University of Groningen

The Rainbow Scale for the Assessment of the Cervicomental Angle

van de Lande, Lara S.; Eyck, Ben M.; Mooij, Jelle J.; Stevens, Hieronymus P.; van Dongen, Joris A.

Published in:
Aesthetic Surgery Journal

DOI:
[10.1093/asj/sjz122](https://doi.org/10.1093/asj/sjz122)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2020

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

van de Lande, L. S., Eyck, B. M., Mooij, J. J., Stevens, H. P., & van Dongen, J. A. (2020). The Rainbow Scale for the Assessment of the Cervicomental Angle: A Validated Scale. *Aesthetic Surgery Journal*, 40(9), 931-937. <https://doi.org/10.1093/asj/sjz122>

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

The Rainbow Scale for the Assessment of the Cervicomentral Angle: A Validated Scale

Lara S. van de Lande, MD; Ben M. Eyck, MD; Jelle J. Mooij;
Hieronymus P. Stevens, MD, PhD; and Joris A. van Dongen, BSc

Aesthetic Surgery Journal
2020, Vol 40(9) 931–937
© 2019 The Aesthetic Society.
Reprints and permission:
journals.permissions@oup.com
DOI: 10.1093/asj/sjz122
www.aestheticsurgeryjournal.com

OXFORD
UNIVERSITY PRESS

Abstract

Background: Aging of the neck results in an increased cervicomentral angle, which can be treated by various surgical and nonsurgical procedures. To measure the success of these procedures, standardized validated objective photographic measurement tools are needed. However, no online standardized photographic measurement tools exist for the assessment of the cervicomentral angle.

Objectives: The purpose of this study was to establish a validated and reliable measurement tool for the assessment of the cervicomentral angle based on the Rainbow Scale.

Methods: A 5-point photographic rating scale was developed and created from 1 photograph with Adobe Photoshop. Fifteen reference photographs of women, 3 photographs per grade, were included for validation. Seven panelists (ie, plastic and maxillofacial surgeons) assessed the reference photographs 3 times with a minimal interval of 3 days in an online survey. Intra- and inter-observer agreements were calculated utilizing the weighted kappa coefficient.

Results: Mean intra-observer agreement was 0.93 (0.78–1.00). Mean interobserver agreement was 0.796 (0.574–0.961) for survey 1, 0.868 (0.690–0.960) for survey 2, and 0.820 (0.676–0.959) for survey 3.

Conclusions: The Rainbow Scale for the assessment of the cervicomentral angle has been validated in an online fashion. The scale is reproducible and reliable and requires no learning curve. Potential applications include objective assessment of neck treatment planning and surgical outcome.

Level of Evidence: 4

Editorial Decision date: April 11, 2019; online publish-ahead-of-print April 26, 2019.

A cervicomentral angle (CMA) between 90° and 100° is considered well defined and a hallmark of a youthful neck.^{1,3} Multiple factors play a role in a less defined, increased

CMA. Anatomically, the CMA is formed by a breakpoint between the horizontal plane of the submental region and the vertical plane of the neck.⁴ When aging of the neck

Dr van de Lande is a PhD candidate, Craniofacial Unit, Great Ormond Street Hospital for Children and UCL Great Ormond Street Institute of Child Health, London, United Kingdom. Dr Eyck is a PhD candidate, Department of Surgery, Erasmus University Medical Center, Rotterdam, the Netherlands. Mr Mooij is a Student at Faculty of Medicine, Erasmus University Medical Center, Rotterdam, the Netherlands. Mr Stevens is a plastic surgeon in private practice in Rotterdam, the Netherlands. Mr van Dongen is a PhD

candidate, Department of Plastic Surgery, University of Groningen and University Medical Centre Groningen, the Netherlands and student at Faculty of Medicine, Erasmus University Medical Center, Rotterdam, the Netherlands.

Corresponding Author:

Mr Joris A. van Dongen, University Medical Center Groningen, Hanzeplein 1, 9713 GZ Groningen, the Netherlands.
E-mail: jorisavandongen@gmail.com; Twitter: @vanDongenJA

occurs, the platysma fibers tend to splay laterally, causing platysmal banding and a subsequent increase in the CMA. Moreover, aging expands cervical skin laxity as well as preplatysmal and subplatysmal adipose tissue, which contributes to an increased CMA.³

Various surgical and nonsurgical techniques (eg, classical rhytidectomy, short scar face-lifting, traction suture lifting, laser resurfacing, and trichloroacetic acid chemical peeling) can be used to treat an increased CMA.⁵⁻¹¹ These procedures are assessed based mostly on visual subjective evaluation of the surgeon with or without the use of pre- and postoperative photographs.

To date, only a few descriptive classifications have been developed to evaluate the (aging) neck.^{3,12,13} These systems were, however, not validated. McCollough et al introduced a condition-specific classification algorithm based on 5 age groups to match patients' problems with an appropriate treatment plan per class. This subjective system was validated with a moderate agreement.¹⁴ Later, a validated neck volume scale was proposed based on a printed booklet survey and showed a good agreement.¹⁵ However, both scales were validated with non-weighted analyses.

Thus far, no objective online validated photographic measurement tool exists to assess the outcome of these CMA restoration procedures. To measure treatment outcomes, an objective photographic measurement tool seems indispensable.¹⁶

In the literature, a few objective and subjective measurement tools for the assessment of other aesthetic entities are available, such as the FACE-Q for psychometric evaluation and the online Rainbow Scale for the objective assessment of the nasolabial fold and breast ptosis.¹⁷⁻¹⁹ The online Rainbow Scale consists of 5 reference photographs, with each photograph corresponding to a specific grade (Grades I-V). These 5 photographs are arranged in an arc with an empty lower-center slot. The photograph to examine can be placed in this lower-center slot for objective examination. This tool has been validated and proven to be simple, reproducible, and reliable. The online setting allows clinicians to examine photographs with patients during consultation as well as via digital communication or a designated website. Considering the need for an online and easy-to-use validated photographic measurement tool to assess the severity of the CMA, this study aims to validate the uniform standardized photographic Rainbow Scale for assessing the CMA.

METHODS

The Rainbow Scale for assessing the CMA is based on the 5-point Rainbow Scale format by van Dongen et al.¹⁷ For the design of the current scale, 5 novel grades were defined. Grade I is a CMA of 90° to 100°, where the cervical skin shows no laxity or submental fat. Grade II shows mild laxity of the cervical skin, which does not exceed the notch

of the thyroid cartilage. In Grade III, there is moderate laxity of the cervical skin. The skin exceeds the notch of the thyroid cartilage and forms an upward curved line between chin and suprasternal notch. Grade IV shows severe laxity of the cervical skin, which forms a vertical straight line between chin and suprasternal notch. In Grade V, there is extreme laxity of the cervical skin. The skin forms a downward curved line between the chin and suprasternal notch.

Identification of Reference Photographs

This study was performed in accordance with the Helsinki guidelines and all models gave written informed consent.²⁰ Reference photographs were taken between March 2013 and August 2017 and were selected from a senior author's (H.P.S.) database. A 3-step selection method was used. First, photographs were excluded if not taken in a standardized fashion (ie, photographs taken from an incorrect angle, no neutral position of the head, or quality too low for computer standardization). Second, 45 photographs were selected as potential reference photographs with each photograph corresponding best to 1 of the 5 grades using the aforementioned description per grade. One photograph was selected by the first author (L.S.vd.L.) as template to create the Rainbow Scale. The 15 most representative photographs were selected for validation of the scale (3 photographs for each grade) and were included after consensus was reached between all coauthors.

Photographic Editing and Equipment

All photographs were taken in right lateral view with a Nikon mirror reflex D3100 camera (Nikon Corporation, Tokyo, Japan) and a Nikon DX—AF-S Nikkor 18 to 55 mm (1:3.5-5.6G) lens. All photographs were standardized in Adobe Photoshop CS6 Version 13.0 × 64 (Adobe Systems Inc., San Jose, CA) by correcting the background, alignment, skin color, contrast, and brightness. The template photograph was utilized as the basis for each grade and changed into the 5 grades of the Rainbow Scale using Adobe Photoshop to create a homogeneous scale. Small parts from other photographs (eg, submental skin or wrinkles) were superimposed to create various degrees of severity of the CMA (Figure 1). These other photographs were not included for validation or utilized as template photographs.

Online Validation

For validation of the Rainbow Scale for assessing the CMA, an online survey was created in SurveyMonkey (SurveyMonkey, Palo Alto, CA). The descriptive information on the 5 grades was included on the front page of the survey. The survey contained 15 questions; each question was a 1-page representation of the Rainbow Scale for assessing the CMA. A reference photograph for assessment

Figure 1. The Rainbow Scale for assessing the cervicomenal angle (demonstrated with a 58-year-old woman). To assess the cervicomenal angle, the reference photograph is placed in lower-middle red box. The cervicomenal angle increases with increasing grades. Grade I: A CMA of 90° to 100°. The cervical skin shows no laxity or submental fat. Grade II: Mild laxity of the cervical skin. The skin does not exceed the notch of the thyroid cartilage. Grade III: Moderate laxity of the cervical skin. The skin exceeds the notch of the thyroid cartilage and forms an upward curved line between chin and suprasternal notch. Grade IV: Severe laxity of the cervical skin. The skin forms a vertical straight line between chin and suprasternal notch. Grade V: Extreme laxity of the cervical skin. The skin forms a downward curved line between the chin and suprasternal notch.

was placed in a free spot in the bottom center (Figure 2). All reference photos were anonymized. Each grade was represented in the survey by 3 questions. A blank copy of the survey (Appendix A) is available online as [Supplementary Material](http://www.aestheticsurgeryjournal.com) at www.aestheticsurgeryjournal.com.

Between January 2018 and March 2018, 7 independent panelists (plastic [$n = 5$] and maxillofacial [$n = 2$] surgeons) assessed the photographs in the free spot according to the appropriate corresponding grade on the scale (Table 1). These panelists did not know any of the study patients in the survey and have not been involved in this study. The panelists completed 3 surveys with a minimal interval of 3 days to minimize memory bias. Each time, the 15 questions in the survey were presented in a random order. Computer randomization was performed with Microsoft Excel Version 14.4.9. (Microsoft, Redmond, WA). For each panelist, the intra-observer agreement was calculated based on the comparison of the 3 completed surveys (first vs second, first vs third, and second vs third). Inter-observer agreement was calculated to determine agreement between pairs of panelists in the 3 completed surveys.

Statistical Analyses

To determine the intra-observer and inter-observer agreement, the weighted kappa coefficient was utilized in SPSS version 21.0.0.1 (IBM, New York, NY).²¹ Intra- and interobserver agreements of 0.41 to 0.60 were regarded as moderate, 0.61 to 0.80 as substantial, and 0.81 to 0.99 as almost perfect.²²

RESULTS

Online Validation of the Rainbow Scale for Cervicomenal Angle

The study population consisted of only females with a mean age of 56.5 years (range 24-70.1 years) (Table 2). The 7 independent panelists had a mean intra-observer agreement of 0.93 (0.78-1.00) (Table 3). The mean inter-observer agreements within pairs of panelists was 0.796

Figure 2. An example of the assessment of the cervicomenal angle utilizing the Rainbow Scale. The patient for assessment in the lower-center slot is this 59-year-old woman. Grade I: A CMA of 90° to 100°. The cervical skin shows no laxity nor submental fat. Grade II: Mild laxity of the cervical skin. The skin does not exceed the notch of the thyroid cartilage. Grade III: Moderate laxity of the cervical skin. The skin exceeds the notch of the thyroid cartilage and forms an upward curved line between chin and suprasternal notch. Grade IV: Severe laxity of the cervical skin. The skin forms a vertical straight line between chin and suprasternal notch. Grade V: Extreme laxity of the cervical skin. The skin forms a downward curved line between the chin and suprasternal notch.

Table 1. Demographics of Panelists

	Panelists (n = 7)
Gender	
Male	7
Female	0
Mean experience, y*	7.12 (range, 1-23)

*Number of years as a plastic or maxillofacial surgeon.

(0.574-0.961) for survey 1, 0.868 (0.690-0.960) for survey 2, and 0.820 (0.676-0.959) for survey 3 (Table 4).

DISCUSSION

In this study, the Rainbow Scale for the assessment of the CMA has been validated as a result of almost perfect

Table 2. Demographics of Study Population

	Reference photographs (n = 15)
Gender	
Female	0
Male	15
Mean age, y (range)	56.5 (24.0-70.1)

intra-observer and inter-observer agreements. Hence, the Rainbow Scale is a reliable, reproducible, and easy-to-use method for the assessment of the CMA in an online fashion.

The utilization of a grading scale in an online fashion has several advantages. First, assessment can be performed faster and easier than a paper scoring system.²³ Second, results of an online scale can be transferred directly into software of choice (eg, SPSS or electronic patient record

Table 3. Intra-Observer Agreement Expressed as Weighted Kappa Coefficient

	Panelist 1	Panelist 2	Panelist 3	Panelist 4	Panelist 5	Panelist 6	Panelist 7
S1 vs S2	1.00	0.96	0.96	0.78	0.81	0.91	0.95
S1 vs S3	0.92	1.00	1.00	0.81	0.88	0.91	0.96
S2 vs S3	0.92	0.96	0.96	0.96	0.92	1.00	1.00
Mean	0.94	0.97	0.97	0.85	0.87	0.94	0.97

S1, survey 1; S2, survey 2; S3, survey 3.

Table 4. Inter-Observer Agreement Expressed as Weighted Kappa Coefficient

	Survey 1	Survey 2	Survey 3
Panelist 1 vs 2	0.84	0.96	0.85
Panelist 1 vs 3	0.84	0.96	0.92
Panelist 1 vs 4	0.61	0.78	0.83
Panelist 1 vs 5	0.77	0.96	0.80
Panelist 1 vs 6	0.88	0.88	0.96
Panelist 1 vs 7	0.88	0.92	0.84
Panelist 2 vs 3	0.84	0.92	0.85
Panelist 2 vs 4	0.69	0.75	0.68
Panelist 2 vs 5	0.85	0.92	0.80
Panelist 2 vs 6	0.80	0.84	0.80
Panelist 2 vs 7	0.96	0.88	0.85
Panelist 3 vs 4	0.76	0.82	0.75
Panelist 3 vs 5	0.85	0.92	0.80
Panelist 3 vs 6	0.80	0.92	0.88
Panelist 3 vs 7	0.88	0.88	0.85
Panelist 4 vs 5	0.63	0.82	0.70
Panelist 4 vs 6	0.57	0.82	0.87
Panelist 4 vs 7	0.65	0.69	0.68
Panelist 5 vs 6	0.88	0.92	0.83
Panelist 5 vs 7	0.89	0.88	0.88
Panelist 6 vs 7	0.84	0.79	0.80

system), which reduces the risk of data loss. Third, clinicians or patients can easily be reached by offering the Rainbow Scale by e-mail or via a designated website. In this way, clinicians will be able to communicate easily with patients and fellow clinicians, and their results will be assessed in an anonymized and objective manner. Outcomes

of the Rainbow Scale can therefore be used to discuss surgical and nonsurgical outcomes, especially when comparing different types of treatments. Thus, the use of the Rainbow Scale might improve shared decision-making between patient and clinician. Moreover, the Rainbow Scale imposes no learning curve, because none of the panelists were trained for the assessment and nevertheless reached almost perfect agreement.

Validation of a measurement tool can be arduous, but the utilization of these tools is essential for quality outcomes in aesthetic surgery. The quality of such a tool depends on the validity, reliability, and feasibility. Validity of an assessment tool is the ability to accurately measure what it is supposed to measure. Reliability refers to the degree to which the measurement tool is free from measurement error.²⁴ Without reliability, validity cannot be reached.²⁵ Moreover, the utilization of the instrument should be feasible. A validation process comes with challenges such as proper head positioning, sufficient quality of the photographs, experience of the photographer, and valid assessment by the panelists. Particularly, variation in head positioning could influence the results significantly. Consistency in photography setting is critical. Hence, we addressed these issues by utilizing a standardized setting and protocol for (neutral) head positioning and professional photo camera. All photographs were taken by the same experienced photographer. To accomplish a neutral and standardized head positioning, we would like to propose the following standardized setting. Firstly, the patient should stand straight (ie, chest up, shoulders back, and arms aligned with the upper body). Secondly, the ears should be aligned directly with shoulders from a lateral view and the eyes should be in line with the ears according to the Frankfurt Horizontal line (ie, a line formed by the plane passing through the inferior margin of the orbit and the upper margin of each ear canal or external auditory meatus). This position would ensure no flexion or extension of the neck. Thirdly, the position of the mandible in relation to the upper jaw should be checked for proper occlusion, and the mandible should not be held in a retruded fashion by the patient, because—if not held in proper occlusion—it

could influence the CMA outcome. A vertical line through the anterior surface of the eye or malar eminence to the menton could be employed as guidance to establish similar positions of the mandible.

The Rainbow Scale is an online 2-dimensional (2D) grading system with photographs assessed from the right lateral view only. This design results in an easy and fast assessment of 2D neck rejuvenating surgery (eg, surgery that tends to improve skin appearance). Patients can easily understand the results of the assessment of pre- and post-operative results of 2D neck rejuvenating surgery. For a more accurate assessment, all angles should be included. However, this scale included solely the right lateral view for an easy and quick assessment. Inclusion of multiple views would be more time-consuming and in the ideal setting done with a 3-dimensional (3D) camera. 3D images would make it possible to evaluate the results from all angles and creates options, such as the assessment of volume changes of the neck. However, for 3D assessments, the clinic would need to possess professional 3D cameras and software and have the personnel for processing. In the future, a Rainbow Scale could be developed that supports other views, such as the frontal view, ideally in a 3D (video) setting.

Moreover, the photographs were assessed without the use of a computerized model. In this way, the Rainbow Scale is easy to use but unable to detect small clinical differences after or between treatments. Two-dimensional photonic scales based on computer-simulated photographs have the ability to detect smaller clinical differences. These 2D photonic scales have already shown to be reliable for the assessment of brow positioning, forehead lines, melomental folds, and crow's feet and might be useful to assess CMAs.²⁶ To increase accuracy, a third dimension could be added because analyzing 3D soft tissue imaging is more accurate than 2D imaging.²⁷ However, to utilize 3D imaging, expensive equipment and extensive time-consuming training is needed.

The Rainbow Scale for the assessment of the CMA alters scales that have been proposed in the past, because these scales were nonvalidated and visualized by simplistic drawings based on anatomical layers^{12,13} or suggested a specific CMA restoration procedure per grade (ie, laser, liposuction, and surgical treatments).³

Moreover, the Rainbow Scale for the assessment of the CMA differs from the Rainbow Scale for breast ptosis. The CMA scale was created of a single template photograph edited with Adobe Photoshop instead of utilizing photographs of different patients for each grade.¹⁸ The utilization of 1 photograph as the template results in a more homogenous scale, potentially leading to less distraction

by phenotypical differences (eg, skin type, hair color, and wrinkles).

In this validation study, patients with abnormal skeletal development, such as an underdeveloped mandible resulting in retrognathia, were excluded. Due to retrognathia, soft tissue under the lower jaw is thickened and results in a less defined CMA compared with a normally developed mandible.²⁸ Therefore, photographs of patients with an "abnormal" facial profile cannot be compared with patients with a "normal" facial profile. For patients requiring skeletal corrective treatments, it would be useful to create a scale on "abnormal" facial profiles to assess different types of jaw surgeries and their influence on the CMA. Another limitation of the study is the utilization of only female patients. This study included only women due to a low number of male patients in the senior authors' database. Although differences exist in bone density, shape, growth, and bone loss between genders (women tend to have more bone loss postmenopausal due to hormone changes), gender differences in the process of fat atrophy, which characterizes facial aging, have not been described.²⁹ Yet, a male version of the scale could be considered in the future and be useful in the assessment of male neck rejuvenating surgery.

This scale did not evaluate parameters such as digastric muscles (changes), and neither the submandibular gland nor jawline differences per grade have been addressed. An additional scale could be created focused on the perimandibular differences.

With the validated Rainbow Scale for CMA, outcomes of different types of treatment could be evaluated and used to decide the most appropriate technique to rejuvenate the appearance of the neck. To fully assess facial aging, a Rainbow Scale for other facial features could be created, such as a scale to evaluate wrinkle and pigmentation severity.

CONCLUSIONS

The Rainbow Scale for assessing the CMA has been validated in an online fashion with high inter- and intra-observer agreements. The scale is reproducible, easy to use, reliable, and requires no learning curve.

Supplementary Material

This article contains supplementary material located online at www.aestheticsurgeryjournal.com.

Disclosures

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

Funding

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

REFERENCES

- Ellenbogen R, Karlin JV. Visual criteria for success in restoring the youthful neck. *Plast Reconstr Surg*. 1980;66(6):826-837.
- Connell BF. Contouring the neck in rhytidectomy by lipectomy and a muscle sling. *Plast Reconstr Surg*. 1978;61(3):376-383.
- Dibernardo BE. The aging neck: a diagnostic approach to surgical and nonsurgical options. *J Cosmet Laser Ther*. 2013;15(2):56-64.
- Hollinshead WH. The suprahyoid and lingual regions. In: *Anatomy for surgeons: the head and neck*. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 1982:361-383.
- Mangat DS, Frankel JK. The history of rhytidectomy. *Facial Plast Surg*. 2017;33(3):247-249.
- Jacono AA, Parikh SS. The minimal access deep plane extended vertical facelift. *Aesthet Surg J*. 2011;31(8):874-890.
- Berry MG, Davies D. Platysma-SMAS plication facelift. *J Plast Reconstr Aesthet Surg*. 2010;63(5):793-800.
- Tonnard P, Verpaele A, Monstrey S, et al. Minimal access cranial suspension lift: a modified S-lift. *Plast Reconstr Surg*. 2002;109(6):2074-2086.
- Skoog I, Falk HK. The changing face of old age. *Gerontologist*. 2016;56:558-558.
- Fulton JE, Rahimi AD, Helton P, Dahlberg K. Neck rejuvenation by combining Jessner/TCA peel, dermasanding, and CO₂ laser resurfacing. *Dermatol Surg*. 1999;25(10):745-750.
- Coleman WP 3rd, Futrell JM. The glycolic acid trichloroacetic acid peel. *J Dermatol Surg Oncol*. 1994;20(1):76-80.
- Dedo DD. "How I do it"—plastic surgery. Practical suggestions on facial plastic surgery. A preoperative classification of the neck for cervicofacial rhytidectomy. *Laryngoscope*. 1980;90(11 Pt 1):1894-1896.
- Knize DM. Limited incision submental lipectomy and platysmaplasty. *Plast Reconstr Surg*. 1998;101(2):473-481.
- Guy WM, Rihani J, Brissett AE, Fedok F, McCollough EG. Establishing objectivity in the McCollough facial rejuvenation system. *J Otolaryng Head Neck Surg*. 2016;2(004).
- Sattler G, Carruthers A, Carruthers J, et al. Validated assessment scale for neck volume. *Dermatol Surg*. 2012;38(2 Spec No.):343-350.
- Lemperle G, Holmes RE, Cohen SR, Lemperle SM. A classification of facial wrinkles. *Plast Reconstr Surg*. 2001;108(6):1735-1750; discussion 1751.
- van Dongen JA, Eyck BM, van der Lei B, Stevens HP. The rainbow scale: a simple, validated online method to score the outcome of aesthetic treatments. *Aesthet Surg J*. 2016;36(3):NP128-NP130.
- Eyck BM, van Dongen JA, Athanassopoulos T, Bastos Martins J, Stevens HP. The rainbow scale for assessing breast ptosis: validation of three different views. *Aesthet Surg J*. 2016;36(9):1010-1016.
- Klassen AF, Cano SJ, Scott AM, Pusic AL. Measuring outcomes that matter to face-lift patients: development and validation of FACE-Q appearance appraisal scales and adverse effects checklist for the lower face and neck. *Plast Reconstr Surg*. 2014;133(1):21-30.
- World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA*. 2013;310(20):2191-2194.
- Fleiss JL, Cohen J. The equivalence of weighted kappa and the intraclass correlation coefficient as measures of reliability. *Educ Psychol Meas*. 1973;33(3):613-619.
- Viera AJ, Garrett JM. Understanding interobserver agreement: the kappa statistic. *Fam Med*. 2005;37(5):360-363.
- Evans JR, Mathur A. The value of online surveys. *Internet Res*. 2005;15(2):195-219.
- Scholtes VA, Terwee CB, Poolman RW. What makes a measurement instrument valid and reliable? *Injury*. 2011;42(3):236-240.
- Keszei AP, Novak M, Streiner DL. Introduction to health measurement scales. *J Psychosom Res*. 2010;68(4):319-323.
- Carruthers A, Carruthers J. A validated facial grading scale: the future of facial ageing measurement tools? *J Cosmet Laser Ther*. 2010;12(5):235-241.
- Van Hemelen G, Van Genechten M, Renier L, Desmedt M, Verbruggen E, Nadjmi N. Three-dimensional virtual planning in orthognathic surgery enhances the accuracy of soft tissue prediction. *J Craniomaxillofac Surg*. 2015;43(6):918-925.
- Haddad RV, Ghafari JG. Chin-throat anatomy: normal relations and changes following orthognathic surgery and growth modification. *Angle Orthod*. 2017;87(5):696-702.
- Leong PL. Aging changes in the male face. *Facial Plast Surg Clin North Am*. 2008;16(3):277-279, v.