

# Multiple-Staged Versus Single-Stage Surgical Excision for the Reconstruction of Congenital Melanocytic Nevi: A Meta-Analysis of Efficacy and Safety

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**AIM:** Systematic evidence comparing multiple-staged and single-stage excision strategies for the excision and reconstruction of congenital melanocytic nevi (CMN) remains limited. Because direct comparative evidence remains scarce, we pooled available studies to determine whether multiple-staged excision differs from single-stage excision in postoperative complications, recurrence, scar outcomes, and satisfaction after CMN reconstruction.

**METHODS:** To retrieve comparative evidence on surgical strategies for CMN, a systematic literature search was conducted across PubMed, Embase, the Cochrane Library, Web of Science, CNKI, VIP, and Wanfang databases. The retrieval covered all records available from the establishment of each database through 31 October 2025. The prespecified outcomes were major wound complications, lesion recurrence, cosmetic satisfaction, patient satisfaction, postoperative scar length, and scar width. After eligible studies were selected, relevant data were extracted, methodological quality was assessed, and quantitative synthesis was carried out using Review Manager (version 5.3, Cochrane Collaboration).

**RESULTS:** Seven retrospective cohort studies or clinical controlled studies were included, involving a total of 578 patients. Compared with single-stage excision, multiple-staged excision was associated with a significantly lower incidence of major wound complications (odds ratio (OR) = 0.54, 95% CI 0.30–0.97,  $p = 0.04$ ), lower recurrence rate (OR = 0.45, 95% CI 0.22–0.93,  $p = 0.03$ ), shorter scar length (MD = –0.32 mm, 95% CI –0.52 to –0.12,  $p = 0.002$ ), and narrower scar width (MD = –0.04 mm, 95% CI –0.09 to –0.01,  $p = 0.04$ ); the upper limit of the 95% CI was rounded to 0.00 by RevMan, while the unrounded value remained below zero. No significant differences were observed between the two groups in cosmetic satisfaction (OR = 1.07, 95% CI 0.64–1.79,  $p = 0.80$ ) or patient satisfaction (OR = 1.29, 95% CI 0.51–3.29,  $p = 0.59$ ).

**CONCLUSIONS:** This meta-analysis demonstrates that multiple-staged excision significantly reduces the incidence of major wound complications, recurrence rate, and scar dimensions compared with single-stage excision, while showing no significant difference in satisfaction outcomes. These findings suggest that multiple-staged excision may offer advantages in safety and efficacy in the excision and reconstruction of CMN and could be considered a valuable surgical strategy in appropriate clinical settings.

**Keywords:** congenital melanocytic nevi; multiple-staged excision; single-stage excision; meta-analysis; complications

## Introduction

Congenital melanocytic nevi (CMN), particularly large or giant lesions, are benign cutaneous lesions commonly encountered in clinical practice [1,2]. Although generally benign, their size, location, and appearance may substantially affect aesthetic outcomes, functional integrity, and psychological well-being, often prompting patients to seek surgical treatment. Surgical excision with reconstruction is widely regarded as the primary treatment approach, with the dual goals of complete lesion removal and optimization of recon-

structive outcomes while minimizing postoperative complications. In clinical practice, surgeons typically choose between single-stage excision with immediate closure and multiple-staged excision with reconstruction according to lesion size, anatomical location, and tissue characteristics. Single-stage excision offers advantages such as procedural simplicity, shorter treatment duration, and greater patient convenience. However, for medium-to-large lesions, excessive wound tension after single-stage closure may increase the risk of hypertrophic scarring, wound dehiscence, infection, and postoperative deformity [3]. In contrast, multiple-staged excision is thought to reduce tension-related complications and improve aesthetic outcomes, although it may require a longer treatment course and greater healthcare utilization [3].

With increasing emphasis on both aesthetic and functional outcomes, the evaluation of surgical strategies for CMN has expanded beyond lesion removal alone to include compli-

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cation rates, recurrence, cosmetic satisfaction, and patient-reported outcomes. Earlier evidence syntheses have mainly summarized postoperative outcomes after CMN surgery rather than directly comparing different excisional strategies. In the study by Gout et al. [4], data from 22 studies involving 643 patients were pooled, showing a major wound-complication rate of 9.8% (95% CI, 4.1–21.6%) and a scar-related complication rate of 1.2% (95% CI, 0.2–7.1%); overall, cosmetic results were reported as favorable in most included cases. Importantly, their analysis demonstrated that postoperative outcomes were strongly influenced by lesion size and anatomical location, with substantially higher complication rates observed in large or giant CMN and deformity rates reaching 54.2% in lesions involving the eyelid. However, that study did not directly compare single-stage and multiple-staged excision strategies and therefore could only indirectly suggest that multiple staged excision or tissue expansion might reduce tension-related risks in extensive lesions.

In addition, several observational studies have directly compared different surgical strategies for CMN. A multifactorial analysis of giant CMN reported that staged surgical approaches were associated with a lower overall complication rate than single-stage tissue expansion [5]. Long-term clinical experience has also suggested that multiple staged excision can achieve stable linear scars in giant CMN while avoiding complications related to skin grafting or tissue expanders [6]. Nevertheless, the currently available evidence is derived primarily from retrospective cohort studies and small case series, with considerable heterogeneity in surgical techniques, lesion characteristics, and outcome definitions. These limitations reduce the comparability of existing studies and preclude definitive conclusions regarding the optimal surgical strategy for CMN [7,8]. Overall, robust quantitative evidence directly comparing multiple-staged and single-stage excision for the reconstruction of CMN remains limited. To address this gap, we conducted a systematic review and meta-analysis to comprehensively compare the safety and effectiveness of multiple-staged versus single-stage excision in patients with CMN, with the aim of providing evidence-based guidance for individualized surgical decision-making.

## Methods

### *Eligibility Criteria*

Study eligibility was determined using a predefined Population, Intervention, Comparison, Outcomes, and Study design (PICOS)-based approach, which specified the target population, intervention, comparator, outcomes, and study designs before literature screening.

**Population:** Eligible participants were individuals diagnosed with congenital melanocytic nevi who underwent surgical removal and subsequent reconstruction. Studies involving giant CMN, large or giant CMN, and pediatric

facial congenital pigmented nevi were also considered eligible when the lesions were congenital and required operative management.

**Intervention:** Multiple-staged excision was defined as a surgical excision performed in two or more stages. Owing to the limited number of available comparative studies, various staged techniques, including staged excision, tissue expansion-assisted excision, and combined flap methods, were included under this broad definition.

**Comparison:** Single-stage excision was defined as complete lesion excision followed by immediate closure or simple reconstruction in a single procedure.

**Outcomes:** Primary outcomes included major wound complication rate and recurrence rate; secondary outcomes included cosmetic satisfaction, patient satisfaction, scar width, and scar length. Major wound complications were variably defined across studies and typically included wound dehiscence, infection requiring surgical intervention, flap or graft necrosis, or other complications requiring additional surgical procedures. Recurrence was generally defined as the reappearance of pigmented lesions within the surgical site or at the surgical margins during follow-up. Cosmetic satisfaction and patient satisfaction were assessed using subjective evaluation scales, such as visual analogue scales, Likert scales, or surgeon-/patient-reported satisfactory outcomes. However, the specific assessment instruments and cut-off values differed among studies. Therefore, outcomes were extracted as originally reported in each study without further standardization. Due to this heterogeneity and the limited number of studies, further subgroup analyses were not feasible. However, leave-one-out sensitivity analyses were performed to assess the robustness of the pooled estimates. Heterogeneity in outcome definitions and assessment methods among the included studies may have influenced the comparability of pooled results.

**Study design:** Retrospective comparative cohort studies and randomized controlled trials (RCTs) reporting surgical outcomes for CMN were eligible for inclusion.

### Definition of Congenital Melanocytic Nevus

In this systematic review, the term “congenital melanocytic nevus” was used to encompass congenital pigmented lesions composed of nevomelanocytic cells and present at birth. We acknowledge that some older or regionally published studies used broader or synonymous terms such as “congenital pigmented nevus” or “congenital facial pigmented nevus”. Studies describing lesions as present at birth and requiring surgical excision were considered eligible regardless of the terminology used in the original publication, provided that all other inclusion criteria were met. This approach allowed comprehensive retrieval of relevant evidence while maintaining a focus on the congenital nature of the lesions.

**Exclusion criteria:** We excluded non-comparative studies, reviews, letters, and studies without extractable outcome data.

### Literature Search Strategy

A systematic search was conducted in the following databases: PubMed, Embase, Cochrane Library, Web of Science, China National Knowledge Infrastructure (CNKI), VIP Chinese Science and Technology Journal Database, and Wanfang Database. The search terms included “congenital melanocytic nevi”, “pigmented nevus”, “giant congenital melanocytic nevus”, “staged excision”, “serial excision”, “multiple-stage excision”, “single-stage excision”, “one-stage excision”, “randomized controlled trial”, and “retrospective study”. Medical Subject Headings (MeSH) terms were combined with free-text terms to ensure comprehensive retrieval.

The reproducible search strategy for the primary database (PubMed) was as follows: (“Congenital Melanocytic Nevi” OR “Pigmented Nevus” OR “Giant Congenital Melanocytic Nevus” OR “Staged Excision” OR “Serial Excision” OR “Multiple-Stage Excision” OR “Single-Stage Excision” OR “One-Stage Excision”) AND (“Randomized Controlled Trial” OR “Retrospective Study”). The complete search strategies for all other databases are provided in **Supplementary Material 2**.

The search strategy was supplemented by manual screening of reference lists from relevant reviews, related articles, and conference abstracts to identify additional eligible studies. The search period covered database inception to 31 October 2025.

### Study Selection and Data Extraction

Two reviewers independently assessed the retrieved records and collected information from the eligible studies. Any discrepancies during study selection or data collection were resolved by consensus, and unresolved issues were adjudicated by a third reviewer. Before title and abstract screening, automated screening functions in the literature management software (EndNote X9, Clarivate Analytics) were used to assist in identifying obviously irrelevant records. All records flagged by the automated tool were subsequently verified manually by the reviewers before exclusion.

For each included study, we recorded basic publication information, including the first author, year of publication, and country or region, as well as the total sample size and the number of patients treated with multiple-staged or single-stage excision. Surgical variables included the specific staged technique, number of operative stages, and reconstruction method used in the single-stage group. Lesion-related information, such as lesion type, size category, and anatomical site, was also extracted. The prespecified outcomes included major wound complications, recurrence, cosmetic satisfaction, patient satisfaction, scar width, and scar length.

### Standardization of Scar Dimension Measurements

To ensure the comparability of scar length and width data across studies, the following standardization steps were implemented:

**Unit Harmonization:** All extracted measurements were converted to a uniform unit of millimeters (mm). All extracted scar measurements were verified for original units, unit conversion, and data entry accuracy before statistical pooling.

**Assessment Time Point:** The primary analysis used measurements taken at 6 months postoperatively. For studies reporting multiple time points, data from the time point closest to this interval were extracted.

**Measurement Method:** The included studies primarily assessed scar dimensions using direct measurement with a ruler.

**Statistical Model:** Meta-analyses were performed using fixed-effects models for major wound complications, recurrence rate, cosmetic satisfaction, scar length, and scar width, and a random-effects model for patient satisfaction, based on heterogeneity.

### Quality Assessment

Because the included studies were mainly retrospective comparative studies, their methodological quality was evaluated using the Newcastle–Ottawa Scale (NOS). The assessment was performed independently by two reviewers, and differences in scoring were resolved through discussion or, when necessary, by consulting a third reviewer.

The NOS assessed non-randomized studies from three perspectives: selection of study cohorts, comparability between groups, and ascertainment of outcomes. In the selection domain, we considered the representativeness of the exposed cohort, the source of the comparison cohort, the method used to determine exposure, and whether the outcome of interest was absent at baseline. The comparability domain evaluated whether important confounders, such as age, sex, lesion size, lesion location, and follow-up duration, were controlled by study design or statistical adjustment. The outcome domain focused on the objectivity of outcome assessment, adequacy of follow-up duration, and completeness of follow-up.

The total NOS score ranged from 0 to 9. Studies scoring 7 or higher were classified as high quality, those scoring 5–6 as moderate quality, and those scoring below 5 as low quality.

### Statistical Analysis

All meta-analyses were conducted using Review Manager (version 5.3, Cochrane Collaboration). Dichotomous outcomes were pooled as odds ratios (ORs) with 95% confidence intervals (CIs), whereas continuous outcomes were analyzed using mean differences (MDs) with 95% CIs.

Statistical heterogeneity was evaluated using the chi-square test and  $I^2$  statistic. A fixed-effects model was used when

**Table 1. Basic characteristics of the included studies.**

| Author (years)             | Country | Multiple-staged group (n) | Single-stage group (n) | Disease type | Key outcomes |
|----------------------------|---------|---------------------------|------------------------|--------------|--------------|
| Rasmussen et al., 2015 [9] | Denmark | 8                         | 17                     | CMN          | ①②③④         |
| Kim et al., 2020 [5]       | Korea   | 68                        | 54                     | CMN          | ①②③④         |
| Cheng et al., 2022 [10]    | China   | 41                        | 56                     | CMN          | ①④           |
| Zhou et al., 2021 [11]     | China   | 35                        | 43                     | CMN          | ③⑥           |
| Tan et al., 2020 [12]      | China   | 22                        | 17                     | CMN          | ③⑤⑥          |
| Cho et al., 2019 [13]      | Korea   | 62                        | 57                     | CMN          | ①②③④         |
| Li et al., 2022 [14]       | China   | 48                        | 50                     | CMN          | ③⑥           |

Notes: ①incidence of major wound complications; ②recurrence rate; ③cosmetic satisfaction; ④patient satisfaction; ⑤ scar width; ⑥ scar length. CMN, congenital melanocytic nevi.

Multiple-staged excision encompasses staged excision, tissue expansion-assisted excision, and combined flap methods. These approaches were pooled because they share the common objective of sequential lesion removal and reconstruction, and separate analyses were not feasible due to the limited number of comparative studies.

heterogeneity was not evident, defined as  $p \geq 0.10$  and  $I^2 \leq 50\%$ ; otherwise, a random-effects model was applied. A two-sided  $p$  value  $< 0.05$  was considered statistically significant. The stability of the pooled estimates was examined by sequentially omitting each study. Funnel plots were not generated because fewer than 10 studies were available for each outcome, which limited the reliability of publication-bias assessment.

#### Protocol Registration and Reporting Standards

The review was prepared in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement (**Supplementary Material 1**).

## Results

#### Study Selection and Characteristics

A total of 705 records were identified through the initial database search. After removal of duplicates and screening of titles, abstracts, and full texts, 7 studies were finally included in the meta-analysis, comprising a total of 578 patients, of whom 284 underwent multiple-staged excision and 294 underwent single-stage excision. The study selection process is illustrated in Fig. 1.

This study ultimately included 7 articles in the meta-analysis, the basic characteristics of which are detailed in Table 1 (Ref. [5,9,10,11,12,13,14]). The publication years of the included studies ranged from 2015 to 2022. All studies were retrospective cohort studies or clinical controlled studies, involving a total of 284 patients in the multiple-staged excision group and 294 patients in the single-stage excision group. Regarding disease types, the included studies primarily focused on congenital melanocytic nevi, specifically encompassing giant congenital melanocytic nevus (GCMN), large/giant congenital melanocytic nevus (L/GCMN), and pediatric facial congenital pigmented nevi. The study populations originated from multiple countries, including South Korea, Denmark, and China, indicating that this meta-analysis incorporated clinical data from di-

verse geographic regions, thereby enhancing its representativeness.

#### Risk of Bias Assessment

Methodological quality was assessed using the Newcastle-Ottawa Scale. Most studies adequately reported participant demographic and clinical characteristics, as well as outcomes or follow-up results. However, comparability between groups was a common limitation, as detailed in the NOS assessment (Table 2, Ref. [5,9,10,11,12,13,14]), primarily due to potential differences in lesion characteristics.

#### Risk of Bias Assessment (Quality Assessment)

The methodological quality of the included observational studies was independently assessed by two reviewers using the NOS, and then their ratings were compared. The appraisal focused on whether the study cohorts were appropriately selected, whether baseline differences between the multiple-staged and single-stage excision groups were adequately considered, and whether postoperative outcomes were assessed with sufficient reliability during follow-up. Particular attention was paid to the source of the cohorts, exposure ascertainment, lesion-related confounders such as size and anatomical location, follow-up duration, completeness of follow-up, and the objectivity of outcome measurement. The standard NOS star-based scoring system was applied, with a maximum score of 9. Studies with higher scores were considered to have better methodological quality. Any inconsistent ratings were discussed until agreement was reached, and a third reviewer was consulted when necessary.

According to the NOS quality assessment results, the overall quality of the 7 included studies was moderate to high. Specifically, three studies [5,10,13] received higher scores (7 stars) and were classified as high-quality studies. The remaining four studies [9,11,12,14] received relatively lower scores (5–6 stars) and were classified as moderate-quality studies. All included studies performed well in the “Selection” domain. However, in the domains of “Comparability” (between groups) and “Outcome” (objectivity of out-

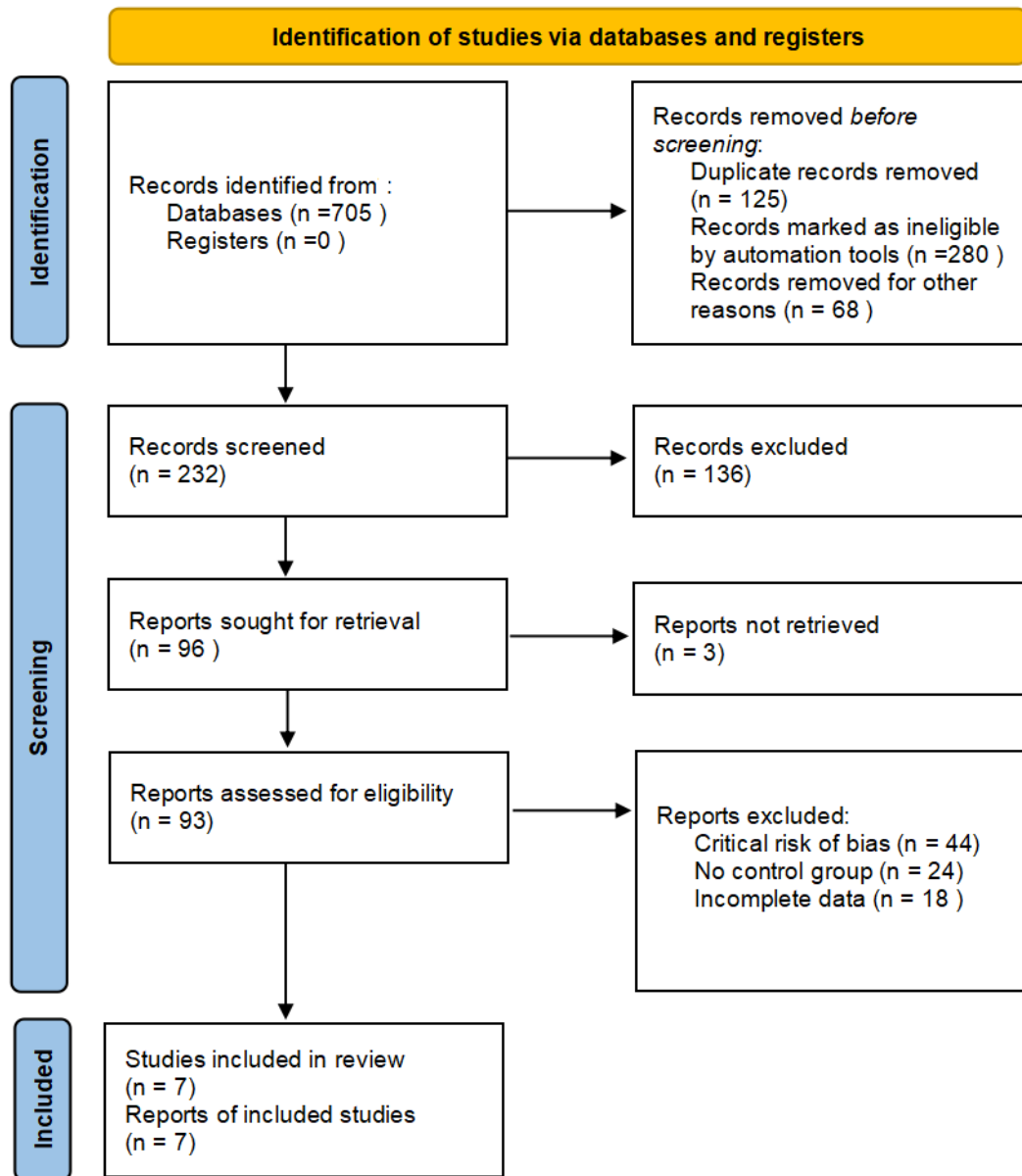


Fig. 1. Flowchart of study selection.

Table 2. Quality assessment of included studies.

| Study                      | Selection | Comparability | Outcome | Total score | Quality  |
|----------------------------|-----------|---------------|---------|-------------|----------|
| Kim et al., 2020 [5]       | 4         | 1             | 2       | 7           | High     |
| Rasmussen et al., 2015 [9] | 4         | 0             | 2       | 6           | Moderate |
| Cheng et al., 2022 [10]    | 4         | 1             | 2       | 7           | High     |
| Zhou et al., 2021 [11]     | 4         | 0             | 2       | 6           | Moderate |
| Tan et al., 2020 [12]      | 4         | 0             | 2       | 6           | Moderate |
| Li et al., 2022 [14]       | 4         | 0             | 1       | 5           | Moderate |
| Cho et al., 2019 [13]      | 4         | 1             | 2       | 7           | High     |

High quality:  $\geq 7$  stars; moderate quality: 5–6 stars.

come assessment), some studies had potential risks of bias, and their influence on the pooled results should therefore be considered in subsequent analyses. Detailed scores are presented in Table 2.

### Meta-analysis Outcomes

#### Primary Outcomes

**Major Wound Complications.** Four studies [5,9,10,13] reported the incidence of major wound complications. Het-

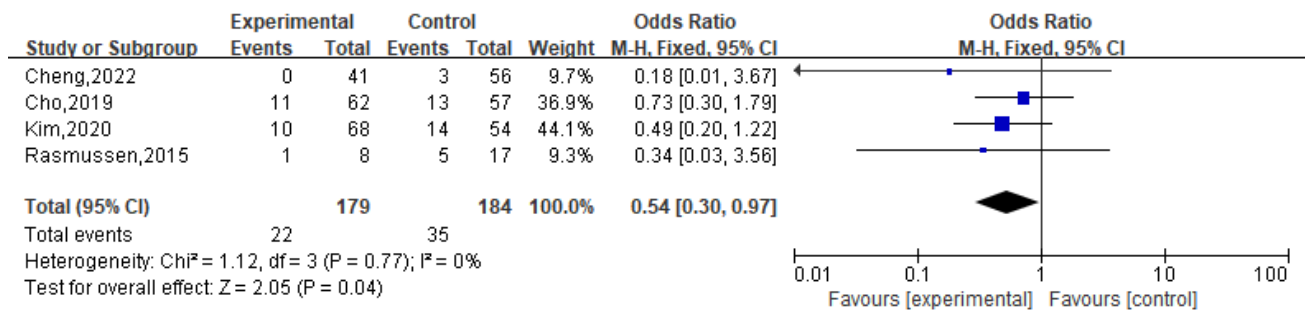


Fig. 2. Forest plot of major wound complication rate.

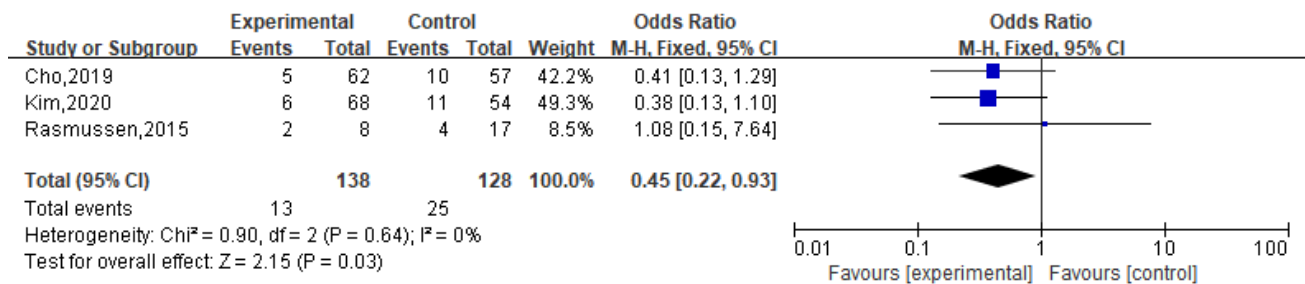


Fig. 3. Forest plot of recurrence rate.

erogeneity analysis showed  $p = 0.77$  and  $I^2 = 0\%$ , indicating no substantial statistical heterogeneity; therefore, a fixed-effects model was used. The results revealed a statistically significant difference between multiple-staged excision and single-stage excision (OR = 0.54, 95% CI 0.30–0.97,  $p = 0.04$ ), suggesting that the incidence of major wound complications was lower in the multiple-staged excision group. See Fig. 2 for details.

**Recurrence Rate.** Three studies [5,9,13] reported the recurrence rate. Heterogeneity analysis showed  $p = 0.64$  and  $I^2 = 0\%$ , suggesting that no substantial statistical heterogeneity was observed among the included studies; therefore, a fixed-effects model was used. The results revealed a statistically significant difference between multiple-staged excision and single-stage excision (OR = 0.45, 95% CI 0.22–0.93,  $p = 0.03$ ), suggesting that the recurrence rate was lower in the multiple-staged excision group. See Fig. 3 for details.

#### Secondary Outcomes

**Cosmetic Satisfaction.** Four studies [5,9,12,13] reported cosmetic satisfaction. Heterogeneity analysis showed  $p = 0.97$  and  $I^2 = 0\%$ , suggesting that no substantial statistical heterogeneity was observed among the included studies; therefore, a fixed-effects model was used. The overall analysis revealed no statistically significant difference between multiple-staged excision and single-stage excision (OR = 1.07, 95% CI 0.64–1.79,  $p = 0.80$ ). See Fig. 4 for details.

**Patient Satisfaction.** Four studies [5,9,10,13] reported patient satisfaction. Heterogeneity analysis showed  $p = 0.04$

and  $I^2 = 65\%$ , indicating moderate heterogeneity; therefore, a random-effects model was used. The overall analysis revealed no statistically significant difference between multiple-staged excision and single-stage excision (OR = 1.29, 95% CI 0.51–3.29,  $p = 0.59$ ). See Fig. 5 for details.

**Scar Length.** Three studies [11,12,14] reported scar length. Heterogeneity analysis showed  $p = 0.32$  and  $I^2 = 12\%$ , indicating no substantial heterogeneity; therefore, a fixed-effects model was used. The overall analysis revealed a statistically significant difference between multiple-staged excision and single-stage excision (MD =  $-0.32$  mm, 95% CI  $-0.52$  to  $-0.12$ ,  $p = 0.002$ ), suggesting that scar length was significantly shorter in the multiple-staged excision group. See Fig. 6 for details.

**Scar Width.** Three studies [11,12,14] reported scar width. Heterogeneity analysis showed  $p = 0.23$  and  $I^2 = 32\%$ , indicating no substantial heterogeneity; therefore, a fixed-effects model was used. The overall analysis revealed a statistically significant difference between multiple-staged excision and single-stage excision (MD =  $-0.04$  mm, 95% CI  $-0.09$  to  $-0.01$ ,  $p = 0.04$ ), suggesting that scar width was significantly shorter in the multiple-staged excision group. See Fig. 7 for details.

The 95% CI upper limit for scar width was rounded to  $-0.00$  in the forest plot due to RevMan's two-decimal display; the exact value is  $<0.001$ .

#### Sensitivity Analysis

Leave-one-out sensitivity analyses were performed for all outcomes. The direction and statistical significance of the

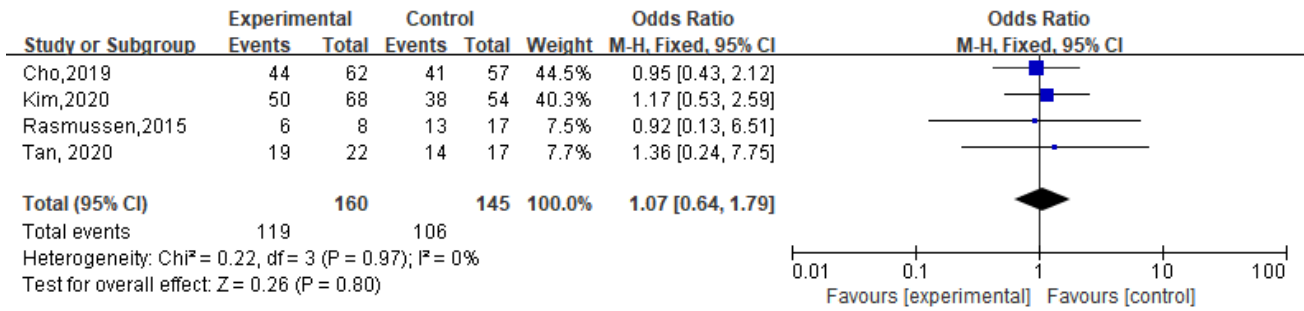


Fig. 4. Forest plot of cosmetic satisfaction.

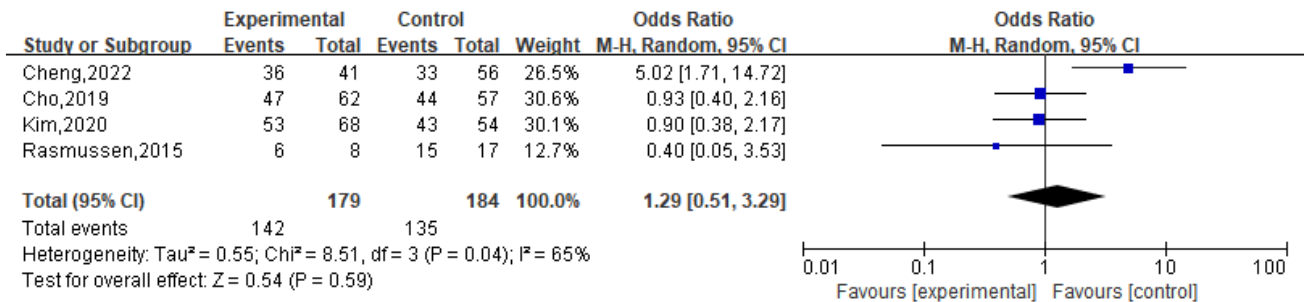


Fig. 5. Forest plot of patient satisfaction.

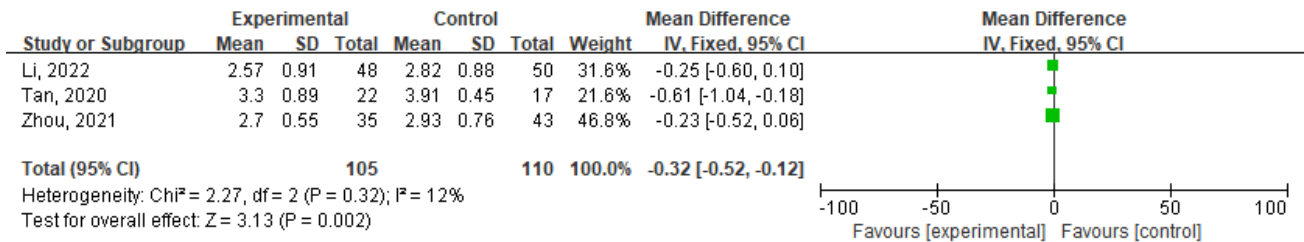


Fig. 6. Forest plot of scar length.

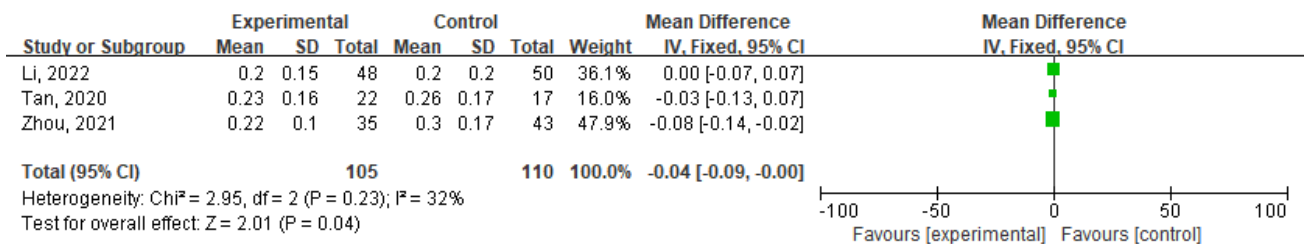


Fig. 7. Forest plot of scar width.

pooled results remained unchanged after sequential exclusion of each individual study, indicating that the findings were robust and not driven by any single study.

## Discussion

This meta-analysis systematically evaluated the differences in clinical outcomes between multiple-staged excision and single-stage excision in the surgical management of congenital melanocytic nevi (CMN). Surgical excision of CMN often results in tissue defects that require careful recon-

struction to achieve satisfactory functional and aesthetic outcomes while minimizing complications, recurrence, and scar formation. Common reconstructive approaches include primary closure, local flaps, skin grafting, and staged excision techniques. Our findings demonstrated that, compared with single-stage excision, multiple-staged excision significantly reduced the incidence of major wound complications ( $OR = 0.54$ , 95% CI 0.30–0.97,  $p = 0.04$ ) and recurrence ( $OR = 0.45$ , 95% CI 0.22–0.93,  $p = 0.03$ ), while also achieving shorter scar length ( $MD = -0.32$  mm, 95% CI -0.52 to -0.12,  $p = 0.002$ ) and narrower scar width ( $MD$

= -0.04 mm, 95% CI -0.09 to -0.01,  $p = 0.04$ ). No statistically significant differences were observed between the two approaches in cosmetic satisfaction or overall patient satisfaction (both  $p > 0.05$ ). Although multiple-staged excision showed statistically significant advantages in complications and recurrence, the absolute scar differences were small (length: MD = -0.32 mm; width: MD = -0.04 mm), notably, 0.04 mm width is visually negligible and prone to measurement error, indicating limited clinical relevance despite statistical significance, which is consistent with the non-significant cosmetic satisfaction. These findings provide quantitative evidence to support surgical decision-making for CMN, particularly for large, giant, or anatomically sensitive lesions. Importantly, all included studies focused exclusively on CMN, particularly large/giant CMN and medium-sized facial CMN in pediatric populations. The relative homogeneity in disease type improved the comparability of outcome measures and contributed to the generally low statistical heterogeneity observed in this study. However, some clinical heterogeneity in lesion type and anatomical location should be considered when interpreting the pooled results. At the same time, the findings should be interpreted within the specific clinical context of CMN rather than generalized to other cutaneous lesions or reconstructive conditions. CMN represents a unique benign lesion with malignant potential, and its surgical management must balance lesion clearance, aesthetic reconstruction, and functional preservation. In this context, the advantages of multiple-staged excision are closely related to both the biological characteristics of CMN and surgical biomechanics. CMNs often exhibit irregular distribution and indistinct borders, while pediatric skin generally possesses favorable elasticity. Single-stage excision may require relatively wide resection and high-tension closure, which can increase the risks of wound dehiscence, infection, necrosis, deformity, and excessive scar formation. In contrast, multiple-staged excision allows progressive removal of the lesion while taking advantage of stress relaxation and gradual expansion of adjacent normal skin, thereby facilitating lower-tension closure and improved scar quality.

Our findings are consistent with previous clinical experience and published literature emphasizing the challenges of managing extensive CMN in a single procedure. Gout et al. [4] reported that postoperative outcomes after surgical excision of CMN were strongly influenced by lesion size and anatomical location, with substantially higher complication rates observed in large or giant lesions and deformity rates reaching 54.2% in eyelid-involved cases. Although their meta-analysis did not directly compare staged and single-stage techniques, it indirectly supports the rationale for tension-reducing strategies such as multiple-staged excision or tissue expansion in extensive lesions. A retrospective study published in 2024 evaluated the effectiveness of W-plasty-based multiple-staged excision in 119 patients with medium-sized CMN and demonstrated advantages in reducing scar length and preventing postoperative

deformity [8]. In addition, a retrospective analysis by Mateuszczuk et al. [15] reported favorable outcomes after surgical management of medium-sized CMN. These findings are consistent with our results showing lower recurrence rates and improved scar outcomes associated with multiple-staged excision, further supporting its potential clinical utility. For lesions involving cosmetically or functionally sensitive areas, such as the face or extremities, multiple-staged excision may be preferable because of its lower risk of scarring and deformity. Conversely, for smaller lesions or cases in which minimizing treatment duration and healthcare utilization is a priority, single-stage excision may still represent a reasonable and efficient option without compromising overall patient satisfaction.

To the best of our knowledge, this meta-analysis is among the first to systematically and directly compare multiple-staged and single-stage excision strategies specifically for CMN. By integrating currently available comparative evidence, this study provides a more comprehensive evaluation of surgical outcomes and patient-related outcomes associated with these two approaches. Several limitations of this study should be acknowledged. First, the number of included studies was limited, and all were retrospective in design, making the results susceptible to selection bias and residual confounding. In clinical practice, surgeons may preferentially select multiple-staged excision for larger or more complex lesions, potentially influencing the treatment outcomes. Second, the definition of multiple-staged excision was broad and encompassed heterogeneous techniques such as staged excision, tissue expansion, and flap reconstruction. These techniques were pooled under this broad definition (further specified in Table 1) owing to the limited number of studies, and subgroup analyses according to specific surgical techniques were not feasible. Owing to the limited number of studies, subgroup analyses according to specific surgical techniques were not feasible. Third, outcome definitions and assessment methods varied across studies, particularly for major wound complications, recurrence, cosmetic satisfaction, and patient satisfaction, which may introduce measurement bias and reduce the precision of pooled estimates. The included studies showed heterogeneity in outcome definitions, assessment methods, and reporting criteria. Moreover, the lack of standardized assessment criteria across studies limited the comparability of outcomes. Due to the limited number of studies and substantial heterogeneity, subgroup analyses based on specific outcome definitions and assessment methods, or surgical approaches were not feasible, and outcomes were pooled as originally reported. Therefore, future multicenter prospective studies and randomized controlled trials with standardized outcome measures are needed to further validate these findings.

## Conclusions

This meta-analysis provides supportive evidence for the use of multiple-staged excision in the surgical management of

congenital melanocytic nevi. Compared with single-stage excision, multiple-staged excision appears to offer advantages in reducing complications, recurrence, and scar formation. Future high-quality prospective studies are warranted to validate these findings, standardize outcome assessment, and further clarify the optimal surgical indications for different CMN subtypes.

### Availability of Data and Materials

The data analyzed are available from the corresponding author upon reasonable request.

### Author Contributions

Conceptualization: JSY and YW. Data curation: JSY and WHY. Formal analysis: JSY and YW. Methodology: MZJ and ZL. Project administration: MZJ and ZL. JSY drafted the manuscript. All authors have been involved in revising the manuscript critically for important intellectual content. All authors gave final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

### Ethics Approval and Consent to Participate

Not applicable.

### Acknowledgment

Not applicable.

### Funding

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### Conflict of Interest

The authors declare no conflict of interest.

### Supplementary Material

Supplementary material associated with this article can be found, in the online version, at <https://doi.org/10.62713/aic.4704>.

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