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CLINICAL ANATOMY OF FACIAL FAT COMPARTMENTS IN FACIAL REJUVENATION: A LITERATURE REVIEW

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Abstract
Background: Facial rejuvenation has undergone a paradigm shift from tissue-tightening approaches to volume restoration. The discovery that facial adipose tissue is organized into distinct anatomical fat compartments has significantly improved the understanding of facial aging and has become the foundation of modern aesthetic procedures, including dermal filler injections and autologous fat grafting. Therefore, a comprehensive understanding of the anatomy of facial fat compartments is essential to achieve optimal aesthetic outcomes while minimizing the risk of complications. Objective: This literature review aims to examine the scientific evidence published over the past decade regarding the anatomy of facial fat compartments, age-related morphological changes, and their implications for facial rejuvenation procedures. Methods: This study employed a literature review approach following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. A comprehensive literature search was conducted in PubMed, Scopus, ScienceDirect, Web of Science, SpringerLink, and Wiley Online Library to identify English-language articles published between 2016 and 2026. Studies addressing the anatomy of facial fat compartments and their relevance to facial rejuvenation procedures were included and synthesized using a narrative approach. Results: The reviewed literature demonstrates that the face comprises superficial and deep fat compartments separated by retaining ligaments and fibrous septa. Age-related changes, including fat atrophy, redistribution, and volume alteration within individual compartments, contribute to the characteristic features of facial aging. A thorough understanding of the anatomy of facial fat compartments improves the accuracy of filler placement, facilitates more natural facial contour restoration, and reduces the risk of complications, particularly vascular injuries. Conclusion: The anatomy of facial fat compartments constitutes a fundamental basis for modern facial rejuvenation. Integrating anatomical knowledge with evidence-based injection techniques plays a crucial role in improving the safety, effectiveness, and overall success of facial aesthetic procedures.
Keywords*: facial fat compartments, clinical anatomy, facial rejuvenation, facial aging, dermal filler*

INTRODUCTION

The continuous increase in life expectancy worldwide has been accompanied by a growing demand for interventions to preserve a youthful facial appearance. Facial rejuvenation is no longer regarded solely as a cosmetic procedure but has evolved into an integral component of strategies to improve quality of life, self-confidence, and psychosocial well-being. Along with the rapid advancement of aesthetic medicine, therapeutic approaches to facial aging have shifted from conventional tissue-tightening techniques toward volume restoration based on a more comprehensive understanding of facial anatomy(1–3).

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For decades, facial aging was primarily attributed to the effects of gravity, which were believed to cause the descent of soft tissues, making facelift surgery the principal therapeutic approach. However, contemporary anatomical studies have demonstrated that facial aging is a multifactorial process involving complex interactions among skeletal remodelling, subcutaneous fat, the superficial musculoaponeurotic system (SMAS), retaining ligaments, facial musculature, and skin quality. Among these components, alterations in facial fat compartments are now recognized as one of the primary determinants of age-related changes in facial contour (2–4).

Advances in cadaveric dissection techniques, high-resolution imaging, and histological investigations have revealed that facial adipose tissue is not distributed homogeneously but is organized into distinct anatomical fat compartments with well-defined boundaries, unique morphological characteristics, and different patterns of age-related changes. This concept has fundamentally transformed the philosophy of facial rejuvenation, shifting the focus from simple tissue repositioning to selective volume restoration based on the anatomical characteristics of individual fat compartments(1,4–6).

The superficial and deep facial fat compartments are closely associated with retaining ligaments, fibrous septa, neurovascular structures, and the facial muscular system. Age-related atrophy of the deep fat compartments results in the loss of structural support for the overlying soft tissues. In contrast, volumetric changes in the superficial fat compartments contribute to characteristic facial deformities, including temporal hollowing, tear trough deformity, midface flattening, deepening of the nasolabial fold, jowl formation, and marionette lines. Consequently, precise identification of the anatomical location of each fat compartment has become fundamental for determining the optimal injection site, depth, and volume of filler materials used in facial aesthetic procedures.(1,2,4,7).

In contemporary clinical practice, the increasing use of hyaluronic acid–based dermal fillers, calcium hydroxylapatite, poly-L-lactic acid, and autologous fat grafting has further emphasized the importance of a thorough understanding of facial fat compartment anatomy. Injection techniques that fail to consider the anatomical boundaries of individual compartments may result in unnatural aesthetic outcomes, facial asymmetry, filler migration, and severe complications such as vascular occlusion, tissue necrosis, and permanent visual impairment. Conversely, anatomy-based approaches facilitate more physiological volume restoration while preserving facial proportions and minimizing the risk of injury to critical anatomical structures(1,7–9).

Over the past decade, the number of publications investigating facial fat compartment anatomy, age-related morphological changes, and their applications in facial rejuvenation has increased substantially. Nevertheless, the available evidence remains dispersed across multiple disciplines, including clinical anatomy, plastic surgery, dermatology, radiology, and aesthetic medicine. This fragmentation highlights the need for a comprehensive literature review that integrates current evidence to provide a thorough understanding of the evolving concepts of facial fat compartment anatomy and their clinical implications (1,2,4,8,9).

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Based on this background, the present literature review aims to synthesize current scientific evidence regarding the anatomy of facial fat compartments, age-related anatomical changes, and their relevance to modern facial rejuvenation procedures. It is anticipated that this review will serve as a valuable scientific reference for researchers, clinicians, anatomists, and aesthetic medicine practitioners by supporting the development of safer, more effective, and evidence-based approaches to facial rejuvenation

METHODS

This study was conducted as a narrative literature review following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure a transparent and systematic process of literature identification, screening, and synthesis. A comprehensive search was performed in six electronic databases, including PubMed/MEDLINE, Scopus, Web of Science, ScienceDirect, SpringerLink, and Wiley Online Library. In addition, the reference lists of eligible articles were manually screened using the snowballing technique to identify relevant studies that may not have been captured through the initial database search.

The search strategy combined Medical Subject Headings (MeSH) terms and free-text keywords using Boolean operators, including “facial fat compartments,” “facial anatomy,” “clinical anatomy,” “facial aging,” “facial rejuvenation,” “deep fat compartments,” “superficial fat compartments,” “dermal filler,” and “fat grafting.” Only English-language articles published between January 2016 and December 2026 were considered. Studies were included if they investigated the anatomy of facial fat compartments and their relationship to facial aging or facial rejuvenation procedures. Original research articles, systematic reviews, and narrative reviews with full-text availability were eligible for inclusion. Editorials, conference abstracts, duplicate publications, and studies unrelated to facial anatomy or aesthetic facial rejuvenation were excluded. The selection process consisted of duplicate removal, title and abstract screening, followed by full-text assessment based on predefined eligibility criteria. Relevant information extracted from each study included publication characteristics, study design, anatomical methods, facial fat compartments investigated, principal findings, and clinical implications for facial rejuvenation. The retrieved evidence was synthesized narratively and organized into key themes, including the anatomy of superficial and deep facial fat compartments, age-related anatomical changes, their relationships with retaining ligaments and neurovascular structures, clinical applications in dermal filler injection and autologous fat grafting, as well as anatomy-related complications.

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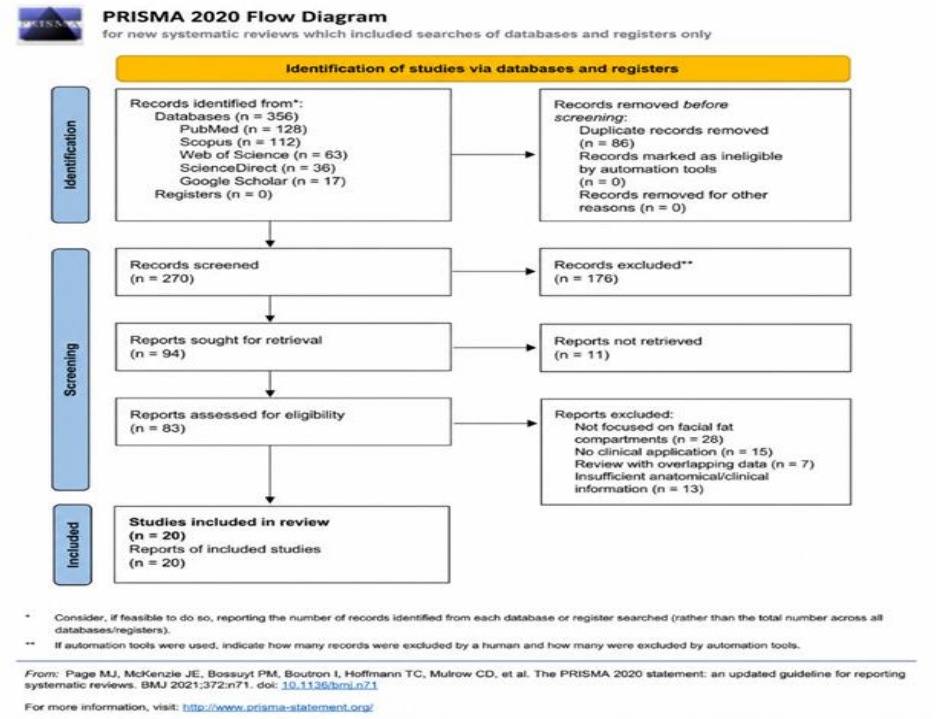

Figure 1. PRISMA 2020 flow diagram illustrating the study selection process (adapted from the PRISMA 2020 Statement).

RESULTS

A comprehensive literature search was performed using Google Scholar, PubMed, Scopus, and the Directory of Open Access Journals (DOAJ). A total of 20 studies related to the clinical anatomy of facial fat compartments in facial rejuvenation, published between 2016 and 2026, fulfilled the predefined eligibility criteria and were included in the qualitative synthesis. The characteristics of the included studies are presented in Table 1:

Table 1. Characteristics of Included Studies (20 articles)

No.	Author(s) (Year)	Title	Study Design	Main Findings	Relevance to the Review
1	Cotofana & Lachman (2019)	*Anatomy of the Facial Fat Compartments and Their Relevance in Aesthetic Surgery*	Narrative review	Summarized the anatomy of superficial and deep facial fat compartments and their clinical significance.	Serves as the principal anatomical reference for compartment-based facial rejuvenation.
2	Schenck et al. (2018)	*The Functional Anatomy of the Superficial Fat Compartments of the Face*	Cadaveric dissection with CT and MRI correlation	Demonstrated the structural organization and biomechanical behavior of superficial fat compartments.	Provides evidence for compartment-specific filler placement.

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No.	Author(s) (Year)	Title	Study Design	Main Findings	Relevance to the Review
3	Schelke et al. (2021)	*The Mobility of the Superficial and Deep Midfacial Fat Compartments*	Prospective ultrasound imaging study	Showed that superficial fat compartments exhibit greater mobility than deep compartments during facial expression.	Supports layered injection techniques based on compartment mobility.
4	Clark et al. (2023)	*Facial Fillers: Relevant Anatomy, Injection Techniques, and Complications*	Narrative review	Reviewed facial anatomy, injection techniques, and complication prevention.	Provides current clinical recommendations for anatomy-guided filler injections.
5	Akinbiyi et al. (2020)	*Better Results in Facial Rejuvenation with Fillers*	Clinical review	Emphasized individualized filler selection according to facial anatomy and rheological properties.	Supports personalized facial rejuvenation strategies.
6	Hong et al. (2025)	*Anatomical-Based Filler Injection Techniques for the Midcheek Groove and Infraorbital Region*	Narrative review	Described anatomy-guided injection techniques for the infraorbital and midcheek regions.	Relevant to deep medial cheek fat (DMCF) and SOOF restoration.
7	Woodward et al. (2023)	*Infraorbital Hollow Rejuvenation*	Narrative review	Highlighted the importance of restoring deep midfacial volume for tear trough correction.	Supports compartment-based rejuvenation of the infraorbital region.
8	Toyoda et al. (2023)	*Filler in the Tear Trough and Lid-Cheek Junction*	Cadaveric anatomical study	Demonstrated filler distribution according to anatomical planes and filler rheology.	Improves understanding of safe tear trough augmentation.
9	Wollina et al. (2017)	*Fillers and Facial Fat Pads*	Narrative review	Discussed the interaction between fillers and facial fat compartments.	Supports anatomical filler placement in facial fat pads.
10	Rohrich, Sinno & Vaca (2019)	*Getting Better Results in Facelifting*	Narrative review	Explained the role of retaining ligaments and	Supports the anatomical basis of facial rejuvenation.

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No.	Author(s) (Year)	Title	Study Design	Main Findings	Relevance to the Review
				facial fat compartments in facial aging.	
11	Tarallo et al. (2025)	*Retaining Ligaments of the Face*	Narrative review	Reviewed the anatomy and clinical significance of facial retaining ligaments.	Supports discussion of ligament-guided facial rejuvenation.
12	Kim (2022)	*Compartment-Specific Effects in Superficial Facial Fat Compartments After Thread-Lifts*	Retrospective cohort study	Demonstrated different responses among superficial fat compartments following thread lifting.	Reinforces compartment-specific treatment concepts.
13	Eid et al. (2023)	*Fat Compartment Gliding Theory*	Ultrasound-based clinical study	Proposed that superficial fat compartments glide inferiorly during facial aging.	Explains the mechanism of age-related soft tissue descent.
14	Paluch et al. (2018)	*Age-Related Changes in Elastographically Determined Strain of the Facial Fat Compartments*	Elastographic imaging study	Identified decreased elasticity of deep facial fat compartments with aging.	Supports age-related anatomical remodeling.
15	Garg et al. (2021)	*Monopolar Radiofrequency for Reposing Drooping Fat Planes*	Prospective clinical study	Demonstrated repositioning of superficial fat planes after radiofrequency treatment.	Supports the concept of facial fat mobility.
16	Yi et al. (2025)	*Temporal Fat Pad Filler Injection for Lifting Purposes*	Clinical anatomical review	Described safe temporal filler injection based on vascular anatomy.	Relevant to temporal fat compartment anatomy.
17	Qiu et al. (2023)	*Delayed Buccal Lipogranuloma Formed by Grafted Fat Migration*	Case series	Reported fat graft migration following anatomical tissue planes.	Demonstrates anatomy-related complications of fat grafting.
18	Gadallah et al. (2023)	*Facial Contouring After Permanent Filler Removal with Combined*	Case series	Combined facelift and fat grafting effectively restored facial volume after	Demonstrates reconstructive applications of compartment-based fat grafting.

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No.	Author(s) (Year)	Title	Study Design	Main Findings	Relevance to the Review
		Facelift and Fat Grafting		permanent filler removal.	
19	Ren & Guo (2026)	*Dynamic Multiform Fat Grafting for Facial Rejuvenation*	Prospective clinical study	Layered fat grafting produced improved facial contour and long-term volume retention.	Supports compartment-oriented autologous fat grafting.
20	Hong et al. (2025)	*Anatomical-Based Filler Injection Techniques for the Midcheek Groove and Infraorbital Region*	Clinical review	Presented practical injection algorithms based on facial anatomy.	Supports anatomy-guided filler techniques and complication prevention.

DISCUSSION

Classification of Superficial and Deep Facial Fat Compartments

Current evidence indicates that facial adipose tissue is organized into distinct superficial and deep fat compartments rather than a continuous layer, providing the anatomical basis for compartment-based facial rejuvenation (1,10,11). Superficial compartments, located above the SMAS, mainly influence facial contour and dynamic expression, whereas deep compartments beneath the SMAS provide structural support and projection(12,13). Aging results in compartment-specific volume loss, fat redistribution, and ligament laxity, leading to characteristic features such as midfacial flattening, temporal hollowing, and jowl formation(14–16). Therefore, modern facial rejuvenation emphasizes restoration of deep structural support followed by superficial contour refinement to achieve natural aesthetic outcomes while minimizing complications(16–18)

Garg et al. demonstrated that monopolar radiofrequency exerts its rejuvenating effect by acting on the dermis and underlying fibro-septal network, promoting favourable remodelling and repositioning of facial fat compartments. These findings support the anatomical concept that age-related facial changes are associated with compartment displacement in addition to volume loss(19).

The management of complications from permanent filler illustrates that restoring normal facial contour extends beyond filler removal alone. Reestablishing facial fat compartment volume through autologous fat grafting combined with soft-tissue repositioning provides more harmonious and durable aesthetic outcomes, highlighting the central role of compartment anatomy in reconstructive facial rejuvenation(20)

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Superficial Facial Fat Compartments

Superficial facial fat compartments are located between the skin and the superficial musculoaponeurotic system (SMAS), where fibrous septa and retaining ligaments divide them into distinct anatomical units. These compartments play an essential role in facial contour, soft-tissue support, and dynamic facial expression while limiting the spread of injectable materials, making anatomical knowledge fundamental for safe facial rejuvenation(1,10–12).

Age-related changes mainly involve compartment-specific volume redistribution, ligament laxity, and gravitational descent, leading to temporal hollowing, deepening of the nasolabial fold, and jowl formation. Consequently, modern facial rejuvenation favours compartment-specific filler placement to restore facial contours while reducing the risk of filler migration and neurovascular complications(13,14,16,17).

Recent clinical evidence indicates that superficial facial fat compartments respond differently to thread-lift procedures because of variations in compartment anatomy, retaining ligaments, and soft-tissue biomechanics. Objective assessment using intraoperative tension measurements and FACE-Q scores demonstrated that compartment-specific tissue characteristics influence lifting efficacy and patient satisfaction, further supporting anatomy-based treatment planning for facial rejuvenation(21).

Deep Facial Fat Compartments

Deep facial fat compartments are located beneath the superficial musculoaponeurotic system (SMAS) adjacent to the periosteum and deep fascia, providing structural support for facial projection and midfacial contour. The major compartments include the deep medial cheek fat (DMCF), sub-orbicularis oculi fat (SOOF), buccal fat pad, and deep pyriform space, which maintain facial volume through their close relationship with the facial skeleton and retaining ligaments(1,10,12,13).

Age-related atrophy of these compartments contributes to tear trough deformity, midfacial flattening, and nasolabial fold deepening. Consequently, contemporary facial rejuvenation prioritizes restoration of deep structural support before superficial contour refinement using anatomy-guided layered injection techniques to improve aesthetic outcomes while minimizing complications(14,16–18)

Retaining Ligaments and Neurovascular Relationship

Retaining ligaments anchor the skin, superficial musculoaponeurotic system (SMAS), and facial fat compartments to the underlying fascia and periosteum, maintaining facial contour and soft-tissue stability. Major ligaments, including the orbital retaining, zygomatic, mandibular, masseteric, and temporal ligaments, closely interact with superficial and deep fat compartments while defining anatomical boundaries for facial rejuvenation (2,10,12,13).

These ligaments are closely associated with major facial vessels and branches of the facial nerve, making precise anatomical knowledge essential during filler injection. Contemporary anatomy-guided techniques emphasize appropriate injection planes and awareness of vascular danger zones to minimize complications such as vascular occlusion, nerve injury, and filler migration while improving treatment

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safety and predictability(14,16–18).

Clinical Application

Advances in facial fat compartment anatomy have shifted facial rejuvenation toward a three-dimensional, anatomy-guided approach that restores compartment-specific volume rather than simply correcting wrinkles. Hyaluronic acid (HA) fillers remain the primary injectable material, while calcium hydroxylapatite (CaHA), poly-L-lactic acid (PLLA), and autologous fat grafting provide additional options for structural support and tissue regeneration according to individual patient needs(11,13,17,18)

Current practice emphasizes layered injection techniques, restoring deep compartments before superficial contour refinement to improve facial projection and minimize filler migration or overcorrection. Ultrasound-guided injection further enhances procedural safety by facilitating real-time visualization of facial fat compartments and adjacent vascular structures(12,16,22–24).

Recent clinical evidence emphasizes that infraorbital hollow rejuvenation should incorporate midface volumization rather than isolated tear trough correction. Restoration of deep midfacial compartments, particularly the DMCF and SOOF, enhances structural support, improves contour transition between the lower eyelid and cheek, and reduces the amount of filler required in the infraorbital region, thereby improving both safety and aesthetic outcomes(25)

Anatomical Complications

Although facial fillers and autologous fat grafting are generally safe, complications may occur when anatomical principles are not respected. Vascular occlusion, nerve injury, filler migration, and contour irregularities are commonly associated with incorrect injection planes, excessive filler volume, or poor recognition of facial fat compartments and adjacent neurovascular structures(13,14,16,17).

Current evidence supports compartment-based, anatomy-guided injection techniques with careful anatomical assessment and ultrasound guidance to reduce procedure-related complications and improve treatment safety and aesthetic outcomes (Schelke et al., 2021; Akinbiyi et al., 2020; Yi et al., 2025; Tarallo et al., 2025)

A cadaveric study demonstrated that different hyaluronic acid fillers exhibit distinct patterns of anatomical spread depending on their rheological properties and the manipulation technique used. These findings highlight the importance of anatomy-guided filler selection to achieve precise compartment-specific volumization while minimizing unintended filler migration(26).

A reported case of delayed buccal lipogranuloma following temporal autologous fat grafting demonstrated that grafted fat may migrate through interconnected facial tissue planes, resulting in delayed inflammatory complications. This finding highlights the importance of detailed anatomical knowledge of facial fat compartments and potential migration pathways to optimize graft placement and minimize long-term adverse events(27)

Future Perspective

Advances in imaging technologies, including magnetic resonance imaging (MRI), computed tomography (CT), and high-frequency ultrasonography, are

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expected to improve three-dimensional understanding of facial fat compartments and support more individualized, anatomy-guided facial rejuvenation (12,16,17).

Future developments integrating ultrasound guidance, regenerative biomaterials, artificial intelligence, and three-dimensional facial analysis may further optimize treatment planning, procedural safety, and long-term aesthetic outcomes. Continued multidisciplinary collaboration will be essential for establishing standardised, precision-based facial rejuvenation protocols (18,22,23).

CONCLUSION

Facial aging is a complex, three-dimensional process involving compartment-specific changes in superficial and deep facial fat, together with alterations in retaining ligaments, the SMAS, and adjacent neurovascular structures. The reviewed evidence indicates that deep fat compartments primarily provide structural support and facial projection, whereas superficial compartments contribute to contour and dynamic facial expression. Consequently, effective facial rejuvenation should be individualized and anatomically guided, prioritizing restoration of deep support before refining superficial contours. Integrating detailed anatomical assessment with appropriate injection planes, product selection, layered techniques, and ultrasound guidance may improve treatment precision, preserve natural facial dynamics, and reduce complications such as vascular occlusion, filler migration, and contour irregularities. Further well-designed clinical studies are required to standardize compartment-based protocols and evaluate their long-term safety and effectiveness across diverse patient populations.

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