

# The role of computer imaging in facial plastic surgery consultation: a clinical study

H.D. VUYK, J. STROOMER & B. VINAYAK

Department of Otolaryngology/Facial Plastic Surgery, Gooi Noord Hospital, Blaricum, The Netherlands Accepted for

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VUYK H.D., STROOMER J. & VINAYAK B.

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## The role of computer imaging in facial plastic surgery consultation: a clinical study

The influence of using computerized visual communication on preoperative communication between the surgeon and the patient was analysed. This was a retrospective study based on a questionnaire completed by 50 patients who had undergone various facial plastic surgical procedures. Prediction tracings and postoperative slides were compared by the surgeon. The role of computer imaging in communication between doctor and patient, as well as the patient-doctor relationship and trust in the judgement of the doctor was considered to be positive by most of the patients. The vast majority of patients thought computer imaging should be a routine part of preoperative evaluation. Both the surgeon and the patients agreed that the representative value of prediction tracing was about 80%. In view of the possible positive influences on communication and relationship in the preoperative phase, computer imaging may help to provide a clear and realistic preoperative informed consent.

Keywords *computer imaging facial plastic surgery*

Communication with the patient is the basis of preoperative analysis and planning for plastic and reconstructive surgery. In order to obtain a satisfactory result, it is important that the wishes, motives and expectations of the patients are clear and realistic.<sup>1</sup> The patient should be informed with regard to the possible outcome and risks of the suggested treatment.<sup>2</sup> Over recent decades there have been a number of methods used for preoperative communication, analysis and planning of facial plastic surgery. Standardized preoperative photography is a prerequisite for adequate documentation and may also be used for preoperative analysis. Drawings on photographs, look-through techniques, or scissors and glue, (photographic surgery) may be used to visualize the patient's wishes and demonstrate the surgical possibilities.<sup>3</sup> However, a degree of uncertainty remains as patients may have difficulty conceptualizing their (final) postoperative appearance.<sup>4</sup>

Other alternatives for enhancing communication and planning include slide projection with artistic manipulation, radiographs,<sup>5</sup> facial casts<sup>6</sup> and soft tissue cephalometric measurements. Most of these methods need a number of steps and sometimes complicated machinery.

Correspondence : H.D. Vuyk, Department of Otolaryngology/Facial Plastic Surgery, Gooi Noord Hospital, Rijksweg 1, 1261 AN Blaricum, The Netherlands.

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A recent development in the field of visual communication, is computer image processing. This makes it possible with the help of a videocamera and computer to present the face of the patient on a monitor. Subsequently this picture may be manipulated according to the patient's wishes, obviously within realistic surgical possibilities. The reproductions may be filed in the computer, or printed and given to the patient.

The first clinical studies on the use of computer simulation for facial plastic surgery are said to be promising. Computer imaging is regarded positively by the patient and the surgeon as a helpful means of communication.<sup>4,7</sup> This improvement in communication also enhances trust in the surgeon.<sup>4</sup>

Compared to photographs, the patient may be more able to visualize the possible results.<sup>4,8</sup> However, a less optimal, unethical use might have medico-legal implications.<sup>2</sup>

To date only three studies, two on orthognathic surgery<sup>7,9</sup> and one on rhinoplasty<sup>10</sup> have compared the computer simulated result with the actual result. Sixteen out of 18 patients found the predictions realistic compared to the surgical outcome.<sup>7</sup> Another study involving 56 patients demonstrated 70% realistic prediction tracing scored by the surgeon.<sup>9</sup> In a study on computer simulated rhinoplasty results<sup>10</sup> all 100 patients found the prediction reasonably realistic. Using measurements to compare predictions and postoperative

photographs, the surgeon found 88% of the predictions (nearly) identical (defined as  $\pm 1$  mm difference) to the postoperative result. The few studies in the literature suggest that the ethical and realistic use of computer imaging may have a positive impact on the patient's final judgement of the functional and aesthetic result. Moreover, computer simulation may play a realistic role in planning surgery.

In Holland this type of computer simulation is rarely used in facial plastic surgery. Evaluation of our 5-year experience with computer imaging includes an extensive questionnaire to document the opinion of Dutch patients on computer simulation, together with the possible influence on communication and on the patient doctor relationship. Moreover, the computer simulated prediction tracings and postoperative results were compared both by the surgeon and by the patient.

## Methods and patients

### COMPUTER IMAGING TECHNIQUE

For computer visual communication we used an IBM compatible personal computer. An analogous flat screen RGB monitor, a CCD videocamera with RGB- and digital output and a summagraphics 961 noteboard. True vision advanced raster graphics adaptor (targa) 16-board digitized the videocamera image enabling the computer to capture the picture.

While using the above mentioned hardware, AT & T true vision image processing software was used for manipulation of the video image.

The images were taken with a videocamera at 2 m from the patient. The patient sat with their head in the Frankfurt position.<sup>3</sup> Preferably the background is black for optimal contrast. After focusing and adjusting exposure the picture is digitized by the computer. With a split screen function, two identical views are created beside each other on the television screen. One view is used for reference, the other view can be digitally manipulated using two techniques from the graphic programme: contour change and contour-fill.

### PATIENTS

The 50 patients who have been involved in this study (10 men and 40 women), varied in age from 16 to 65 years (mean 31 years) with the exception of one patient of 8 years. Table 1 gives a list of the various procedures, together with the view used for computer imaging.

In nine patients a combination of rhinoplasty together with chin augmentation was performed, while both procedures were separately scored. Therefore in 50 patients a total of 59 procedures could be studied making use of 50 views. History taking and assessment of the whole face and the specific deformity preceded the photographic documentation. Subsequently these patients participated in a computer graphic

**Table 1.** Surgical procedure and views of 50 patients

Procedure	Number of procedures	View	
		Frontal	Lateral
Otoplasty	2	2	0
Rhinoplasty	47	1	46
Chin augmentation (with rhinoplasty)	9	(0)*	(9)*
Chin augmentation (without rhinoplasty)	1	0	1
Total	59	3	47

\* The nine patients who underwent chin augmentation combined with rhinoplasty are assessing their computer simulation added up with the rhinoplasties

session. All patients were given a print of the view on the television screen.

The basis of this study is a questionnaire (compiled together with a clinical psychologist and a statistician) which was sent to the patients after a mean period of 17 months after the operation (4-36 months) (Appendix 1). Together with this questionnaire the patient received a print of the same computer graphics which was given to them before the operation. The sequence of the questions is random to minimize patient bias. The questions could be categorized into six headings:

1. Reaction to image (questions 3, 11).
2. Communication (questions 8, 9, 12a, 12b, 14).
3. Doctor-patient relationship (questions 4, 5).
4. Confidence level (questions 6, 15).
5. Role of computer simulation (questions 2, 16).
6. Educational value (questions 7, 10, 12c, 13, 17).

The representative value was derived by comparing the postoperative slides (taken at a mean of 8 months after the operation, range 1-30 months) with the previous computer simulation of the result by the surgeon.

## Results

### RESPONSES TO QUESTIONNAIRE

#### *Reaction to the image*

(Questions 3 and 11). Patients were surprised by both their initial image (78%) and their computer-altered image on the screen (76%).

#### *Communication*

(Questions 8, 9, 12a, 13, 14). The vast majority of the patients (84%) found that computer simulation improved the ease with which they could express their wishes and expectations. A number of patients (38%) had their wishes and expectations changed during or after the computer graphic session. A small number of patients (6%) said they had completely eliminated

some wishes with regard to plastic surgery. Thirty-one patients (62%) said that changes had been proposed which they themselves had not considered in the first place. In 26 of 31 patients these changes were included in the operation and in retrospect none of these patients was disappointed.

#### Patient-doctor relationship

(Questions 4, 5). Not one patient felt that the patient-doctor relationship was jeopardized because of the computer imaging. On the contrary, 41 patients (82%) thought that it had enhanced the relationship.

#### Confidence level

(Questions 6, 15). The vast majority of patients (66%) found their decision to have an operation was easier after viewing the computer graphics. A relatively large number of patients (42%) said they had more confidence in the judgement of the surgeon after computer simulation.

#### The role of computer graphics

(Questions 2, 16). Only 16% of the patients were familiar with the concept of computer imaging. The vast majority (84%) felt that computer imaging should be a routine part of pre-operative counselling for facial plastic surgery.

#### Educational value

(Questions 7, 10, 12c, 13, 17). Of 59 computer predictions, 49 (83%) appeared educational. To that end, the surgical results were bound to be judged as identical to (27; 46%) or even more aesthetic (22; 37%) than the computer-simulated results from the patient's perspective. Ten out of 59 computer predictions (17%) appeared not to be educational; the surgical result was judged as less aesthetic than the computer-simulated results. Table 2 focuses on the anatomical location of the discrepancy between the result and the simulation viewed

**Table 2.** Localization of discordance result/simulation according to the patient

Localization	No. patients
Nose dorsum high/low	4
Tip	
Over-projection	2
Columella-labial angle	
Acute	1
Supratip	
Low	1
Undecided	2
Total	10

from the patient's perspective. Figure 1a-c, is a representative example of the discrepancies detected in Table 2. None of the differences was of such magnitude that these patients had to be reoperated upon.

Gender, age (older or younger than 30 years) and time of operation (more or less than 18 months ago) did not yield significant differences in answers. The group of 10 patients who felt the final result was less favourable than the computer simulation, did not answer the rest of the questionnaire (except Questions 7, 10, 12c, 13) significantly different from all the other patients.

#### PREDICTIVE VALUE OF COMPUTER GRAPHICS

Of 59 computer predictions, 49 (83%) appeared representative. To that end, the surgical result was bound to be judged as identical to (27; 46%) or even more aesthetic than (22; 37%) the computer-simulated result from the surgeon's perspective. Ten out of 49 computer predictions (17%) appeared not to be representative; the surgical result was judged as less aesthetic than the computer-simulated result. Table 3 focuses on the anatomical location of the discrepancy between the result and the simulation, viewed from the surgeon's perspective. Figure 2a-c is a representative example of the discrepancies depicted in Table 3.

The representative value (judgement of surgeon) and the educational value (patient's judgement) were both around 80%. Table 4 correlates the surgeon's judgement to the patient's judgement. The (chance-corrected) inter-rated agreement of the judgement of surgeon and patient is fair:  $\kappa$  0.28 + 0.36." From Table 4 one may conclude that in 47 of the 59 images the judgement of the surgeon and the patient agree. In 10 computer prediction tracings, the operation result was less favourable than the computer-simulated result for both the patient and the surgeon. However, only in four was the same surgical procedure involved. Even in these four there was discrepancy between surgeon and patient regarding the anatomical location responsible for the less favourable surgical result. Figure 3a-c give an example of one of these discrepancies.

## Discussion

In facial plastic and reconstructive surgery the patient and doctor should agree on achievable goals before the surgical procedure. Computer simulation is a promising adjunct both in communication and in planning of the procedure.

The importance of computer imaging and the preoperative communication between doctor and patient is made clear in this study in a number of ways. The vast majority (> 80%) of patients found computer imaging helpful in clarifying their wishes and expectations. Using computer imaging, 38% of the patient's wishes and expectations were modified to a



**Figure 1.** (a) Preoperative profile view. (b) Computer-simulated result. (c) Two-year postoperative result. Surgical result (c) was assessed as less aesthetic than the computer-simulated result (b) by the patient. Although (b) and (c) were rated as identical by the surgeon, the patient expressed concern that the nasal dorsum was not changed to the degree predicted when using the computer imaging system. The chin augmentation was, however, satisfactory for both patient and surgeon

**Table 3.** Localization discordance result/simulation according to the surgeon

Localization	No. patients
Nasion	
Anterior/posterior	2
Nose dorsum	
High	2
Supratip	
High	2
Low	1
Alae	
Retraction	1
Chin	
Undercorrection	2
Total	10

realistic level. Computer imaging makes it possible to visualize additional changes which may lead to a better aesthetic and realistic result. The modest, though important, number of patients (6%) who abandoned certain surgical changes they had previously considered is worth mentioning.

In this study of the value of computer imaging only those patients were studied who agreed to an operation after computer simulation. It is of importance to note that in our practice about 5% of patients seen in consultation including computer imaging sessions, declined surgery or were rejected for surgery by the surgeon. To some patients the possible surgical changes depicted did not agree with their idea of what the surgical outcome should be. Furthermore, their unrealistic wishes might be depicted on the screen while at the same time reasons could be put forward as to why surgery would be either too risky, impossible or not of benefit. Subsequently other treatment modalities such as psychological help may be discussed.

Obviously it may be suggested that computer imaging by itself may "scare off" some patients. But this is not supported by clinical research and, if so, it would constitute a very small group of patients. All in all computer imaging helps the patient develop realistic expectations. The more realistic the expectations, the greater the likelihood that the patient will be satisfied.<sup>12</sup>

Possibly because only a small number of patients were acquainted with computer imaging a relatively large number of patients were surprised with this form of visual communication. This contrasts with a previously studied group of North American patients who were more familiar with and less surprised by computer imaging.<sup>4</sup> However, two-thirds of our patients still found it less complicated to agree to facial plastic surgery after computer imaging. Moreover, none of our patients thought that computer imaging was harmful to the patient doctor relationship; it only appears to enhance this relationship, which agrees with the American findings.<sup>4</sup>

Another important aspect is the number of patients who said they had more confidence in the judgement of the surgeon who used computer imaging. As in the American studies,<sup>4</sup> the vast majority of Dutch patients studied felt that computer imaging should be a routine part of the preoperative counselling in facial plastic surgery.

The educational value in this study appeared to be approximately 80%. One-fifth of the patients said that the result did not fully agree with the computer imaging. Although some differences may be < 1 mm, even these were pointed out by the patient. In none of the patients was the difference between computer simulation and the surgical result large enough to reoperate. Furthermore, even these patients were positive about the role of computer imaging. It must be noted that a patient's perception of the final surgical result, as well as their comparison with the computer-predicted outcome, may be influenced by a number of non-surgical criteria. First of all their evaluation may be directly related to their degree of satisfaction. It is well established that patient's satisfaction is determined by many factors apart from the surgical result.<sup>13</sup> Furthermore a retrospective questionnaire filled in up to 2.5 years after surgery has limitations, as an increasing number of other factors influencing the patient's judgements might come into play. The representative value appeared to approximate to 80% and, therefore, computer imaging might also be a helpful modality in planning of the surgical procedure. The inter-observer agreement of patient's and surgeon's judgement appeared to be fair. However, no absolute agreement was found. This might be explained by the fact that patients from their final judgement on different criteria than the surgeon. For example their established social world, the postoperative recovery and possibly the patient-physician relationship.<sup>13</sup>

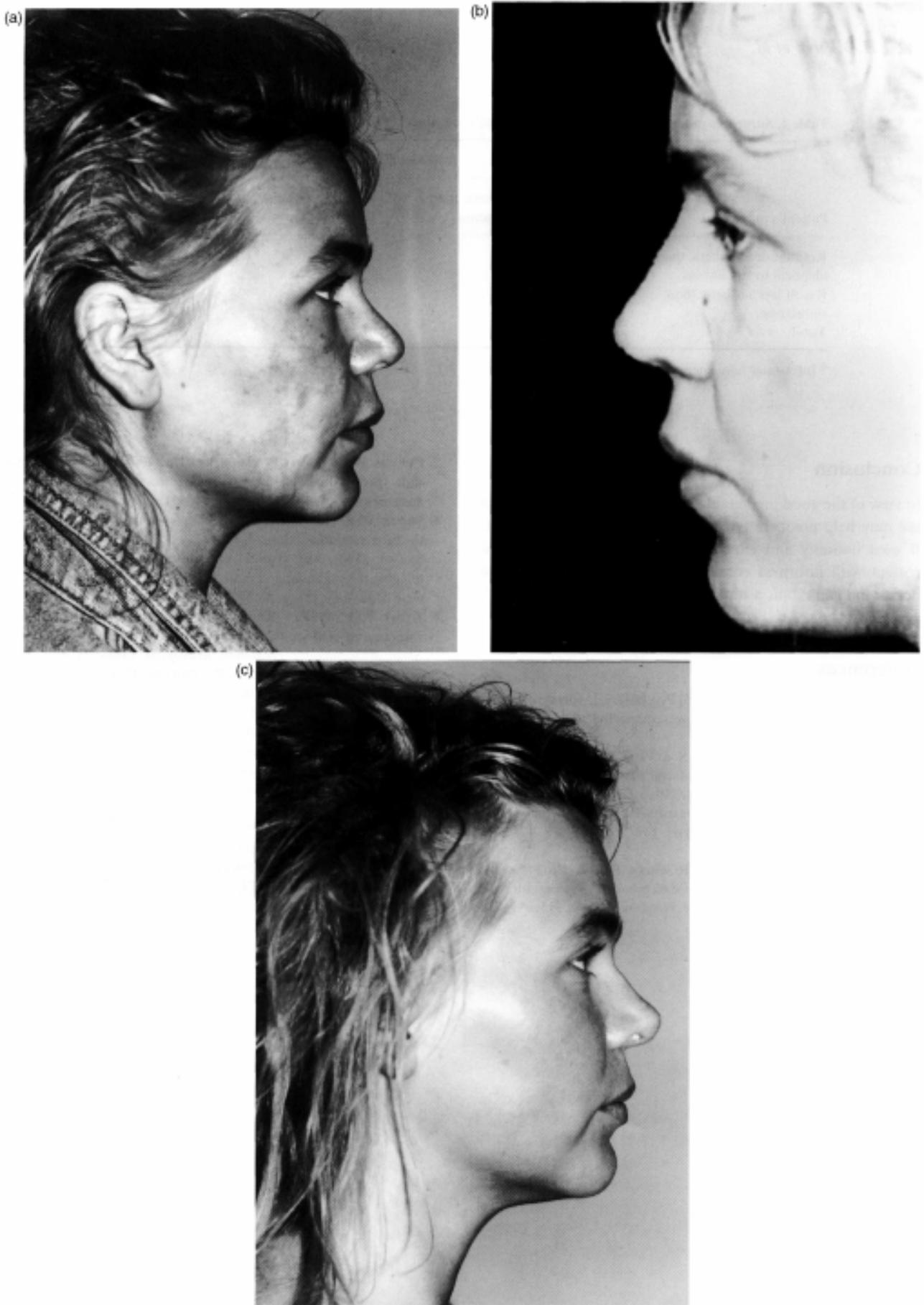
There were only small differences between otoplasty, rhinoplasty and chin augmentation, being a representative value of 100%, 83%, 80%, respectively. There are only a few studies published on the value of computer imaging in the prediction of the final results.<sup>7,10</sup> Comparison of these studies is difficult because of large differences in surgical procedures and research methods.

This study shows that rhinoplasty with computer imaging has a relatively high rate of predictability. The patients were told clearly that computer imaging was merely an illustration of the possible expected result and not a guarantee. The use of computer imaging must be honest and ethical. Under these circumstances there is no objection to giving the patient a printout of the simulated result. Although no disclaimers or warnings were displayed on screen (e.g. 'treatment simulation only') we have never been sued.

The reconstructed image on the computer is limited to two dimensions. A frontal view is harder to depict because of vague or reduced contrast compared to the manipulation of profile views. Although most patients have profile problems, they see themselves mostly in the A-P view.



**Figure 2.** (a) Preoperative profile view of revision rhinoplasty previously performed at another institution. (b) Computer-simulated result. (c) Nine months postoperative surgical result. The surgical result (c) was assessed as less aesthetic than the computer-simulated result (b) by the surgeon. A discrepancy was noted in the nasal frontal angle which was augmented but not to the degree predicted when using the computer imaging system.



**Figure 3.** (a) Preoperative profile view of revision rhinoplasty after nasal trauma and two previous rhinoplasties, performed at another institution. (b) Computer-simulated results. (c) Thirteen months postoperative result. The surgical result (c) was considered to be less aesthetic than the computer prediction (b), by both the patient and the surgeon. The patient specifically mentioned the naso-labial angle which was still sharper postoperatively than the computer prediction, while the surgeon noted that the nasal dorsum was not augmented to the degree predicted.

**Table 4.** Surgeon's judgement (columns) versus patient's judgement (rows)\*

Patient's judgement	Surgeon's judgement		Total
	Result more aesthetic than/ identical to simulation	Result less aesthetic than simulation	
Result more aesthetic than/ identical to simulation	43	6	49
Result less aesthetic than simulation	6	4	10
Total	49	10	59

\* Inter-rater agreement ( $\kappa$ ) 0.28 + 0.36: 'fair'.

## Conclusion

In view of the good predictable value of computer imaging its use may help preoperative communication with the patient. If used honestly and ethically, it can help the doctor and patient with informed consent and positively reinforce the doctor-patient relationship.

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**APPENDIX 1.** Questionnaire evaluating the role of computer imaging in facial plastic surgery

Name..... Date of birth.....

	Yes (%)	No (%)	Undecided (%)	Not Applicable (%)
1. Surgical procedure was performed ... months ago	16	82	2	
2. Did you visit the outward ORL/Facial Plastic Surgery of the Gooi-Noord Hospital specifically for its computer-imaging facilities?	78	20	2	
3. Were you surprised at your initial image on the computer monitor?	78	20	2	
4. Do you think computer-imaging is jeopardising the personal aspect of the patient physician relationship?	0	98	2	
5. Do you feel the personal aspect is enhanced by computer-imaging?	82	6	12	
6. Did you find it less complicated to commit to facial plastic surgery after your imaging session?	66	24	10	
7. Do you feel that the computer-imaging prediction is fulfilled by the surgical result?	82	16	2	
8. Do you think the imager was beneficial in communicating your wishes and expectations?	84	10	6	
9. Did you abandon certain surgical changes, you had previously considered, after your imaging session?	6	82	12	
10. Do you think the surgical result is more aesthetic than the generated image of prediction?	34	52	14	
11. Were you surprised at your computer-manipulated image on the computer monitor?	76	20	4	
12a. Were any potential surgical changes proposed, previously not considered on your part?	62	34	4	
12b. Did you adopt these changes?	52	10	4	34
12c. Are you satisfied with them?	48	0	4	48
13. Do you think the surgical result is less aesthetic than the generated image of prediction?	20	70	10	
14. Did computer imaging result in a modification of your wishes and expectations?	38	46	16	
15. Did you have more confidence in the surgeon's judgement after your imaging session than before it?	42	44	14	
16. Should computerized imaging be a routine part of pre-operative facial plastic surgical evaluation in your opinion?	94	0	6	
17. Question 13 answered "yes": which part of the surgical result or which procedure (in case of an additional procedure) do not feel is less aesthetic?	responded: 16% not responded: 84%			

(Partially based on Thomas *et al.*<sup>4</sup>).

