

# Anatomical Importance of Fat Compartments in Facial Aging: A Review

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**Abstract** : The face comprises five histological layers: skin, subcutaneous fat, the superficial musculoaponeurotic system, a deep fat layer, and the periosteum. Facial aging is characterized by progressive bone resorption, connective-tissue remodeling, loss of skin tone, and redistribution of fat. Repetitive muscular contraction and ligamentous strain promote superficial fat redistribution around deep wrinkles, crow's feet, and perioral folds, whereas deep fat undergoes both atrophy and ptosis. The face contains several fat compartments, including the nasolabial fold fat pad, buccal fat pad, medial cheek fat pad, infraorbital fat pad, lateral temporal cheek fat pad, and medial temporal fat pad. Depending on depth, these pads are further classified as superficial or deep fat pads. With advancing age, the degree of sagging is dictated by the intrinsic properties of each compartment and the regional density of connective tissue. Consequently, an individualized therapeutic strategy is required for each compartment. This review summarizes age-related changes in the facial fat compartments and underscores their importance in the clinical management of facial aging.

**Keywords** : Aged face, Fat compartment, Superficial fat pad, Deep fat pad

## INTRODUCTION

The face is composed of several consecutive layers: (1) skin; (2) subcutaneous fat, including the retinacula cutis formed by fibrous connective tissue; (3) the superficial musculoaponeurotic system (SMAS); (4) deep fat; and (5) periosteum or deep fascia [1]. The galea aponeurotica, also known as the epicranial aponeurosis, is a sturdy sheet of dense fibrous tissue covering the upper skull. Laterally, the

galea continues as the superficial temporal fascia, whereas the periosteum becomes the deep temporal fascia [1]. The term SMAS was first introduced in 1976 to designate a distinct fascial layer between the superficial and deep fat layers [2]. More recent work, however, suggests that the SMAS cannot yet be precisely defined [3]. Contrary to earlier reports that a continuous SMAS exists throughout the face [2], anatomical studies have failed to identify a discrete SMAS above the mid-cheek or anterior to the submandibu-

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lar gland [4,5]. Moreover, the SMAS has been described as a network of fibrous septa linking the mimic muscles and periosteum to the dermis, implying that it may be bilaminar rather than trilaminar [6]. Accordingly, uncertainty persists regarding the existence and extent of the SMAS, and further reevaluation is warranted. In the present review, we use the term SMAS to preserve continuity with previous literature.

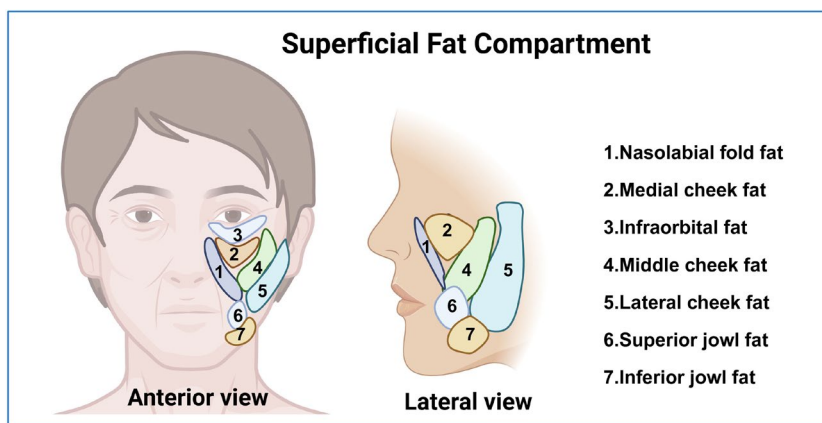
The retaining ligaments of the face are dense fibrous septa that traverse the facial tissue planes from the periosteum or deep fascia to the dermis, thereby supporting and stabilizing both the skin and SMAS [7]. Each ligament branches from its origin on the periosteum or deep fascia, fans out toward the SMAS, and ultimately inserts into the dermis [8]. This network, termed the retinacular cutis, is part of a complex fibrous septal system known as the facial “facial fatty layer” [9,10]. By creating zones of adhesion, the retaining ligaments and subcutaneous septa partition the face into superficial and deep compartments.

With age, bones resorb, connective tissue relaxes, skin quality declines, and fat compartments shift [11]. Progressive skeletal reduction yields relative skin excess and displacement of fat. Concurrently, repetitive muscular activity and ligamentous attenuation deepen facial wrinkles [12]. Together, these changes compromise structural integrity [13,14] and promote volume loss [15]. The principal fat compartments include the nasolabial fold fat pad, buccal fat pad, medial cheek fat pad, infraorbital fat pad, lateral temporal cheek fat pad, and medial temporal fat pad (Figs. 1 and 2). These compartments are categorized broadly as super-

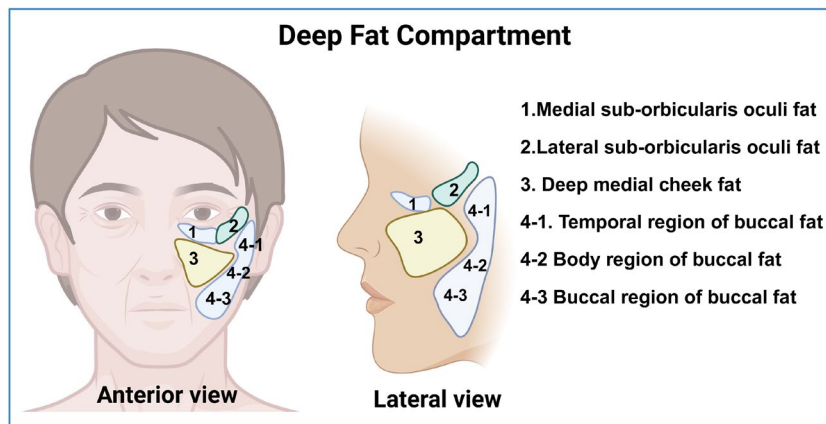
ficial fat compartment (Fig. 1) or deep fat compartment (Fig. 2) [16]. With aging, redistribution and sagging of the superficial compartments accentuate the lateral nasolabial and labiomental folds [11], whereas atrophy and descent of the deep compartments generate a hollow, fatigued appearance [16-18]. Optimal rejuvenation, therefore, requires a comprehensive understanding of these anatomical changes. In this review, we synthesize current evidence on age-related alterations in facial fat compartments to guide individualized treatment of the aging face.

## FACIAL FAT COMPARTMENT ANATOMY

In the subcutaneous fat of the face, discrete compartments have been described (Table 1), including the nasolabial fold, buccal, cheek, orbital, medial temporal, and lateral-temporal cheek fat pads (Figs. 1 and 2). Each compartment is bordered by retaining ligaments and supports facial muscle movement [9]. The forehead contains three superficial fat compartments—the central, middle temporal, and lateral-temporal cheek pads [19]. The middle temporal pads lie on either side of the central compartment, and the compartment of the forehead continues into the lateral-temporal cheek and cervical fat [9]. The central third of the face houses the buccal fat compartments (medial, middle, and lateral temporal) as well as the nasolabial fat [9]. The buccal fat pad, also known as Bichat’s fat pad, is located in the masticatory region, posterior to the buccal space, and contributes to



**Fig. 1.** Superficial fat compartments in facial regions. Superficial fat compartments in anterior and lateral views. In the face, superficial compartments include the (1) nasolabial fold fat pad, (2) medial cheek fat pad, (3) infraorbital fat pad, (4) middle cheek fat pad, (5) lateral cheek fat pad, (6) superior jowl fat pad, and (7) inferior jowl fat pad.



**Fig. 2.** Deep fat compartments in facial regions. Deep fat compartments in anterior and lateral views. In the face, deep compartments include the (1) medial sub-orbicularis oculi fat pad, (2) lateral sub-orbicularis oculi fat pad, (3) deep medial cheek fat pad, and the buccal fat pad regions ([4-1] temporal, [4-2] body, and [4-3] pterygoid).

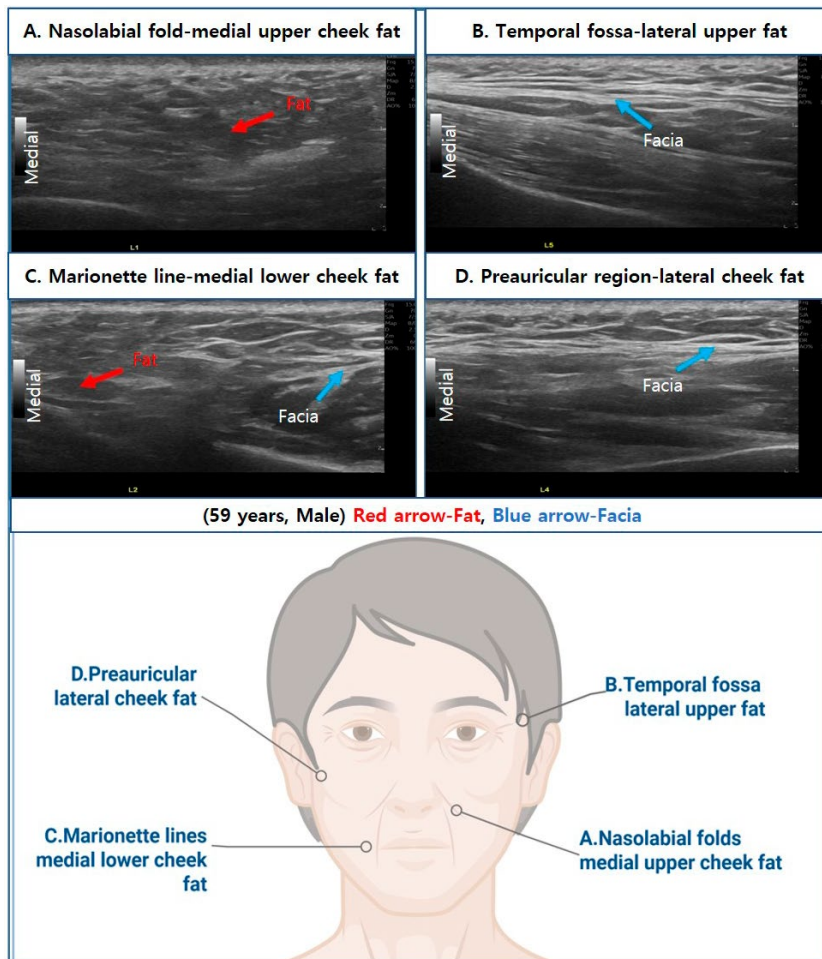
**Table 1.** Facial fat compartments and aging manifestations

Fat compartment	Location/characteristics	Aging manifestations
Superficial fat	Lies directly beneath the skin; mobile, influenced by mimetic muscles	Formation of wrinkles and folds, descent leading to jowling
Deep fat	Firmly anchored to underlying bone and fascia; relatively immobile	Volume loss causing midface hollowing, deepened tear trough, flattening of malar region
Buccal fat	Masticatory region, posterior to buccal space	Progressive volume reduction, sunken cheek
Periorbital fat	Around the orbit; subdivided into distinct superficial fat compartments	Herniation or atrophy leading to eyelid bags, hollowing, or accentuated tear trough deformity
Jowl fat	Lower third of face, submental region, within superficial layer	Sagging of jawline, appearance of jowls.

facial muscle movement [20]. Three superficial periorbital fat compartments—superior, inferior, and lateral—have also been identified [9]. Jowl fat comprises the superficial fat layer of the lower third of the face and the submental region [21,22]. Deep fat is relatively immobile because it is firmly anchored to underlying bone; it defines contours, supports overlying compartments, and provides a gliding plane for muscle movement (Fig. 2) [23,24]. In contrast, superficial compartments are more mobile and subject to dynamic muscular tension (Fig. 1) [23]. Because facial fat is highly compartmentalized, the quantity and stability of each compartment strongly influence facial appearance and expression. Given the heterogeneity of the surrounding ligaments and muscles, not all compartments change at the same rate with aging; therefore, detailed knowledge of each compartment is essential for understanding facial aging [25,26].

## IMPORTANCE OF FAT COMPARTMENTS IN FACIAL AGING

With advancing age, gravitational forces shift fat within its compartments, resulting in medial displacement of the skin envelope, deepening cheek hollows, and flattening facial angles [12]. The temporal region loses superficial fat pads, bilateral cheekbone width decreases, and the temples experience the greatest volume loss of any facial region [27]. Magnetic resonance imaging suggests that apparent temporal deflation may result from fat migration within the supratemporal compartment rather than absolute volume loss [28]. Fat depletion above the eye alters the upper-eyelid arch [29]. The lower eyelid also descends, while fat accumulation and scleral show become more prominent. Inferior orbital fat prolapses anteriorly because diminished skeletal



**Fig. 3.** Ultrasound images by facial region. Ultrasound images obtained from four facial regions. (A) Nasolabial fold, medial upper cheek fat pad; (B) temporal fossa, lateral upper cheek fat pad; (C) marionette lines, medial lower cheek fat pad; (D) preauricular area, lateral cheek fat pad. Red arrows indicate fat droplets containing adipocytes, whereas blue arrows indicate connective tissue containing fibroblasts.

support cannot contain the weakened soft tissue [30]. Nasolabial folds form when lip levator muscles contract during smiling, increasing tissue-expansion pressure within the overlying superficial nasolabial fat pad [31]. The nasolabial pad—the inferolateral portion of what was formerly termed the zygomatic fat pad—may descend owing to recession of the maxillary and mandibular bones [32,33] and/or atrophy of the lateral and deep medial buccal fat pads. This descent can be exacerbated by weakening of the zygomatic and orbital ligaments, thereby losing support [34], and by laxity of the fascial septum within the nasolabial pad [35].

With age, facial fat does not atrophy uniformly; rather, the deep and superficial compartments change in distinct ways. Deep central buccal fat demonstrably atrophies, whereas superficial buccal fat hypertrophies [25]) One study

likewise reported hypertrophy of superficial submandibular fat concurrent with shrinkage of buccal fat [36]. Adipose tissue in the face can be subdivided into superficial fat (layer 2) and deep fat (layer 4), separated by the SMAS (layer 3). Both superficial and deep layers are composed of discrete fat compartments bordered by septa, fascia, ligaments, or muscle [37]. The deep compartment contains smaller adipocytes than the superficial compartment [38]. As the severity of nasolabial folds increases, mid-face volume decreases [39], suggesting that nasolabial folds arise secondarily from selective hypertrophy of the upper portion of the buccal fat pad [25].

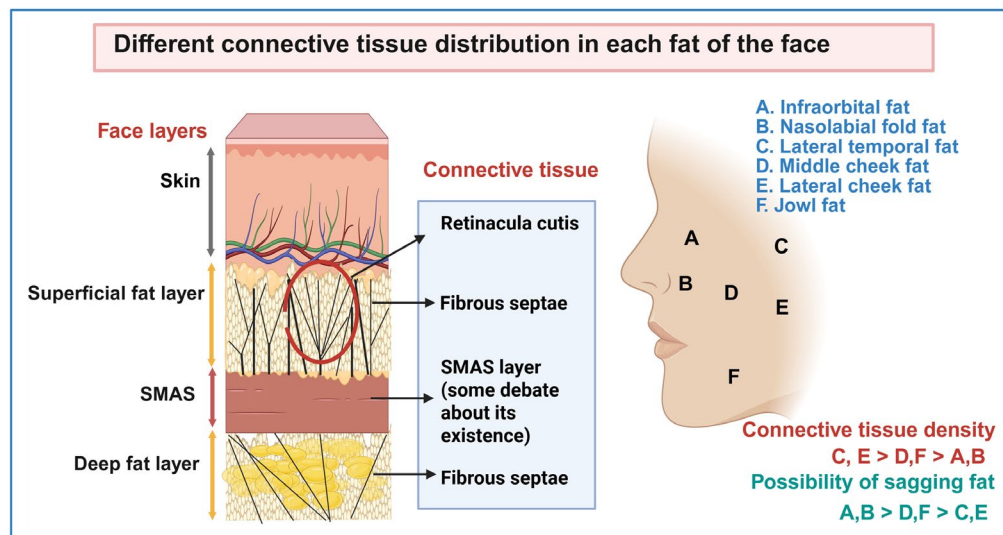
The buccal fat pad is divided into three lobes— anterior, middle, and posterior—and is anchored to the maxilla, posterior zygomatic bone, medial and lateral margins of the

infraorbital fissure, temporalis tendon, and buccinator fascia by six ligaments. With age, buccal fat pad volume increases significantly and its density decreases [40,41]. Contraction of the superficial lateral temporal fat pad also leads to lateral buccal atrophy [24]. In the lateral facial view shown in Fig. 2, we illustrate the temporal region of the buccal fat pad (4-1), body region of buccal fat pad (4-2) and the pterygoid region of the buccal fat pad (4-3) (Fig. 2). With age, the buccal fat pad located in the temporal region descends into the lower face and subsequently aggravates the labiomandibular fold [42]. Weakening of facial retaining ligaments—such as the orbital and zygomatic ligaments—and/or superficial fascial attachments may also contribute to this descent. These changes in the central facial fat pad reduce cheek prominence and create a sagging appearance [24]. As we age, the oral commissure sags into the space created by volume loss in the jaw area, and the lipomandibular folds become more prominent, leading to a sad expression [31]. The lipomandibular folds are further aggravated by loss of cheek support and the downward pull of chin fat as the buccal fat pad covers the anterior border of the inferior pterygoid muscle [37].

As mentioned above, differences in the distribution of connective tissues such as the SMAS are expressed variably across fat compartments 1 (nasolabial fold fat pad), 2 (buc-

cal fat pad), and 5 (lateral temporal cheek fat pad) when the face is viewed laterally (Fig. 3). Fig. 3 presents ultrasound images of these compartments. In Fig. 3A, the nasolabial fold-medial upper cheek fat pad contains scant connective tissue with abundant adipocytes; in Fig. 3B, the temporal fossa-lateral upper fat pad contains relatively little fat and abundant connective tissue. Consequently, the lateral temporal fat pad resists sagging more effectively than the nasolabial fold fat pad, as connective tissues such as the SMAS and retinacula cutis do not sufficiently support the inner portion of the nasolabial fold [42]. Fig. 4 further illustrates the distribution of connective tissue within each facial fat compartment. The superficial fat layer contains tree-like retinacula cutis and fibrous septae, whereas the deep layer contains only fibrous septae. Ultimately, the density of connective tissue within each fat pad, combined with reduced skin elasticity, governs the degree of facial sagging during aging [43]. Consequently, nasolabial fat pads, which possess lower connective-tissue density, sag more readily than lateral cheek fat pads (Fig. 4).

Healthy adipocytes—normal in size and exhibiting an anti-inflammatory phenotype—are critical for determining fat-pad volume, susceptibility to sagging, and the overall skin-aging process of the face [44,45]. Earlier studies regarded facial adipose tissue as a relatively inert, purely



**Fig. 4.** Connective tissue distribution in each facial fat pad. Within the superficial fat layer, two principal connective-tissue structures—retinacula cutis and fibrous septae—are observed. The SMAS layer comprises connective tissue; however, its existence remains controversial. In the deep fat layer, fibrous septae are again present. Among facial fat pads, the infraorbital and nasolabial fold pads demonstrate lower connective-tissue density and, consequently, a higher tendency to sag. In contrast, the lateral cheek and lateral temporal pads exhibit greater connective-tissue density and are less prone to ptosis. The relative connective-tissue density and propensity for sagging in each fat pad are denoted by inequality signs.

volumetric substrate whose principal role was lipid storage; accordingly, interventions aimed to augment or reduce volume for cosmetic contouring. Contemporary research, however, now evaluates facial fat in terms of both quantity and quality [44]. The quality and quantity of adipose tissue influence systemic metabolism and modulate its capacity to maintain surrounding skin elasticity [46,47]. Adipose-tissue quality dictates adipocyte size as well as the ability to expand and differentiate [48]. A pro-inflammatory adipocyte phenotype initiates a negative feedback loop: inflammation slows adipogenesis, compelling existing cells to hypertrophy in compensation [49,50]. Moreover, aging-related inflammation impairs preadipocyte differentiation and further amplifies inflammatory signaling [51]. Collectively, this evidence underscores the importance of improving fat quality within individual compartments when treating the aging face.

## CONCLUSIONS

In this review, we emphasize the importance of facial fat layers and compartments in the aging process. As we age, fat is redistributed across facial regions: deep and superficial layers evolve differently, as do lateral and medial compartments. The size of individual fat droplets, together with the distribution of adipocytes, fibroblasts, and connective tissue within each compartment, determines the compartment's susceptibility to age-related sagging. Within the connective tissue, fibroblasts are the primary cells responsible for synthesizing the extracellular matrix, thereby maintaining homeostasis and supporting regeneration during aging [52]. Adequate fibroblast stimulation promotes collagen and elastin synthesis, forming a dense supporting layer that stabilizes the retinacula cutis, SMAS, and fibrous septae, thereby limiting fat-layer sagging. Optimal anti-aging management, therefore, hinges on recognizing the distinct properties of superficial and deep fat, restoring fibroblasts and collagen to enhance compartment elasticity, selectively removing unwanted adipose tissue, and replacing volume where required.

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