Original Article

A systematic review and meta-analysis of the efficacy and complication rates of augmentation rhinoplasty with autologous cartilage and silicone prosthesis

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Background: Rhinoplasty is one of the most common operations in plastic and aesthetic surgery. Both solid silicone material and autologous cartilage (AC) tissue have their individual advantages and disadvantages. In this meta-analysis, the efficacy, complication rate of rhinoplasty with AC and silicone material were comprehensively analyzed and compared.

Methods: The databases Medline, Embase, PubMed, China National Knowledge Infrastructure (CNKI) and Wanfang were searched by rapid matching of keywords to obtain randomized controlled trials related to AC rhinoplasty or silicone filled rhinoplasty, which were analyzed using the software Stata 16.0 after screening and quality assessment.

Results: A total of 1,233 patients undergoing rhinoplasty from 7 articles were included in the study. Meta-analysis showed that rhinoplasty with AC would gain more satisfaction [risk ratio (RR) =1.11; 95% confidence interval (CI): (1.02, 1.21); Z=2.413; P=0.016]. would reduce the complication rate [RR =0.34; 95% CI: (0.22, 0.52); Z=−5.010; P<0.0001], and resulting in less secondary surgery rate [RR =0.34; 95% CI: (0.18, 0.64); Z=−3.363; P=0.001] comparing to silicone prosthesis (SP) material.

Discussion: In rhinoplasty, the use of AC material gains more satisfaction, has less total complication rate, and results in less secondary surgery rate than silicone material. But based on the heterogeneity and publication bias in the studies, this topic still needs to be further explored by including more high-quality studies.

Keywords: Autologous cartilage (AC); silicone prosthesis (SP); rhinoplasty; complications; meta-analysis

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Introduction

Background

Rhinoplasty is a plastic surgery in which various implant materials could be used to sculpt or elevate the nose to beautify its shape, and it is one of the most common procedures in plastic and aesthetic surgery (1,2). The traditional rhinoplasty is achieved by means of artificial prosthesis, the materials of which include silicone, expanded polytetrafluoroethylene (ePTFE), and hydroxyapatite (3). A solid silicone nasal prosthesis is a solid polymer formed by high temperature vulcanization, with certain elasticity

and hardness. There are "L" shaped and willow leaf solid silicone prostheses, the operation is simple and easy, with relatively low price. Furthermore, a personalized prosthesis can be created based on the patient's nasal sculpture, and the postoperative shape is natural and realistic (4). However, there are complications such as deformation and infection in the site of solid silicone placement, a study by Jung *et al.* (5) has counted that the complications of rhinoplasty with silicone prosthesis (SP) alone are as high as 17%. Autologous bone tissue is another common material used in rhinoplasty, which has the advantage that it can easily survive after transplantation without rejection; however, there are also problems such as inconvenient sampling, long-term bone resorption, and shape changes (6).

Purpose

In a previous meta-analysis (7), 53 case series were included to analyze rhinoplasty with autologous costal cartilage and artificial prosthesis placement (including silicone material and resin material), but the study focused more on the comparison of plastic surgery effect, rather than that of complication rate, and it included more combined plastic surgery, rather than the direct comparison of autologous cartilage (AC) and silicone material rhinoplasty. In order to compare the efficacy and complicate rates of the two surgeries, 7 randomized controlled trials were included in our meta-analysis for further discovery. We present the following article in accordance with the PRISMA reporting checklist (available at https://apm.amegroups.com/article/view/10.21037/apm-22-111/rc).

Methods

Criteria for inclusion for meta-analysis

Literature type

All the studies were randomized controlled trials, but those with a total number of cases less than 20 were excluded. We also excluded case series studies, cohort studies, and case-control studies. Other summaries of experience, reviews or single-arm studies were also excluded.

Participants

Participants were adults >18 years of age, regardless of gender, who underwent rhinoplasty, regardless of whether it was the first operation or reoperation.

Description of intervention

The surgery was augmentation rhinoplasty (AR) with AC or silicone filling. AC was obtained from the participant's own organs (costal cartilage, ear cartilage), and AR with SP was performed with and L-shaped SP according to the popular trend. Since the study type was reported by randomized controlled trial, there should be two groups in the study, which were experimental group and control group. We excluded studies in which a combined approach was adopted for surgery, such as those in which silicone filling was adopted in combination with AC for rhinoplasty. We only included studies in which AC AR was performed, and allogeneic cartilage AR was excluded.

Outcome indicators

In this study, we performed statistical analysis on the effect of surgery and satisfaction indicators, also on the postoperative complications, including: (I) satisfaction rates; (II) total complication rates; (III) secondary surgery rates. We did not perform statistical analysis for postoperative pain, swelling, and nasal non-ventilation, because postoperative pain, swelling, and nasal non-ventilation are foreseeable side-effects of surgery.

Search strategy

We searched the databases of Medline, Embase, PubMed, China National Knowledge Infrastructure (CNKI), and Wanfang. We also searched Google Scholar for relevant literatures with the keywords of "autologous cartilage" or "rib cartilage" or "costal cartilage" or "auricular cartilage" or "Silicone" or "Rhinoplasty" or "nasal plastic" or "nasal augmentation" or "nasal augmentation". We only included articles published in English and Chinese, studies in other languages would be excluded. We tried to contact the original author for the full text by email, telephone.

Literature screening and data extraction

The included studies independently screened by two researchers who excluded duplicate articles and obviously unqualified articles by reading the titles and abstracts. If there was a conflict of opinion between the two researchers, a 3rd researcher was consulted to arbitrate.

The two researchers independently extracted the data, read each study using a pre-prepared form, and obtained the following data from the text: author, journal name,

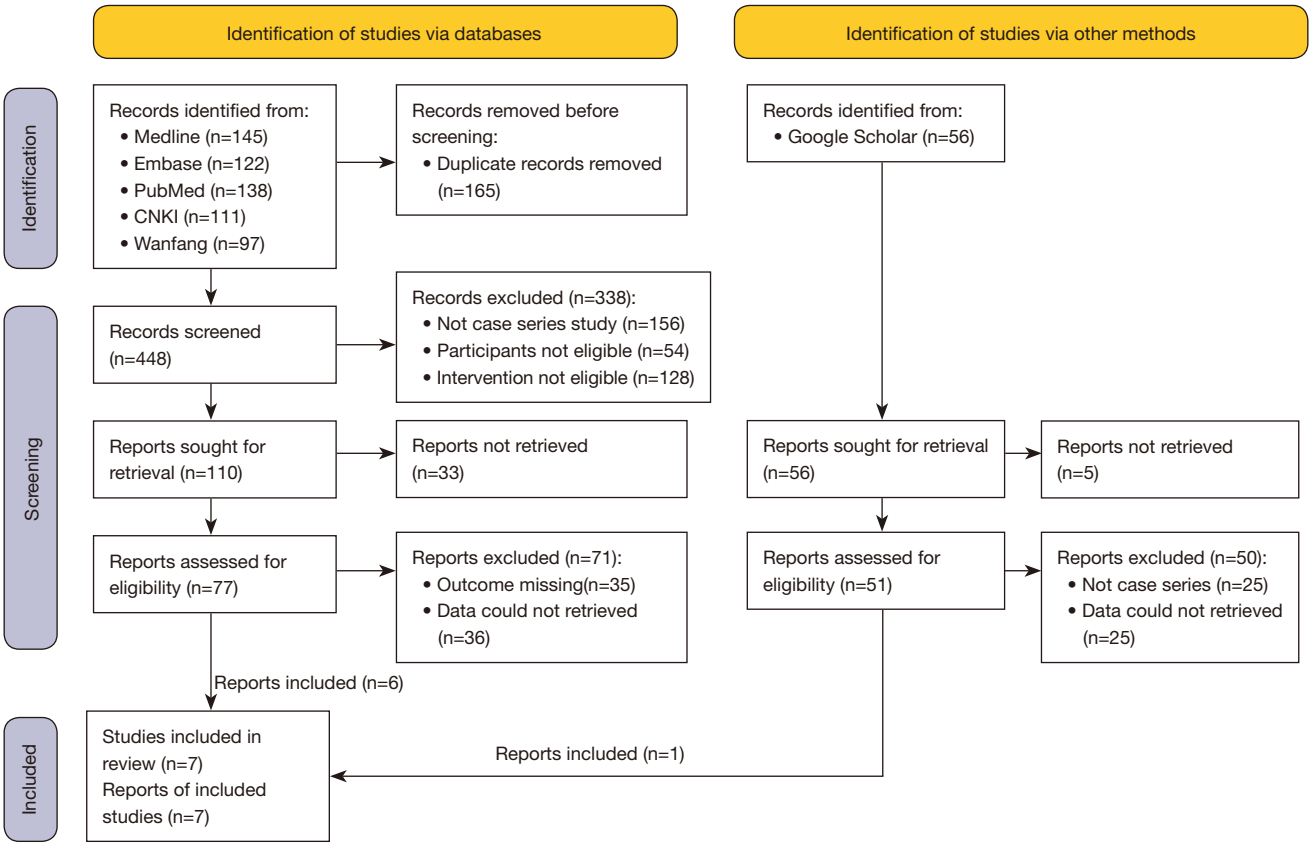

Figure 1 Literature screening flow chart. CNKI, China National Knowledge Infrastructure.

publication time, number of participants, age, gender composition, type of implant, operation time, follow-up time, and type and number of complications.

If there was no data in the literature for processing, the original author of the article was contacted for obtainment of the data. If the data could not be obtained, the literature was excluded.

Literature quality evaluation

As the studies we included were all RCT reports, we used the Jadad scale (8) for the quality evaluation, which has a score range of 0–5, assess the bias from the aspect of randomizing and allocation, blinding, loss of follow-up. A score ≥3 indicated better quality.

Statistical analysis

We used the software Stata 16.0 (Stata Corp. LLC, College Station, TX, USA) as the analytical tool for this study. The Mantel-Haenszel model was used to analyze discrete data. Effect sizes were expressed as risk ratios (RRs), and a forest plot was used to display results.

We used Cochran Q test and I^2 to assess the heterogeneity of the study, and I^2>50% or P<0.1 indicated statistically significant heterogeneity. Heterogeneity was investigated by using subgroup analysis, and if sources of heterogeneity were not obtained, only general descriptive analysis was performed.

Funnel plots were used to represent publication bias.

Results

Literature search results

The results of the literature search and the screening process are shown in *Figure 1*.

Basic characteristics and quality assessment of the included articles

A total of 7 articles (9-15) with a total of 1,233 patients

Table 1 Basic characteristics of included literatures, participant characteristics, and quality evaluation scores

Author	Type of material	Number of participants	Gender (M:F)	E/C group	Outcomes	Jadad score
Gao YZ *et al.*, 2021 (9)	Costal cartilage	56	3:53	28/28	(I), (II), (IV)	3
Ren SX *et al.*, 2020 (10)	Auricular cartilage	169	70:99	85/84	(I), (II), (III), (V), (VI)	3
Song LC *et al.*, 2020 (11)	Costal cartilage	300	122:178	150/150	(II), (IV)	4
Xu YL *et al.*, 2020 (12)	Costal cartilage	126	15:101	66/60	(I), (II), (III), (IV)	3
Yan XR *et al.*, 2017 (13)	Auricular cartilage	156	24:132	83/73	(I), (II), (IV)	3
Xu HQ *et al.*, 2016 (14)	Auricular cartilage	332	28:304	176/156	(I), (II), (III)	3
Han JD *et al.*, 2019 (15)	Auricular cartilage	94	14:80	47/47	(I), (IV)	3

Outcomes: (I) satisfaction rate; (II) complications rate; (III) the incidence of secondary surgery; (IV) nasal aesthetic score; (V) operation time; (VI) healing time. E/C, experimental/control.

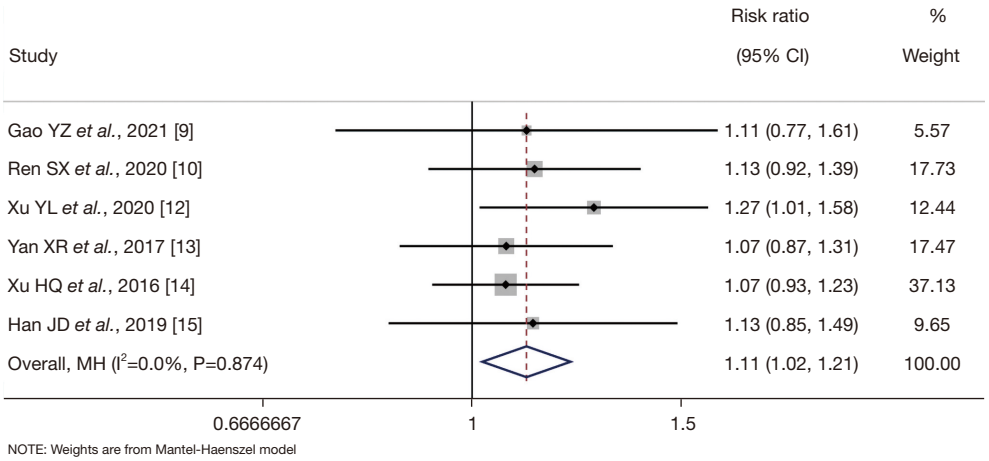

Figure 2 Overall satisfaction rate of rhinoplasty with AC material comparing to SP material (9,10,12-15). CI, confidence interval; AC, autologous cartilage; SP, silicone prosthesis.

were included in the study, published between 2016 and 2021, of which 3 articles (9,11,12) involved AR with AC, while 4 articles (10,13-15) involved AR with SP. Specific information is shown in *Table 1*.

Meta-analysis results

Overall satisfaction rate of rhinoplasty with AC comparing to SP material

A total of 6 articles (9,10,12-15) reported the satisfaction rate of AR with AC comparing to SP material. There was no statistical heterogeneity among the 6 articles (I^2=0%; P=0.874). A fixed effects model analysis yielded a pooled RR of 1.11, 95% confidence interval (CI): (1.02, 1.21), suggesting that rhinoplasty with AC would gain more satisfaction than SP material (Z=2.413; P=0.016), as shown in *Figure 2*.

Overall complication rate of rhinoplasty filled with AC comparing to SP material

A total of 6 articles (9-14) reported the overall complication rate of rhinoplasty with AC comparing to SP material. There was no statistical heterogeneity among the 6 articles (I^2=27.3%; P=0.230). A fixed effects model analysis yielded a pooled RR of 0.34, 95% CI: (0.22, 0.52), suggesting that rhinoplasty with AC would reduce the complication rate comparing to SP material (Z=–5.010; P<0.0001). We introduced subgroup analysis according to the cartilage

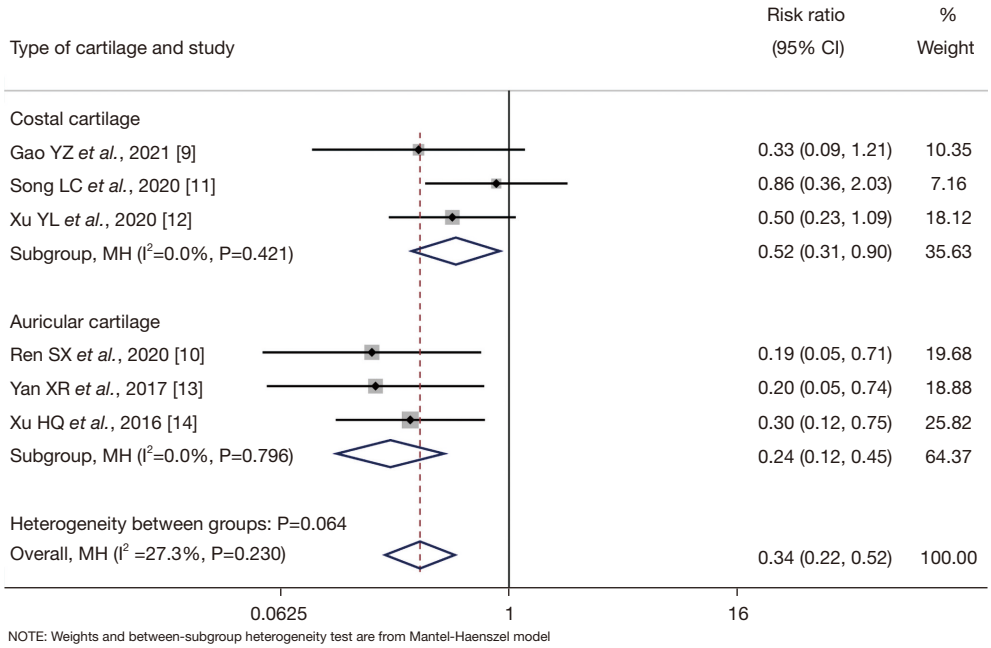

Figure 3 Overall complication rate of rhinoplasty with AC material comparing to SP material (9-14). CI, confidence interval; AC, autologous cartilage; SP, silicone prosthesis.

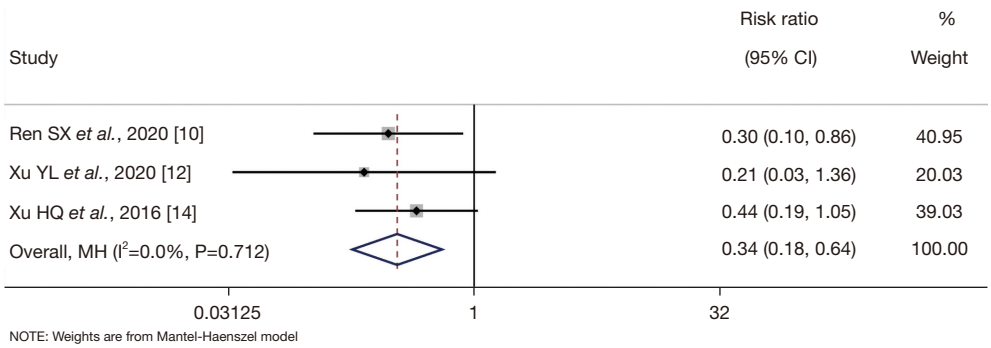

Figure 4 Secondary surgery rate of rhinoplasty with AC material comparing to SP material (10,12,14). CI, confidence interval; AC, autologous cartilage; SP, silicone prosthesis.

type, as shown in *Figure 3*.

Secondary surgery rate of rhinoplasty with AC comparing to SP material

A total of 3 articles (10,12,14) reported the secondary surgery rate of AR with AC comparing to SP material. There was no statistical heterogeneity among the 3 articles (I^2=0%; P=0.712). A fixed effects model analysis yielded a pooled RR of 0.34, 95% CI: (0.18, 0.64), suggesting that rhinoplasty with AC would resulting in less secondary surgery rate than SP material (Z=−3.363; P=0.001), as shown in *Figure 4*.

Heterogeneity investigation and subgroup analysis

In the analysis of the overall complications of rhinoplasty with AC comparing to SP material, the study was further divided into two subgroups according to the type of surgery: costal cartilage group [RR =0.52; 95% CI: (0.31, 0.90)] and auricular cartilage group [RR =0.24; 95% CI: (0.12, 0.45)], but still there was no statistically heterogeneity within the subgroups (*Figure 3*).

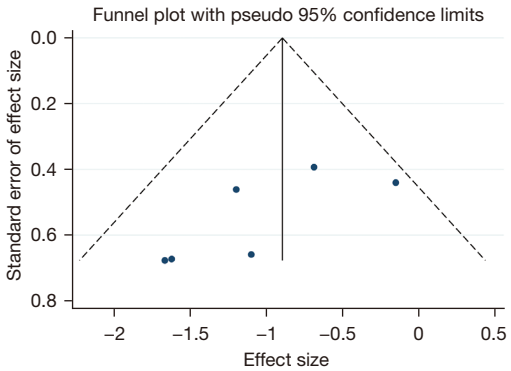

Figure 5 Funnel plot analysis for overall complication rate indicator.

Publication bias analysis

In the analysis of the overall complications rate, a funnel plot was drawn, and the left and right distributions of the 6 included articles were asymmetric, suggesting that there might be small publication bias, as shown in *Figure 5*.

Discussion

With the increasing demand for beauty, rhinoplasty has been widely used. If the prosthesis carving during rhinoplasty does not conform to the aesthetic principles, the inferior rhinoplasty materials used or the improper operation will cause complications such as the exposure of nasal prosthesis, the rupture of nasal skin, the change of nasal skin color and poor nasal shape, resulting in the failure of the operation (16,17). At present, the main methods and materials used in rhinoplasty include AC, SP and ePTFE (18).

In this meta-analysis, 7 RCT reports with a total of 1,233 patients treated with AC or SP material for rhinoplasty were included, the results showed that rhinoplasty with AC gained more satisfaction than SP material, the complications of AC material were less than those of SP material, and patients undergoing rhinoplasty with AC would end up with less secondary surgeries, which was similar to the report by Varadharajan *et al.* (19). The reason for the results may be that autologous costal cartilage and ear cartilage are natural autologous tissue grafts, with high tissue fusion characteristics, stable and not easy to move after transplantation, and no rejection reaction occurs after AC transplantation, with high survival rate (20). The tissue hardness of SP is higher than that of normal human nasal tissue. After surgery, the skin tension of the nasal tip increases, persistent tension may make the skin thinner, and even present the risk of prosthesis penetrating the skin and protruding, and it is easy to have prosthesis extrusion displacement and deformation, which affect the aesthetics (21).

Infection could be the most common complication. The occurrence of infection may be more related to intraoperative operation, disinfection, operation time, postoperative care, and other factors, but not significantly related to the placement of prosthesis (22). The results of animal experiments (23) showed that there was no significant difference in the immune response between silicone and its own cartilage materials for surgical recipients, which may also be one of the reasons for the close infection rate. In rhinoplasty, no matter which kind of material is inserted, the operation should be performed on the basis of familiarity with the anatomical structure. The surgeon should pay close attention to aseptic protocols and meticulously avoid the occurrence of large hematoma after operation. Once the signs of infection are confirmed, active anti-infection and drainage treatment should be performed.

Although AC materials are easy to reside after transplantation and are associated with less rejection, their plasticity is more difficult than other non-biological materials, and the acquisition of materials may cause complications at the acquisition site. It has been reported in the literature (11) that the sampling of costal cartilage may cause complications such as chest wound deterioration, pneumothorax, and scar at the incision site. In addition, AC material can be prone to bone resorption in the long term, resulting in the disadvantage of shape change (24). A study by Won *et al.* (25) believed that AC transplantation is more suitable for the correction of complex nasal deformity or severe saddle nose. It has also been shown in the study (26) that the combination of AC and silicone material applied in rhinoplasty achieves better plastic results.

In order to investigate the source of heterogeneity, the study was divided into groups according to the source of AC material (costal cartilage and ear cartilage). The RR of the two cartilage types were 0.52 *vs.* 0.24, respectively. That didn't necessarily mean a more complicate rate for costal cartilage than auricular cartilage, because we didn't compare the rate for both of them directly. The study (14) concluded that nasal septum cartilage and costal cartilage are usually the first choice of donor material surgery for nasal surgery because they are more convenient to obtain. However, auricular cartilage graft can be used as a safe, effective, and universal method when needed.

In this study, the quality of 7 included RCT literatures was evaluated using the Jadad scale. The scores showed that the quality of articles was not high. The publication bias analysis showed uneven distribution on both sides, suggesting possible small publication bias. Regarding the source of publication bias, it may have been related to the fact that more attention had been paid to the complications at the nasal end, while ignoring the complications could also happened at the sites where the cartilage was fetched.

Conclusions

In conclusion, in rhinoplasty, the use of AC material gains more satisfaction, has less total complication rate, and results in less secondary surgery rate than silicone material. Based on the heterogeneity and publication bias in the studies, this topic still needs to be further explored by including more high-quality randomized controlled trials reports in clinical practice.

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Footnote

Reporting Checklist: The authors have completed the PRISMA reporting checklist. Available at https://apm.amegroups.com/article/view/10.21037/apm-22-111/rc

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://apm.amegroups.com/article/view/10.21037/apm-22-111/coif). 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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