Submental-Cervical Angle: Perceived Attractiveness and Threshold Values of Desire for Surgery

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Abstract

Aim The submental-cervical angle may alter as a result of mandibular orthognathic surgery and/or the ageing process and is therefore an important facial aesthetic parameter for comparative diagnosis and treatment planning. The purpose of this study was to undertake a quantitative evaluation of the influence of the submental-cervical angle on perceived attractiveness and threshold values of desire for surgery.

Study Design The submental-cervical angle of an idealized profile silhouette image was altered incrementally between 90° and 130°. The images were rated on a seven-point Likert scale by pre-treatment orthognathic patients (n = 75), laypeople (n = 75), and clinicians (n = 35).

Results A submental-cervical angle of 90°–105° was deemed acceptable. Angles up to 120° were deemed slightly unattractive by the lay and clinician groups, but very unattractive by the patient group. By 125°–130° all groups perceived the angle as very unattractive. The threshold value of desire for surgery was 110° for patients, 115° for lay people and 125° for clinicians. Patients appear to be more critical than lay and clinician groups.

Conclusions These ranges of normal variability of the submental-cervical angle and threshold values of desire for surgery, in terms of observer acceptance, should be considered by clinicians in planning mandibular orthognathic

surgery and aesthetic surgical procedures of the submental-cervical region.

Keywords Submental-cervical angle · Aesthetics · Perception · Desire for surgery · Orthognathic surgery

Introduction

The morphology of the upper aspect of the neck and its transition with the submental region has a potentially major impact on the aesthetics of the lower face, and the submental-cervical angle is an important determinant of facial profile attractiveness [1].

A number of aetiological factors may be involved in creating a poor aesthetic contour of the submental-cervical region, which include the tonicity and laxity of the submental-cervical skin, the suprahyoid muscular support, excessive submental, supraplatysmal and subplatysmal fatty deposits, the size of the submandibular glands, the spatial position of the hyoid bone and the skeletal framework of the mandible and chin [1]. The reduction in submental length associated with mandibular and/or chin setback procedures may lead to an increase in submental fullness, an obtuse submental-cervical angle and potentially a deterioration in submental-cervical aesthetics. Conversely, mandibular advancement and/or advancement osseous genioplasty tend to improve submental-cervical aesthetics [1].

Each facial parameter, such as the submental-cervical angle, has an ‘average’ value or ‘norm’ for a given population, which is specific for age, gender and ethnicity. Each of these norms also has a range of normal variability, with the existence of a facial deformity often resulting from a significant deviation of one or more facial parameters from

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the accepted norm for a population. For clinical practice, it is important to know at what point the deviation of a facial parameter moves from the acceptable range of variability to being perceived as a facial deformity.

The magnitude of the deviation, whether it is due to an underlying dentoskeletal discrepancy, the overlying submental-cervical soft tissues or a combination of the two, is an important factor in deciding when surgery may be required. If the magnitude of the discrepancy of a facial parameter is great (for example, excessive submental-cervical angle) the treatment planning decision may be relatively straight forward. However, a significant number of patients are regarded as ‘borderline’ in terms of need for surgical treatment. In such patients, the decision making process may be transferred from subjective clinical judgement to objective, evidence-based guidance based on data from studies investigating perceptions of facial attractiveness [2].

The submental-cervical angle is a potentially important factor in the perception of facial attractiveness. The purpose of this study was to find objective evidence to aid clinicians in planning the treatment of patients requiring alteration of the submental-cervical region.

The principal aim of this investigation was to evaluate quantitatively the influence of the submental-cervical angle on perceived attractiveness. The relationship between degree of the submental-cervical angle and attractiveness was recorded to ascertain the range of normal variability, in terms of observer acceptance, and to determine the clinically significant threshold value or cut-off point, beyond which the angle is perceived as unattractive and surgical correction is desired. The perceptions of orthognathic patients, clinicians and laypeople were compared for these different variables.

Materials and Methods

Ethical approval was sought and granted for the study by the National Research Ethics Service; NRES (UK); REC reference: 06/Q0806/46, and each subject in the study signed a detailed informed consent form.

Images

Image Creation

Two-dimensional facial profile silhouettes are used routinely to assess the perceptions of facial profile attractiveness [3, 4]. A facial profile silhouette image was created with computer software (Adobe® Photoshop® CS2 software; Adobe Systems Inc., San Jose, CA, USA). The image was manipulated using the same software to construct an

‘ideal’ facial profile image with proportions [1] and soft tissue measurements [1, 5–10] based on currently accepted criteria.

Profile Image Manipulation (Incremental)

The submental-cervical angle of the idealized profile image was altered in 5° increments from 90° to 130°, in order to represent variations in the angle and morphology of this region (Fig. 1). The landmarks and planes used to describe the submental-cervical region are described in Fig. 2.

Observers, Questionnaire and Rating Method

Observers

A pilot study was undertaken in order to perform a power calculation. The pilot study was undertaken with 35 pre-treatment orthognathic patients, 35 laypeople and seven clinicians. The data from these observers was carried forward into the results of the main study. Based on the results of the pilot study, the anticipated standard deviations of rating were 1.0 in all groups of observers. Our study aimed to recruit 35 clinicians, 75 pre-treatment orthognathic patients and 75 laypeople to guarantee 80 % power to detect differences in the mean rating score of approximately 2.5 in the clinician group versus 3.1 in the patient and laypeople groups (this corresponds to a standardised mean difference of 0.6). Based on the results of a pilot study and power calculation, 185 observers took part in the study, separated into three groups (pre-treatment orthognathic patients, laypeople and clinicians; Table 1), with the following selection criteria:

- *Orthognathic patients* pretreatment (only 1 consultation appointment); primary concern was facial appearance; no previous orthodontic or facial surgical treatment; no history of facial trauma; no severe psychological issues, e.g. body dysmorphic disorder.
- *Laypeople* no previous orthodontic or facial surgical treatment; no facial deformities; no history of facial trauma.
- *Clinicians* involved in the management of patients with facial deformities. This group included 19 clinicians in oral and maxillofacial surgery and 16 orthodontists, with 1–16 years of experience in the clinical management of patients requiring orthognathic surgery.

The pretreatment orthognathic patients were recruited from the author’s (FBN) new patient clinics consecutively. At the end of the first brief consultation, if a patient agreed to potentially take part in the study, they were provided with an information sheet. An appointment was made for data collection, prior to which, if the patient was happy to continue

Fig. 1 Submental-cervical angle of the idealized profile image was altered in 5° increments from 90° to 130°

Fig. 2 Landmarks and planes used to describe the submental-cervical region: *Submental-cervical angle* The anterior inferior angle formed by the intersection of the submental plane and the cervical plane. *Cervical point (C-point or 'point C')* The innermost (posterior-superior) point between the submental plane and the anterior aspect of the neck in the midsagittal plane, located at the intersection of lines drawn tangent to the submental region and the anterior neck. *Submental plane* A plane or line constructed between the cervical point (C-point) and the most inferior point on the chin (soft tissue menton, Me'). If C-point cannot be defined, the submental plane is drawn tangent to the submental contour passing through soft tissue menton. The submental plane is referred to as the 'throat' plane by some authorities; the submental length (distance from C-point to menton) is therefore sometimes referred to as the 'throat length'. *Cervical plane* A plane or line drawn tangent to the anterior soft tissue contour of the neck above and below the thyroid prominence

with the study, they signed a formal consent form to take part in the study. The laypeople group were all non-clinical individuals, recruited from the Greater London area.

The age of the 185 observers was median 25 years (range 13–79 years). For the patient group the age was median 18 (range 13–60) years, for lay people 27 (range 16–79) and for clinicians 32 (range 24–39) years. Regarding ethnicity, 111 of the observers were white Caucasian, 68 were Asian, 3 were oriental, 1 was black and 2 another ethnicity. Of the 75 patients and lay people, 32 and 24 were males respectively and 11 of the 35 clinicians were males.

Questionnaire

Each observer was given a questionnaire and asked to provide the following information: age, gender, ethnic origin, how would you rate the attractiveness of your facial appearance, and how important do you think it is to have an attractive facial appearance. An instruction sheet accompanied the questionnaire, asking the observers to rate each image in terms of facial attractiveness using the following rating scale:

1. Extremely unattractive.
2. Very unattractive.
3. Slightly unattractive.
4. Neither attractive nor unattractive.
5. Slightly attractive.
6. Very attractive.
7. Extremely attractive.

Table 1 Observer demographics

Observer group	Number	Mean age (in years)	95 % CI	Age range	Gender (% male)	Ethnicity (% white)
Orthognathic patients	75	22	20–24	13–60	42	66
Laypeople	75	31	28–35	16–79	31	49
Clinicians	35	31	30–33	24–39	33	72

Fig. 3 An example of an image viewed by study observers on the monitor during data collection

Observers were also asked whether they would consider surgery to correct the appearance if this was their facial appearance (yes or no).

The images were placed in random order into the software application Microsoft PowerPoint® (Microsoft Corporation, USA). Each image was identified by a randomly assigned double letter in the top right corner of the screen (e.g. GH, HJ etc. Fig. 3). A duplicate of one of the images was used to assess intra-examiner reliability (images EB and DE). Each observer sat undisturbed in the same room in front of the same computer and 43.2-cm flat screen monitor. The presentation and the images were created in such a way that each of the profile silhouette images, when viewed on the monitor, had the same dimensions as a normal human head, based on an average lower anterior facial height. This helped to reduce the potential effect of image magnification or size reduction on the observer's perception. Each observer examined the images in the PowerPoint® presentation by pressing the 'Page Down' button on the keyboard, in their own time.

Rating Method

The Likert-type rating scale used is largely accepted in the psychology literature as the most useful rating method [11]. The seven-point Likert scale described above was used by each observer to rate each image in terms of attractiveness.

Statistical Analysis

The observer's ratings were recorded in a Likert scale from 1 to 7. In order to assess how perceived attractiveness

varies with submental-cervical angle, the median and interquartile observer ratings were calculated for each angle and for each observer group; these descriptive statistics were calculated using software that we developed using MATLAB (The MathWorks Inc, Natick, MA, USA). Similarly, the software calculated the proportions in each group suggesting a desire for surgery. Additional statistical analysis including Spearman's rank correlation and paired Wilcoxon tests were performed using Minitab v16 (Minitab Inc, State College, PA, USA). The Ryan-Joiner test in Minitab was used to examine if data were consistent with a normal distribution [12].

Results

The variable 'self-rating of attractiveness' had very few observers in its border values (very unattractive, seven patients; very attractive, seven laypeople) and was recoded into two levels: attractive ($n = 123$) versus unattractive ($n = 62$). The variable 'vertical face height' was dichotomized into two levels: normal ($n = 166$) versus non-increased/decreased ($n = 19$). Only 11 observers responded that attractiveness was very unimportant (one patient) or unimportant (six patients and four laypeople). As a consequence this variable was dichotomized as important versus not important.

All the laypeople and the clinicians had Class I jaw relationship whilst 96 % of the patients had Class II or III jaw relationships. There was no significant difference in perceptions of attractiveness between observers with skeletal Class II and III jaw relationships ($p = 0.91$) but they appeared to differ significantly from those with skeletal Class I. When skeletal Class was fitted on the patient group alone no difference was detected between skeletal Classes II and III ($p = 0.86$).

Reliability Analysis

Table 2 demonstrates the first and third quartile rankings of the Likert score. The results are generally similar in the three observer groups. The maximum interquartile range for all three groups was 2. The two images with a submental-cervical angle of 105° showed almost identical first and third quartile (Table 2) as well as identical median

Table 2 The first and third quartile rankings of the Likert score

Angle (°)	First quartile			Third quartile		
	Patients	Lay	Clinicians	Patient	Lay group	Clinician
90	4	4	4	5	6	6
95	5	5	6	6	6	6
100	4	4	4	6	6	6
105	3	4	4	5	5	5
105	3	3	3	5	5	5
110	2	3	3	3	4	4
115	2	2	2	3	4	3
120	1	2	2	3	4	3
125	1	2	1	2	3	3
130	1	1	1	2	3	2

Table 3 Median attractiveness observer ratings on the Likert scale

Angle (°)	Median score		
	Patients	Lay	Clinicians
90	5	5	5
95	6	5	6
100	5	5	5
105	4	4	4
105	4	4	4
110	3	3	3
115	2	3	3
120	2	3	2
125	1	2	2
130	1	2	2

attractiveness rankings (Table 3) thus indicating very good repeatability in the groups: using the Friedman test there was no significant difference in attractiveness ratings ($p = 0.17$). Furthermore when taking paired observations there was no significant difference for all three groups when comparing the difference in rankings of the identical images using a paired Wilcoxon test, $p = 0.83$, $p = 0.65$ and $p = 0.89$ for the patient, lay and clinicians group respectively. For the clinician group there was good concordance in ratings, Kendall's coefficient of concordance = 0.91 ($p < 0.001$).

Perceived Attractiveness of Images

Table 3 indicates the median attractiveness rating of the observers on a Likert scale from 1 to 7, where 1 indicates 'extremely unattractive' and 7 indicates 'extremely attractive'. Increasing angle deviation from a submental-cervical angle of 95° (Image BB) was associated with a reduction in the median attractiveness scores in all three groups of observers. In all cases there was a significant ($p < 0.001$) negative correlation (Spearman's rank

Table 4 Data in rank order from most to least attractive

Angle (°)	Median score		
	Patients	Lay	Clinicians
95	6	5	6
100	5	5	5
90	5	5	5
105	4	4	4
105	4	4	4
110	3	3	3
115	2	3	3
120	2	3	2
125	1	2	2
130	1	2	2

correlation) between median attractiveness rating and submental-cervical angle: for patients $r = -0.96$, for laypeople $r = -0.96$ and for clinicians $r = -0.95$.

Most Attractive and Least Attractive Images

Table 4 demonstrates the data in rank order from most to least attractive, sorted on the basis of responses from the clinician group. The rank ordering observed in the clinician group from most attractive to least attractive is also seen in the patient and lay people groups (Fig. 4).

Outcome: Desire for Surgery

Table 5 demonstrates the proportion expressed as a percentage of each observer group suggesting that surgery is required. The data are also presented in graph form for clear comparison of the observer groups (Fig. 5). The results indicate that clinicians were least likely to suggest surgery for all degrees of submental-cervical angle. In addition, there appears to be a high degree of agreement amongst clinicians. As images 3 and 4 (105°) were

Fig. 4 Rank ordering observed in all observer groups

Table 5 Percentage of each observer group suggesting a desire for surgery

Angle (°)	Proportion suggesting surgery		
	Patients	Lay	Clinicians
90	17	19	0
95	11	5	0
100	16	12	0
105	36	9	0
105	39	28	0
110	61	39	26
115	69	59	42
120	76	63	49
125	83	77	60
130	88	85	74

identical, repeatability of the 35 clinician's assessment was excellent, in both cases 0 % suggesting surgery. For the 75 lay people the assessment of the two repeated images shows clear variability (9 and 28 %), which is not seen in the group of 75 patients (36 and 39 %). For most images there was very good agreement among clinicians as to whether surgery is required except for angles between 110° and 120°. There was much more variability in the assessment for the patient and lay groups even for small displacements. Taking 50 % (i.e. majority) of each observer group as a cut-off where the majority suggested surgery as previously applied [11], for patients the threshold value of desire for surgery was 110°, for lay people the threshold value was 115° and similarly 125° for clinicians. In all cases there was a significant correlation between the proportion suggesting surgery and submental-cervical angle: for patients $r = 0.95$ ($p < 0.001$), for laypeople $r = 0.88$ ($p < 0.005$) and for clinicians $r = 0.96$ ($p < 0.001$). For observers who considered attractiveness to be important (>2), Table 6 indicates the proportion suggesting surgery. For patients

Fig. 5 Desire for surgery in relation to observer group

Table 6 Percentage of observers desiring surgery who considered attractiveness to be important

Angle (°)	Suggesting surgery		
	Patients	Lay	Clinicians
90	18	20	0
95	10	6	0
100	16	13	0
105	38	10	0
105	41	30	0
110	68	37	26
115	72	58	43
120	79	62	49
125	87	77	60
130	90	86	74

68/75, for laypeople 71/75, and all clinicians considered attractiveness to be important.

For those who did not consider attractiveness to be important (7 patients and 4 laypeople), Table 7 summarises the proportion desiring surgery; the table has no column for clinicians as all considered attractiveness to be important.

Thus higher submental-cervical angle deviations were again associated with a higher proportion desiring surgery.

Discussion

In the context of facial attractiveness research, the term 'perception' (from Latin *percipere*: to seize, to understand) refers to the neurophysiological processes by which an observer views a face and interprets the information received with the mind. Facial attractiveness is recognized as an important attribute in psychosocial well-being. The facial profile may be a particular source of concern for some individuals, with a considerably increased submental-cervical angle being a significant reason for patients seeking

facial aesthetic surgery. The morphology of the chin-neck region in profile view is a potentially important determinant of perceived attractiveness and thereby knowledge of perceptions of attractiveness, in addition to average population values, is important for clinicians correcting facial deformities [1].

In order to determine and validate the correct facial proportions and morphological relationships with which to plan clinical treatment, two sources of information are required [13]. Firstly, population averages, which permit comparison of an individual's facial measurements and proportions to the normative values for the population. Ideally, such data should be age, gender and ethnicity specific. Such data are based on anthropometric studies and long-term cephalometric growth studies of normal individuals, where available. No longitudinal data is available for the submental-cervical angle, but there is some cross-sectional data available [14]. Secondly, the perceived attractiveness of the proportions and morphological relationships must be confirmed by the judgement of patients and the lay public, and ideally compared to the judgement of treating clinicians. This was the main purpose of this investigation.

The results of this investigation demonstrated that increasing the submental-cervical angle deviation in either direction from an angle of 95° (Image BB) was associated with a reduction in the median attractiveness scores in all three groups of observers. The highest attractiveness scores were for image BB (submental-cervical angle of 95°), closely followed by image CC (angle of 100°) and LC (angle of 90°). At 105°, the submental-cervical angle was deemed to be neither attractive nor unattractive, i.e. essentially acceptable, even if not attractive. However, from a submental-cervical angle of 110° the images are viewed as slightly unattractive by all observer groups. The further the angle increases from 110°, the more unattractive it is perceived to be, with 125° and 130° being perceived as very and extremely unattractive by all observer groups. It

thereby appears from Tables 3 and 4 that a submental-cervical angle of 90° to 100° is perceived as the most attractive and up to 105° is deemed acceptable. Angles above this value begin to be perceived as unattractive, though up to 120° is deemed only slightly unattractive by the lay and clinician groups, but very unattractive by the patient group. By 125°–130° all groups perceive the submental-cervical angle as very/extremely unattractive.

In terms of desire for surgical correction, the results of this investigation indicate that clinicians were least likely to suggest surgery for all degrees of submental-cervical angle (Table 5). In addition, there appears to be a high degree of agreement amongst clinicians, and even the repeatability of the clinician group's assessment was excellent, with 0 % suggesting surgery for the repeated images. The reason for this may be conjectured to be that clinicians develop higher critical capabilities because of their training. The patient group also demonstrated relatively good reliability and agreement, which again may be conjectured to be that the very existence of a facial deformity may lead to patients developing a greater sensitivity to noticeable differences in facial appearance from the norm. For example, previous studies have found significant differences between the perceptions of facial profile attractiveness of orthodontists and maxillofacial surgeons compared with lay people [15]. Differences have also been demonstrated to exist between orthognathic patients and clinicians in terms of perceived need for orthognathic surgery. Juggins et al. [16] recruited forty patients from combined orthodontic-surgical clinics. They were asked to rate their perceived need for treatment based on facial appearance, dental appearance, function, and overall need. Twenty orthodontists and 20 maxillofacial surgeons were asked to rate perceived need for treatment of the patients based on the same parameters, using study models and clinical photographs. Significant differences were found between patients and clinicians in perceived need for treatment based on facial appearance. Clinicians rated greater need for orthognathic treatment based on facial appearance than did patients. Surgeons also rated greater overall need for treatment than patients. In addition, surgeons rated treatment need based on facial appearance and function significantly higher than orthodontists, but large variations existed in both clinician groups.

For most images there was very good agreement among clinicians as to whether surgery is required, except for angles between 110° and 120°. There was much more variability in the assessment for the patient and lay groups even for small deviations.

For patients the threshold value of desire for surgery was a submental-cervical angle of 110°, for lay people the threshold value was 115° and similarly 125° for clinicians.

Table 7 Proportion of observers suggesting surgery who did not consider attractiveness to be important

Angle (°)	Suggesting surgery	
	Patients	Lay
90	14	0
95	14	0
100	14	0
105	14	0
105	14	0
110	0	75
115	43	75
120	43	75
125	43	75
130	71	75

There are no long-term growth data available for the submental-cervical angle. Farkas presented cross-sectional anthropometric data for many facial parameters, but not for the submental-cervical angle. A variety of values have been provided by different authorities, based on clinical judgement and analysis of patients. Ellenbogen and Karlin [17] described six visual criteria in the evaluation of the facial profile for “success in restoring the youthful neck”, based on the evaluation of the submental-cervical region in their post-operative female rhytidectomy patients. The values provided for the submental-cervical angle (which they referred to as the cervicomental angle) was between 105° and 120°. An angle greater than 120° was said to give the visual impression of a ‘double chin’ or ‘heavy neck’. Epker and Stella [18] said the ideal submental-cervical angle was 110°–120°. Average values provided by Somerville et al. [19] were 126° in adult males and 121° in adult females. In a study based on ‘ideal’ subjects and surgical patients, Moreno et al. [14] provided an average value of 118° (standard deviation of 8°; range of between 100°–135°). It appears that the often described ‘ideal’ 90° submental-cervical angle appears to be an extreme of the normal variation [1].

Rejuvenation of the submental-cervical region encompasses numerous surgical procedures e.g. platysma plication, submental lipectomy, suprahyoid myotomy, neck-lift or rhytidectomy. One or more of these procedures may be required in any patient, depending on the characteristics which the patient and surgeon desire to achieve. Youthful characteristics of an attractive submental-cervical region include good skin elasticity, distinct inferior mandibular border, a submental-cervical angle within normal limits, adequate mandibular body length and chin projection and a high and posterior hyoid bone position [20].

Conclusions

- The results of the present investigation demonstrate that a submental-cervical angle of 90°–105° is deemed acceptable. Angles above this value begin to be perceived as unattractive, though up to 120° is deemed only slightly unattractive by the lay and clinician groups, but very unattractive by the patient group. By 125°–130° all groups perceive the submental-cervical angle as very/extremely unattractive.
- In terms of threshold values of desire for surgery, for patients the threshold value of desire for surgery was 110°, for lay people the threshold value was 115° and similarly 120° for clinicians.
- Patients appear to be more critical than lay and clinician groups. This stresses the importance of using

patients as observers, as well as lay people and clinicians, in facial attractiveness research.

Compliance with Ethical Standards

Conflict of interest None.

Ethical Approval NRES (UK); REC reference: 06/Q0806/46.

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