Facial Surgery

Defining the Fat Compartments in the Neck: A Cadaver Study

Jeffrey D. Larson, MD; William S. Tierney, MS; Cemile Nurdan Ozturk, MD; and James E. Zins, MD

Abstract

Background: Cervicoplasty is an important component of aesthetic facial and neck surgery, but the fat content in this area has not been described.

Objectives: The authors identify anatomic compartments of fat in the neck (specifically the areas relevant to surgical management), quantify the fat in each compartment, and describe the relationships between each compartment and the submandibular glands.

Methods: The skin was removed from 10 fresh cadaver heads. Each compartment of fat was weighed, along with the submandibular gland. Supraplatysmal fat was found between the skin and the platysma muscle, and it was compartmentalized into suprahyoid and infrahyoid fat. Subplatysmal fat was found deep to the platysma and between the medial edges of the anterior digastric in the midline; this fat also fell into supraphyoid and infrahyoid compartments. The “very deep” fat was deep to the anterior digastric muscles and submandibular gland, and adherent to the strap muscles.

Results: On average, supraplatysmal fat represented 44.7% of the fat in the neck, the subplatysmal fat represented 30.7%, and the submandibular gland represented 24.5%. The very deep fat was scant, representing less than 1% of the fat in the neck.

Conclusions: This anatomic study provides a comprehensive review of fat in the neck, and the results should serve as an additional guide as surgeons approach this challenging area in surgical rejuvenation.

Keywords
facial surgery, aging neck, neck fat, cadaver, facelift, necklift

Accepted for publication September 23, 2013.

As surgeons have gained a more thorough understanding of the complexities of facial anatomy and the physiology of aging, rhytidectomy has progressed from addressing only skin to treating multiple facial layers. Cervicoplasty is an important component of aesthetic facial surgery, and the literature is replete with descriptions of surgical options for treating this region.

Comprehensive descriptions of the surgical anatomy of the neck have been offered by Feldman,1 Rohrich and Pessa,2 Nahai et al,3 Raveendran et al,4 and others. In recent years, the area has received increased attention from an aesthetic standpoint, and isolated neck procedures have gained popularity. The current consensus—although not universally accepted5—supports the submental approach to altering supraplatysmal and subplatysmal neck structures such as submental fat, subplatysmal fat, the anterior digastric muscles, and perhaps the submandibular gland in selected patients to enhance surgical results.6 9

A thorough understanding of the nuances of the 3-dimensional anatomy of anterior neck structures is the most likely means of ensuring consistent surgical results. Therefore, a description of supraplatysmal, subplatysmal, and very deep fat compartments and their spatial and quantitative relationships should be helpful for practicing plastic surgeons. This study expands on recent reports on fat compartments in the neck by Rohrich and Pessa2 and

Dr Larson is a plastic surgeon in private practice in Madison, Wisconsin. Mr Tierney is a medical student at the Cleveland Clinic Lerner College of Medicine, Cleveland, Ohio. Dr Ozturk is a Fellow in and Dr Zins is Chairman of the Department of Plastic Surgery, Cleveland Clinic Foundation, Cleveland, Ohio.

Corresponding Author:
Dr Jeffrey D. Larson, Meriter Medical Group, 202 S. Park St, Madison, WI 53715, USA.
E-mail: jeffdlarson@yahoo.com
others\textsuperscript{10,11} and to determine the relative distribution and variability of fat in these compartments.

**METHODS**

Ten fresh cadaver heads were utilized. The age, sex, and race of each subject were recorded. Subjects’ weights were not available. Each fat compartment was weighed with an electronic scale and photographed; the weight was recorded as a percentage of total anterior neck fat. The submandibular glands were removed, weighed, and measured, and their contribution to the total weight was also noted.

The skin of the neck was removed sharply. The superior extent of the supraplatysmal dissection was the border of the mandible. The inferior extent was the clavicle and the sternal notch in the midline. The lateral extent was the anterior aspect of the sternocleidomastoid muscle (Figure 1). The skin was removed just deep to the dermis, preserving the supraplatysmal fat overlying the platysma and SCM muscle.

The hyoid bone was noted; the supraplatysmal fat was divided into 2 compartments, 1 above and 1 below the hyoid bone (Figure 2). The supraplatysmal fat above the hyoid was removed, with care taken not to disrupt the underlying platysma muscle. The supraplatysmal fat inferior to the hyoid and superior to the thyroid cartilage was removed and weighed in a similar fashion. The jowl fat was identified, and its relationship to the supraplatysmal fat of the neck was noted. The platysma was then removed, noting the decussation pattern described by de Castro\textsuperscript{12} and exposing the subplatysmal fat deep to the platysma. This included fat in the midline between the medial edges of the platysma and was divided into central and lateral fat compartments above and below the hyoid (Figures 3 and 4).

The central suprahyl oid fat is bordered laterally by the anterior digastric muscle, and the central infrahyoid fat is between the hyoid bone and the thyroid cartilage. The lateral suprahyl oid fat lies lateral to the submandibular gland, while the lateral infrahyoid fat is a discrete, triangle-shaped layer found medial to the SCM muscle. The very deep fat compartment in the neck is bordered superficially by the anterior belly of the digastric and the submandibular gland (Figure 5). This fat adheres tightly to the superficial layer of strap muscles, the sternohyoid and omohyoid, the thyroid cartilage, and the investing deep fascia of the neck.
Because of its small volume relative to the supraplatysmal and subplatysmal compartments, adherence to the deep structures, and lack of relevant surgical treatment, it was not removed or weighed.

Dye injection studies were also performed on 4 specimens (Figure 6) by injecting 10 mL of methylene blue subcutaneously through 1 central submental injection site. Care was taken to inject superficially and allow the dye to diffuse through the tissue planes rather than directly injecting the fat compartments themselves. Injections were performed 12 to 24 hours prior to dissection to allow the dye to diffuse throughout the soft-tissue planes. Dissection was performed as previously described, with attention to dye diffusion patterns throughout the neck’s fat compartments.

Measurements were recorded, and percentages of total fat weight were calculated for each subcompartment of each cadaver. All statistics were calculated using the JMP Statistical Package, Version 7 (SAS Institute, Inc, Cary, North Carolina). Descriptive statistics were calculated for all fat weights and percentages, and statistical testing was performed to compare fat weights by compartment in the male and female groups. To limit multiple-comparisons errors, statistical testing was performed only for values that seemed to differ between male and female subjects. Sample sizes were too small to justify comparisons between age groups.

Figure 3. The subplatysmal fat compartment, located between the platysma and the submental musculature, is shown in a cadaver. This compartment is further divided into 6 subcompartments: the central suprahypoid is between the hyoid and the border of the mandible, bordered laterally by the anterior belly of the digastric muscle. The central infrahyoid is between the hyoid bone and the thyroid cartilage. The lateral suprahypoid subcompartments (1 on each side) are between the anterior digastric muscle, the border of the mandible, and the submandibular gland. The lateral infrahyoid subcompartments (1 on each side) are between the submandibular gland and the anterior border of the sternocleidomastoid.

Figure 4. Superior and inferior lateral subcompartments of the subplatysmal fat compartment. Note the natural division around the submandibular gland and the lateral location of the fat, which differs from previous descriptions.

Figure 5. The very deep fat compartment, located deep to the submandibular glands and submental musculature, is shown adjacent to the strap muscles and fascia of the neck in a cadaver.
Ten cadavers—4 male and 6 female—were dissected. All patients were elderly, with ages from 64 to 87 years (mean, 73 years). Eight specimens had type 1 platysmal decussation, 1 had type 2, and 1 had type 3.12

The weight of fat from each subcompartment is shown in Figure 7. The supraplatysmal suprahypoid compartment contained 29.7% (±11.2%) of the fat complement of the neck, and the supraplatysmal infrahyoid compartment contained 15% (±8.3%). The subplatysmal compartment consisted of 6 subcompartments: central suprahypoid, the central infrahyoid, the left and right suprahypoid, and the left and right infrahyoid. The infrahyoid central contained 6.0% (±4.2%) of the total subcutaneous soft-tissue complement, the infrahyoid lateral contained 7.6% (±1.4%), the suprahypoid central contained 9.1% (±4.9%), and the suprahypoid lateral

RESULTS

Figure 6. A cadaver is shown 24 hours after dye injection in the submental area. (A) Dye injection demonstrated consistent staining of the supraplatysmal (B) and subplatysmal (C) fat compartments. (D) The very deep compartment did not stain (dye pictured is from the overlying superficial compartment and the subplatysmal compartment, which has been reflected off the deep structures).
contained 8.0% (±4.1%). The submandibular glands, including the deep lobe of the gland underneath the mandibular rim, were removed and weighed separately from the rest of the neck fat. They weighed an average of 9.4 g (±3.2 g), representing 24.5% (±14.4%) of the total subcutaneous soft-tissue complement.

Comparing sexes, we found that in female cadavers, 51% of the fat and glandular content was found in the supraplatysmal compartment (Figure 8), while in males, it was only 35% (Figure 9). This difference failed to reach statistical significance using Wilcoxon rank sum nonparametric testing ($P = .1344$). Both sexes had a similar amount of fat in the subplatysmal compartment, which was approximately one-third of the fat/glandular content of the neck (males 33%, females 29%). In males, 32% of the fat/glandular content was occupied by the submandibular gland, while in females, it was only 20%. When the proportions of one cachectic male (specimen 9) were excluded, the proportion in males was closer to that of females, with the supraplatysmal fat being 41.4%, subplatysmal fat being 36.2%, and the submandibular gland being 22.3%.

Cadavers were also analyzed by age group. Those aged 60 to 69 years ($n = 4$) had 40% of their fat in the supraplatysmal compartment, those aged 70 to 79 years ($n = 3$) had 50%, and those aged 80 to 87 years ($n = 3$) had 44%. Subjects aged 60 to 69 years had 28% of their fat in the subplatysmal compartment, compared with 35% in those aged 70 to 79 years and 33% in those aged 80 to 87 years. These differences failed to reach statistical significance, and further study would be required to determine whether these results are due to small sample size or homogeneity among these age groups.

Jowl fat was encountered during dissection of the lateral aspect of the suprahyoid fat in the supraplatysmal plane. That fat was a brighter yellow in appearance and its consistency was more globular than the fat in the neck. When dye injections were evaluated, supraplatysmal and subplatysmal fat compartments were found to be continuous in both the anterior/posterior and supraplatysmal/subplatysmal planes. Dye staining was present throughout the supraplatysmal fat, platysma, and subplatysmal fat but was not present in the very deep fat compartment in any

Figure 7. Weights of the fat from the supraplatysmal and subplatysmal subcompartments.

Figure 8. Proportion of fat in each subcompartment in female cadavers.
specimen, demonstrating that the subplatysmal and very deep compartments were distinct from each other. Also, jowl fat was stained in continuity with the supraplatysmal fat. Within the subplatysmal compartment, the lateral infrahyoid fat did not stain, suggesting that this fat pad may be an anatomically distinct plane within the neck.

DISCUSSION

Early descriptions of fat compartments in the face and neck were published by Whetzel and Mathes\(^\text{13}\) and Taylor and Palmer,\(^\text{14}\) who described the blood supply and angiosomes in the face and neck. Recent studies by Rohrich and Pessa\(^\text{15}\) have further detailed these fat compartments, their relationship to retaining ligaments, and their clinical significance to facial aging. Feldman\(^\text{7}\) and Nahai et al\(^\text{3}\) have also described anterior neck fat anatomy as it pertains to cosmetic surgery. Regarding the quantity of subplatysmal fat, these authors noted that it was “variable,” with obese patients having subplatysmal fat that extended to the lateral border of the platysma and thin patients having less fat. The first attempt to quantify the amount of fat in the neck was made by Adamson et al,\(^\text{16}\) who removed and weighed fat from obese, elderly cadavers as part of their correction of the “turkey gobbler” deformity. They found that this “submental fat pad” weighed 15 to 25 g and had a volume of 15 to 27 mL. Later, Renaut et al\(^\text{17}\) studied subplatysmal fat in preserved cadaver specimens of unknown ages and sexes and found that subplatysmal fat represented 12% to 53% of the supraplatysmal and deep fat of the neck. In addition to their work on fat compartments in the face, Rohrich and Pessa\(^\text{2}\) also conducted a study focusing on the fat deep to the platysma and superficial to the mylohyoid. They described 3 compartments of subplatysmal fat (central, medial, and lateral) based on anatomic location, fat composition, and dye injection studies.

We know that the central compartment of fat is yellow, whereas the medial and lateral compartments are lighter in color. These 3 compartments form a V-shaped mass of adipose tissue that extends from the lateral third of the mandible to the thyroid cartilage. They further demonstrate the presence of a central subcompartment of fat deep to the platysma. Most recently, Raveendran et al\(^\text{4}\) performed a similar study in which the neck fat and submandibular glands were removed from 29 cadavers and weighed.

In an attempt to extend the work of Rohrich and Pessa\(^\text{2,15}\) and others, we have described the fat compartments of the neck and relative amounts of fat in each compartment compared with the total neck fat. Our results differ from those of Rohrich and Pessa with regard to their classification of the fat lateral to the midline. While they identified medial and lateral subcompartments of fat in the neck, our study identified only central and lateral fat compartments. Based on the figures and descriptions in their study, fat they labeled as “medial” most likely corresponds to the lateral, suprahyoid subcompartment described in our study (Figure 4), and fat they labeled as “lateral” most likely corresponds to fat overlying the submandibular gland, which was not identified in our cadavers. Differences in methodology may explain these discrepancies. Rohrich and Pessa did not include the submandibular gland, so precise correlations between the 2 studies are difficult to identify. Furthermore, they were able to suggest different fat compartments based on the appearance of fat in coronal sections, but because we did not perform coronal cuts, we were unable to appreciate these differences in fat appearance.

We found the majority of the fat in the supraplatysmal plane. Nearly half (44.7%) of the total fat in the neck was found in this superficial layer. It is important to note that the supraplatysmal fat compartments were difficult to distinguish; all of the anatomic structures are deep to it and not identifiable until the fat itself is removed. The division above and below the hyoid bone was performed for 2 reasons: (1) the hyoid bone was palpable deep to the neck fat while it was in situ, and (2) it was consistent with the anatomic descriptions of the subplatysmal fat.

Further, almost a third (30.7%) of the fat in the neck was in the subplatysmal compartment deep to the platysma. However, fat in this layer varied from as little as 18% to as much as 45% of the total fat. Subplatysmal fat is difficult to assess clinically prior to surgery; often, a true appreciation is only attained under direct vision. Our observations of this sometimes-significant but often-variable amount of fat in the subplatysmal compartment
to the platysma support the surgical approach of opening the platysma to address this fat when a significant amount is expected.

Of the 10 specimens studied, 8 had type 1 platysmal decussation, and a statistically significant difference between these and the other types of platysmal decussation (of which there was only 1 instance of type 2 and 1 of type 3) was not found. The inclusion of more specimens would have allowed us to examine this association more closely. No difference in fat deposition was identified based on the pattern of platysmal decussation.

Based on our findings regarding fat distribution differences between sexes, women would be expected to have more fat in the suprplatysmal plane, where it is amenable to removal by liposuction or under direct vision, and men and women would be expected to have equal amounts of fat when the subplatysmal space is assessed surgically after opening the platysma.

Using a subcutaneous dye injection technique patterned after a similar study of fat in the submental region, we found diffuse dye staining of the suprplatysmal and subplatysmal planes, including their subcompartments. This finding is contrasted with those of Rohrich and Pessa, who employed a different injection technique in which subcompartments were injected directly. They described distinct staining of different regions of fat in the subplatysmal plane without dye diffusion between subcompartments. This difference is most likely related to our differing techniques of dye injection, and the findings of our dye studies may have been clarified further with an injection technique that addressed the fat compartments more directly.

What happens to neck fat as we age? The answer to this question would best be answered by a longitudinal study of patients studied noninvasively over time. Unfortunately, we cannot even indirectly address this issue because the age distribution of our cadavers was narrow (range, 64-87 years).

Limitations of our report included the use of cadavers that all were older than 64 years. We were unable to obtain young specimens through our cadaver program, and a wider range of ages would have allowed us to impart an additional measure of comparison and evaluate how fat in various locations in the neck differs over time. Also, using a caliper to measure the thickness of the fat while it was in situ, instead of simply weighing it after removal, would have been a useful additional measurement of the fat compartments.

Ptosis of the submandibular gland contributes significantly to the aging of the neck. Phtotic mandibular glands would be expected in all specimens in this study, but the inclusion of younger specimens that do not display this feature would have offered another measure of comparison and allowed us, for example, to determine whether the submandibular gland represents a smaller proportion of the neck’s fat and glandular component in younger people. Unfortunately, we are not able to comment on this. Our study results also implied that men may have relatively larger submandibular glands and relatively less superficial fat than women. More anatomic specimens may have helped confirm this and determine whether these differences between men and women are significant. Our study demonstrated that the submandibular glands comprised an average of 24.5% of the soft-tissue complement of the neck, but it is important to note that the whole submandibular gland was weighed and included in the calculation. The superficial lobe is typically the portion of the gland that contributes to neck fullness. Including the deep lobe may have biased our results. The size and volume of the digastric muscle also contribute to neck fullness, and the characteristics of this muscle could have been addressed. The same may be said about fat overlying the thyroid cartilage, which—while not included in our study—can be significant in the obese neck.

The most significant flaw of this study is that subjects’ body weights were not available. The study included a range of body habitus, from cachectic to obese, but these descriptions are based only on investigators’ gross observations and therefore characteristics and conclusions relating to the body weight cannot be included in this report. The ability to correlate fat content with BMI would have strengthened this study considerably. There was significant variation in fat distribution between individual males. In fact there was an almost-complete reversal of the fat ratio in 2 specimens, including an extraordinary male outlier who had a submandibular gland volume of 60%, which suggests he was cachectic. Unfortunately, this could not be corroborated. Fat ratios were therefore recalculated without data from the outlier male. Inclusion of more specimens or the body weight of existing specimens would have provided more information about these discrepancies. Areas for further research may include descriptions of fat overlying the thyroid cartilage, which, as described by Feldman and histologic analysis of fat specimens to identify the presence of fascial boundaries between compartments.

**CONCLUSIONS**

This study represents an attempt to further classify the clinically relevant fat compartments that may be encountered during surgical rejuvenation of the neck. Building on the work of previous investigators, we have attempted to quantitatively document the relative amounts and variability of fat in the suprplatysmal and subplatysmal planes of the neck, and thus emphasize the importance of assessing this fat at the time of surgical exploration.
Disclosures
The authors declared no potential conflicts of interest with respect to the research, authorship, or publication of this article.

Funding
The authors received no financial support for the research, authorship, and publication of this article.

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