative temperature.

4 studies reported the postoperative temperature of the test group and the control group. Meta-analysis showed that the postoperative temperature of the test group was significantly higher than the control group (SMD: 0.83; 95% Cl: 0.47,1.19; $P <$ .01, Figure 8). Compared with the control group, active body temperature protection in the treatment of elderly patients undergoing arthroplasty increases the level of postoperative temperature. The results of all these trials showed high heterogeneity, and a sensitivity analysis was conducted (Figure 9).

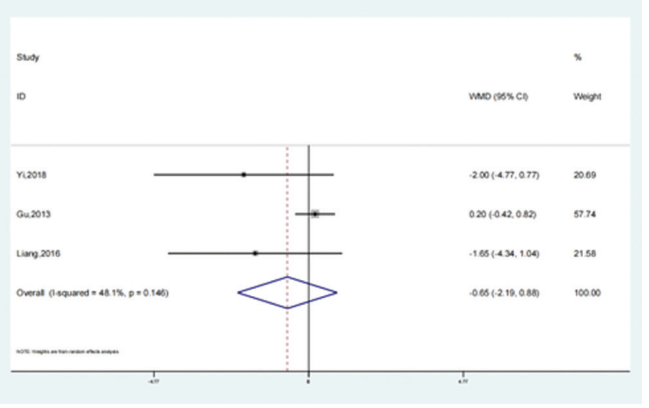
Incidence of Shiver.

4 studies reported the shiver incidence of the test group and the control group. Meta-analysis showed that the shiver incidence of the experimental group was significantly lower than the control group (OR:0.29; 95% Cl: 0.19,0.46; $P <$ .01, Figure 10). Compared with the control group, active body temperature protection in the treatment of elderly patients undergoing arthroplasty decreases the shiver incidence. The results of all these trials showed low heterogeneity, and a sensitivity analysis was conducted (Figure 11).

Length of hospital stay.

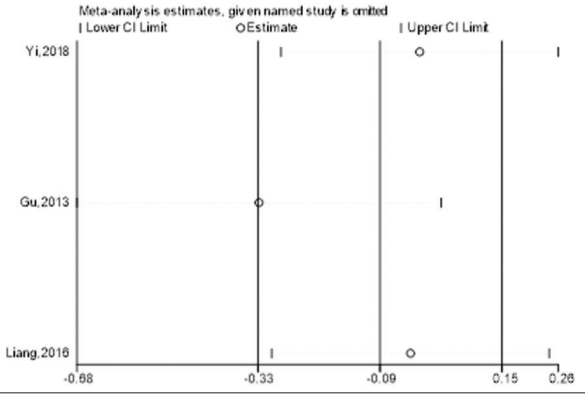
3 studies reported the length of hospital stay of the test group and the control group. There was no significant

Figure 12. Forest illustration of the Length of hospital stay.



difference in the length of hospital stay between the two groups (SMD: -0.65; 95% Cl: -2.119,0.88; P = .044, Figure 12). Compared with the control group, active body temperature protection in the treatment of elderly patients undergoing arthroplasty did not decrease the level of length of hospital stay. The results of all these trials showed moderate heterogeneity, and a sensitivity analysis was conducted (Figure 13).

Figure 13. Sensitivity analysis of the Length of hospital stay.



DISCUSSION

TJA, including THA and TKA, is a major treatment for advanced joint disease. It can effectively help patients to relieve joint pain and discomfort caused by severe joint deformity, restore joint range of motion, and improve quality of life. Using the latest national data system analysis, the U. S. TJA will continue to grow linearly or slowly in the next few years. The population is aging, with a sharp increase in the elderly population and an increase in joint pain due to degeneration, and therefore, a relatively greater number of patients requiring joint replacement surgery. Although joint replacement has many benefits, it can also result in more surgical complications. Common surgical complications include infection, pain, fractures, and joint dislocation, even leading to massive blood loss, blood loss is one of the most common complications during surgery, and may result in the need for allogeneic blood transfusions if the patient has more blood loss. Perioperative allogeneic blood transfusion can lead to more complications, including the spread of infectious diseases, immune response, heart and lung complications and prolonged hospital stay. Previous studies have shown that in non-orthopedic procedures, higher transfusion rates are clearly associated with intraoperative hypothermia, and a review of the literature found a positive correlation between transfusion rates and hypothermia. Although the current definition of hypothermia varies, the prevailing view is that the body temperature is below 36°C, and intraoperative hypothermia is due to, among other things, the effects of anesthetics during the surgical procedure and skin, long-term, a common occurrence resulting from exposure. Hypothermia can lead to changes in the body's basic metabolism and delayed drug metabolism. Under the condition of hypothermia, the basal metabolic rate of the body is further reduced, and the metabolism and excretion time of a variety of drugs are prolonged, thus prolongating the anesthesia time and affecting the recovery and recovery of patients. Hypothermia was also associated with fever, increased risk of heart disease, increased rates of surgical site infection, prolonged use of anesthetic agents, and prolonged hospital stay.[30-32] The results of this study suggest that active body temperature protection may be effective on intraoperative bleeding in elderly patients undergoing arthroplasty, as evidenced by blood loss, number of blood transfusions, intraoperative temperature, postoperative temperature, shiver incidence, length of hospital stay.

Related studies found that[33-34] operation can cause hyperfibrinolysis, and increase intraoperative and postoperative early bleeding. Maintaining normal blood volume plays a vital role in the prevention and treatment of hemorrhagic shock and tissue hypoxia. At this time, it is very important to accurately judge the amount of blood loss and the trend of disease change. Hypovolemic shock occurs when blood loss reaches 30% of circulating blood volume and is not treated. Total blood loss is affected by a number of factors and can be broadly classified into three categories. 1. Preoperative factors related to the type of disease, femoral head necrosis and rheumatoid arthritis patients will significantly increase the amount of drainage; Acetabular deformities (including congenital acetabular dysplasia and osteoarthritis after acetabular fractures) require re-grinding and reconstruction of the acetabulum, with a significant increase in postoperative drainage, and are associated with primary replacement or revision, in addition, long-term use of nsaids, glucocorticoid, reserpine, aspirin, etc. Before surgery can increase the amount of blood oozing after surgery, long-term excessive drinking, hypertension history of more than 3 years or preoperative liver function abnormalities can also cause postoperative drainage volume increase.[35-36] 2. Intraoperative factors: excessive filing of the bony acetabulum or too small selection of acetabulum leads to an increase in the exposure of the acetabular bed, which can directly lead to an increase in the amount of blood oozing after surgery. 3. Postoperative factors: postoperative functional rehabilitation of the intensity of excessive will, to some extent, lead to increased drainage.[37] Blood routine examination after the operation showed that the hemoglobin of the patients decreased significantly and even appeared to have moderate anemia, which led to a serious decline in the recovery and anti-infection ability of the patients after the operation. Lee et al. [38] reported massive bleeding during and after surgery. Acute blood deficiency during and after hip arthroplasty severely affects the smooth recovery of patients and increases the possibility of infection in the operative area, even life-threatening, which often requires massive blood transfusions. Allogeneic blood transfusion is the main method to correct acute postoperative blood loss. However, adverse effects of allogeneic blood transfusion have been reported from time to time, which can lead to increased transfusion complications in patients and also increased medical costs in patients. How to reduce the rate of allogeneic blood transfusion has become a major challenge of artificial joint replacement.

A total of 9 literature were included in this study, including 455 patients in the experimental group and 449 patients in the control group. Meta-analysis showed that elderly patients undergoing arthroplasty who received active body temperature protection had lower levels of blood loss compared with controls. After heating, the body is warmed by air convection or contact conduction to reduce heat loss, so as to maintain the patient's core body temperature in the normal range, and do

not increase the incision infection rate. Compared with passive insulation (quilt and cotton blanket), it can more effectively prevent perioperative hypothermia and accelerate the rewarming of patients with hypothermia. Meta-analysis showed satisfactory blood loss for the experimental group (SMD: -45.09; 95% Cl: -67.76, -22.43; $P < .01$). Based on the results of the meta-analysis of Number of blood transfusions, compared to the control group, meta-analysis showed that the Number of blood transfusions of the test group was significantly lower (OR:0.60; 95% Cl: 0.39,0.92; $P = .019$). Based on the results of the meta-analysis of intraoperative temperature, compared to the control group, meta-analysis showed that the intraoperative temperature of the test group was significantly higher (SMD:0.60; 95% Cl: 0.20,0.99; $P = .003$). Based on the results of the meta-analysis of postoperative temperature, compared to the control group, meta-analysis showed that the postoperative temperature of the test group was significantly higher (SMD: 0.83; 95% Cl: 0.47,1.19; $P < .01$). Meta-analysis showed that the shiver incidence of the experimental group was significantly lower (OR:0.29; 95% Cl: 0.19,0.46; $P < .01$). For the results of the meta-analysis of length of hospital stay, compared with the control group, meta-analysis showed that the length of hospital stay of the test group was no significant statistical significance than the control group.

Limitations

The limitations of this systematic review are that only Chinese and English literature was searched, with no other language literature obtained. Also, there may be incomplete research inclusion and bias in selection. Therefore, further studies are still needed to verify this conclusion.

CONCLUSION

The results of this study suggest that active body temperature protection may be effective on intraoperative bleeding in elderly patients undergoing arthroplasty, as evidenced by blood loss, Number of blood transfusions, intraoperative temperature, postoperative temperature, shiver incidence, length of hospital stay, and the above conclusions need to be verified by more high-quality studies.

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AUTHOR CONTRIBUTIONS

Xing Wang: Conceptualization, Methodology, Software, Supervision. **Wei Zhao:** Data curation, Writing- Original draft preparation. Visualization, Investigation. **Yang Hu**: Software, Validation, Writing- Reviewing and Editing. all authors have read and approved the final submitted manuscript.

REFERENCE

1. Vogelsang EM, Raymo JM, Liang J, Kobayashi E, Fukaya T. Population Aging and Health Trajectories at Older Ages [published correction appears in *J Gerontol B Psychol Sci Soc Sci*. 2017 Oct 1;72(6):1111-1112].
2. Man W, Wang S, Yang H. Exploring the spatial-temporal distribution and evolution of population aging and social-economic indicators in China. *BMC Public Health*. 2021;21(1):966. Published 2021 May 22. doi:10.1186/s12889-021-11032-z
3. Ferguson RJ, Palmer AJ, Taylor A, Porter ML, Malchau H, Glyn-Jones S. Hip replacement. *Lancet*. 2018;392(10158):1662-1671. doi:10.1016/S0140-6736(18)31777-X
4. Gross AF, Fickert S, Günther KP. Ubergewicht und Arthrose. [Obesity and arthritis]. *Orthopade*. 2005;34(7):638-644. doi:10.1007/s00132-005-0814-9
5. Centers for Disease Control and Prevention (CDC). Prevalence of doctor-diagnosed arthritis and arthritis-attributable activity limitation --- United States, 2007-2009. *MMWR Morb Mortal Wkly Rep*. 2010;59(39):1261-1265.
6. Goodman SB, Wimmer MA, Ploeg HL. Recent advances in total joint replacement. *J Orthop Res*. 2020;38(7):1413. doi:10.1002/jor.24734
7. Baier C, Grifka J, Keshmiri A, Maderbacher G. Gelenkersatz des älteren Menschen. [Joint replacement in the elderly]. *Orthopade*. 2017;46(1):63-68. doi:10.1007/s00132-016-3367-1
8. Sloan M, Premkumar A, Sheth NP. Projected Volume of Primary Total Joint Arthroplasty in the U.S., 2014 to 2030. *J Bone Joint Surg Am*. 2018;100(17):1455-1460. doi:10.2106/JBJS.17.01617
9. Vendittoli PA, Shahin M, Rivière C, Barry J, Lavoie P, Duval N. Ceramic-on-ceramic total hip arthroplasty is superior to metal-on-conventional polyethylene at 20-year follow-up: A randomised clinical trial. *Orthop Traumatol Surg Res*. 2021;107(1):102744. doi:10.1016/j.otsr.2020.102744
10. Williams M, El-Houdiri Y. Inadvertent hypothermia in hip and knee total joint arthroplasty. *J Orthop*. 2018;15(1):151-158. doi:10.1016/j.jor.2018.01.035
11. Simpson JB, Thomas VS, Ismaily SK, Muradov PI, Noble PC, Incavo SJ. Hypothermia in Total Joint Arthroplasty: A Wake-Up Call. *J Arthroplasty*. 2018;33(4):1012-1018. doi:10.1016/j.arth.2017.10.057
12. Frisch NB, Pepper AM, Rooney E, Silverton C. Intraoperative Hypothermia in Total Hip and Knee Arthroplasty. *Orthopedics*. 2017;40(1):56-63. doi:10.3928/01477447-20161017-04
13. Horosz B, Malec-Milewska M. Methods to prevent intraoperative hypothermia. *Anaesthesiol Intensive Ther*. 2014;46(2):96-100. doi:10.5603/AIT.2014.0019
14. Rosencher N, Kerkkamp HE, Macheras G, et al; OSTHEO Investigation. Orthopedic Surgery Transfusion Hemoglobin European Overview (OSTHEO) study: blood management in elective knee and hip arthroplasty in Europe. *Transfusion*. 2003;43(4):459-469. doi:10.1046/j.1537-2995.2003.00348.x
15. Bruce W, Campbell D, Daly D, Isbister J. Practical recommendations for patient blood management and the reduction of perioperative transfusion in joint replacement surgery. *ANZ J Surg*. 2013;83(4):222-229. doi:10.1111/ans.12000
16. Zhao J, Li J, Zheng W, Liu D, Sun X, Xu W. Low body mass index and blood loss in primary total hip arthroplasty: results from 236 consecutive ankylosing spondylitis patients. *BioMed Res Int*. 2014;2014:742393. doi:10.1155/2014/742393
17. Vamvakas EC, Blajchman MA. Transfusion-related mortality: the ongoing risks of allogeneic blood transfusion and the available strategies for their prevention. *Blood*. 2009;113(15):3406-3417. doi:10.1182/blood-2008-10-167643
18. Liu X, Zhang X, Chen Y, Wang Q, Jiang Y, Zeng B. Hidden blood loss after total hip arthroplasty. *J Arthroplasty*. 2011;26(7):1100-5.e1. doi:10.1016/j.arth.2010.11.013
19. Li B, Wen Y, Liu D, Tian L. The effect of knee position on blood loss and range of motion following total knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc*. 2012;20(3):594-599. doi:10.1007/s00167-011-1628-4
20. Markar SR, Jones GG, Karthikesalingam A, Segaren N, Patel RV. Transfusion drains versus suction drains in total knee replacement: meta-analysis. *Knee Surg Sports Traumatol Arthrosc*. 2012;20(9):1766-1772. doi:10.1007/s00167-011-1761-0
21. Xu H, Xu G, Ren C, Liu L, Wei L. Effect of forced-air warming system in prevention of postoperative hypothermia in elderly patients: A Prospective controlled trial. *Medicine (Baltimore)*. 2019;98(22):e15895. doi:10.1097/MD.0000000000015895
22. Yi J, Liang H, Song R, Xia H, Huang Y. Maintaining intraoperative normothermia reduces blood loss in patients undergoing major operations: a pilot randomized controlled clinical trial. *BMC Anesthesiol*. 2018;18(1):126. doi:10.1186/s12871-018-0582-9
23. Winkler M, Akça O, Birkenberg B, et al. Aggressive warming reduces blood loss during hip arthroplasty. *Anesth Analg*. 2000;91(4):978-984. doi:10.1097/00000539-200010000-00039
24. Sun Y, Yuan WH. Effect of intraoperative temperature protection on postoperative joint replacement. *Contemporary Medicine*, 22(22) : 26-28.
25. Pan CL, Chen LL, Zhou QQ. Perioperative temperature management of elderly patients with joint replacement based on the concept of rapid rehabilitation. *Chinese maternal and child health study*, 2017,28(s 2) : 402.
26. Gu KF, Ma K, Ma XJ. Effect of perioperative heat preservation on cognitive function in elderly patients after total knee arthroplasty. *Journal of Clinical Anesthesiology*, 29(10) : 1026-1027.
27. Si JL, Yang MQ, Zhang LY. Effect of perioperative temperature protection on coagulation function during total knee arthroplasty. *Chinese tissue engineering research*, 21(23), 2017:3652-3657.
28. Liang H. *A randomized controlled study on the effect of active aerated heating to reduce intraoperative blood loss in patients undergoing total hip replacement.* Hebei North University; 2016.
29. Zhang X, Li X. A prospective study on the application value of composite heat preservation nursing in hip joint replacement of senile patients. *Int J Nurs (N Y)*. 2019;(15):2432-243.
30. Leijtens B, Koëter M, Kremers K, Koëter S. High incidence of postoperative hypothermia in total knee and total hip arthroplasty: a prospective observational study. *J Arthroplasty*. 2013;28(6):895-898. doi:10.1016/j.arth.2012.10.006
31. Brandt S, Oguz R, Hüttner H, et al. Resistive-polymer versus forced-air warming: comparable efficacy in orthopedic patients. *Anesth Analg*. 2010;110(3):834-838. doi:10.1213/ANE.0b013e3181cb3f5f
32. Sandoval MF, Mongan PD, Dayton MR, Hogan CA. Safety and efficacy of resistive polymer versus forced air warming in total joint surgery. *Patient Saf Surg*. 2017;11(1):11. doi:10.1186/s13037-017-0126-0
33. Blanié A, Bellamy L, Rhayem Y, et al. Duration of postoperative fibrinolysis after total hip or knee replacement: a laboratory follow-up study. *Thromb Res*. 2013;131(1):e6-e11. doi:10.1016/j.thromres.2012.11.006
34. de Jonge T. Gyógyszeres vérzéscsillapítás csípőízületi endoprotézis-beültetések során. [Pharmacological reduction of bleeding during hip endoprosthetic replacement]. *Orv Hetil*. 2012;153(41):1607-1612. doi:10.1556/OH.2012.29455
35. Baghdadi YM, Larson AN, Stans AA, Mabry TM. Total hip arthroplasty for the sequelae of Legg-Calvé-Perthes disease. *Clin Orthop Relat Res*. 2013;471(9):2980-2986. doi:10.1007/s11999-013-3006-7
36. Brueggemann PM, Tucker JK, Wilson P. Intermittent clamping of suction drains in total hip replacement reduces postoperative blood loss: a randomized, controlled trial. *J Arthroplasty*. 1999;14(4):470-472. doi:10.1016/S0883-5403(99)90103-1
37. Kumar S, Penematsa S, Parekh S. Are drains required following a routine primary total joint arthroplasty? *Int Orthop*. 2007;31(5):593-596. doi:10.1007/s00264-006-0245-1
38. Lee YC, Park SJ, Kim JS, Cho CH. Effect of tranexamic acid on reducing postoperative blood loss in combined hypotensive epidural anesthesia and general anesthesia for total hip replacement. *J Clin Anesth*. 2013;25(5):393-398. doi:10.1016/j.jclinane.2013.02.006