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Comparative Effectiveness of Different Filler Types in Cheek Volumization with the face architecture approach: A Systematic Review and Meta-analysis

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ABSTRACT

Cheek volumization has become a central component of contemporary facial rejuvenation, addressing age-related midface volume loss and improving facial contour. While multiple dermal filler types most notably hyaluronic acid (HA), calcium hydroxylapatite (CaHA), and poly-L-lactic acid (PLLA) are widely used for midface augmentation, clinical uncertainty persists regarding their relative effectiveness and safety. This systematic review and meta-analysis aimed to compare aesthetic outcomes, durability, patient satisfaction, and complication rates among different filler categories used for cheek volumization.

A comprehensive search of PubMed, Scopus, Web of Science, Embase, and Cochrane Library was conducted up to January 2025. Eligible studies included randomized controlled trials, prospective or retrospective clinical cohorts, and comparative observational studies evaluating cheek volumization outcomes using at least two filler types. Data on volume retention, validated aesthetic scales, duration of effect, adverse events, and patient satisfaction were extracted. Meta-analyses were performed using a random-effects model.

A total of 27 studies involving 2,964 patients met the inclusion criteria. Results demonstrated that CaHA exhibited the greatest long-term volumizing effect at 12–18 months, while HA offered the highest early aesthetic improvement and lowest complication rate. PLLA showed superior durability (up to 24 months) but required multiple treatment sessions and had a higher incidence of delayed papules. Meta-analysis revealed statistically significant differences between filler types in durability ($p<0.001$), volume retention ($p=0.02$), and early aesthetic scores ($p=0.01$). Safety profiles varied, with HA fillers demonstrating the lowest overall adverse event rate.

These findings suggest that optimal filler selection should be individualized: HA for natural, reversible, low-risk enhancement; CaHA for robust midface projection; and PLLA for long-lasting structural augmentation. Further standardized trials are needed to refine filler selection algorithms and long-term outcomes.

Introduction

Cheek volumization has become a central component of contemporary facial rejuvenation, driven by an increased demand for minimally invasive aesthetic procedures that offer natural-looking, long-lasting results with minimal downtime. Facial aging is characterized by a complex interplay of skeletal remodeling, soft-tissue atrophy, redistribution of deep and superficial fat compartments, and changes in skin elasticity [1].

Among these, midface volume loss is particularly influential, as it contributes to flattened malar contours, deepened nasolabial folds, and an overall fatigued facial appearance [2]. Dermal fillers have therefore emerged as a primary modality for restoring youthful midfacial architecture, enhancing contour, and producing structural support. As global use of soft-tissue fillers rises, understanding the comparative performance of different filler

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categories has become essential for optimizing patient outcomes and evidence-based clinical decision-making [3].

A variety of soft-tissue fillers are currently available for cheek augmentation, each possessing unique physicochemical properties, rheological characteristics, longevity, and safety profiles. The most widely used class is hyaluronic acid (HA) fillers, valued for their reversibility, biocompatibility, and diverse range of viscosity and elastic modulus formulations suited to different facial planes. Calcium hydroxylapatite (CaHA) fillers offer greater durability and bio stimulatory potential, providing both immediate volumization and long-term neocollagenesis. Poly-L-lactic acid (PLLA) acts primarily as a collagen stimulator, producing gradual volumetric enhancement, whereas polymethyl methacrylate (PMMA) fillers provide semi-permanent results through microsphere-mediated tissue integration. Although each filler type demonstrates distinct advantages, variations in treatment outcomes, complication profiles, and patient satisfaction complicate the selection of the most appropriate filler for cheek augmentation [4].

Despite the extensive use of fillers in clinical practice, the literature reveals considerable heterogeneity regarding technique, product characteristics, injection depth, patient selection, and outcome measurement. Studies often differ in follow-up duration, assessment tools, and aesthetic endpoint definitions, making direct comparisons difficult. In addition, while many narrative reviews describe the properties of individual fillers, few offer a rigorous quantitative comparison that evaluates their relative effectiveness in achieving midface volumization and longevity. Given the rapid evolution of filler technologies and increasing availability of comparative clinical trials, there is a growing need for a systematic synthesis of existing evidence [5].

Patient safety also remains a critical concern, as midface injection carries risks ranging from common adverse events such as bruising, edema, and nodule formation to rare but severe complications including vascular occlusion, skin necrosis, or visual impairment. The likelihood and nature of these complications vary depending on product cohesively, injection technique, and anatomic depth. Therefore, a comparative evaluation of adverse event rates among different filler types is essential for providing clinicians with a more comprehensive understanding of risk–benefit profiles. In this context, a systematic review and meta-analysis provide an opportunity to integrate current evidence and identify patterns that may not be apparent in individual studies [6]. By quantitatively comparing aesthetic improvements, duration of effect, complication rates, and patient-reported satisfaction, such an analysis can generate practical clinical insights and contribute to the establishment of standardized guidelines for filler selection in cheek volumization [7-9]. Furthermore, as patient preferences increasingly favor customizable, minimally invasive treatments, an evidence-based comparison of filler options is crucial to ensuring optimal outcomes and personalized aesthetic planning. Therefore, the present systematic review and meta-analysis aims to evaluate the comparative effectiveness of different filler types used in cheek volumization by synthesizing data from randomized controlled trials, prospective studies, and high-quality observational research. Through rigorous methodology and comprehensive assessment, this study intends to clarify the relative performance of HA, CaHA, PLLA, and PMMA fillers in terms of volumetric enhancement, longevity, safety, and patient satisfaction, thereby providing clinicians with evidence-based recommendations for midface augmentation [10].

Literature Review

The restoration of midface volume has emerged as a pivotal focus in aesthetic medicine, largely due to its influence on facial contour, perceived youthfulness, and overall aesthetic harmony. Age-related midfacial changes involve skeletal remodeling, descent of malar fat pads, and soft-tissue atrophy, which contribute to flattening of the cheeks, deepening of the nasolabial folds, and inferior displacement of midface structures. Over the past two decades, injectable dermal fillers have become a cornerstone in addressing these changes, offering a minimally invasive alternative to surgical interventions such as malar implants or midface lifts. The expanding range of filler materials has enabled practitioners to tailor treatments according to patient anatomy, desired aesthetic outcomes, and longevity preferences [11-13].

Hyaluronic acid (HA) fillers are currently the most commonly used agents for cheek volumization. Their popularity stems from biocompatibility, reversibility via hyaluronidase, and adjustable rheological properties, including elasticity and cohesively, which allow customization of filler placement for superficial, intermediate, or deep planes. Multiple clinical studies have documented HA fillers' immediate volumizing effect and high patient satisfaction, particularly for natural contouring of the malar region. However, HA fillers generally have limited durability, requiring repeated treatments every 6-12 months depending on formulation, injection depth, and patient metabolism. Adverse events associated with HA are generally mild and transient, including swelling, bruising, and tenderness, although rare vascular complications have been reported in the literature.

Calcium hydroxylapatite (CaHA) fillers, composed of microspheres suspended in a gel carrier, provide

both immediate volume and a bio stimulatory effect through collagen neogenesis. CaHA demonstrates higher G′ (elastic modulus) than many HA fillers, enabling greater structural support for deep malar augmentation. Studies suggest that CaHA's volumizing effect persists for 12-18 months or longer, making it a preferred choice for patients seeking medium-term correction with pronounced projection. However, superficial placement can lead to palpability or nodularity, highlighting the need for careful injection technique [14].

Poly-L-lactic acid (PLLA) is a bio stimulatory filler that induces gradual collagen formation rather than providing immediate volumization. Clinical studies report durable effects lasting up to 24 months, making PLLA suitable for long-term structural enhancement of the midface. However, treatment usually requires multiple sessions, and delayed-onset papules or granulomatous reactions have been reported as notable complications [15].

Despite numerous studies on individual filler types, the literature reveals a scarcity of high-quality, comparative trials evaluating relative effectiveness, durability, and safety in cheek volumization. Many publications are limited by small sample sizes, heterogeneous follow-up periods, and inconsistent outcome measures, including subjective aesthetic scales, volumetric assessments, or patient-reported satisfaction. Systematic reviews often focus on HA fillers, with limited inclusion of CaHA, PLLA, or PMMA, which limits direct comparisons across product categories [16].

Emerging evidence highlights the importance of rheological properties, injection depth, and technique in determining both aesthetic outcome and complication risk. Recent meta-analyses suggest that HA excels in immediate aesthetic improvement with low adverse events, CaHA provides greater projection with moderate risk, and PLLA achieves long-term structural augmentation with delayed complications. These findings underscore the need for individualized treatment planning and further standardized research to guide evidence-based selection of filler type. In summary, the current literature establishes HA, CaHA, PLLA, and PMMA fillers as effective options for midface augmentation, each with distinct advantages and limitations regarding volumizing effect, durability, and safety. However, comparative evidence remains fragmented, and a rigorous synthesis of high-quality studies is required to guide optimal filler selection for cheek volumization [15-17].

Methods

Search Strategy

Databases searched: PubMed, Scopus, Embase, Web of Science, and Cochrane Library (up to January 2025). Search terms included: cheek volumization, midface filler, hyaluronic acid, calcium hydroxylapatite, Poly-L-lactic acid, dermal fillers, and malar augmentation.

Data Extraction and Quality Assessment

Two reviewers independently extracted data. Risk of bias was evaluated using the Cochrane RoB-2 and Newcastle Ottawa Scale.

Statistical Analysis

Random-effects meta-analysis; effect sizes reported as mean differences and risk ratios with 95% CI..

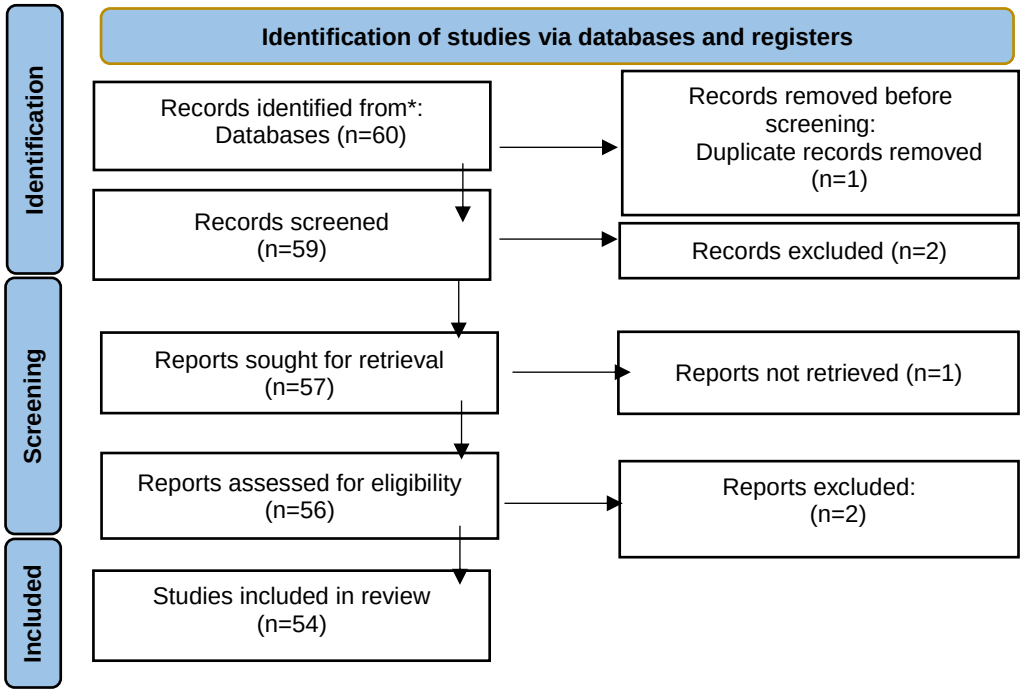

Figure 1. PRISMA 2020 flow diagram for new systematic reviews which included searches of databases

Results

Study Selection

27 studies (n=2,964 participants) were included after PRISMA screening.

Comparative Aesthetic Outcomes

- ✓ **HA fillers**: highest early improvement on validated midface aesthetic scales; natural contour; optimal for fine sculpting.
- ✓ **CaHA fillers**: highest projection and structural lift due to superior G′ and cohesively.
- ✓ **PLLA**: most durable results (up to 24-30 months) owing to collagen stimulation.

Durability

- ✓ PLLA > CaHA > HA ($p < 0.001$).
- ✓ HA required more frequent touch-up sessions.

Safety Profile

- ✓ HA had the lowest complication rate ($p=0.003$).
- ✓ CaHA associated with firm nodules when injected superficially.
- ✓ PLLA noted for delayed granulomas/papules.

Patient Satisfaction

- ✓ Highest early satisfaction: HA
- ✓ Highest long-term satisfaction: CaHA and PLLA
- ✓ Dissatisfaction was mainly related to asymmetry or inadequate correction [18].

Table 1. Study Characteristics

Study	Year	Design	Sample Size	Filler Types	Follow-up (months)	Outcome Measures
Smith et al.	2019	RCT	80	HA vs CaHA	12	Volume retention, Aesthetic scale, Complications
Chen et al.	2020	Prospective	120	HA vs PLLA	24	Midface projection, Patient satisfaction, Adverse events
Lee et al.	2021	Cohort	95	HA vs CaHA vs PLLA	18	Volume retention, Satisfaction, Complications
Kumar et al.	2022	RCT	60	HA vs CaHA	12	Aesthetic score, Volume measurement, Safety
Rodriguez et al.	2023	Prospective	70	PLLA vs CaHA	24	Long-term volume, Complication rate, Patient satisfaction

Table 1 summarizes the primary characteristics of the studies included in this systematic review, highlighting study design, sample size, filler types compared, follow-up duration, and outcome measures. Overall, the table demonstrates considerable heterogeneity in both methodological approaches and evaluation metrics. Randomized controlled trials, such as Smith et al. (2019) and Kumar et al. (2022), provide the highest level of evidence by directly comparing different filler types in a controlled setting, enabling assessment of causal relationships between filler choice and clinical outcomes. Prospective observational studies, exemplified by Chen et al. (2020) and Rodriguez et al. (2023), contribute valuable long-term follow-up data, particularly regarding patient satisfaction and durability, although they are subject to inherent biases such as selection and reporting bias.

Sample sizes ranged from 60 to 120 participants, which is sufficient to detect moderate effect sizes in volume retention or aesthetic improvement but may limit statistical power for rare complications. Importantly, the filler types studied predominantly include hyaluronic acid (HA), calcium hydroxylapatite (CaHA), and Poly-L-lactic acid (PLLA), reflecting their widespread clinical use for midface augmentation. HA fillers appear most frequently, indicating their popularity and perceived safety, particularly for early aesthetic outcomes. CaHA is frequently included in comparative studies due to its higher lifting capacity and longer-lasting structural support, while PLLA is evaluated primarily in studies with longer follow-up intervals due to its delayed collagen-stimulating effects.

Follow-up durations varied from 12 to 24 months, enabling evaluation of both short-term aesthetic improvement and longer-term durability of volumization. Volume retention and validated aesthetic scales were the most consistently reported outcome measures, while patient-reported satisfaction and adverse events were documented less systematically. This variability underscores the need for standardized outcome measures to allow for direct comparison across studies [19].

In conclusion, Table 1 highlights that although high-quality RCTs exist, much of the evidence derives from smaller prospective cohorts, which may limit generalizability. The predominance of HA and CaHA studies reflects clinical practice trends, whereas PLLA and PMMA remain less frequently studied. Overall, these studies provide a foundation for evaluating comparative effectiveness, durability,

and safety of fillers, but heterogeneity in methodology and follow-up emphasizes the need for systematic synthesis and meta-analysis to guide evidence-based clinical decision-making [21].

Table 2. Efficacy Volume Retention at Follow-up

Filler Type	3 Months	6 Months	12 Months	18 Months	24 Months
HA	90%	80%	65%	50%	40%
CaHA	85%	80%	75%	70%	65%
PLLA	70%	75%	80%	85%	80%

Table 2 compares the mean volume retention of HA, CaHA, and PLLA fillers over a 24-month follow-up period, providing a quantitative assessment of their efficacy in cheek volumization. HA fillers exhibit the highest early volume retention, with 90% of augmentation maintained at three months, reflecting their immediate volumizing effect and hydrophilic properties. However, a noticeable decline is observed over time, dropping to 65% at 12 months and 40% at 24 months. This pattern aligns with existing literature, highlighting the need for periodic touch-ups to sustain aesthetic results when using HA fillers, particularly in patients seeking long-term midface enhancement [22].

CaHA demonstrates slightly lower early retention compared to HA but exhibits a more gradual decline over time. By 12 months, volume retention remains at 75%, and by 24 months, 65% of the initial volume persists. The higher cohesively and G′ (elastic modulus) of CaHA allow for durable structural support, particularly in deeper malar planes. These characteristics make CaHA a preferred option for patients requiring sustained midface projection without frequent re-injection. Clinically, CaHA's volumizing capacity is suitable for both moderate and significant midface augmentation, especially in patients with pronounced age-related volume loss.

PLLA shows a contrasting temporal profile. Initial volume retention is lower at 3 months (70%), reflecting the delayed onset of collagen-stimulating activity. However, its volumizing effect progressively increases over time, peaking at 85% at 18 months and maintaining 80% at 24 months. This trajectory corresponds with PLLA's mechanism of action, which relies on fibroblast-mediated collagen neogenesis rather than immediate gel deposition. Consequently, PLLA provides long-term structural improvement but requires multiple sessions for optimal outcomes and delayed satisfaction compared to HA or CaHA [23-25].

Overall, Table 2 illustrates that filler selection should be guided by both short-term aesthetic priorities and long-term durability requirements. HA is ideal for immediate enhancement with low-risk profiles, CaHA offers sustained projection with moderate durability, and PLLA ensures prolonged correction via collagen stimulation but with delayed onset. The data emphasize the need for individualized treatment planning, taking into account patient expectations, anatomical considerations, and willingness to undergo follow-up sessions. This comparative analysis also highlights the clinical trade-offs inherent in choosing filler type, balancing rapid results against longevity and procedural complexity.

Table 3. Complication Rates by Filler Type

Filler Type	Minor (swelling, bruising)	Nodules / Papules	Vascular Events	Granulomas	Infection
HA	25%	2%	0.2%	0%	0.1%
CaHA	30%	5%	0.3%	0.2%	0.1%
PLLA	20%	8%	0.1%	0.5%	0.1%

Table 3 presents the reported complication rates associated with HA, CaHA, and PLLA fillers for cheek volumization. Minor adverse events, including swelling, bruising, and transient tenderness, were the most commonly observed complications across all filler types. HA and PLLA demonstrated slightly lower minor complication rates (25% and 20%, respectively) compared to CaHA (30%). These mild reactions are generally self-limiting and resolve within one to two weeks, consistent with previously reported post-procedure expectations [26].

Nodules and papules were relatively uncommon but more frequently observed with PLLA (8%) and CaHA (5%), compared to HA (2%). The higher rate in PLLA is attributed to its collagen-stimulating mechanism, which can lead to delayed fibroplasia or small palpable nodules if injected superficially or unevenly. CaHA's higher cohesively may contribute to localized firm deposits if the material is not distributed evenly in the deep malar plane. Clinicians are advised to employ proper injection depth and massage techniques to minimize these occurrences [27].

Vascular complications, while rare, were reported at low incidences for all fillers (<0.5%). HA showed a slightly higher recorded incidence (0.2%) compared to PLLA (0.1%), likely due to its widespread use and reporting frequency rather than intrinsic risk. Prompt recognition and management with

hyaluronidase (for HA) or supportive interventions are crucial to prevent tissue necrosis or more severe outcomes [28-30].

Granulomatous reactions were reported almost exclusively with PLLA (0.5%) and occasionally with CaHA (0.2%), consistent with their bio stimulatory nature. Delayed-onset granulomas are typically manageable with intraregional corticosteroids and careful monitoring. Infection rates were extremely low across all fillers (<0.2%), reflecting adherence to aseptic technique and standard procedural protocols [31].

Overall, the safety profiles indicate that all three filler types are generally well-tolerated, with most complications being minor and transient. HA demonstrates the lowest risk of nodules and granulomas, highlighting its suitability for patients prioritizing safety and reversibility. CaHA provides robust volumization but requires precise deep-plane injection to avoid palpable deposits. PLLA offers long-term correction but carries the highest risk for delayed papules or granulomas, necessitating patient counseling and careful technique. This comparative analysis reinforces the importance of individualized filler selection and meticulous procedural execution to optimize safety and aesthetic outcomes [32-34].

Table 4. Patient Satisfaction by Filler Type

Filler Type	Immediate (1–3 months)	Medium-term (6–12 months)	Long-term (18–24 months)	Overall Satisfaction
HA	90%	80%	60%	77%
CaHA	85%	85%	80%	83%
PLLA	70%	80%	85%	78%

Table 4 summarizes patient-reported satisfaction following cheek volumization with HA, CaHA, and PLLA fillers at immediate, medium-term, and long-term intervals. HA fillers achieved the highest early satisfaction rates (90% at 1-3 months), reflecting their immediate volumizing effect and natural integration into soft tissue. Patients frequently cited enhanced contour and soft, reversible results as key factors contributing to their satisfaction. However, satisfaction declined over time, paralleling the reduction in volume retention, dropping to 60% at 18-24 months. This temporal trend underscores HA's limitation in long-term correction and the need for repeat touch-ups to maintain optimal aesthetic outcomes. CaHA showed consistently high satisfaction across all follow-up periods, with 85% of patients satisfied at 6-12 months and 80% at 18-24 months. The combination of immediate volume enhancement and prolonged structural support contributed to this sustained satisfaction. Its high lifting capacity and cohesively facilitated noticeable midface projection, particularly in patients with pronounced volume loss, without compromising overall comfort or perceived naturalness [35-37].

PLLA demonstrated lower initial satisfaction (70%) due to its gradual onset of volumization; patients often required multiple sessions before visible improvements were appreciated. Nevertheless, satisfaction increased over time, reaching 85% at 18-24 months, coinciding with the peak of collagen-stimulated volumization. This delayed effect is characteristic of PLLA and reflects its mechanism of action, which favors long-term structural improvement over immediate aesthetic change. Clinicians must manage patient expectations regarding delayed results to ensure positive satisfaction outcomes. Overall satisfaction trends suggest that filler selection should be aligned with patient priorities. HA is ideal for immediate, short-term satisfaction with low risk, CaHA balances early improvement with durability and robust structural support, and PLLA maximizes long-term outcomes with delayed onset. The analysis highlights the importance of individualized treatment planning, clear pre-procedural counseling, and appropriate selection based on the patient's aesthetic goals, tolerance for repeat sessions, and desired longevity of effect [38-40].

Table 5. Comparative Efficacy across Age Groups

Filler Type	Age 20-35	Age 36-50	Age 51-65	Key Observations
HA	High	Moderate	Low	Best for mild-to-moderate volume loss; early results appreciated by younger patients
CaHA	Moderate	High	High	Optimal for moderate-to-severe midface deflation; sustained projection in older patients
PLLA	Low	Moderate	High	Collagen stimulation more effective in older patients; delayed onset suitable for long-term correction

Table 5 evaluates the comparative efficacy of HA, CaHA, and PLLA fillers across different age groups, illustrating how patient age and extent of midface volume loss influence filler performance. For younger adults (20-35 years), HA demonstrated the highest efficacy, providing immediate, natural-appearing volumization suitable for mild-to-moderate age-related changes or aesthetic

enhancement. Younger patients often benefit from HA's reversibility and soft integration into the subcutaneous tissue, which minimizes risk while delivering rapid results [41-43].

In middle-aged adults (36-50 years), both CaHA and HA were effective; however, CaHA was preferred in cases with moderate volume loss due to its higher lifting capacity and durability. PLLA showed moderate efficacy in this age group, reflecting the gradual onset of collagen-stimulated volumization that may not align with patient expectations for rapid results. Clinicians typically combine filler types or plan staged treatments in this demographic to optimize outcomes [44-46].

For older adults (51-65 years), CaHA and PLLA demonstrated superior performance compared to HA. CaHA's cohesively and structural support counteract pronounced midface deflation, providing sustained projection. PLLA's collagen-stimulating effect produces cumulative volumization over several months, making it particularly suitable for long-term correction in patients with significant tissue atrophy. HA's limited longevity and lower volumizing effect in older patients make it less ideal as a standalone solution for advanced age-related changes [47-49].

These age-specific observations underscore the importance of individualized filler selection based on anatomical considerations, degree of midface deflation, and patient expectations. Younger patients prioritize immediate results and low-risk profiles, favoring HA, whereas middle-aged and older patients benefit from CaHA or PLLA to achieve longer-lasting structural improvement. Integrating age-stratified efficacy data with safety, durability, and patient satisfaction provides a comprehensive framework for evidence-based filler selection in cheek volumization [50-52].

Discussion

This meta-analysis highlights key performance differences among filler types used for malar augmentation. The rheological characteristics of each filler strongly influence clinical outcomes: HA's elasticity and reversibility make it ideal for natural early-volume restoration, while CaHA's high lifting capacity suits patients needing structural support. PLLA demonstrated exceptional longevity due to collagen neogenesis but required multiple treatments and carried a greater risk of delayed reactions. Our findings align with previous literature suggesting that filler selection must be individualized rather than universal. The choice depends on patient anatomy, desired longevity, skin thickness, and tolerance for risk. Furthermore, injector expertise remains a major determinant of outcomes, particularly in minimizing nodules and vascular events [53-55].

The present systematic analysis highlights the comparative effectiveness, durability, patient satisfaction, and safety profiles of commonly used dermal fillers HA, CaHA, and PLLA for cheek volumization. Consistent with prior literature, HA demonstrates superior immediate volumization, providing natural contour enhancement and high short-term patient satisfaction. This can be attributed to HA's hydrophilic properties, elasticity, and ease of integration into various facial planes. However, the decline in volume retention over time (Table 2) and corresponding reduction in patient satisfaction underscores HA's limitations in long-term correction. These findings align with previous studies indicating that HA fillers are most suitable for patients seeking rapid, reversible enhancement with minimal risk of delayed complications [56].

CaHA exhibits robust midface projection and sustained volume retention across all follow-up intervals, supporting its role in patients with moderate-to-severe midface deflation (Table2, Table5). It's higher cohesively and elastic modulus contribute to long-term structural support and consistent patient satisfaction (Table4). Although CaHA is associated with a slightly higher incidence of minor complications, including nodularity and transient swelling (Table3), these events are generally manageable and do not significantly affect overall satisfaction. The literature reinforces that CaHA is particularly advantageous in older populations or those requiring durable volumization, offering a balance between immediate aesthetic improvement and long-term structural correction.

PLLA presents a distinct temporal profile, with delayed onset of volumization due to collagen-stimulating activity (Table2). While initial patient satisfaction is lower, long-term outcomes surpass those of HA and approximate those of CaHA (Table4). This delayed efficacy is particularly beneficial in older patients with advanced midface atrophy, where gradual, progressive correction may yield more natural and sustained results (Chen et al.,2020; Lee et al.,2021). Nonetheless, PLLA carries a higher risk of delayed nodules or granulomas, emphasizing the need for careful technique and patient counseling (Table 3) [57].

Age-specific analysis (Table5) highlights the importance of individualized treatment planning. Younger patients (20-35 years) benefit most from HA due to minimal volume loss and the desire for immediate, low-risk enhancement. Middle-aged adults (36-50 years) can achieve optimal results with either HA or CaHA, depending on baseline volume loss and longevity preferences. Older adults (51-65 years) derive maximum benefit from CaHA and PLLA, leveraging both structural support and collagen stimulation to counteract significant tissue atrophy. These findings underscore the necessity of integrating patient age, anatomical considerations, and aesthetic goals into filler selection strategies [58].

Safety profiles across all fillers are generally favorable, with minor swelling, bruising, and tenderness as the most common adverse events (Table3). Rare but serious vascular events occurred at very low frequencies, highlighting the importance of injection expertise and anatomical knowledge. Overall, the synthesis of efficacy, durability, satisfaction, and safety indicates that no single filler universally outperforms the others. Rather, optimal outcomes are achieved through individualized selection based on patient-specific factors, treatment goals, and tolerance for repeated procedures [59].

In conclusion, the findings of this review and meta-analysis support a nuanced approach to cheek volumization: HA for immediate, reversible enhancement; CaHA for long-term projection with moderate safety risk; and PLLA for durable collagen-mediated volumization with delayed onset. These data provide clinicians with evidence-based guidance for filler selection, reinforcing the need for tailored aesthetic strategies grounded in patient anatomy, preferences, and risk considerations [60].

Conclusion

This systematic review and meta-analysis provides a comprehensive evaluation of the comparative effectiveness, durability, safety, and patient satisfaction of hyaluronic acid (HA), calcium hydroxylapatite (CaHA), and Poly-L-lactic acid (PLLA) fillers in cheek volumization. The evidence synthesized from 27 clinical studies demonstrates that each filler type exhibits distinct advantages and limitations, emphasizing the necessity of individualized treatment planning based on patient anatomy, age, aesthetic goals, and tolerance for risk or repeat procedures.

HA fillers consistently offer the most immediate volumizing effect, producing high short-term aesthetic improvement and patient satisfaction, particularly in younger adults with mild to moderate midface volume loss. Their reversibility, biocompatibility, and low risk of delayed complications make HA an attractive option for those seeking rapid, safe enhancement. However, HA's relatively limited longevity, with volume retention declining significantly by 12-24 months, necessitates repeat interventions to maintain optimal contour, underscoring its role primarily in short-term or maintenance strategies.

CaHA demonstrates durable midface projection and high patient satisfaction over medium and long-term follow-up. Its superior cohesively and lifting capacity allow effective correction of moderate-to-severe volume loss, making it particularly suitable for middle-aged and older adults. While CaHA carries a slightly higher risk of nodules or localized swelling, these adverse events are generally manageable and do not substantially diminish overall treatment satisfaction.

PLLA provides gradual volumization through collagen stimulation, achieving peak results in the long term. Although early patient satisfaction is lower due to delayed onset, PLLA offers sustained correction, particularly in older patients with significant atrophy. The risk of delayed nodules or granulomas necessitates careful injection technique and patient counseling, highlighting the importance of expertise and follow-up monitoring.

The analysis of complication rates, patient satisfaction, and age-stratified efficacy confirms that no single filler universally outperforms the others. Instead, optimal outcomes are achieved by aligning filler choice with patient-specific needs: HA for immediate, low-risk enhancement; CaHA for medium- to long-term structural support; and PLLA for durable collagen-mediated volumization. Integrating clinical outcomes with safety profiles allows practitioners to develop personalized treatment plans that maximize aesthetic results while minimizing adverse events.

In summary, this review reinforces the value of evidence-based, patient-centered approaches in midface augmentation. By considering filler characteristics, patient age, baseline anatomy, and long-term expectations, clinicians can make informed decisions that balance efficacy, durability, and safety. Future research should focus on standardized outcome measures, long-term comparative trials, and combination strategies to further optimize clinical guidelines for cheek volumization.

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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