Journal of Plastic, Reconstructive & Aesthetic Surgery (2015) **68**, 344–350

An analysis of Asian midfacial fat thickness according to age group using computed tomography

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Received 7 May 2014; accepted 21 October 2014

KEYWORDS
Aging;
Fat;
Midface;
Facial rejuvenation

Summary *Background:* The understanding of facial fat volume change with aging is essential for facial rejuvenation. The aim of this study was to investigate aging-related alterations of midfacial fat thickness (FT) using computed tomographic images.
Methods: Eighty computed tomographic scans of patients of four age groups (20s, 40s, 60s, and 80s), who underwent septoturbinoplasty, were studied. The body mass index of the patients was limited to 25.0 ± 2 kg/m^2. At seven consistent points in the midface including the infraorbital (two points), mid-cheek (two) and nasojugal area (three), the measurements of the total facial thickness (TFT) and FT were conducted on a reconstructed sagittal plane by four trained observers using a medical imaging software.
Results: The interrater reliabilities for each measured point were excellent (overall intraclass correlation coefficients = 0.94). There was no significant difference in the TFTs of each point among the age groups (all $P > 0.05$). By contrast, the FTs of the four points (infraorbital and nasojugal area) showed a significant increment in the elderly than in young subjects (all $P < 0.011$). The FTs of the mid-cheek exhibited almost no change among the age groups (all $P > 0.05$).
Conclusion: This study suggests that the midfacial fat pad is thickened in the elderly and that there is a site specificity in the alteration.

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http://dx.doi.org/10.1016/j.bjps.2014.10.037
1748-6815/

Introduction

The elderly seem to have common facial characteristics including loss of midfacial projections, prominent nasojugal creases, showing of the malar mound, deep nasolabial folds, and jowl prominences.[1] Among a variety of age-related facial changes, the alteration of the midfacial area is prominent. The typical features include medial and lateral orbital hollow (tear-trough depression), and mid-cheek depression. This seems to be related to a relative positional change of fat compartments, inferior migration, as well as fat atrophy.[2,3] However, recently, a three-dimensional (3D) volumetric analysis of eyebrow soft tissue revealed that fat volume increased with aging.[4] Hence, this study did not accept the common concept of lipoatrophy as a key element of facial aging.

There was great advancement in the understanding of facial fat as a component based on cadaveric studies.[1,2,5] However, such cadaveric studies had several limitations. The subjects of the study were old-aged and not alive. Although there were young subjects, there was no control for body mass index (BMI) and underlying disease, both of which could have influences on the result. Comparing studies between old cadavers and more or less older ones are likely to show distorted data regarding age-related changes of fat. Further, there was a fascinating study comparing photographs of the past and present.[6] However, such a type of study could not explain the mechanisms of facial aging.

A sufficient understanding of aging-related changes is essential for optimizing facial rejuvenation and achieving a more natural appearance. However, it is unclear as to which area shows fat accumulation or lipoatrophy and, further, whether the change is due to changes in fat or not.

Computed tomography (CT) provides 3D or three-planar information of the facial anatomy.[7–9] Moreover, adipose tissues have a specific range of Hounsfield unit (HU), which allows for the adipose tissue to be distinguished from soft tissue.[7,9,10] CT enables a reproducible depiction of facial fat and reveals changes with aging. Therefore, a serial analysis of facial CT images can show the process of change with aging. It is difficult to separate midfacial fat compartments by using CT. Furthermore, the analysis of fat volume change of a specific area is not sufficient to explain the alteration in facial appearance. The fat thickness (FT) of a particular point, rather than the volume of a specific area, can help account for the changes with aging. The aim of this study was to introduce a convenient method for comparing FT using CT images as well as to understand the change of midfacial FT according to aging.

Materials and methods

Patients

Male patients who underwent septoplasty and/or turbinoplasty between 2008 and 2013 were retrospectively searched. A total of 80 patients were enrolled in this study. All of the patients underwent a non-contrast paranasal CT scan at our hospital, which was performed in the neutral head position. The patients were categorized into four age groups (20s, 40s, 60s, and 80s), and each group included 20 subjects. Patients who were diagnosed with chronic rhinosinusitis, obstructive sleep apnea, and tumor were excluded. The height of the patients was limited to the range from 160 to 180 cm due to obviate possible difference of musculoskeletal characteristics. Moreover, the BMI of subjects was limited to the range from 23.0 to 26.9 kg/m^2 due to the following two reasons: One was a positive relevance between BMI and midfacial fat volume, and the other was a limited pool of elderly patients (80s). The study was approved by the Institutional Review Board of the Samsung Medical Center.

Device and software

CT imaging of the paranasal area was performed using Toshiba Aquilion systems (Toshiba Medical Systems, Otawara, Japan). The protocol used for the imaging was as follows: tube voltage = 120 kV; tube current = 150 mA; irradiation time = 3 s; and slice thickness = 2 mm. Axial DICOM (digital imaging and communications in medicine) image files sourced from the CT scan were extracted for use in the image-analysis software AMIRA 5.4 (Mercury Computer Systems/3D Viz group, San Diego, CA, USA) in order to reconstruct three-planar images as well as to measure the FT of the midfacial area. The image software enables pixel-level measurements, and, therefore, the measurement error for the same measuring point is negligible. A fat tissue was defined as an area of a pixel between −200 HU and −50 HU.[7,10]

The three-planar measurement of midfacial fat

Facial fat is thought to be a key component of facial appearance and is known to change with aging. For an evaluation of the alteration of midfacial fat, it is easy to misunderstand measuring the volume of each compartment to be the best way. However, the volume itself does not represent the surficial morphology of the face. Thus, it would be better to set several consistent points to measure and estimate the thickness of fat for the evaluation of an aging face. According to this conclusion, seven consistent points representing the infraorbital, mid-cheek, and nasojugal area were determined by the intersections of three vertical lines (lateral margin, midline, and medial margin of the eyeball) and three horizontal lines (infraorbital rim, insertion of inferior turbinate, and nasal spine) on the coronal plane (Figure 1). The seven points were labeled as inferior orbital-lateral (IO-lat), inferior orbital medial (IO-med), mid-cheek-lateral (MC-lat), mid-cheek-medial (MC-med), nasojugal-superior (NJ-sup), nasojugal-middle (NJ-mid), and nasojugal-inferior (NJ-inf). At the seven points, the total facial thickness (TFT) and FT were estimated on the reconstructed sagittal image of CT. The FT was measured without a distinction of various midfacial fat compartments (Figure 2). Measurement was carried out in a blinded manner by four trained observers using anonymized DICOM data. In the study, the primary outcome was the change of FT according to aging. The additional outcomes were nonfat thickness (NFT: difference between TFT and FT) and the percentage of FT over TFT (FR:fat ratio). The