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The ideal male jaw angle – An Internet survey

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ABSTRACT

Background: The ideal male jaw angle has not been established. With the advent of additive manufacturing, precise customized shaping is a reality. This study aimed to define the ideal masculine mandibular angle as an aid for 3-dimensional (3D) design.
Methods: An Internet survey was conducted using black/white photographs of celebrities and non-celebrities. Preferences regarding gonial angle (profile and frontal views), intergonial width and vertical jaw angle position (face frontal view), and angle curvature and definition in oblique views were obtained using simplified, unbalanced Likert scales. Constructs were defined for planning 3D implant designs.
Results: The preferred jaw angle had these characteristics: 130° in face profile view, intergonial width similar to facial width, vertical position in frontal view at the oral commissure or at least not below the lower lip, jawline slope in the face frontal view nearly parallel to (with a maximum 15° downward deviation from) a line extending from the lateral canthus to the alare, ascending ramus slope 65°–75° to the Frankfort horizontal, and curvature in the oblique view visible from earlobe to chin and not pointy.
Conclusions: Photogrammetric analysis of panel preferences lead to constructs with values useful for the design of 3D printed jaw angles.
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1. Introduction

Batides and Zide wrote in 2014, "Esthetically, a fuller, augmented gonial angle portrays a look of masculinity, and a 'stronger' jaw is often desired." To underscore their statement, the authors referred to articles published at least 12 years earlier (Whitaker, 1989; Aiache, 1992). Indeed, no reports regarding the aesthetic appraisal of the male jaw angle have been published since 1994 (Ousterhout, 1991; Whitaker, 1991; Taylor and Teenier, 1994). The sparse articles published more recently regarding jaw angle augmentation have emphasised implant shape (Terino, 1994; Ramirez, 2000) and surgical complications (Semergidis et al., 1996; Thomas and Yaremchuk, 2009).

The emergence of 3-dimensional (3D) printing based on computed tomography (CT) and cone-beam CT segmentation allows the design of patient-specific implants, but specifications regarding the ideal jaw shape are clearly lacking. As noted by Adrien Aiache in 1992, no cephalometric standards are available, so surgeons must depend on the "ideal concept." The ideal concept according to Aiache (1992) is a jaw angle "well below the ear …, long and low in profile and less than 105° when measuring the slope of the lower border and the ascending process. In front view, the bigonial distance should be as wide as the bitemporal distance … usually less than or equal to 10% less than the bizygomatic distance …" These guidelines are rather vague for use with contemporary computer-aided designs, which have a precision of 0.1 mm.

The aim of this study was to determine specifications that can assist in designing ideal jaw angle patient-specific implants for men. We performed a contemporary appraisal of the aesthetically ideal male jaw angle and created constructs for use when guiding the planning of implants.

2. Methods

An Internet survey was established at www.netq.nl to reach a database of 770 consenting people. The database was based on the author's professional and personal list of contacts. Study participants were recruited by email with a request to assist in completing a survey regarding facial contours and definition. The survey was

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available online during the entire month of May 2015. After informed consent was obtained, the survey began with questions about the participants' age, sex, and occupation (facial surgeon or non-facial surgeon). These personal data remained anonymous.

In addition to the participants' personal data, the survey contained nine questions, each based on a set of facial pictures. All pictures used in the survey were non-copyrighted images obtained from the Internet. They were modified (mainly cropped and converted to black and white), and the eyes were covered when necessary to reduce the likelihood of confounding relationships between other facial features than aimed for. Many of the pictures were images of celebrities, as they were the most readily available pictures that demonstrated features appropriate for this study. The pictures of celebrities were interspersed with pictures of non-celebrities. The celebrities were Ben Affleck, Brad Pitt, Colin O'Donoghue, Colton Haynes, Dean Winchester, Hrithik Roshan, Jensen Ackles, Liam Hemsworth, Matthew Bomer, Michael Fassbinder, Richard Armitage, Tahmoh Penikett, and Tom Hiddleston. Some individuals were included in more than one question (using the same or another image) to distract the study participants.

Two initial questions were asked to sensitize the participants to subsequent questions focussing on the mandible (questions 1 and 2). Further questions were posed to retrieve information about the ideal intergonial width (question 3), ideal inclination of the jawline in the face frontal view (question 4) and face profile view (question 6), ideal vertical position of the gonial angle in the face frontal view (question 5), relationship between the inclination of the forehead and inclination of the posterior border of the mandible (question 7), opinion regarding the angle and posterior border of the jaw when the forehead is taken into account (question 8), and shape of the mandible angle in the face oblique view (question 91a–f). The responses for questions 3 to 8 were rated on a 3-item Likert scale,

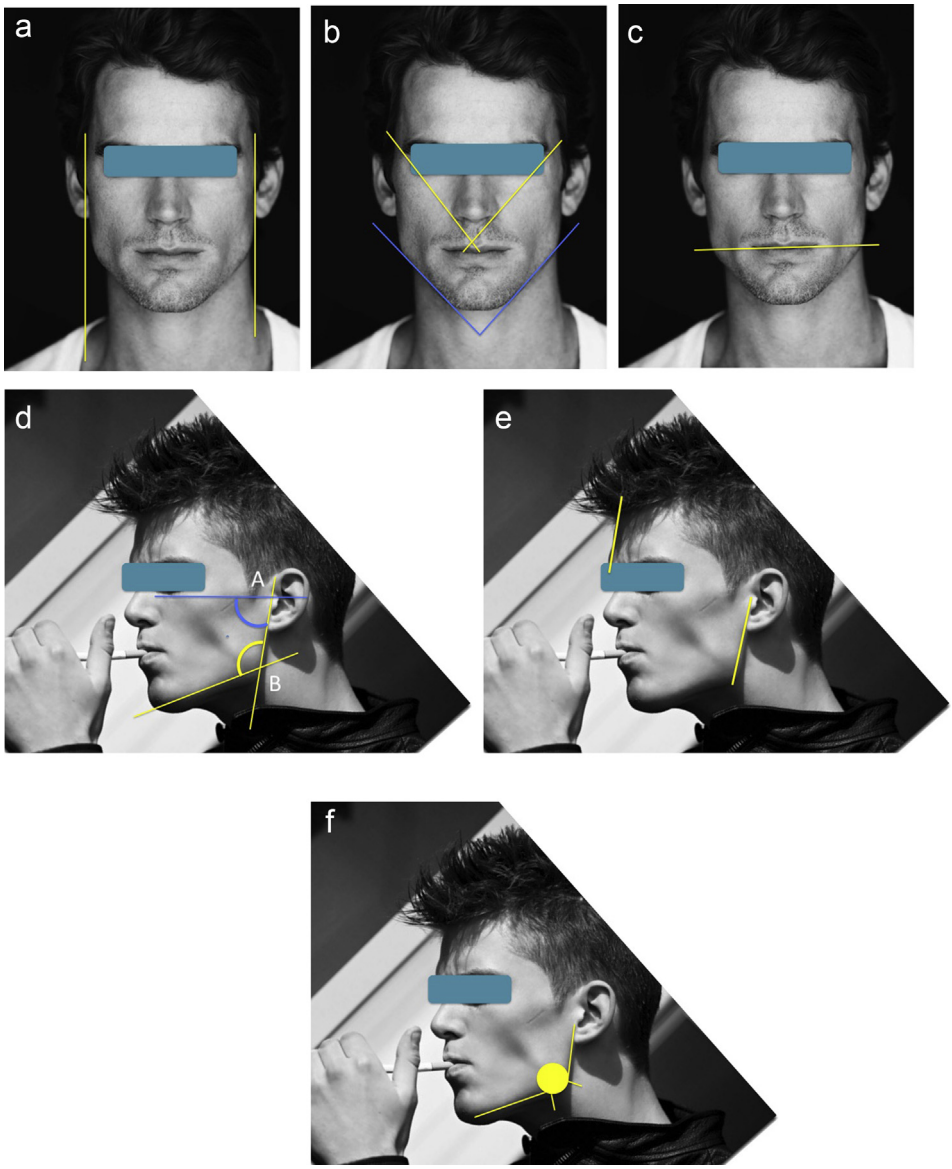

Fig. 1. Constructs used in the study. a. Construct showing the intergonial width vs interzygomatic width. b. Construct showing the angle between the lower mandibular border and a line connecting the lateral canthus with the ipsilateral alare. c. Construct showing the level of bigonial plane in relation to the lips. d. Construct A shows the angle between the posterior border of the mandible and the Frankfort horizontal plane. Construct B shows the gonial angle, between the posterior and lower borders of the mandible. e. Relationship between the slope of the posterior border of the mandible and the slope of the forehead. f. Pointiness of the jaw angle, whether judged using the radius of a circle segment or the distance between the posterior end of the lower straight mandibular border contour and the lower end of the straight posterior border contour.

Fig. 2. Question 1 – "Not considering the chin or cheek shadows, which is most appealing for a male model?" This question was used to sensitize the study participants. Shown are the percentage of respondents who considered the pictures to be the most appealing.

with items tailored toward the specific question (e.g., for question 3, the items were "too wide," "good," or "too narrow").

Constructs were created to be used during 3D print planning of patient-specific implants. The constructs are displayed in Fig. 1a–f. Ideal aesthetics for the male jaw were defined by transposing the survey results onto the constructs. Based on qualitative appreciation assessments and quantitative measurements with Image J, a public domain, Java-based image processing program developed at the United States National Institutes of Health, we developed a set of guidelines for the ideal male jaw.

3. Results

A total of 770 persons were inclined to participate in the study. Of these, 124 (16%) started the survey, 115 continued it (82 males, 33 females), and 81 (11%; 82 males, 33 females) completed the survey.

Fig. 3. Question 2 – "A hypoplastic angle produces a concealed jaw (1 & 2). A jaw angle can be concealed by fat, sagging skin, and/or a beard, and this is not aesthetically pleasing. Do you agree?" This was also used as a sensitizing question. Overall, 74% of those who answered the question indicated that a concealed angle was not aesthetically pleasing.

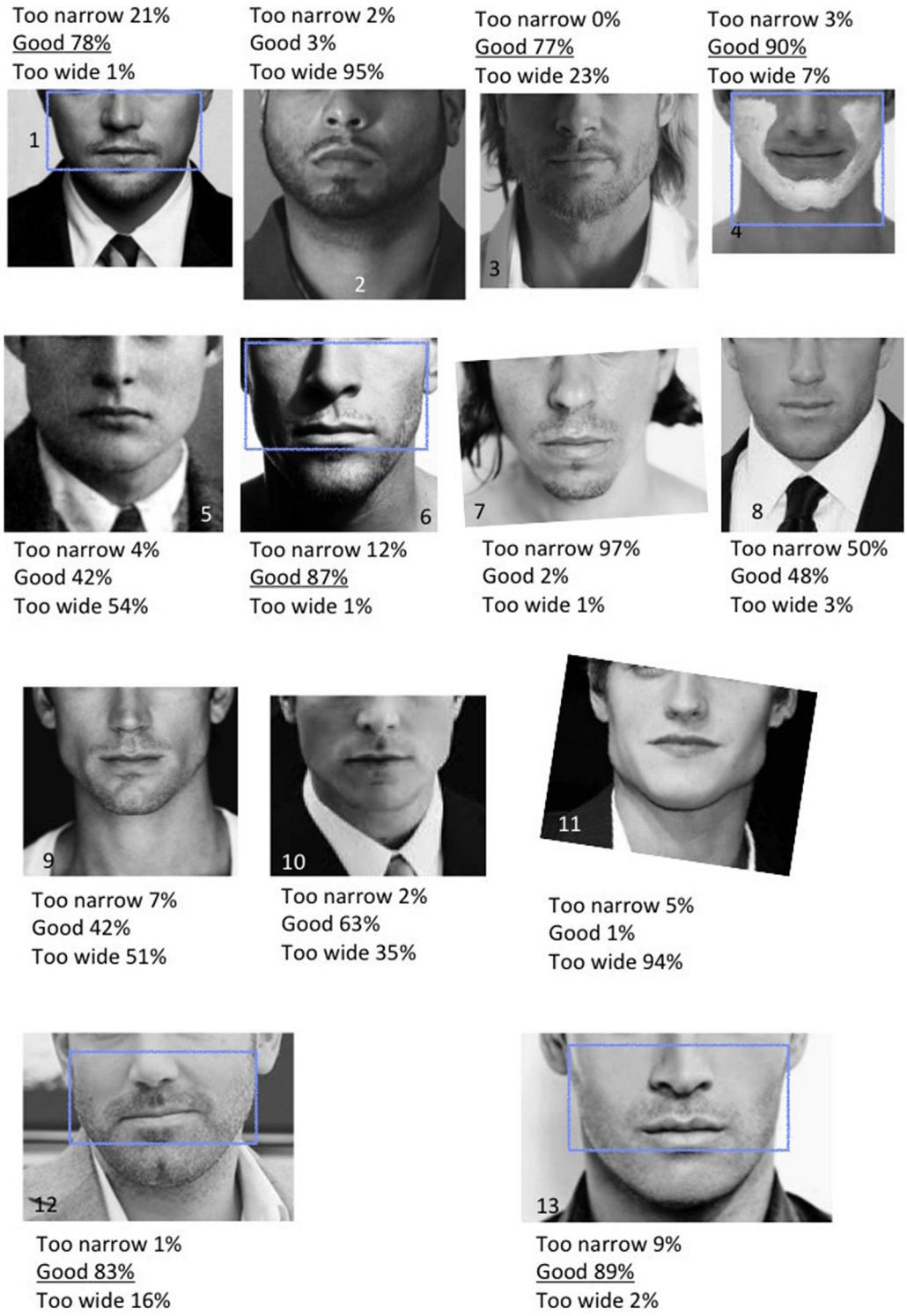

Fig. 4. Answers to question 3 regarding the aesthetics of bigonial width compared to bizygomatic width in the face frontal view: "Compared to the total facial width at the malar level, how do you score the lower jaw width at the jaw angle level?"

For those who completed the survey, the mean completion time was 11 min 15 s and the mean number of sessions was 1.3. Nearly half of the respondents who completed the survey were facial surgeons (48%). Overall, 29% of respondents who completed the survey were younger than 40 years of age and 61% were between 40 and 60 years old.

Question 1, regarding which image was most appealing, was answered by 114 study participants: 52% chose picture #1 and 36% chose #5 (Fig. 2). A total of 108 responses were obtained for question 2 regarding a concealed jaw angle, 74% of which indicated that a concealed angle was not aesthetically pleasing (Fig. 3). Responses to question 3, comparing the intergonial width to the

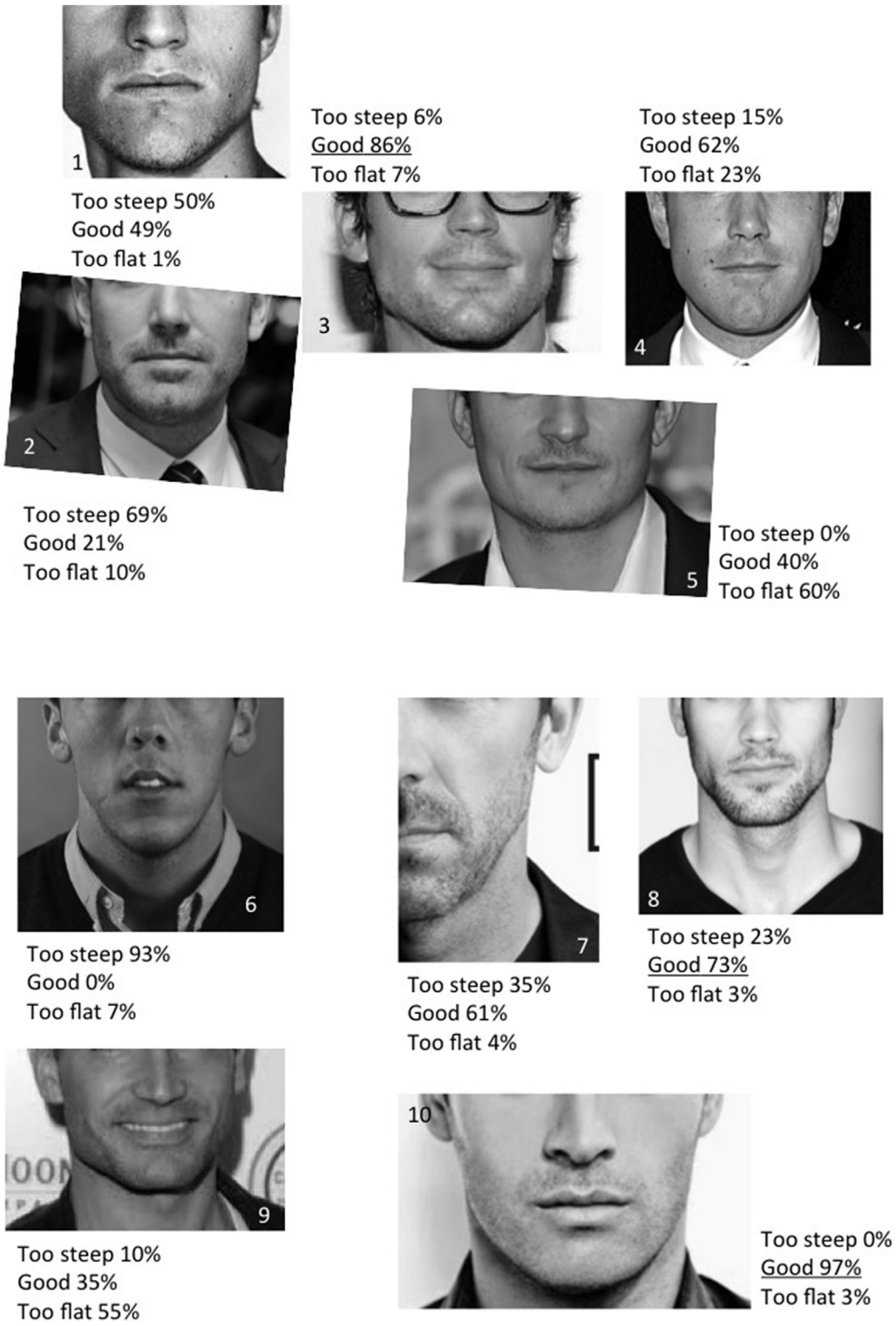

Fig. 5. Answers to question 4 regarding the inclination of the lower border in the face frontal view: "Is the inclination of the lower border in the face front view too steep, neutral, or too flat?"

interzygomatic width, were obtained in 103 respondents, as shown in Fig. 4. Question 4, about the ideal inclination of the jawline in the face frontal view, was answered by 94 people, the results of which are displayed in Fig. 5. The vertical position of the jaw angle in the face frontal view (question 5) was assessed by 93 study participants; these results are shown in Fig. 6. The inclination of the lower jaw border in the face profile view (question 6) was answered by 89 participants (Fig. 7). Question 7, comparing the slope of the posterior border and the slope of the forehead, was answered by 84 people; their responses are shown in Fig. 7a and b.

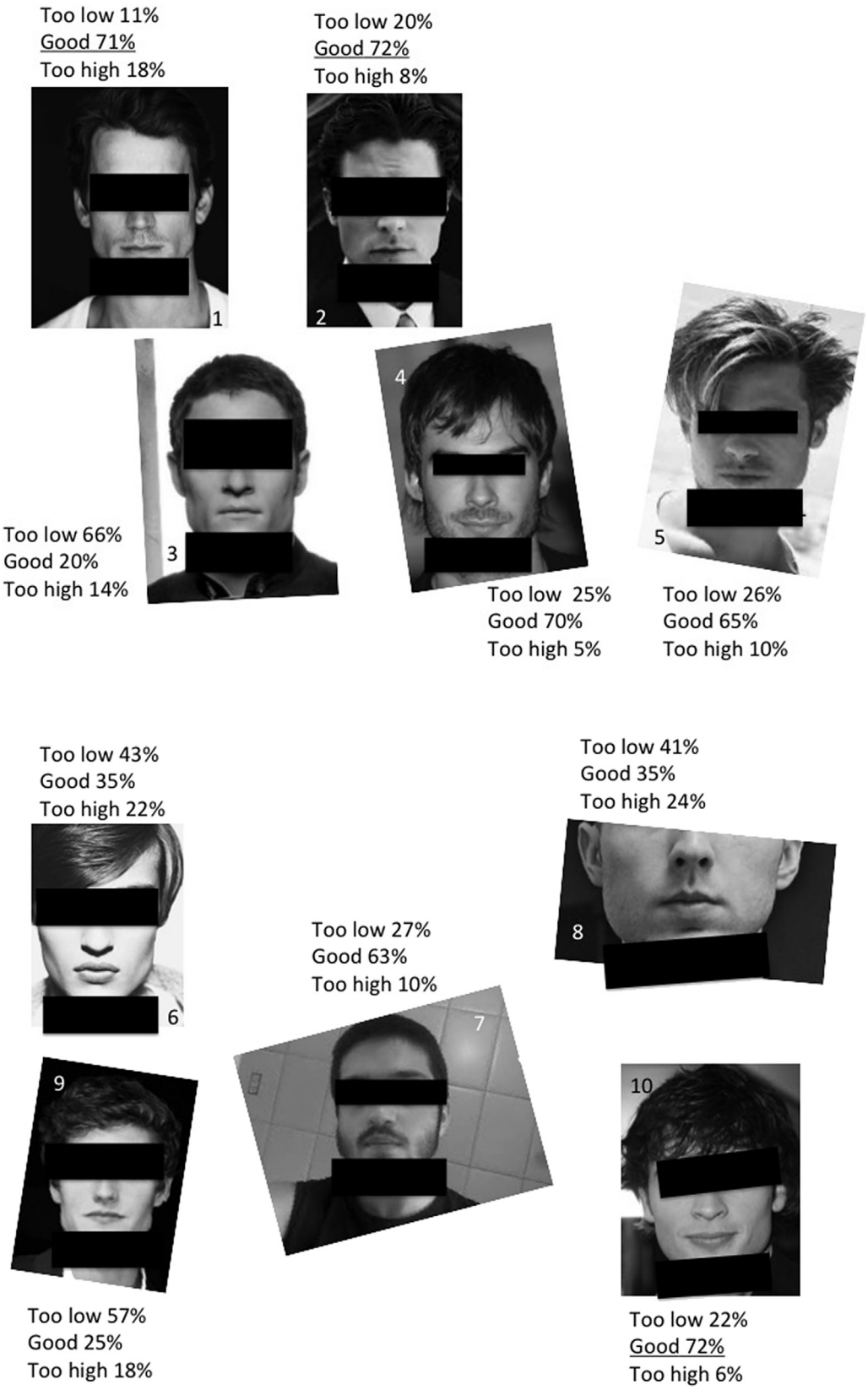

Fig. 6. Answers to question 5 regarding the ideal vertical position of the jaw angle in the face frontal view: "Is the vertical position of the jaw angle too high, good, or too low?"

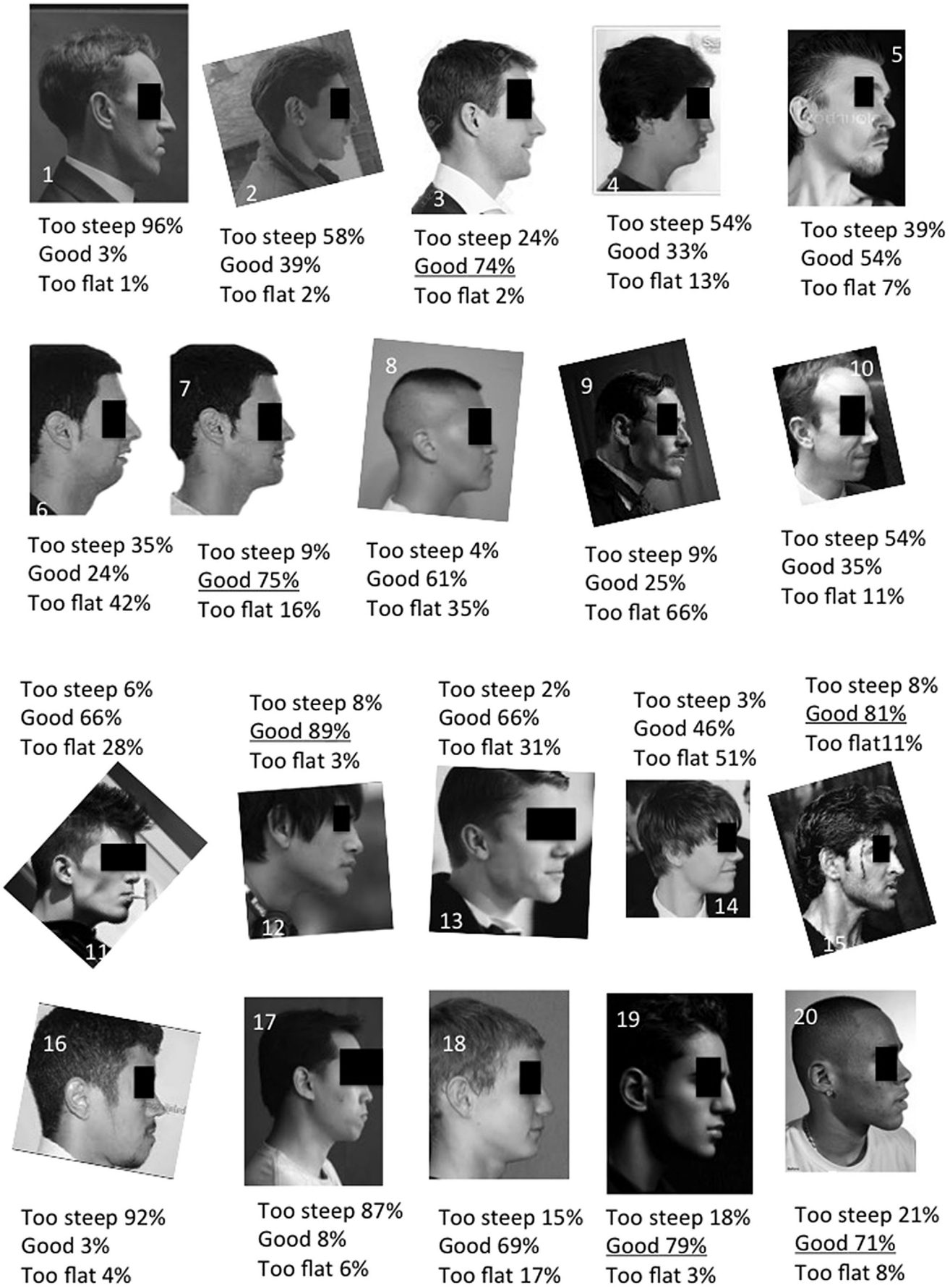

Fig. 7. Answers to question 6 regarding the inclination of the lower border in the face profile view: "Is the inclination of the lower border in the face profile view too flat, good, or too steep?"

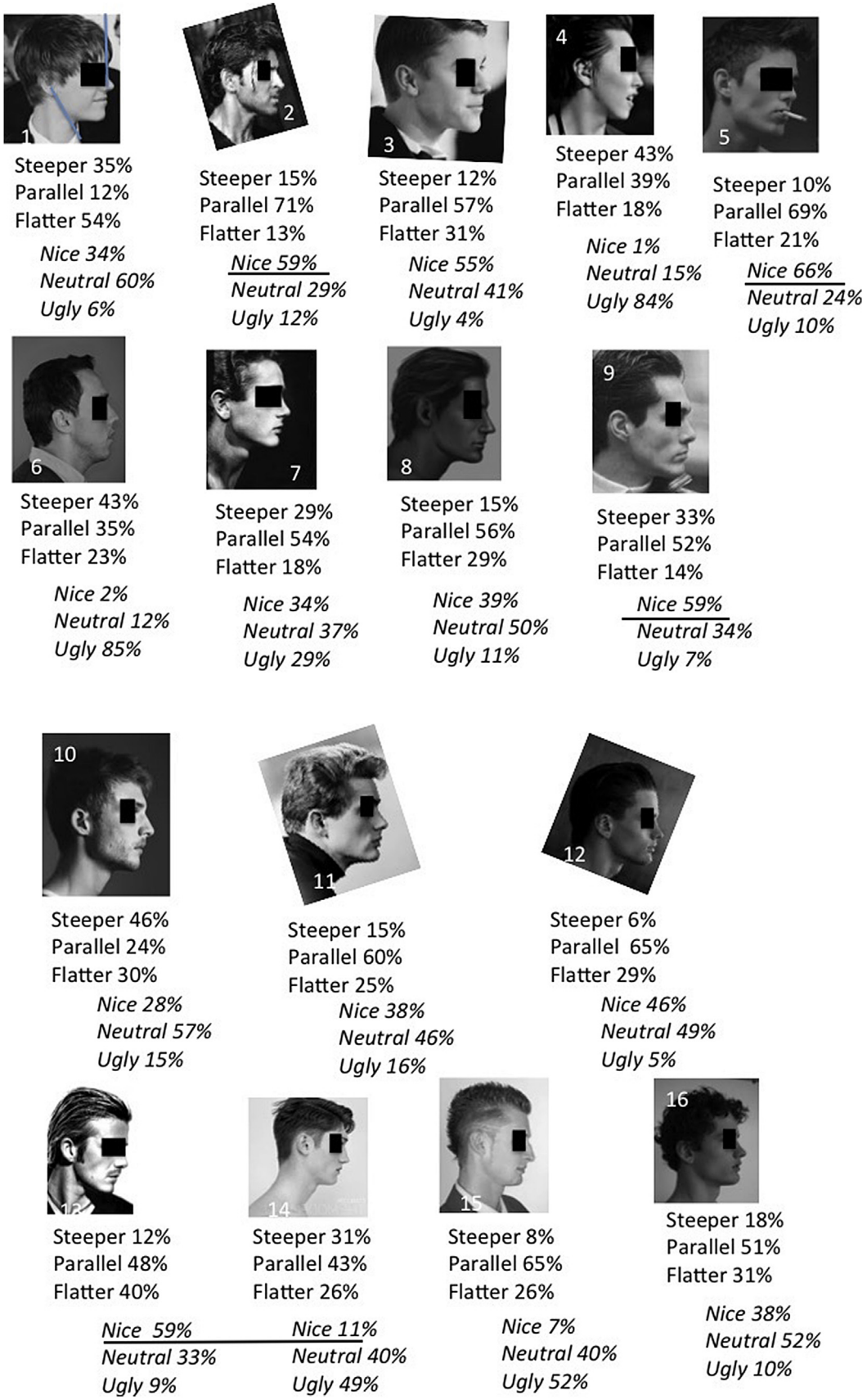

Fig. 8. Answers to questions 7 and 8 regarding comparisons between the posterior border of the mandible and forehead in the face profile view and opinions regarding the jaw angle and posterior border when recognizing the forehead as a possible confounding factor: 7.) "Compared to the forehead slope, is the posterior border of the lower jaw steeper, parallel, or flatter?"; 8.) "Now that you appreciate the relationship with the forehead, can you again indicate your opinion regarding the angle and posterior border of the jaw? Is it nice, neutral, or ugly when taking the forehead into account?"

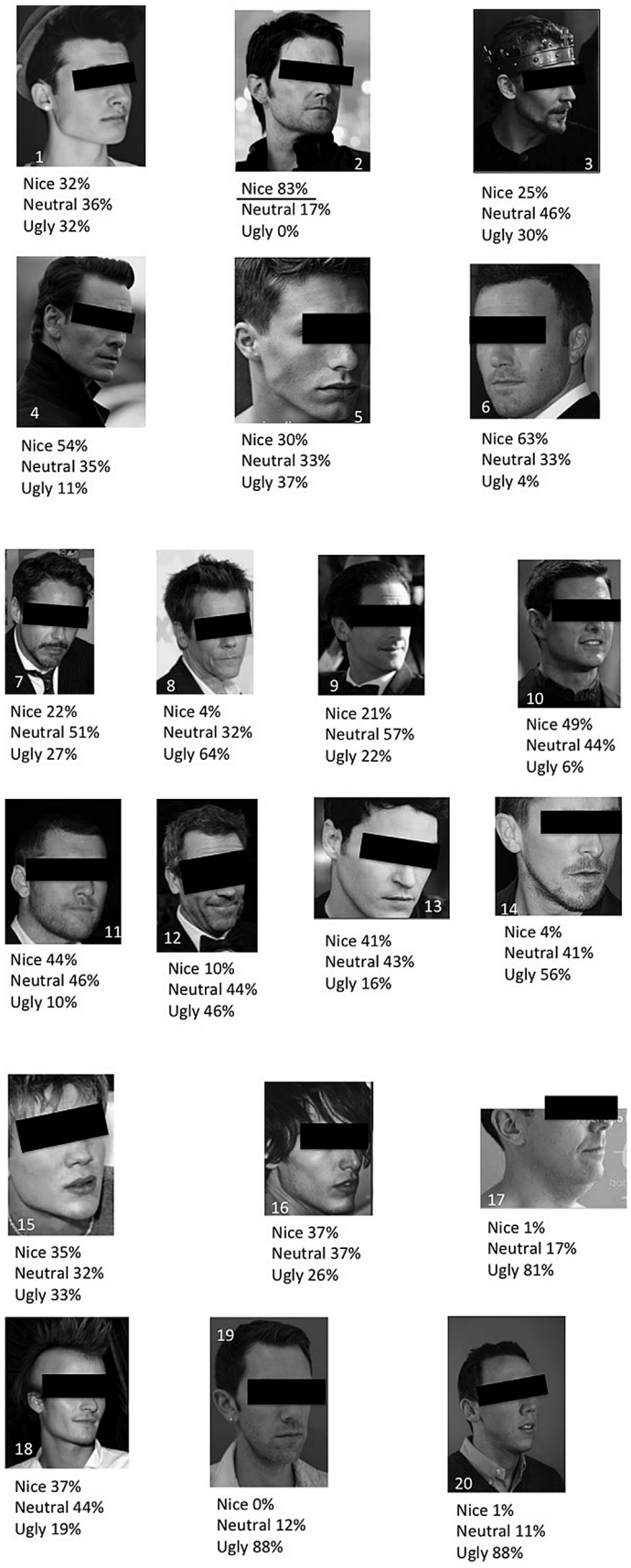

Fig. 9. Answers to question 9 regarding the shape of the jaw angle in the face oblique view: "What do think of the shape of these angles – nice, neutral, or ugly?"

This assessment prepared the participants for question 8, in which the forehead was noted as being a confounder in the judgement of the inclination of the posterior border of the jaw; question 8 was answered by 82 respondents (Fig. 8). Question 9 regarding the shape of the angle judged in the face oblique view was answered by 81 participants, the responses of which are shown in Fig. 9.

Fig. 10 shows the set of guidelines we developed for the ideal aesthetics of a male jaw angle, based on transposing our panel survey results to our series of constructs.

4. Discussion

Designing the ideal jaw is not an easy task. Determining aesthetic appreciation is preferably performed using panel studies and Likert or visual analogue scales (Mees et al., 2013). In this study, we used an Internet survey approach to create a panel of individuals who assessed the aesthetic characteristics of the ideal jaw angle. However, it was not possible to use an assessment scale that separated the jaw angle from the overall facial features of the models, nor was it possible to use a completely balanced scoring system. Hence, we decided to use photographs of many individuals and to ask the panel to score each variable on a symmetrical, yet unbalanced 3-item Likert scale. The scale was simplified from 7 to 3 grades, so the survey could be finished within a reasonable time (15 min). This was important because the attention and focus of respondents were found to be relatively low during a test run of the survey. The low response rate is to be linked with the difficulty of the task, which proved to be mentally exhausting according to the feedback we received. This may also be the reason for the decreasing response during the answering procedure. We used copyright-free pictures that were readily available on the Internet because clinical studio pictures tend to obliterate facial definitions, and although standardized (Ettorre et al., 2006), they do not necessarily provide appealing images with strong characteristics. Most of the pictures used in the study were images of celebrities. Although we tried to reduce the possibility that they would be recognized, this was likely not always successful and it may have been a source of bias. Gender, age, and occupation of the participants were other potential confounding factors that could not be excluded.

Additive manufacturing from a 3D-computer aided design can create patient-specific jaw implants of titanium, tantalum, and ceramic (Büttner and Mommaerts, 2015). The shape of the implants can be liberally chosen to provide augmentation in a lateral, dorsal, and/or caudal direction. This freedom in design poses an artistic challenge. When facial symmetry constitutes the main indication, then mirroring the healthy or most pleasing side solves the issue of shape. When the wish is to enhance gonial definition bilaterally, then the surgeon is faced with the issue of the definition of an ideal customized shape. A jaw angle is by definition the angle within the jaw. Izard (1927) cited normal angles of 120°–130° at 12 years of age and 120°–150° in the elderly. Using Indian dry skulls, Upadhyay et al. (2012) measured an average jaw angle of 129° (standard deviation 7.6°) in a group of 17–35 years old, with no significant differences observed between males and females. This finding was confirmed by Raustia and Salonen (1997), Ceylan et al. (1998), and Al-Faleh (2008). The literature norm seems to be far from Aiache's (1992) ideal of less than 105°, with a long and low mandible in the facial profile view. The panel in our study also chose a less angulated ideal shape in the face profile view, which more closely approached the normal values. Lateral projection, however, coincides with Aiache's (1992) statement. In the face frontal view, the ideal jaw angle should approach the face width, from zygion to zygion.

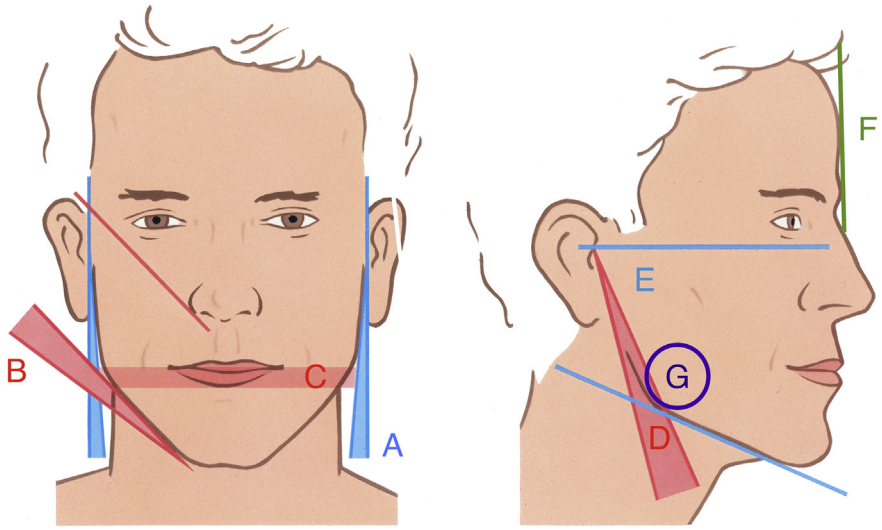

Fig. 10. Guidelines generated using the constructs, qualitative survey results, and quantitative measurements. A. The ideal intergonial width in men is very close to the interzygomatic width, whereas the normal width is up to 10% less than the interzygomatic distance. B. The inclination of the jawline in the face frontal view is parallel to (with a maximum 15° downward deviation from) a line extending from the lateral canthus to the ipsilateral alare. C. The jaw angle should ideally be at the height of the oral commissure in the frontal view or at least no lower than the lower lip border. D. The gonial angle (formed by the jawline and posterior mandibular border) preferably measures 130°. E. The angle between the posterior mandibular border and Frankfort horizontal preferably measures 65–75°. F. The relationship between the slope of the forehead and slope of the posterior border of the mandible is more indicative of the forehead than the jawline. G. The jaw angle should demarcate the face well from the neck, without being too pointy.

The vertical position of the jaw angles and the slope of the mandibular borders in the face frontal view often pose a dilemma. The slope of the mandibular plane is determined by both the vertical position of the jaw angle and the height of the chin. Chin height is determined by the growth pattern and whether the face is long or short; it can also be surgically altered. Height reduction of the bony chin does not change the vertical position of the gonial angle. In the current study, we found that the ideal vertical position of the jaw angle was at the level of the oral commissure or lower lip. The ability to change chin height by reduction chin osteotomy and alter gonial position by shaping a 3D printed implant permits correction of a long face either without, or as an adjunct to, a bimaxillary procedure.

The radius of the gonial curvature is still an enigma. While many patients seeking enhancement prefer pointiness, the survey indicated that a wide curvature is preferred. Qualitative judgement indicated that the mandibular border should cast a shadow extending from the earlobe to the chin. A clear distinction between the face and neck, with no fat or sagging tissue obliterating the retromandibular fovea or interrupting the mandibular border, projects a youthful appearance.

One can ask why a strong jaw angle is preferred for the modern man. It may be an indicator of youthfulness and, hence, strength in general. When teeth are present, muscular activity associated with mastication maintains a constant angle magnitude. With the loss of teeth, bone at the muscular attachments resorbs, leading to an increase in jaw angulation. Casey and Emrich (1988), using orthopantomograms, found that the mean size of the gonial angle was 126.3° for edentulous patients and 123.9° for those with teeth. Similarly, Ohm and Silness (1999) found that the mean gonial angle was 131° degrees for edentulous patients and 127° degrees for partially dentate adults, and the angles were similar for men and women. Although all existing studies indicate that the normal gonial angle does not differ between sexes, males wishing mandibular accentuation generally prefer more extreme features.

The study results will form the basis for a prospective study in our male patients receiving jaw angle implants. Especially the already predicted skewness of the individually desired deviation to the now proposed ideals will be intriguing.

5. Conclusion

Using an Internet-based survey to conduct a panel study, we found clear indications of the preferred characteristics of a male jaw angle. These included a 130° gonial angle, intergonial width similar to the facial width, vertical position of the angle at the level of the lips, slope of the jawline in the face frontal view nearly parallel to (with a maximum 15° downward deviation from) a line extending from the lateral canthus to the ipsilateral alare, slope of the posterior mandibular border 65°–75° to the Frankfort horizontal, and a wide diameter curvature of the gonial angle in the oblique view. This information will be helpful in generating 3D print designs for men desiring mandibular aesthetic surgery.

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