A Comparative Study of Surgical Techniques on the Cervicomental Angle in Human Cadavers

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**Background:** The cervicomental (CM) angle is formed by the horizontal plane of the submental region and the vertical plane of the neck.

**Objective:** To compare the 2-dimensional effect of 4 surgical techniques on the CM angle in a human cadaver model.

**Design:** Anatomic presurgical and postsurgical comparative study performed on human cadavers preserved with ethylene glycol.

**Setting:** Academic medical research center in St Louis, Mo.

**Subjects:** Twelve cadaver specimens with obtuse CM angles with heads attached to the sternum and upper thorax.

**Interventions:** Standard superficial musculoaponeurotic system rhytidectomy techniques were performed on all cadaver heads. Four techniques were compared: (1) platysmal plication; (2) platysmal plication and plication of the anterior bellies of the digastrics; (3) platysmal plication, plication of the anterior bellies of the digastrics, and interlocking mastoid-to-mastoid sutures; and (4) platysmal plication and interlocking mastoid-to-mastoid sutures.

**Main Outcome Measures:** The comparative changes in CM angle, the distance between the mentum and CM angle (mentum-CM distance), and the distance between the sternum and CM angle (sternum-CM distance) obtained with each of the 4 surgical techniques. Anatomic characteristics of the cadavers were also noted.

**Results:** On average, the CM angle was significantly reduced after all procedures \( (P<.001) \). The mean sternum-CM distance increased significantly \( (P = .01) \). A trend toward significance was observed in the change in mentum-CM distance \( (P = .10) \). The presence of a low hyoid was significantly associated with a smaller CM angle after surgery \( (P = .009) \) and demonstrated a trend toward significance with an increase in mentum-CM distance \( (P = .07) \), but it was not significantly associated with an increase in sternum-CM distance \( (P = .58) \). After controlling for the presence of a low hyoid, the mastoid-to-mastoid suture significantly reduced the CM angle by approximately 11.3° \( (P = .002) \) and the sternum-CM distance by 1.15 cm \( (P < .001) \).

**Conclusions:** The CM angle and the sternum-CM distance were significantly affected by all procedures. The addition of the mastoid-to-mastoid suture had the greatest effect on the CM angle, and the reduction in CM angle was strongly associated with an increase in the sternum-CM distance. Presence of a low hyoid was the only preoperative factor associated with a significant postoperative reduction in CM angle.

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The cervicomental (CM) angle is formed by the horizontal plane of the submental region and the vertical plane of the neck. A well-defined CM angle is a hallmark of youth, complementing other aesthetic units of the face. The youthful neck is generally considered to include an acute CM angle (90°-100°), a distinct inferior mandibular border, subhyoid depression, a visible thyroid cartilage, and a visible anterior border of the sternocleidomastoid muscle.1,2 A lack of definition in the CM angle is frequently seen with aging due to the gradual loss of dermal elasticity and the progressive effect of gravity on the facial soft tissues. Unfavorable anatomic characteristics, including cervical skin laxity, attenuation of the platysma, preplatysmal and subplatysmal fat, a low hyoid, and retrognathia, can also blunt the CM angle. Regardless of the etiology, treatment of the obtuse CM angle can be a challenging surgical problem in facial rejuvenation.

Numerous classifications have been devised to describe the aging neck. The Dedo3 system, which is based on anatomic factors and not direct measure-
ment of the CM angle, is a useful guideline. According to this classification system, class I describes a youthful neck with a well-defined CM angle, without submental fat or loss of platysmal tone. A class II neck represents simple laxity of cervical skin without submental fat or loss of platysmal tone. Class III is characterized by submental fat accumulation, while class IV describes platysmal banding. Patients with retrognathia are considered to have a class V neck, and the individual with a low hyoid bone is described as class VI.

Different techniques have been reported to rejuvenate the appearance of the aging neck. The principal methods described include cervical supraplatysmal liposuction, wide supraplatysmal undermining, direct excision of subplatysmal fat, and approximation or division of the medial platysmal edges. Less conventional techniques, such as tailoring of the digastrics via resection or suturing, mastoid-to-mastoid suspension sutures, and direct excision of submental skin, have also been advocated. In addressing the wide CM angle, various methods include 1 or more of these maneuvers, performed via open and endoscopic techniques. These methods of CM angle modification may or may not be performed in conjunction with preauricular or postauricular modifications to the superficial musculoaponeurotic system (SMAS) or platysma. Despite the existence of numerous methods to address the obtuse CM angle, an objective comparative analysis between techniques is lacking in the literature.

Cervicofacial rejuvenation requires a detailed knowledge of head and neck anatomy. This anatomy is best highlighted in a review of pertinent structures and serious complications associated with rhytidectomy.

Anatomically, the CM angle is created by a break- point between the vertical portion of the neck and the transverse submandibular plane. Generally, this area corresponds to the vertical position of the hyoid bone relative to the mandible. Therefore, a low hyoid or a recession of the hyoid bone may affect the breakpoint of the CM angle. The anterior belly of the digastric is superiorly attached to the posterior belly of the digastric, which is innervated by the facial nerve. Therefore, when performing surgical maneuvers on the cadaver heads in the area of the digastric muscles, caution must be exercised with the effects of these additional techniques. Indeed, cadavers preserved in ethylene glycol maintain much of the pliability of live tissue.

This was an anatomic presurgical and postsurgical comparative study performed on human cadavers. The specimens consisted of cadaver heads attached to the sternum and upper thorax to allow for accurate measurement of sternum-CM distance.

The objectives of this study were to analyze (1) the 2-dimensional changes in the CM angle of human cadaver heads on which standard SMAS tightening procedures with platysmal plication have been performed and to contrast them with the effects of 3 additional techniques, (2) the changes in distance between the mentum and CM angle (mentum-CM distance) and the sternum and CM angle (sternum-CM distance) as a result of each type of procedure, and (3) the anatomic variables of each individual cadaver with respect to the procedure chosen and to the changes noted as a result of each procedure.

**METHODS**

The platysma attaches to the cervicoperiosteal fascia inferiorly and to the depressor anguli oris, risorius, and mentalis muscles superiorly. It follows a course from superior medial to inferolateral bilaterally, with a variable amount of decussation in the midline. The greatest amount of decussation is generally seen at the cephalic aspect of the muscle close to the mentum. The aging process tends to splay the platysma fibers laterally, causing platysmal banding and a subsequent increase in the CM angle.

Immediately superficial to the platysma are the subcutaneous fat and skin. Deep to the platysma, the marginal mandibular branch of the facial nerve is found or just inferior to the portion of the mandible traversed by the facial artery. There is considerable variation in the position of this nerve, so caution must be exercised with any dissection in the subplatysmal plane.

Twelve cadaver heads of similar age (60-70 years) with obtuse CM angles were used for the study. Each specimen was preserved with ethylene glycol, which preserves tissue elasticity. Unlike formalin, ethylene glycol preservation allows for an accurate representation of tissue characteristics, because it is less likely to alter tissue elasticity or emulsify fat. Indeed, cadavers preserved in ethylene glycol maintain much of the pliability of live tissue.

A standard cervicofacial rhytidectomy technique with preauricular and postauricular SMAS and midline platysmal plication was performed in isolation or combined with other surgical maneuvers on the cadaver heads. Identical submental and preauricular and postauricular skin incisions were used for all procedures, and similar suture material (3-0 braided polyester or silk) was used for all plications and wound closures. Four techniques were compared: group A, preauricular and postauricular SMAS plication and midline platysmal plication; group B, preauricular and postauricular SMAS plication, midline platysmal plication, and suturing of the anterior bellies of the digastrics; group C, preauricular and postauricular SMAS plication, midline platysmal plication, and suturing of the anterior bellies of the digastrics, and interlocking mastoid-to-mastoid preplatysmal sutures; and group D, preauricular and postauricular SMAS plication, midline platysmal plication, suturing of the anterior bellies of the digastrics, and interlocking mastoid-to-mastoid preplatysmal sutures.

Cadaver heads were assigned randomly to the 4 surgical groups. Three cadaver heads were used exclusively for each group. Each cadaver head served as its own control, and only 1 set of modifications was performed per cadaver, according to its assigned group.
A neurosurgical cranial fixation device was used to guarantee consistent upright head position, with the Frankfort horizontal plane positioned parallel to the floor during preoperative and postoperative measurements (Figure 1).

INTERVENTION

A standard cervicofacial rhytidectomy technique with preauricular and postauricular SMAS plication, midline platysmal plication, and sharp submental preplatysmal or subplatysmal lipectomy was performed on all specimens. This was the only intervention in group A. The medial edges of platysma were approximated using buried interrupted 3-0 braided polyester sutures (Figure 2).

In group B, suturing together of the anterior bellies of the digastrics was performed after determining if subplatysmal fat was present. If present, subplatysmal fat was excised. The medial edges of the anterior bellies of the digastric muscles were exposed and sutured together using buried interrupted 3-0 braided polyester sutures (Figure 3). The digastric plication was begun at the mentum and continued as far distally as possible, using 3 to 5 sutures.

Intervention in group C included preauricular and postauricular SMAS plication, midline platysmal plication, and sharp submental lipectomy, in addition to the placement of a mastoid-to-mastoid suture sling. A 3-0 braided polyester horizontal mattress suture was placed across the previously approximated edges of the platysma muscles, from right to left. This suture was interlocked with a second horizontal mattress suture from left to right in the fashion described by Giampapa and DiBernardo (Figure 4). The suture was then tunneled in a preplatysmal plane toward the mastoid and secured to the mastoid periosteum. Before tying the suture, an effort was made to ensure that it lay within the intended tunnel and did not ride over the angle of the mandible. The procedure was repeated in a similar fashion on the contralateral side.

Intervention in group D consisted of preauricular and postauricular SMAS plication, midline platysmal plication, suturing of the anterior bellies of the digastrics, and placement of a mastoid-to-mastoid suture sling. All of these steps were performed as previously described in this subsection.
DATA

The following data were collected: the preoperative, postsubmental lipectomy, and postoperative CM angles; the preoperative and postoperative distances from the mentum to the CM angle; and the preoperative and postoperative distances from the CM angle to the sternum. The changes in the CM angle, mentum-CM distance, and sternum-CM distance were considered the 3 primary measurements.

Measurements of the CM angle were taken using a ruler placed on the sternum, following the vertical plane of the neck. Using a protractor, the angle formed by the lowest portion of the horizontal submental tissue and the vertical plane of the neck was recorded as the CM angle. A ruler was used to measure the preoperative and postoperative mentum-CM distances and the preoperative and postoperative sternum-CM distances.

Before performing the procedures on the cadavers, the presence or absence of redundant cervical skin, platysmal bands, and a low hyoid (by palpation) was noted. During the cadaver dissection, the presence or absence of excessive preplatysmal fat, platysmal decussation from the midline, and excessive subplatysmal fat was noted.

STATISTICAL ANALYSIS

Raw differences in the primary end points were tested using paired t test. Differences in primary end points across groups were tested using analysis of variance. When significance was detected, post hoc tests were performed using Duncan multiple range test. Multivariate analysis was performed using linear regression to control for physical characteristics of the specimens and to estimate the effect of the individual surgical procedures within the groups. Statistical significance was defined as \( P < 0.05 \). All analyses were performed using SAS statistical software (version 8.1; SAS Institute, Cary, NC).

RESULTS

Preoperatively, all of the specimens were noted to have redundant cervical skin. Ten of the cadavers had platysmal bands, and 5 had low hyoids. During the dissection, all of the specimens were noted to have abundant preplatysmal fat, 11 had splaying of the platysma in the midline, and 9 had extensive subplatysmal fat.

We first tested whether the primary measurements were significantly different after surgery across all groups. Results presented in Table 1 suggest that, on average, the CM angle was significantly reduced after all procedures (\( P < 0.001 \)). The mean sternum-CM distance increased significantly (\( P = 0.01 \)). The mean increase in mentum-CM distance was not significant, although a trend toward significance was observed (\( P = 0.10 \)).

The relative change in each of the 3 primary measurements was then compared across groups (Figure 5). Although a trend toward significance was observed, the mean change in CM angle was significantly different after all procedures (\( P = 0.06 \)). Likewise, the mean change in mentum-CM distance was not significantly different across groups (\( P = 0.19 \)). The mean difference in sternum-CM distance, however, was significant (\( P < 0.001 \)). Furthermore, post hoc analysis using Duncan multiple range test showed that groups A and B were not significantly different from each other and that groups C and D were not significantly different from each other (\( P < 0.05 \)).

These findings suggest that the mastoid-to-mastoid suture may be responsible for the differences observed between the groups.

Linear regression analysis was used to test whether the types of procedures within the groups accounted for differences observed between groups after controlling for the presence of a low hyoid and to quantify the magnitude of the effect. The primary end points were regressed on binary variables representing the digastric plication, mastoid-to-mastoid suture, and the presence of

Figure 4. A, A mastoid-to-mastoid suspension suture is placed through the medial edge of the platysma in a horizontal mattress fashion and interlocked with a second suture placed in the same fashion through the contralateral edge of the platysma (inset). These sutures are drawn through a previously formed subcutaneous preplatysmal tunnel and sutured to the mastoid periosteum bilaterally. The face is turned toward the contralateral side when the suture is secured to the mastoid periosteum. Adapted from Caplin and Prendiville.\(^{20}\) B, Posterior view of a mastoid-to-mastoid suspension suture placed in the left neck of a cadaver.
a low hyoid. Table 2 summarizes the results from all 3 regression analyses. The presence of a low hyoid was significantly associated with a smaller CM angle after surgery (P = .009) and demonstrated a trend toward significance with an increase in mentum-CM distance (P = .07), but it was not significantly associated with an increase in sternum-CM distance (P = .10). The digastri c plication further reduced the CM angle by approximately 7.5° (P = .03), but it was not significantly associated with mentum-CM (P = .07) or sternum-CM (P = .61) distance increases.

The physiologic changes associated with aging and pre-existing anatomic factors can separately or in combination contribute to the formation of an obtuse CM angle. Multiple techniques have been developed to address this aspect of facial rejuvenation.

The most widely used technique in addressing the obtuse CM angle involves cervicofacial rhytidectomy with submental liposuction, combined with sutureting the posterior edge of the platysma to the fascia of the SCM and midline plication of the medial platysmal edges.12,4,6,8 In effect, a platysmal sling or corset is created to improve the cervical contour and deepen the CM angle. Although some improvement is usually achieved with this method, limited results are possible in the case of a very obtuse CM angle. Modifications to this technique include partial or complete midline horizontal division of the platysma at the CM angle.6

Modification of the suprahyl oid musculature has also been advocated as a method of improving the CM contour.3,13 The theory behind this technique relates to the anatomic effect of the suprahyl oid musculature to the hyoid bone. The hyoid bone is pulled anterosuperiorly by the anterior belly of the digastri c, mylohyoid, and geniohyoid musculature; posterosuperiorly by the stylohyoid and posterior belly of the digastri c; and inferiorly by the strap muscles. In a series of 54 patients undergoing face-lift, Guyuron13 found that a submental myotomy produced a statistically significant elevation of the hyoid bone. The submental myotomy was performed through lysis of the anterior bellies of the digastri c, mylohyoid, and geniog hyoid muscles. The patients were analyzed by preoperative and postoperative cephalometric findings. The change in hyoid position was attributed to the compensatory posterior and cephalic pull of the stylohyoid muscle and posterior belly of the digastri c. Suturing of the anterior bellies of the digastrics has been reported as a method of eliminating a submental concavity after lipectomy but not as a method of altering hyoid position.3 However, because of the role of these muscles in hyoid elevation, it can be reasonably deduced that suturing the digastrics might alter hyoid position and subsequently the CM angle.

A well-described alternative to modify the CM angle without altering the hyoid position is neck contouring

Table 1. Changes in Primary End Points Across All Groups

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Before Surgery</th>
<th>After Surgery</th>
<th>Difference</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervicomen tal (CM) angle, °</td>
<td>124.25 (16.24)</td>
<td>110.75 (15.42)</td>
<td>-13.50 (9.03)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Mentum-CM distance, cm</td>
<td>4.42 (1.62)</td>
<td>4.75 (1.48)</td>
<td>0.33 (0.65)</td>
<td>.10</td>
</tr>
<tr>
<td>Sternum-CM distance, cm</td>
<td>5.00 (2.04)</td>
<td>5.58 (1.56)</td>
<td>0.58 (0.66)</td>
<td>.01</td>
</tr>
</tbody>
</table>

*Data are given as mean (SD) unless otherwise indicated. Mentum-CM distance indicates the distance between the mentum and the CM angle; sternum-CM distance, the distance between the sternum and the CM angle.

Table 2. Summary of Linear Regression Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Change in Cervicomen tal (CM) Angle, °</th>
<th>Change in Mentum-CM Distance, cm</th>
<th>Change in Sternum-CM Distance, cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low hyoid</td>
<td>-10.32 (.009)</td>
<td>0.72 (.07)</td>
<td>0.12 (.58)</td>
</tr>
<tr>
<td>Mastoid-to-mastoid suture</td>
<td>-11.28 (.002)</td>
<td>0.55 (.10)</td>
<td>1.15 (.001)</td>
</tr>
<tr>
<td>Digastri c plication</td>
<td>-7.49 (.03)</td>
<td>0.69 (.07)</td>
<td>-0.11 (.61)</td>
</tr>
</tbody>
</table>

*Data are given as estimated regression coefficient (P value). Mentum-CM distance indicates the distance between the mentum and the CM angle; sternum-CM distance, the distance between the sternum and the CM angle.
with suture suspension. This surgical option creates a more cephalic position for the breakpoint of the CM angle and thus produces a more acute angle (Figure 6). The technique advocated by Giampapa and DiBernardo uses minimal incisions, combined with midline platysmal plication and interlocking supraplatysmal suspension sutures (3-0 polypropylene) that are secured laterally to the mastoid periosteum. The method illustrated by Webster et al uses a submental supraplatysmal suture suspension (2-0 polyester) in combination with a traditional cervicofacial rhytidectomy. In this method, the suspension sutures are secured to the fascia of the sternocleidomastoid laterally.

Other techniques to address the CM angle, including chin implants, submental skin excision, and Z-plasty, were not included in this study. The primary purpose of a chin implant is to increase projection of the pogonion. Any real or perceived changes in CM angle attributable to this technique rely more on skin extensibility than support of deeper tissues. Therefore, this technique was not evaluated. Submental skin excision or Z-plasty is not typically performed in conjunction with face-lift, which was a requisite for all of the specimens in the study.

The findings of this study suggest that the CM angle and the sternum-CM distance were significantly affected by all procedures. However, when a comparison across groups was performed, the change in sternum-CM distance was significant and the change in CM angle demonstrated a trend toward significance. Statistical analysis showed that the addition of the mastoid-to-mastoid suture produced significant changes in CM angle and in sternum-CM distance. Suturing of the digastrics significantly altered the CM angle without significantly affecting the other recorded measurements. Furthermore, the change in CM angle was significantly greater when a low hyoid was noted preoperatively.

Based on these results, the addition of the mastoid-to-mastoid suture had the greatest effect on the CM angle. The reduction in CM angle was strongly associated with an increase in the sternum-CM distance. It appears that the mastoid-to-mastoid suture achieved this effect by cephalic repositioning of the CM angle, without posterior displacement of the CM angle or elevation of the hyoid bone. A low hyoid was the only preoperative factor associated with a significant postoperative reduction in CM angle.

This study provides information on immediate postoperative results in human cadavers. However, no positive or negative determinations on the long-term results of these procedures can be concluded from this model. Likewise, no comparison can be made regarding subjective sensations of tightness, temporary dysphagia, or other factors that may be seen in the clinical setting. These results from cadaveric dissections suggest that the addition of a mastoid-to-mastoid suture is more effective than other techniques in changing the CM angle.

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REFERENCES


Quotable

Whoever loves for years hasn’t lived in vain.
Rolf Johnson