



Arthroscopic debridement combined with proximal fibular osteotomy in medial tibial articular genu osteoarthritis treatment: systematic review and meta-analysis

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Background: We performed a systematic review and meta-analysis to evaluate the therapeutic effects of arthroscopic debridement and proximal fibular osteotomy (AD & PFO) on medial tibial articular genu osteoarthritis (MTAGO), so as to provide a theoretical reference for clinical surgical analgesia for patients.

Methods: We searched and screened randomized controlled trials (RCTs) focusing on AD & PFO on MTAGO surgical analgesia published before December 31, 2020 in English databases including PubMed, Embase, Medline, Ovid, Springer, and Web of Science. The Cochrane Handbook for Systematic Reviews of Intervention 5.0.2 was adopted for bias risk assessment, and Review Manager 5.3 was used to conduct the meta-analysis.

Results: Twelve eligible studies were included, involving 765 research subjects. The meta-analysis results indicated that, relative to control group, satisfaction was markedly increased [mean difference (MD) =3.10; 95% confidence interval (CI), (1.48 to 6.51); Z=3; P=0.003], adverse reactions were reduced [MD =0.33; 95% CI, (0.08 to 1.32); Z=1.56; P=0.12] the hospital special surgery (HSS) score was lower [MD =5.37; 95% CI, (3.18 to 7.55); Z=4.82; P<0.00001], the visual analogue scale (VAS) score decreased [MD =-1.68; 95% CI, (-2.22 to -1.13); Z=6.01; P<0.00001], and the Knee Society score (KSS) was reduced [MD =6.16; 95% CI, (3.85 to 8.47); Z=5.23; P<0.00001]. However, the difference in the femoro-tibial (FT) angle between the control and study groups was not statistically considerable [MD =0.14; 95% CI, (-6.22 to 6.49); Z=0.04; P=0.97].

Discussion: The combined adoption of AD & PFO for MTAGO surgical analgesia can reduce the HSS, KSS, and VAS scores of patients. The postoperative analgesia effect is good, and effectively reduces pain and adverse reactions in patients. Thus, it is suitable for analgesia in MTAGO.

Keywords: Medial tibial articular genu; osteoarthritis; arthroscopy; proximal fibula osteotomy; treatment effect

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Introduction

The tibiofemoral joint is an important part of the knee joint. It can move in six directions in a three-dimensional space, namely, flexion, extension, internal rotation, external rotation, varus, and valgus; however, the main movement

is flexion and extension between the tibia and femur (1). Osteoarthritis is a chronic joint disease characterized by articular cartilage degeneration and secondary bone hyperplasia, which often affects the surrounding articular cartilage or the entire bone and joint. The clinical

manifestations of patients after illness mainly include pain, joint stiffness, and joint swelling. OA is not a single disease entity, but a collection of multiple diseases that are caused by mechanical/biological factors that cause slow cartilage destruction and osteoblastic proliferation and new bone formation in subchondral bone. The pathogenesis of the disease is not clear, but aging is considered the strongest risk factor. Other factors include physical labor, trauma, exercise, overuse, obesity, genetics, and inflammation, hormone levels, and bone content. The diagnosis of OA is mainly based on X-ray examination, but most patients have OA radiographic changes in the affected joints without clinical symptoms. Moreover, with aggravation of the disease, the patient's clinical manifestations can gradually worsen, potentially resulting in severe joint deformities, which lead to serious physical and psychological burdens on patients (2). Currently, clinical treatment of this disease mainly involves conservative and surgical treatments. Conservative treatments primarily include physical therapy, medicine, injection therapy, and traditional Chinese medicine treatment. For patients whose symptoms are not severe at the initial diagnosis, surgical treatment is required if conservative treatment fails (3).

Surgical therapy, which is a commonly used clinical method, aims to reduce or eliminate pain, prevent or correct deformity, prevent further aggravation of joints, and improve joint function (4). These surgical procedures include simple proximal fibular osteotomy (PFO), arthroscopic debridement (AD), and knee replacement. Of these, AD was proposed in the early 1940s, and the success rate of this operation was found to be greater than 60%. Both PFO and total knee arthroplasty can effectively relieve knee pain and improve knee function in the treatment of knee osteoarthritis. However, PFO has the advantages of short operation time, less intraoperative bleeding, and low hospitalization cost, which is worthy of clinical promotion and adoption. There are also reports that the treatment effect of single PFO surgery is relatively better. Clinically, there have been numerous related studies focusing on combined AD and PFO (AD & PFO) treatment for medial tibial articular genu osteoarthritis (MTAGO).

Current studies focus on the effect of opening-wedge osteotomy on osteoarthritis. However, the treatments reported in the literature were uneven and lacked a unified treatment standard (5). Therefore, we performed this meta-analysis on international randomized controlled trials (RCTs) of AD & PFO for the treatment of MTAGO, and the related pain indicators of MTAGO patients were

analyzed comprehensively. The purpose of this study was to systematically assess effectiveness of AD & PFO for MTAGO patients, and provide reference for the clinical treatment of patients.

We present the following article in accordance with the PRISMA reporting checklist (available at <https://dx.doi.org/10.21037/apm-21-1381>).

Methods

Inclusion and exclusion criteria

Inclusion criteria (I) the subjects were clinically diagnosed with MTAGO; (II) RCT study design; (III) RCTs published in foreign English language databases, with the language restricted to English; (IV) AD & PFO was performed for experimental group, while that of the control group was AD alone; (V) the baseline data of the experimental and control groups was comparable; (VI) studies involving cases of failed conservative treatment; and (VII) evaluation indicators of research outcomes include postoperative satisfaction of patients and occurrence of adverse reactions.

Exclusion criteria: (I) non-RCT studies such as retrospective studies, case reports, and cohort studies; (II) studies that involved research objects such as animals, cells, etc.; (III) unpublished or non-English documents such as degree theses; (IV) the surgical method of the trial group was knee replacement or drug treatment; (V) studies in which the research object was a trial of MTAGO patients with other diseases; (VI) studies with incomplete data and those where the corresponding effect index can't be calculated.

Literature search

PubMed, Embase, Medline, Ovid, Springer, and Web of Science were searched (the search deadline was December 31, 2020), and publicly published MTAGO RCTs were retrieved. Literature search terms were composed of subject terms and keywords, including: "AD", "PFO", "Medial tibiofemoral joint bone", "arthritis", etc. "and" or "or" was used for joint search between search terms, and the literature search was carried out by two researchers using independent search methods.

Literature screening

Two researchers independently screened the literature.

Upon completion of the search, Note Express 3.2 (Developer: Beijing Aegean Software Co., Ltd.; Location: No. 289 Xinhua East Street, Tongzhou District, Beijing) was employed to establish a literature database. The retrieved RCTs were checked to eliminate duplicate studies. After eliminating duplicate studies, the remaining RCTs were manually screened by two researchers. First, the titles and abstracts were read in order to eliminate RCTs that didn't meet the inclusion criteria. Subsequently, the full texts of the RCTs were read, and the decision to include or exclude the literature was determined regarding literature inclusion/exclusion criteria. When there was a disagreement between two experts, discussion was made to reach a congruent conclusion. If not, a third party would make a decision after arbitration.

Data extraction

The basic information including characteristics of the research object, interventions, outcome indicators, and bias evaluation were recorded as a table by two researchers. The data from the RCTs that met the inclusion criteria was extracted by two researchers independently. Following data extraction, cross-examination was carried out. When there was a disagreement between two experts, discussion was made to reach a congruent conclusion. If not, a third party would make a decision after arbitration. The following data were extracted and included in this study: (I) the title of the research, the first author (only one name), the publication time of the document, and the research area; (II) age of research objects, sample size, and baseline comparability; (III) research plan design, implementations, intervention and control measures, and anti-bias measures; and (IV) outcome indicators and data.

Quality evaluation

The bias risk assessment criteria provided in the Cochrane Handbook for Systematic Reviews of Intervention 5.0.2 was adopted to carry out bias risk assessment of the included original RCTs, including generation of random sequence, implementation of blinding for patients and experimenters, implementation of the blinding for the outcome assessor, if research data is complete, if there are selective reporting results, and if there are other sources of bias. Inconsistent results were resolved through discussion or via arbitration by a third party.

Statistical analysis

The Cochrane Handbook for Systematic Reviews of Interventions 5.0.2 was employed to evaluate the risk of bias. STATA11.0 (Developer: Beijing Wangshu Times Technology Co., Ltd.; Location: Huihuang International Building, Shangdi 10th Street, Haidian District, Beijing) was employed to merge the statistics of the included literatures. Review Manager 5.3 (Developer: Nordic Cochrane Centre; Location: Denmark) was employed to perform the meta-analysis on the combined statistics and to construct forest plots and funnel plots. The binary variables in the count data of postoperative adverse reactions take the relative risk (RR) as the effect size. The 95% confidence intervals (CIs) and measurement continuous variables such as heart rate (HR), mean arterial pressure (MAP), and visual analogue scale (VAS) were calculated. If the unit of the detection index was the same, the weighted mean difference (MD) was taken as the effect size, whereas if the detection index units were not the same, the standardized MD (SMD) was taken as the effect size. When the research results could be combined, meta-analysis is performed on them. The I^2 test can evaluate the heterogeneity of the included RCTs, with higher I^2 indicating greater heterogeneity. If $I^2 > 50\%$ and it failed to explain the source of heterogeneity, a random effects model (REM) was adopted to combine effect size for meta-analysis. However, if $I^2 < 50\%$, which means that the heterogeneity of the study is good, a fixed effects model (FEM) was adopted to combine the effect size. If research data was less than two items and meta-analysis could not be performed, there is descriptive analysis. The combined effect size was tested by u test and 95% CI. The u test result was expressed as a P value, and $P < 0.05$ indicated considerable difference. Binary variables were tested with the 95% CI. When the 95% CI was > 1 or < 1 , the difference was considerable. However, when the 95% CI contained 1, the difference wasn't considerable. Continuous variables used the 95% CI test; when the 95% CI > 0 or < 0 , the difference was considerable.

Results

Literature screening results

After preliminary search, 436 related studies were identified. Among them, 113 related studies were from PubMed, 58 were from Embase, 43 were from Medline, 52 were from Springer, 29 were from Ovid, and 141

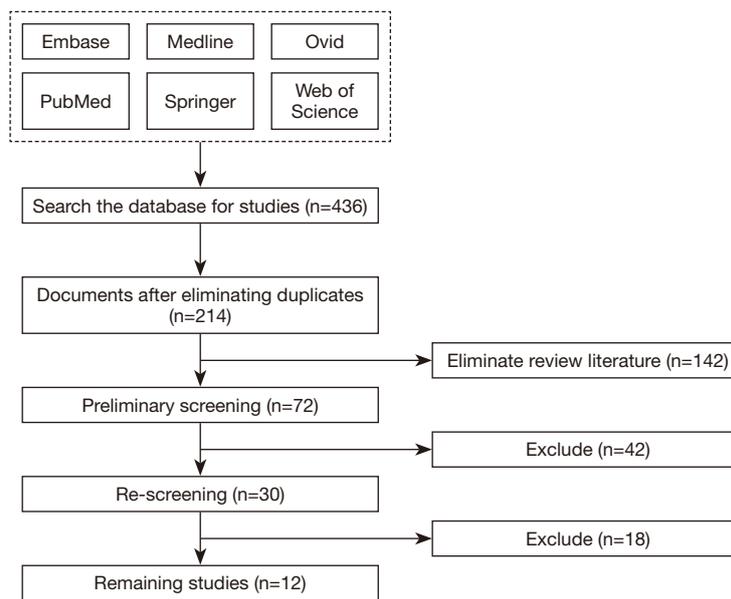


Figure 1 Search flow chart of literatures.

were from Web of Science. All 436 RCTs were imported into NoteExpress3.2, and 214 studies remained after the duplicate check was performed. Next, the two researchers screened them according to the inclusion and exclusion criteria after reading the title and abstract. After screening, 72 studies remained. Finally, the two researchers read and cross-examined the texts of the remaining studies, and subsequently screened and excluded the unqualified studies. Finally, twelve RCTs were included, and all were publicly published RCTs, and the publication time ranged from 2010 to 2020. The 12 included RCTs involved a total of 765 study subjects, and the baseline data, such as age of subjects in two groups, were comparable (6-17). The literature search flowchart is shown in *Figure 1*.

Bias risk assessment

The risk assessment items for bias included the following (*Table 1*). (I) Random sequence generation: 6 of the 12 included studies described the specific grouping method as “rolled into different groups according to surgical treatment”, etc., suggesting that these six studies were at a low risk of bias; another six studies only mentioned random grouping, but didn’t specifically describe which random method was used, suggesting an unclear risk of bias. (II) Allocation concealment: none mentioned whether “allocation concealment” was adopted or not, indicating unclear risk of bias. (III) Blinding of subjects:

seven of the 12 included studies mentioned that “patients knew and signed informed consent”, but did not mention blinding of experimenters, suggesting an unclear risk of bias. (IV) Blinding of the outcome assessor: none of the 12 included studies mentioned whether the outcome assessor was blinded, suggesting that the risk of bias is not clear. (V) Result data integrity: the outcome data of the 12 included studies were complete, suggesting a low risk of bias. (VI) Selective reporting: there was no selective reporting in the 12 included studies, indicating a low risk of bias. (VII) Other risks of bias: five studies involved an inconsistent number of people in the test and control groups, indicating a high risk of bias. It could not be determined whether there were other biases in the seven remaining studies, suggesting that the risk of bias is not clear. The results of our bias risk assessment are shown in *Figures 2,3*.

Clinical treatment satisfaction

Three studies analyzed the patients’ satisfaction with clinical treatment. A total of 204 patients with MTAGO were enrolled, including 105 and 99 in experimental and control group, respectively. Through heterogeneity test results ($I^2=20\%$, $P=0.29$), small heterogeneity was revealed among the studies. Therefore, a FEM was used, and the results are displayed in *Figure 4*. The combined effect is MD =3.10; 95% CI, (1.48 to 6.51); $Z=3.00$; $P=0.003$. The diamond

Table 1 Basic characteristics of the included studies

| The first author | Published year | Group | Sample size | Counter measure |
|------------------|----------------|--------------|-------------|-----------------|
| Bai (6) | 2017 | Experimental | 16 | AD & PFO |
| | | Control | 20 | AD |
| Feng (7) | 2018 | Experimental | 63 | AD & PFO |
| | | Control | 63 | AD |
| Hou (8) | 2016 | Experimental | 27 | AD & PFO |
| | | Control | 27 | AD |
| Yao (9) | 2017 | Experimental | 38 | AD & PFO |
| | | Control | 38 | AD |
| Sun (10) | 2018 | Experimental | 50 | AD & PFO |
| | | Control | 50 | AD |
| Xiong (11) | 2018 | Experimental | 54 | AD & PFO |
| | | Control | 54 | AD |
| Li (12) | 2017 | Experimental | 50 | AD & PFO |
| | | Control | 50 | AD |
| Song (13) | 2019 | Experimental | 26 | AD & PFO |
| | | Control | 26 | AD |
| Chen (14) | 2019 | Experimental | 43 | AD & PFO |
| | | Control | 43 | AD |
| Jian (15) | 2019 | Experimental | 35 | AD & PFO |
| | | Control | 35 | AD |
| Wu (16) | 2019 | Experimental | 102 | AD & PFO |
| | | Control | 96 | AD |
| Hao (17) | 2016 | Experimental | 24 | AD & PFO |
| | | Control | 24 | AD |

AD & PFO, arthroscopic debridement combined with proximal fibular osteotomy.

in the forest plot is on right of vertical line (VL), and the clinical treatment satisfaction of AD & PFO of MTAGO patients is superior to control group.

Occurrence of adverse reactions

Three studies analyzed the occurrence of adverse reactions in patients. In total, 266 MTAGO patients were enrolled, including 133 in experimental and 133 in control group. After the heterogeneity test results ($I^2=67\%$, $P=0.06$), a certain degree of heterogeneity was found, so the REM was used, and the analysis results are shown in *Figure 5*.

The combined effect is MD =0.33; 95% CI, (0.08 to 1.32); $Z=1.56$; $P=0.12$. The diamond is located on the left side of VL in the forest plot. Thus, the incidence of adverse reactions of AD & PFO of MTAGO patients was inferior to control group.

Hospital special surgery (HSS)

Six studies analyzed the postoperative HSS scores of patients. A total of 430 MTAGO patients were included, with 223 experimental cases and 207 controls. From the heterogeneity test results ($I^2=67\%$, $P=0.01$) suggested that

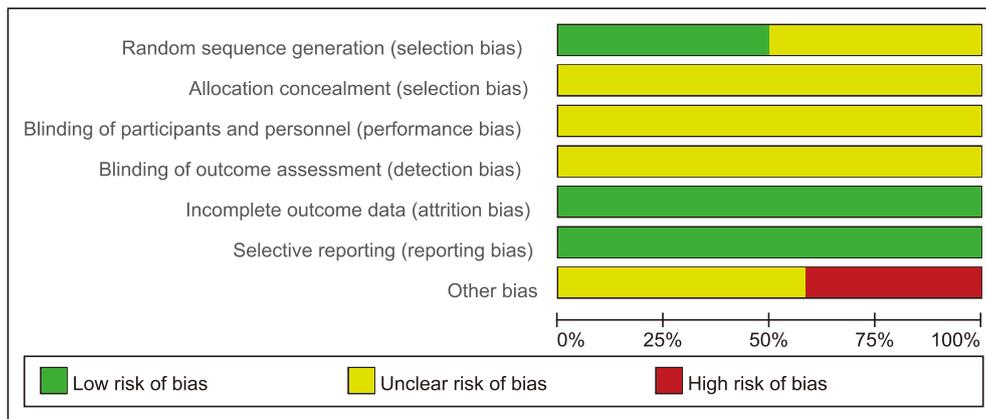


Figure 2 Bar graph of bias risk assessment of the included studies.

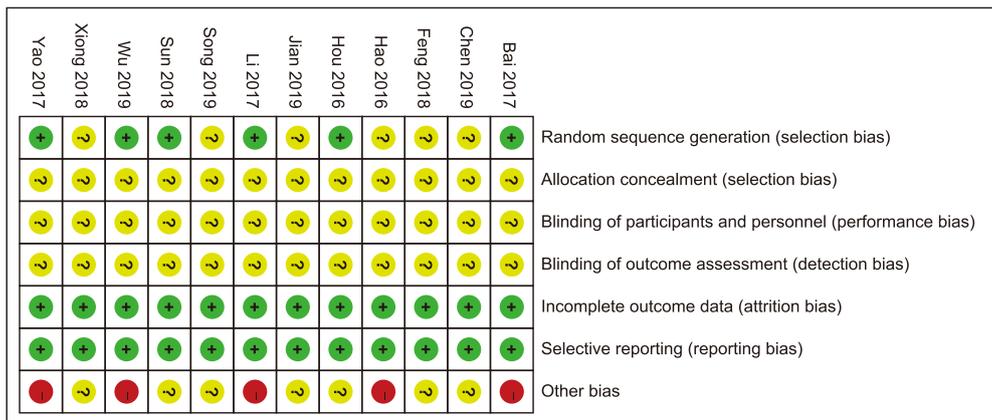


Figure 3 A diagram of the bias risk assessment in the included studies.

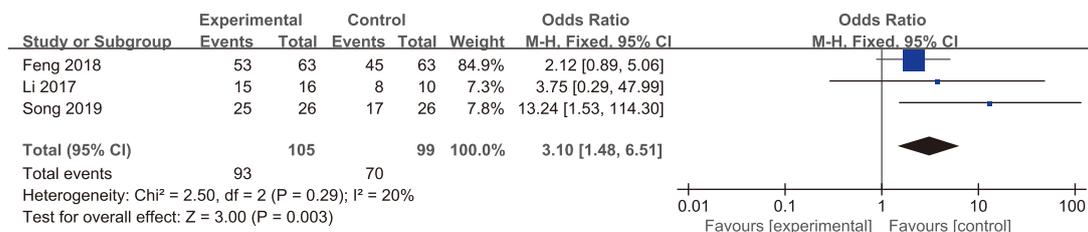


Figure 4 Forest plot of patient satisfaction with AD & PFO treatment for MTAGO. AD & PFO, arthroscopic debridement combined with proximal fibular osteotomy; MTAGO, medial tibial articular genu osteoarthritis; CI, confidence interval.

there was heterogeneity among the studies, so the REM was used for analysis, and results are shown in Figure 6. The combined effect is MD =5.37; 95% CI, (3.18 to 7.55); Z=4.82; P<0.00001. In the forest plot, the diamond is on the right side of VL, so the postoperative HSS scores of AD & PFO-treated MTAGO patients were higher relative to

control group.

VAS

Ten studies analyzed the VAS scores of patients. A total of 687 patients with MTAGO were included. There were

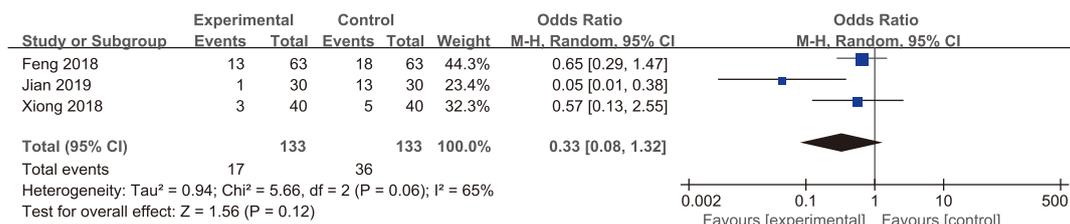


Figure 5 Forest plot of adverse reactions of AD & PFO treatment for MTAGO. AD & PFO, arthroscopic debridement combined with proximal fibular osteotomy; MTAGO, medial tibial articular genu osteoarthritis; CI, confidence interval.

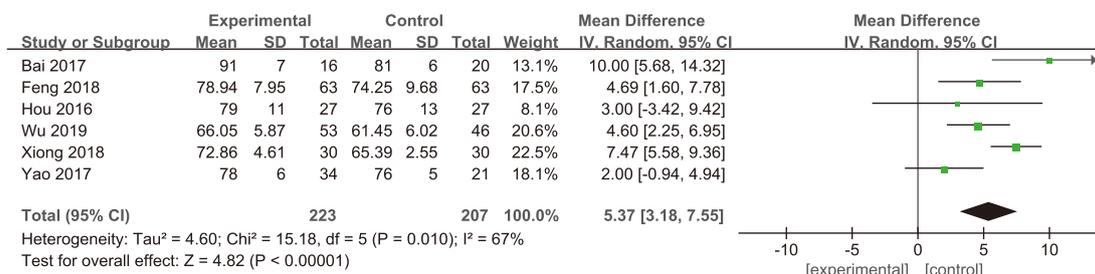


Figure 6 Forest plot of the HSS scores of AD & PFO-treated patients with MTAGO. HSS, hospital special surgery; AD & PFO, arthroscopic debridement combined with proximal fibular osteotomy; MTAGO, medial tibial articular genu osteoarthritis; CI, confidence interval.

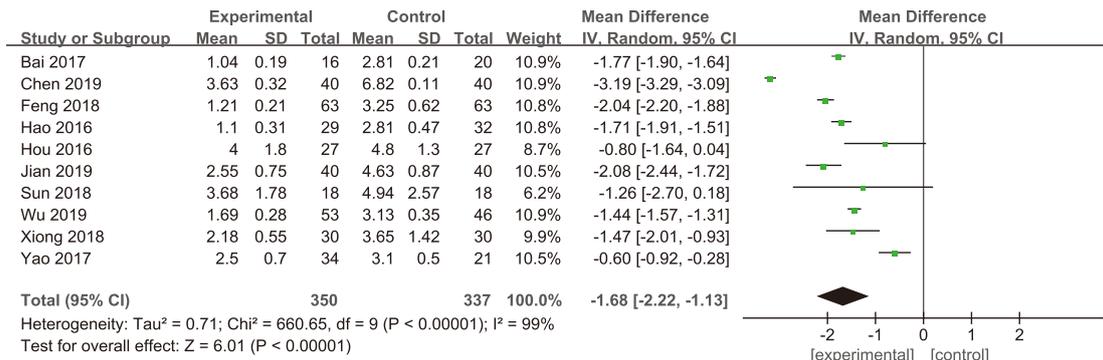


Figure 7 Forest plot of VAS scores of AD & PFO-treated patients with MTAGO. VAS, visual analogue scale; AD & PFO, arthroscopic debridement combined with proximal fibular osteotomy; MTAGO, medial tibial articular genu osteoarthritis; CI, confidence interval.

350 and 337 cases in experimental and control group, respectively. The heterogeneity test result (I²=99%, P<0.00001) indicated certain heterogeneity, so the REM was used, and the results are illustrated in *Figure 7*. The results demonstrated that the combined effect is MD =-1.68; 95% CI, (-2.22 to -1.13); Z=6.01; P<0.00001. The diamond is on the left of VL, which indicates that the postoperative VAS scores of AD & PFO for MTAGO patients were lower in contrast to control group.

Knee Society score (KSS)

Six studies analyzed the postoperative KSS scores of patients. A total of 455 MTAGO patients were included, with 236 experimental cases and 219 controls. The heterogeneity test (I²=75%, P=0.001) suggested that there is heterogeneity among the studies, so the REM was adopted, and the results are presented in *Figure 8*. The results revealed that the combined effect is MD =6.16; 95% CI,

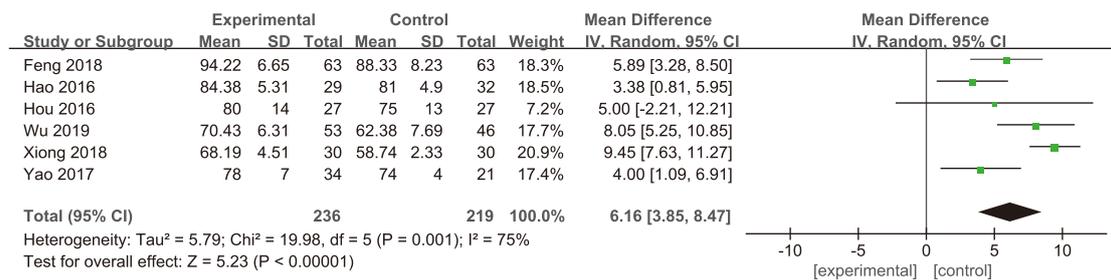


Figure 8 Forest plot of KSS scores of AD & PFO-treated patients with MTAGO. KSS, Knee Society score; AD & PFO, arthroscopic debridement combined with proximal fibular osteotomy; MTAGO, medial tibial articular genu osteoarthritis; CI, confidence interval.

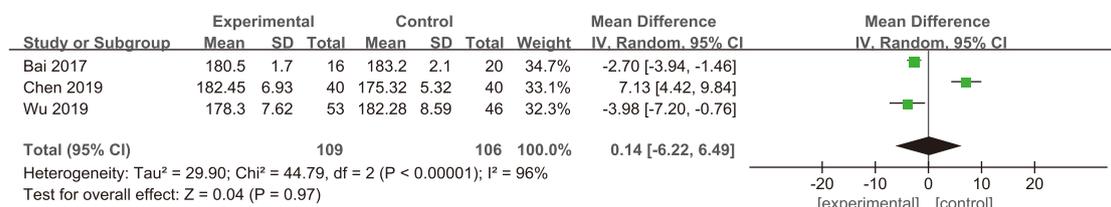


Figure 9 Forest plot of FT angle of AD & PFO-treated patients with MTAGO. FT, femoro-tibial; AD & PFO, arthroscopic debridement combined with proximal fibular osteotomy; MTAGO, medial tibial articular genu osteoarthritis; CI, confidence interval.

(3.85 to 8.47); $Z=5.23$; $P<0.00001$. In the forest plot, the diamond is on the right side of VL, so the postoperative KSS scores of AD & PFO-treated MTAGO patients were superior to control group.

Femoro-tibial (FT) angle

Three studies analyzed the postoperative FT angle of patients. A total of 215 MTAGO patients were included, including 109 and 106 in experimental and control group, respectively. The heterogeneity test results ($I^2=96\%$, $P<0.00001$) indicated certain heterogeneity among the studies, so the REM was used for analysis, and the analysis results are illustrated in *Figure 9*. The results demonstrated that the combined effect is MD =0.14; 95% CI, (-6.22 to 6.49); $Z=0.04$; $P=0.97$. The diamond is located on VL, which means that the postoperative FT angle difference of AD & PFO-treated MTAGO patients was not remarkable.

Publication bias analysis

AD & PFO treatment of MTAGO and postoperative analgesia indicators were analyzed for publication bias (*Figure 10*). The results showed that patients' satisfaction with clinical treatment, occurrence of adverse reactions,

HSS, KSS, and FT angles are basically distributed within the credible interval, and the bias was low. Some scattered points in the funnel plot of patients' VAS scores are scattered outside the credible interval, and the distribution is relatively scattered, indicating that there was a certain publication bias in the included studies.

Discussion

MTAGO is a chronic joint disease characterized by articular cartilage degeneration and bone hyperplasia (18-20). At present, the purpose of clinical treatment is primarily to delay the course of the disease and relieve symptoms. Treatment methods, such as oral drugs, physical therapy, and intra-articular injection have their own advantages and disadvantages, and the final treatment effect cannot achieve favorable satisfaction. Generally, the patient's stress response remains high after treatment, which has a great impact on daily life, and postoperative pain is still obvious (21). With the development of medical technology, the clinical combination of AD and PFO treatments has substantially improved the treatment effect and safety for patients. It effectively controls the postoperative pain response and is considered to be a safe and effective surgical method for clinical treatment (22-24).

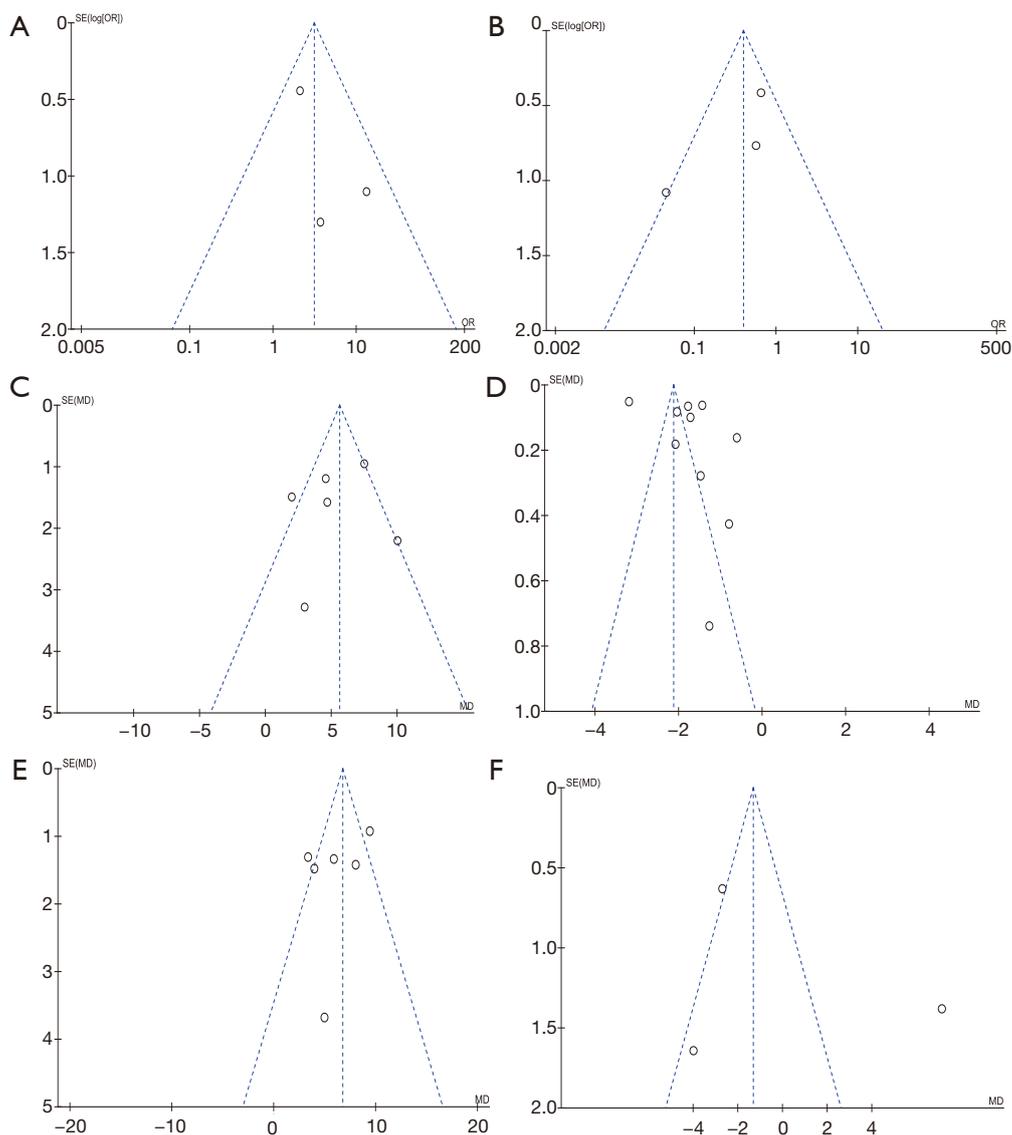


Figure 10 Funnel plots of various evaluation indicators. (A) Satisfaction of clinical treatment; (B) occurrence of adverse reactions; (C) HSS evaluation results; (D) VAS evaluation results; (E) KSS evaluation results; (F) FT angle evaluation results. HSS, hospital special surgery; VAS, visual analogue scale; KSS, Knee Society score; FT, femoro-tibial; MD, mean difference.

To systematically evaluate the clinical efficacy of AD & PFO for MTAGO, 12 studies were included, and meta-analysis was performed (25). It was revealed that patient satisfaction after treatment in experimental group was higher than controls, and the number of adverse reactions was lower. AD combined with PFO for the treatment of patients with osteoarthritis in the medial compartment of the knee joint can not only improve the condition of the patients, but also reduce the pain of the patients, and has good clinical effects. The effect of AD & PFO is definite, which can improve the

knee function of patients, reduce the level of inflammatory factors, and lower the incidence of complications.

Arthroscopy is a minimally invasive technique, which is widely used in the treatment of knee arthritis. It has a considerable therapeutic effect on young people and patients with mild disease. The adoption effect of arthroscopy is also described in the evidence-based guidelines of the Association of Foreign Orthopaedic Surgeons (26). However, in the follow-up treatment, it was found that arthroscopy could only be used in palliative surgery and

cannot cure arthritis (27). PFO can improve the lower limb force line of the knee joint, and promotes the movement of the lower limb force line of the stress center of the condyle joint in the center of the femoral head by changing the pressure of the inner and outer compartments of the knee joint to achieve a better treatment effect (28,29). Combining these two therapies can solve the problem of force line deviation, mitigate the damage to surrounding tissues, and reduce the patient's stress and inflammatory responses. In addition, compared with traditional arthroscopic de-section, AD & PFO for osteoarthritis of the knee has a higher safety, and the postoperative effect of patients has obvious advantages. Our results showed that the patients' HSS, KSS, and VAS scores decreased after surgery, highlighting the considerable advantages of AD & PFO treatment.

Conclusions

Our meta-analysis of AD & PFO treatment of MTAGO included 12 studies, involving 765 MTAGO patients. The results showed that AD & PFO can substantially reduce the incidence of postoperative adverse reactions, as well as patients' VAS, HSS, KSS scores relative to the use of AD alone. It also increases the clinical satisfaction of patients, which reflects the considerable superiority of AD & PFO treatment.

However, there were certain limitations such as large publication bias of some studies. In addition, due to differences in the research directions, some analysis indicators contained a small number of samples, and the results are not accurate enough. Therefore, in future work, it is still necessary to select more high-quality AD & PFO studies with large sample sizes to verify the effect of MTAGO surgery.

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Footnote

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <https://dx.doi.org/10.21037/apm-21-1381>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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